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CONTENTS

SELECTED GLOSSARY

ATTG	Air Technical Training Group
BDA	Battle Damage Assessment
C2	Command and Control
COMINT	Communications Intelligence
DJRP	Digital Joint Reconnaissance Pod
DLGS	Data-Link Ground Stations
EO	Electro-Optical
EOLOROP	Electro-Optical Long Range Oblique Photography)
ELINT	Electronic Intelligence
EWI	Electronic Warfare Instructor
FRG	Federal Republic of Germany
FMV	Full Motion Video
GASOs	Group Air Staff Orders
GCS	Ground Control Station
GDR	German Democratic **Republic**
HUMINT	Human Intelligence
IA	Intelligence Analysts
IED	Improvised Explosive Device
IRLS	Infra-Red Line Scanner
LDP	Laser Designation Pod
LOROP	Long-Range Oblique Photography
LOS	Line of sight
LRE	Launch and Recovery Element
MCE	Mission Control Element
MIC	Mission Intelligence Co-ordinator
MLU	Mid-Life Upgrade
MWIR	Medium Wave Infra-Red
PI	Photographic Interpreter
QWI	Qualified Weapons Instructor
RAPTOR	Reconnaissance Pod on Tornado
RIC	Reconnaissance Intelligence Cell
SIGINT	Signals Intelligence
SLIRS	Sideways Looking Infra-Red
SPRITE	Signal Processing In The Element
SSM	Surface-to-Surface Missile
TBM	Theatre Ballistic Missile
TGRF	Tornado Ground Attack, Reconnaissance Force
TICM	Thermal Imaging Common Module
TIRRS	Tornado Infra-Red Reconnaissance System
TTP	Tactics, Techniques, and Procedures

(ANOTHER) MESSAGE FROIM THE EDITOR

Among the many well-established routines that have been disrupted by the beastly COVID-19 pandemic has been the business of this Society. In the good old, pre-bug, days, the content of this Journal would have been published in Journal 75, reflecting the proceedings of a 'Cold War Intelligence' seminar hosted by the RAF Museum in April 2020. That event had to be postponed – twice – and it was eventually decided to wait no longer for a live show and to publish the papers that would have been presented in a largely dedicated edition. This is it. 'Largely' because, in the absence of the customary Q&A sessions, it would have been a relatively slim volume, so I have added one random paper to plump it up.

At the time of writing, we anticipate running a seminar on the Buccaneer – with people present! – in October 2021 at Hendon, where we last met as long ago as April 2019. **Ed**

AIRBORNE ELECTRONIC RECONNAISSANCE – FROM COLD WAR TO GULF WAR

by Gp Capt Barry Smith[1]

Airborne electronic reconnaissance involves the use of aircraft, specifically modified to carry equipment capable of examining radio and radar emissions, with a view to assessing the combat capability and intentions[2] of hostile nations or non-State actors.

It is important to recognise that the antecedents of this capability go back to WW II when the RAF was at the forefront of the technology war that was fought to deny access to, and/or to deceive, the various capabilities that the Germans developed to support their Air C2 networks in the defence of their homeland. A specialist Group organisation – 100 Group – was formed to develop the various techniques, tactics and procedures that were employed. The following quote from Air Cdre Addison, AOC No 100 Gp, in 1944 said this of some of the activities of his unique command:

> 'No less valuable, however, have been the results obtained by those units whose job it is to confound our enemies or to probe into his technical secrets. Although not so spectacular, these latter roles are of vital importance and frequently produce results whose value either cannot be fully appreciated at the time, or, if known, cannot always be divulged for reasons of security.'

His words still resonate today with the continuing activities of the RAF in this arena. And, of course, we must not forget that 51 Squadron took a key part in, what I would describe as, the first active SIGINT operation of WW II war – OP BITING – when airborne troops were deployed, together with the UK's foremost radar expert, to capture key technology from the *Wurzburg* radar station at Bruneval on 27 February 1942.

By 1948, however, there was little doubt that the main post-war threat to international stability was going to be the Soviet Union. In the West, we simply did not know what was going on in the interior of this secretive state and this fear of the unknown drove the need for electronic reconnaissance missions. U-2 overflights were not possible until the late 1950s and the era of spy satellites would not begin until the mid-1960s. As a result, the West lacked information on what the Soviet

Union might be doing in its heartlands and this secrecy fostered a considerable degree of distrust.

The first signs of a revival in the RAF's electronic reconnaissance capability came in September 1948 when a Lancaster and a Lincoln were deployed to RAF Habbaniyah in Iraq. These aircraft, which were fitted with a crude radio receiving suite, flew sorties along the border of the Soviet Union listening to signals traffic.

A particular cause of concern in the 1950s was the suspicion that the Soviets might be building a large long-range bomber fleet that could threaten the population centres of Europe and North America. It was feared that the USSR might acquire a devastating first strike capability which it could then exploit, in Europe at least, with its massive concentration of conventional ground forces. Of equal concern were fears that Western air forces might be unable to penetrate Soviet defences to reach their targets and, even if they did, that they might not be able to identify their aiming points. For all of these reasons, electronic surveillance missions, operating close to (or within) Soviet airspace, were tasked with monitoring Soviet weapon system developments in terms of their air defence assets as well as their offensive capabilities.

Both the USAF and the RAF established 'special duty flights' which were tasked with penetrating Soviet airspace. The initial aims were to confirm or disprove the development of a fleet of long-range bombers and to bring back photographic material, to assist in radar navigation and bomb-aiming for Allied aircraft. Such activities were bound to provoke the Soviet air defence system and this provided significant opportunities for electronic monitoring from both air- and ground-based platforms. The successful long-range penetrations of Russian airspace by RAF-operated RB-45s in 1952, and again in 1954, provided ample evidence of the Soviet Union's inability to detect and destroy intruders at that time, although this may have been partly due to route selection based on the known deployment and characteristics of the Soviet air defences.

By now it had been accepted that airborne electronic reconnaissance would be a growth area if any sort of meaningful watch was going to be kept on the Soviet Union. This led to a requirement for a dedicated electronic reconnaissance force built around a cadre of experienced operators whose function would be to monitor Soviet radio and radar

A Washington, WZ966, of No 192 Sqn.

transmissions. It was No 192 Sqn (which would be re-numbered in 1958 to become the present No 51 Sqn) that was to perform a key element of this role. In fact it was one of No 192 Sqn's Washingtons that achieved the *coup* of establishing that the Soviets had acquired an airborne radar intercept capability when it recorded the SCAN ODD radar aboard a MiG-15.

No 192 Sqn was not the only unit conducting these clandestine missions (termed 'Air Ministry Operations' at the time), of course, but the whole capability area was reorganised and given increased prominence in 1958 when HQ 90 (Signals) Gp at RAF Medmenham became HQ Signals Command. The Washingtons and Lincolns of the 1950s were replaced by Canberras and Comets and No 51 Sqn established itself as the critical unit in the delivery of the vital airborne electronic reconnaissance capability in the increasingly bitter Cold War confrontations that were to take place.

In the 1960s the bedrock of the capability provided by No 51 Sqn was delivered by the Comet R2 which operated alongside specially modified Canberras as well as other transport aircraft used for test and development purposes such as the Hastings and Andover. The first Comet R2 was delivered in April 1957, followed by a second in July and the third and last in March 1958. Unlike the RAFs Comet C4 transports, these aircraft were not modified structurally and were thus constrained to flying with a reduced cabin pressure differential to minimise the risks associated with metal fatigue. The performance of the platform was excellent with a service ceiling of 38,000 feet and a

Sporting a number of radomes on its underside, No 51 Sqn's Comet R2, XK695, on finals at Luqa in 1974. (John Visanich)

maximum range with a full payload of 2,200 nm. Deployments worldwide, undertaking the cover operations of radio and radar calibration, allowed the squadron to 'hide in plain sight' and perform their critical collection activity against both the Soviet Union and Communist China. The data they collected was the foundation of the Electronic Warfare databases that provided the basis of the Electronic Counter Measure capabilities available to our own bombers and fighters.

So what was the squadron trying to discover? Essentially, as much as possible about the defensive radar systems ranged along the borders of the USSR and its Warsaw Pact allies, and around the high-value point targets that would be the prime candidates for destruction by NATO aircraft in the event of war. Were there any gaps in the coverage? What was the response time of the system? How was command and control exercised, and how effectively? If effective electronic counter measures were to be developed, it was also necessary to know the specific characteristics and capabilities of the types of enemy radar associated with each weapon systems.

A key element in the conduct of airborne electronic reconnaissance is that, if you are looking for something very specific, you need to know where and when the enemy might expose this capability. This is absolutely vital if you wish to record an event of short duration, such as the trial firing of a missile system. There are many ways in which this sort of information might be derived but, whatever the source, the aim

would be to have the airborne collection asset at the best location and altitude from which to monitor the activity at the time that it was expected to take place. Alternatively, the mere presence of the electronic reconnaissance aircraft in itself might be sufficient to trigger an event, as was the case when one of No 192 Sqn's Washingtons provoked a MiG-15 pilot into using his radar, permitting its transmissions to be recorded and analysed. Dual aircraft operations became increasingly prevalent, including overt stimulation of Soviet air defences by a Canberra of No 51 Sqn, permitting covert collection of the reaction by a Comet R2 operating, either below the opponent's radar horizon or at sufficient stand-off range to be undetected by his target systems.

The importance of the role, and the unparalleled success of the collection activities of 51 Squadron, led to the decision to refresh the capability by adding the Nimrod R1 to the RAF's acquisition of a new fleet of maritime reconnaissance aircraft.

The Nimrod R1 – A Brief Overview

The Nimrod R1 entered service with 51 Squadron in the early 1970s. Its airframe, engines and flight systems differed very little from the Nimrod maritime reconnaissance aircraft. The most obvious outward differences were the deletion of the Magnetic Anomaly Detection system, with its associated boom at the rear of the aircraft, and the wing mounted searchlight. Both were replaced with dielectric radomes. Some additional blade antennas were also distributed around the fuselage. Internally, the cockpit layout and controls, including those at the flight engineer's position, was much the same as the maritime version. However, from behind the flight deck all the way to the rear pressure bulkhead, and inside the bomb bay, the two aircraft were completely different. In addition, there were significant differences in the cabin conditioning and cooling systems to cater for the size of the mission crew, as well as the demands of the extensive mission system avionics suite.

Cabin Layout (see Figure 1)

The pilots' and flight engineer's positions were as per the MR1. A radar navigator sat at a port-facing workstation behind the flight deck immediately opposite the front door. His job was to operate the ASV-21 radar in order to provide navigational updates for the routine

When first delivered, the R1s (this is the second one, ZZ665) wore the same white-top colour scheme as maritime models but both fleets had switched to hemp by the end of the 1960s. (David Hedge)

navigator and a Cloud and Collision Warning Radar (CCWR) service for the pilots. The next aft position was manned by the routine navigator who had a conventional set of navigation equipment including a periscopic sextant, ADF, TACAN, VOR/ILS, LORAN and a Ferranti 1012 Inertial Navigation System (INS). Over the years, the platform's navigational avionics were updated to overcome both obsolescence issues and to meet the increasingly exacting requirements for accurate navigation and aircraft positional and heading data to support mission system direction finding and thus target system location.

One such update included the replacement of the original ASV 21 radar with an EKCO 290 which was later replaced by an even more capable Bendix radar. The controls and display for the Bendix were positioned at the routine navigator's position, thus removing the need for a dedicated radar navigator's position. His seat was subsequently used as a COMINT-logging station or as a passenger seat when so required. Later, the routine navigator position was updated with the installation of a Twin Carousel INS, automatically updated by range data from a Twin Hoffman TACAN system. Further improvements included the installation of an OMEGA hyperbolic navigation system and, later, GPS. Navigation accuracy was paramount. Flights were often flown along FIR boundaries in, nominally, international airspace

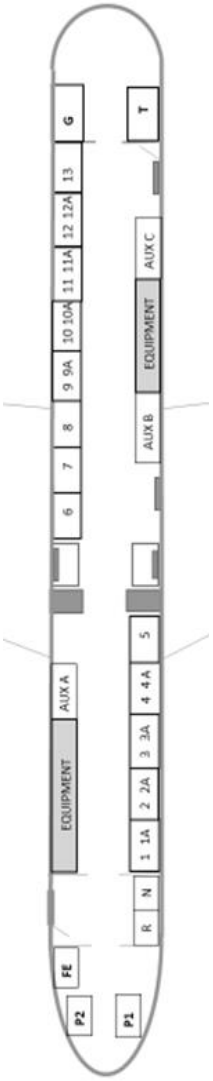


Fig 1. Early Nimrod R1 Internal Layout.

observing 'due regard' protocols in that no permission was sought from the regional Air Traffic Control authorities.[3] Maintaining track accuracy, measured in tenths of a mile, was vital to assure those who took the political risk involved in providing the authority for our covert collection activity (essentially the Foreign Secretary) would not be embarrassed by the squadron's activities.

Moving further aft was the mission sensor cabin – see Figure 1. This comprised 24 workstations, or 'racks' as they were known. The racks were numbered, fore-to-aft, from 1 to 13. Rack 1 was a dual position (1 and 1A) and over time came to be used for the interception of complex signals such as multi-channel communications and data links. Racks 2 and 3 were dual COMINT positions. Rack 4 and Racks 9 through 12 were all dual positions, each of which provided an ELINT and a COMINT operator sitting side by side. Racks 5 and 13 were dedicated ELINT positions. Seated at Rack 6 was the ELINT Supervisor; Rack 7 the SIGINT Mission Commander (not to be confused with the aircraft captain), and at Rack 8, the COMINT Supervisor. A further three Auxiliary positions were situated in the mission cabin comprising Aux A for a COMINT operator, Aux B for the HF communications operator and Aux C for another COMINT operator. Domestic facilities such as the galley and crew toilet were positioned at the furthest aft position in the cabin close by the rear pressure bulkhead.

The roles of the Mission Commander and the COMINT and ELINT Supervisors were many-fold including the maintenance of their SIGINT

system integrity, liaising with the flight deck crew to position the aircraft to meet their collection tasking, and gathering and distributing information around the mission crew via the computer and intercom systems. They also provided a measure of quality control to the SIGINT product prior to it being transmitted from the aircraft and also managed some of the secure, Line-of-Sight (LOS) and Beyond Line-of-Sight (BLOS) voice and data communications.

As mission requirements evolved over the years, the Aux B position ceased to be used for off-board voice communications and instead became the main operating position for the management of LOS and BLOS data links. Rack 5 gave up its manual ELINT role and became the main operator position for a newly installed automatic ELINT system. Other updates, some substantial and others piecemeal, resulted in some other minor changes to the mission cabin seating arrangement.

Mission Equipment

The sensor suite on the R1 was capable of intercepting all types of Radio Frequency (RF) emissions ranging from High Frequency (HF) through to millimetric wave frequencies (30+ GHz). A small level of HF signal monitoring and reporting was conducted on-board the aircraft. However, the Nimrod R1 airframe was too small for the installation of effective high gain HF directional antennas and HF Direction Finding (DF) arrays. For this reason, the in-depth exploitation of HF signals tended to be left to much better equipped ground stations. This left the main focus of on-board activity concentrated on those signals operating at Very High Frequency (VHF) and above. As a general rule, RF signals operating at these frequencies and above tend to follow a line-of-sight propagation path. Hence, the higher the sensor, the further it will 'see'. For that reason, aircraft conducting wide area electronic reconnaissance missions tend to be flown at as high an altitude as possible. Although the design of the Nimrod R1 was not optimised for high altitude flight, it did, nevertheless, offer a reasonable performance in that regard, typically spending most of its flight time at altitudes ranging from 29 to 35 thousand feet, determined by fuel weight.

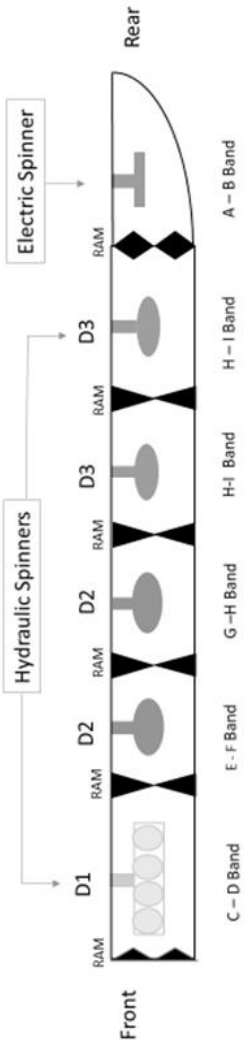
COMINT Suite

When the Nimrod R1 first entered service, it had only a rudimentary COMINT suite that lacked an on-board computing and direction finding

Nimrod R1 XW664 over Lincoln Cathedral.

capability. However, this was rectified in the late 1970s by the introduction of ASTRAL BOX, a V/UHF direction finding and computer system. It offered an excellent and reliable DF performance against V/UHF communications signals and the computer element allowed, not only COMINT, but also ELINT signals to be displayed on map and alpha-numeric CRT displays at the Supervisor positions. It was this system that introduced the boomerang-shaped V/UHF antennas on the wings and fuselage. It also introduced other antennas hidden within the aircraft's structure. However, as obsolescence started to take its toll, and spares became more and more difficult to obtain, it became clear that a replacement for ASTRAL BOX would soon be required. Therefore, in early 1989, a search began for a replacement V/UHF intercept and DF system, and a separate on-board computing system.

Eventually, both these requirements were merged under Project STARWINDOW. A US Company, E-Systems, was selected to do the work. Two years of design and fabrication resulted in the installation of the first Nimrod R1 system in 1994. STARWINDOW provided a significant upgrade to the aircraft's V/UHF intercept, DF and computing capability. It increased the frequency range and types of signals that could be prosecuted, as well as providing a mission system, Ethernet Local Area Network, a distributed processing capability and



Note. J and K frequency bands covered by electric spinning antenna in tail cone.

Fig 2. Nimrod R1 Bomb Bay Antenna Layout.

new displays for all the mission crew. Operators now had access to coloured map and textual displays for briefing material, and pre-formatted reports for COMINT data entry. Some existing elements of the ASTRAL BOX antenna array were retained for low VHF DF and these were augmented with new antenna arrays housed within the fin-top radome. Ground-based elements of the STARWINDOW system included the Ground Based Analysis System and the Rear Crew Training (RCT) facility. Incremental improvements continued to be made during the life of the system including the provision of better displays and more powerful micro-processors.

ELINT Suite

The early Nimrod R1 made extensive use of 1960s-era American ELINT equipment. Signals were received via a mix of electrically- and hydraulically-driven, high gain spinning antennas mounted in the bomb bay compartment with an additional electrically-driven spinning antenna in the tail cone – see Figure 2. The R1's bomb bay doors were made of a dielectric material to allow for low-loss passage of signals through to the antennas. The hydraulic drives and high gain spinners that were purpose-built for the Nimrod R1 by Ferranti in Edinburgh, were very highly regarded by the operators for their precise control and their ability to speed up and slow to a stop much faster than the electrically-driven spinners that had been

Aeroplane porn 1993-style. A naked (inside and out) Nimrod R1 with only her serial number, XW665, and the squadron's goose emblem on the fin to preserve her dignity. Having been stripped by British Airways at Heathrow, she would have been flown up to Kinloss in this bare-metal state for repaint and then back to Wyton to have all the kit re-installed. (Keith Heywood)

fitted to the squadron's Comets. That said, two electrical spinners were retained, one in the rear bomb bay fairing covering signals in particular bands of interest and the other in the tail cone to cover higher frequency signals. The three larger antennas, D1, D2 and D3, were attached to their hydraulic motors via gear boxes and were optimised to deliver high gain in the frequency bands within which each was required to operate. The single D1, designed to cover the 500 MHz-2 GHz band, was a very large, four-aperture, phase-matched device that offered unprecedented performance for its size. The two D2 spinning antennas were designed to acquire signals operating in the 2-8 Ghz range and the D3s were optimised for 8-12 GHz. Signals operating in the 12-18 GHz range were covered by an electrically-driven spinner mounted in the tail. A new back-to-back spinner mounted in this position, plus extra on-board equipment, eventually extended the frequency range up above 30GHz.

A major upgrade to the early ELINT system was the installation of an Integrated Data Measurement Systems, designed, built and installed by the Royal Air Force Signals Engineering Establishment (RAFSEE) at Henlow and the Electronic Warfare Avionics Unit (EWAU) at Wyton. This system significantly improved the accuracy and range of the signal parameters that could be measured. Prior to the introduction

of the ASTRAL BOX computer system, signal Lines-of-Bearing (LOB) were measured, logged on paper and then drawn on maps with coloured pens to derive emitter positions. This was an awkward, slow and difficult procedure that was error prone and not conducive to efficient operations. Eventually, LOB data could be input to a laptop computer and processed by RAFSEE-developed software to calculate emitter location. This process was automated as part of the ASTRAL BOX upgrade.

Receivers were also updated as technology advanced offering better bandwidth, sensitivity, dynamic range and RF stability. This allowed greater insight into the structure of complex radar signals. However, all of these piecemeal upgrades, while improving the capability of the aircraft, did not adequately facilitate the need for the faster signal acquisition, emitter location and identification required to support modern combat operations. For this reason, it was decided to initiate an ambitious upgrade to the ELINT suite under Project EXTRACT.

Project EXTRACT ran from 1995 through to 2000. It resulted in a significant upgrade to the ELINT system, including a new Tactical ELINT Function (TEF) sub-system dedicated to the very rapid and automatic acquisition, accurate geolocation and identification of radar signals. Although the operation of this system was concentrated at Rack 5, its product could be viewed and, if required, melded with signals acquired by the Manual ELINT Function (MEF) operators at Rack 4 and Racks 9 through 13.

The TEF was a very sensitive device based upon an in-service Automatic Electronic Emitter Location System. The TEF's phase-matched antenna sets were located in the aircraft's wing-tip pods offering a wide and unobstructed field of view. The MEF operator positions were also upgraded with wide bandwidth, coherent receivers and modern pulse analysers. New control facilities allowed operators greater flexibility in the selection of spinning antenna, receiver and pulse analyser assets. Also, large, high definition touch screen displays replaced the smaller screens provided earlier by STARWINDOW. An upgrade to the ELINT signal recording capability replaced the tape-based recording system with wide bandwidth digital recorders at each Manual ELINT position. The EXTRACT upgrade, coupled with an earlier embodiment of modern SATCOM, secure radios and modern data links, ensured that the Nimrod R1 would play a vital role during

A late internal fit.

Allied operations in the Balkans and the Middle East from the early1990s onwards.

Support

Much of the success accorded to No 51 Sqn and its Nimrod R1s can be put down to a number of important factors, some of which deserve special mention. First, the outstanding engineering design, manufacture, installation and support provided by EWAU at Wyton – later at Waddington – and RAFSEE at Henlow, cannot be overstated. EWAU had design authority for the Nimrod R1 mission system and, as such, became heavily involved with the design and integration of the many systems that became part of the Nimrod's sensor, computer and communications suites. Much of the equipment installed in the aircraft was designed and built from scratch and provided the mission crew with unprecedented, and much envied, capabilities. One example of particular benefit to the R1 mission crew was the unique Communications Control System.

Another notable feature of the Nimrod R1 force was the high quality of its operators. Once they were selected and trained, by the squadron, they were almost guaranteed to stay there for evermore, if they so

wished. This allowed operators to build up an enormous amount of experience in operating their sensor systems and an encyclopaedic knowledge of the target signals of interest. Each took a very personal interest and pride in what they were doing and were recognised within the wider intelligence community as the bedrock of the Nimrod R capability.

In a similar way, credit must go to the ground crew personnel who managed to keep the aircraft and all its systems in immaculate condition. It was a statement of pride that station personnel could set their watches by the sight or sound of a Nimrod R taking off on a mission. For an organisation with only three, highly complex aircraft, each unique in its mission fit, the extremely high level of aircraft availability provided by the ground servicing personnel bore testament to their dedication and professionalism.

Training

Operators and maintenance personnel started their training by undergoing many hours of classroom work coupled with hours spent in the RCT. The facility replicated, as far as possible, the fit and function of the R1's mission cabin and it provided excellent training for the maintenance personnel. It also provided, to a lesser degree, sound basic training for mission crews. The RCT included a radar signal simulator which generated realistic RF signals upon which ELINT operators could hone their skills. Simulating signals for COMINT operators was a more difficult proposition and their ground-based training was largely restricted to equipment familiarisation and subsequent control manipulation as well as crew procedures.

Realistic flying training for the Nimrod R1's war role of tactical SIGINT support was extremely difficult to arrange due to the limited assets that could be made available to act as Blue (friendly) and Red (hostile) forces. The best that could generally be accomplished was to piggy-back, when possible, on other players' exercises. Small scale exercises could not adequately exercise the all-embracing capability of the R1 platform. This limitation was exacerbated by the tendency for 'actors' to limit their radio and radar transmissions to peace-time/exercise modes of operation. Thus, while the experience gained from such exercises was valuable, it was quite limited. It was only towards the end of the R1's time in service that crews were given the

opportunity to fly on Red Flag exercises in the United States where a reasonably authentic wartime scenario could be played out. However, the Red Flag exercises, while extremely beneficial, were also extremely expensive to mount in terms of the flying hours spent on transiting to and from Nellis AFB in Nevada, in addition to the Flag sorties themselves. This could very quickly eat into the valuable flying hours required for operations, bearing in mind that the squadron's task only amounted to some 2,000 hrs per year for its three-aircraft fleet, of which only two were normally available. No training hours were allocated within that annual tasking, which meant that all continuation training for the pilots and flight engineers had to be carried out on the MR1/2 fleet; navigator conversion training took place on operational sorties.

Operations

During the Cold War, the Nimrod R1 operated regularly over the Baltic, around the North Cape of Norway and along the Inner German Border. It also made many visits to the eastern Mediterranean and further east to Saudi Arabia and (pre-revolutionary) Iran. When operating in the Baltic area and around the North Cape, the aircraft would almost always be intercepted and escorted by Soviet, and later Russian, fighters, in much the same manner as the RAF routinely escort Russian aircraft flying close to our own shores. The fighters that the Nimrods encountered were always fully armed and their message was clear. For this reason, great care was taken to ensure that the aircraft avoided any incursion into forbidden airspace. Flying close to potentially hostile states always incurred a certain level of risk. While being subject to hostile fire from a fighter or a surface-to-air weapon system was always deemed possible, it was nevertheless considered to be unlikely, providing the aircraft did not stray from its authorised flight path within international airspace. That said the almost daily experience of having a fully armed enemy fighter closing on your aircraft, with its weapon systems locked-on, did capture the attention of the crews. They were acutely aware that a number of electronic reconnaissance aircraft belonging to other Allied air forces had been shot down in the past and one could never be completely sure that the country under reconnaissance was not about to provoke a crisis or make a 'political statement'. Nevertheless, it was important to fly these sorties so that the intelligence gained, plus that collected by other assets,

A goose-bedecked Nimrod of No 51 Sqn making its final public appearance at Waddington's open day in 2011.

was readily available to provide the UK and its allies with the best information possible upon which to base future weapon requirements and tactics.

During the 1970s and '80s, most of the sorties flown were strategic reconnaissance missions. These were dedicated intelligence collection flights, conducted to observe and monitor the activities of potential enemies such as the Soviet Union. A close eye was also kept on other geographical areas where the potential for conflict was high. However, 1990 was to prove a turning point in the history of 51 Squadron. Although much of the detail remains classified, the squadron was the first RAF asset declared to Operation GRANBY – the UK response to the Iraqi invasion of Kuwait – and deployed to Cyprus on 10 August 1990. For the next 6 months, the squadron flew sorties on a daily basis, protecting, via its electronic surveillance overwatch, the vast Allied air armada as the build-up of men and materiel to counter the Iraqi forces in theatre took place in Saudi Arabia. In addition, the mapping of the Iraqi air defences and, in particular, its Command and Control nodes was a vital piece of the intelligence picture that enabled the Allied planners to unleash the devastating attack on this Integrated Air Defence Network at the start of the air war on 17 January 1991. During the next 6 weeks, the squadron was to fly two sorties a day against the Iraqi air and ground forces providing direct tactical support to Allied aircraft as they performed their missions, as well as continuing to monitor and report on the performance of the Iraqi Air Defence networks as they were gradually degraded. As a result of its outstanding efforts in this campaign, 51 Squadron was granted the honour of emblazoning the Gulf War campaign on its Standard.

By the end of the Gulf War, the Nimrod R was capable of a very broad range of collection, exploitation and dissemination tasks and

could conduct them simultaneously across any theatre of operations. Its product could be used from the tactical to the strategic level, defined principally through the route, timeliness, granularity and customer that received the product. The requirement set that underpinned this capability formed the basis for a replacement mission system programme – Project HELIX – which aimed to sustain the capability until 2025. However, this was cancelled following the loss of a Nimrod MR2, XV230, over Afghanistan, and the subsequent decision to gap the RAF's maritime surveillance capability from 2010 onwards. To restore the RAF's airborne electronic reconnaissance capability, Project AIRSEEKER was launched in 2011. This saw the first RC-135 RIVET JOINT arrive at Waddington some two years later. The story of that unique procurement programme will be told one day – but not yet.

Acknowldgement. The assiatance provided by Sqn Ldr Jim Walls in the descriptions of the recent equipment upgrades was much appreciated.

Notes:

[1] The technical data in this paper has been garnered from official, but unclassified, data sets.

[2] HUMINT and SIGINT are the only intelligence disciplines which provide analysts and decision makers with an understanding of an opponent's intent with respect to their future plans and strategy.

[3] While there is no internationally agreed form of words, 'due regard' is defined by the (US) Federal Aviation Administration as, and is generally recognised to mean, a phase of flight during which the commander of a State-operated aircraft assumes responsibility for maintaining the safe separation of his/her aircraft from all other traffic. In short – running silent.

REFLECTIONS ON No 51 SQUADRON OPERATIONS IN THE 1980s

by Air Cdre Bill Tyack

Introduction

This paper was conceived as a short talk that would offer some local colour on No 51 Sqn's operations in the 1980s to complement Gp Capt Barry Smith's paper on the history of airborne electronic intelligence in the RAF. It is based on my flying logbook and my failing memory, backed up by the squadron F540.[1]

I took command of 51 Squadron at Wyton on 1 October 1983. At that time the squadron establishment was three Nimrod R aircraft, 93 aircrew and 75 ground engineers. The Nimrod R was equipped with 'special fit' electronic systems that enabled us to detect, locate, analyse and report electronic emissions of different types over a wide range of frequencies. (The Nimrod R's capabilities are described in some detail in the preceding paper.) Eighty percent of the aircrew, and the heart of the squadron, comprised the special operators who worked 'down the back' of the aircraft – the air electronics officers, air electronics operators and air signallers (RC), ie 'Radio Calibration'. The latter were linguists trained to analyse military voice communications. The aircrew establishment broadly equated to three crews. A typical crew size was about 28; the largest crew that I flew with was 33. However, crew composition varied from sortie to sortie as the mix of special operators would vary depending on tasking. Most of the aircrew had been on the squadron for a long time (more than 20 years in some cases) and were exceptionally skilled and experienced.[2]

Aircraft availability was a perennial issue. It was rare to have more than two of the aircraft on line at any time and not unusual to have only one available for a month or so. This was because, in addition to planned maintenance, there was a programme to continually upgrade the role equipment to keep pace with the evolving threat. The corollary to this was that each aircraft had a slightly different standard of role equipment, which presented challenges both to the operators and the engineers. In 1983 the role of the squadron was not acknowledged, and the cover story was that the Nimrod R was used in a radar and communications research role.[3]

Bombing in Beirut

Shortly after taking command, I led a detachment to Akrotiri in Cyprus.[4] It was an interesting time at that end of the Mediterranean. The USA, France and the UK all had forces in the Lebanon as part of a Multinational Force trying to maintain a fragile peace in the long-running Lebanese Civil War. Many people will remember the news coverage, at the time, of RAF Buccaneers from Akrotiri 'showing the flag' fast and low over Beirut.[5]

On 23 October 1983, two Hezbollah suicide bombers drove lorry-bombs into the US Marine Corps Barracks and the French camp in Beirut, killing 241 US marines, 58 French paratroopers and six civilians. I was on the Nimrod sortie early the next day off the coast of Lebanon. We took over the patrol line from a USAF aircraft and among the contacts they handed over was an unidentified communications net with one static and three mobile stations. Within a short time, our special operators assessed that this net was being used to control three lorry bombs moving-in for a follow-up attack on the Marine Corps Barracks. We sent a FLASH report up the line.[6] We later learned that on the strength of our report (and possibly other evidence) the US Marines in Beirut were ordered to pause rescue and recovery efforts to concentrate on defence against a follow-up attack. The attack was foiled and somewhere in the squadron archives is a message from the US President thanking 51 Squadron. This sortie gave me an early and very powerful message about the capability of the Nimrod R and the highly skilled analysts in the back of the aircraft. It also illustrated the very close intelligence co-operation between the UK and the USA. The incident is a good example of the Nimrod R operating at the operational/tactical level. This was relatively rare during the Cold War, as most of the operations were strategic, to update intelligence databases and to help determine the order of battle of potential adversaries.

Routine Operations

Routine operations were essentially overt, filing a flight plan and talking to air traffic control. One of the bread-and-butter operations was a patrol line over West Germany, monitoring activity in the East. Another routine operation was in the Baltic, where we patrolled off the coast of the (then) Soviet Baltic States. We filed a flight plan and talked

A pair of No 51 Sqn's Nimrod R1s up together – not a frequent occurrence.

to air traffic control until reaching the Danish island of Bornholm, south of Sweden. Then we 'went operational' and silent until calling up at Bornholm on our return. On the way in and out of the Baltic we would normally be intercepted by Swedish aircraft and sometimes Polish fighters would also take a look. Once we reached our assigned patrol line it would not be long before we were joined by a Soviet interceptor, a *Flogger*, *Flagon* or *Foxbat*. To all intents and purposes this was the equivalent of RAF Tornado F3s intercepting and escorting Soviet *Bears* over the North Sea. The Soviet fighters were usually ordered to stay three kilometres from us, but most of them sat on our wingtip and waved – and we took pictures of one another. We, of course, were flying on a prescribed track in the sky that we had been ordered not to deviate from. However, as a prudent precaution, the squadron pilots did train in fighter evasion tactics. At that time Soviet pilots used a permanent personal callsign. So, we knew which pilot was intercepting us and we learned their foibles.

Occasionally one of the more adventurous Soviet pilots would try to frighten us. One trick was to approach the Nimrod from behind and below, pull up just in front and then cut in afterburners, presumably to try to flame out our engines. One day in 1985, a known cowboy tried this manoeuvre. However, he misjudged and he very nearly hit us. I was standing between the pilots, as an extra pair of eyes, when the

windscreen suddenly filled with *Foxbat* tailfins and jet-pipes. Our engines kept going, but the fighter's wake disturbed the Nimrod's flightpath. The pilots recovered with little height loss and there were no injuries or damage. The *Foxbat* pilot must have given himself an even bigger fright, because he departed the scene with his tail between his legs. We later learned that shortly afterwards the same pilot had flown into the sea while playing with a pair of Swedish fighters.

On one occasion, flying into the Baltic on the airway towards Bornholm, the Swedish air traffic controller ordered us to, 'Turn 10 degrees port for air traffic reasons.' We protested that to do so would infringe Swedish airspace, but were ordered to turn left immediately. We complied and shortly afterwards we heard on the guard frequency, 'British military aircraft you have infringed Swedish territorial airspace. Leave Swedish airspace immediately.' This was followed a few seconds later by Swedish air traffic saying, 'Resume own navigation.' The British Air Attaché was duly summoned to the Swedish MOD to answer for this 'violation'. However, we had it all on tape, so he and the MOD (and, of course, the Swedes) knew exactly what had happened. After this incident we learned that a Soviet aircraft had infringed Swedish airspace not long before. So, I surmise that our contrived 'violation' was the Swedes demonstrating their neutrality.

Other Operations

Alongside these routine operations and regular detachments to Cyprus, the squadron undertook a range of specialised operations at home and abroad. These were usually covert and were frequently authorised at the highest levels of government. Some were programmed and repeated from time to time, while others were tasked at very short notice to respond to unexpected activity in areas of interest.[7] The special tasking included counter-terrorism, VVIP protection and responding to intrusions into the UK's area of interest. Each had its own challenges, and they often gave the 'front-end' operating crew, as well as the special operators, the opportunity to display their professional skills in more challenging situations.

Occasionally we were tasked to fly into the Baltic at low-level, without filing a flight plan and maintaining radio silence, with the objective of stimulating some reaction when we were eventually detected by the Soviet air defence system. We did a radio-silent take-

off and crossed the North Sea at medium level. Descending, we crossed Denmark on an agreed route at 500 feet AGL and flew across the Baltic at low level, before popping up and climbing to cruise altitude on our patrol line off the Soviet coastline. These sorties were closely co-ordinated with allies and were usually combined operations, with a high-flying aircraft coming over the horizon as we popped up and, I suspect, overhead sensors looking and listening. Covert sorties around the North Cape involved silent rendezvous with a Victor tanker, offering a welcome challenge to both pilots and navigators.

The squadron was tasked to respond to intrusions into the UK's area of interest by Soviet air and naval forces. When such activity was expected the squadron would be called to a readiness state. With typically only two aircraft on line for most of the time, it was a challenge to hold an aircraft and crew at readiness for this type of operation in addition to flying routine operations. So, a declaration of readiness frequently involved a degree of negotiation with the tasking authority and/or a change to routine operations. It was standard practice for the squadron's engineers to turn around an aircraft and prepare it for a potential standby as soon as possible after it had landed from any sortie. Notwithstanding these complications, 51 Squadron was held at readiness for this type of reactive operation for long periods[8] and these standbys played havoc with the squadron's social life.[9] If launched, the Nimrod R sortie was totally covert; we had no communications with the ground or with any UK or NATO aircraft that might also be responding to the intrusion. It was interesting to sit silently, high above the North Atlantic, listening to the chatter between RAF Tornado F3s, USAF fighters from Iceland, Norwegian F-16s, AWACS and assorted tankers all responding to a probe by, for example, a *Bear Foxtrot*.

Conclusion

My tour in command of 51 Squadron was probably the most rewarding of my career in the RAF. I had the privilege of leading a group of extremely professional aircrew, supported by a team of skilled and dedicated engineers. The squadron was in virtually daily contact with potentially hostile forces and its operations produced tangible results. For much of the Cold War, No 51 Sqn had been regarded as a strategic intelligence gathering asset, conducting mainly routine operations to 'hoover up' electronic data. However, by the mid-1980s

the squadron was engaged in a wide variety of operations and was starting to prove itself as a responsive operational asset as well as a valuable intelligence gathering resource.

Notes.

[1] The National Archives (TNA): AIR 27/3678 No 51 Squadron F540 January 1983 to December 1984; AIR 27/3758 No 51 Squadron F540 January 1985 to December 1986

[2] Once posted to 51 Squadron most of the special operators tended to remain until the end of their flying careers. However, many of the pilots and navigators also stayed on the squadron for a long time. For example, Sqn Ldr Derek Brice, a pilot, joined No 51 Sqn in 1968 and flew his last sortie prior to retirement in April 1985. This meant that the aircrew average age was much older than on most squadrons. When I took over the squadron all the aircrew, apart from the two Flight Commanders were older than me.

[3] The Operational Policy, as recorded in the F540, was 'Operations in the routine Radar and Communications Research Role with frequent detachments overseas. This policy is applicable to both peace and war.'

[4] No 51 Sqn routinely sent an aircraft on a (typically 10-day) detachment to Akrotiri several times a year.

[5] See 'Op PULSATOR – Buccaneers Over Beirut' by Air Cdre Ben Laite in *RAFHS Journal No 38*, pp106-120. **Ed**

[6] The Nimrod R was fitted with an early version of airborne satellite communications for intelligence reporting.

[7] For instance, on one occasion four divisions of the Soviet Second Guards Tank Army slipped silently out of their barracks in East Germany and 'disappeared' to Western eyes and ears. A Nimrod R (and no doubt several other assets) was scrambled to find the missing divisions.

[8] TNA AIR 27/3678 and AIR 27/3758.

[9] For example, the Squadron Ladies Guest Night to dine out my predecessor was postponed twice at 24 hours' notice and then cancelled because of short-notice stand-by commitments.

60 SQUADRON AND OPERATION HALLMARK

by AVM Mike Jackson

On 30 November 1945, at Soviet instigation, an agreement was signed between the four allied powers to establish three air corridors over the Soviet Occupation Zone into and out of Berlin. While air safety was cited as the main reason, Marshal Zhukov, the Commander-in-Chief of the Group of Soviet Occupation Forces in Germany, made no bones about the fact that it was 'to prevent your aircraft from observing Russian armies.' The agreed corridors were 20 miles wide, with a control zone of 20 miles radius around Berlin.* Gradually the Soviets introduced height limitations and other conditions which were strictly outside the formal agreement, but reluctantly accepted by the Allies. Therefore, by convention, the corridors ranged from 3,500 feet to 10,000 feet and the Berlin Control Zone from 2,500 feet to 10,000 feet. Moreover the corridors were only to be flown by transport-type aircraft. It was through these corridors that the Berlin Airlift was conducted.

The Berlin air corridors.

It is not clear how the precise routes were selected between the four powers but, while they were limiting, they still offered a huge intelligence collection opportunity. East Germany at this time was one of the most highly militarised parts of the world, hosting the cutting edge of the Warsaw Pact order of battle. At the height of the Cold War the Group of Soviet Forces in Germany fielded 21 Tank and Motor Rifle divisions grouped into five armies with 6,100 main

* Unusually for the dimensions of airspace, the width of the Berlin Control Zone, and the three access corridors was measured in statute, not nautical, miles. **Ed**

In the early days of the Cold War, the RAF kept an eye on Soviet activities using Lincolns, probably including this one, No 151 Sqn's RA685. (MAP)

battle tanks, 8,000 armoured vehicles, 4,300 artillery pieces, 1,200 air defence systems, and more than 600 helicopters. The Tactical Air Army had over 600 fighters, 320 fighter bombers, 50 attack helicopters and 150 transport helicopters. In addition the East German Army had six tank and motor rifle divisions, plus five motor rifle divisions in reserve. They comprised nearly 180,000 personnel, operating around 2,700 main battle tanks, 5,400 armoured vehicles, 1,700 artillery pieces, 700 air defence systems, and 150 helicopters. The East German Air Force operated 450 fighters, 90 fighter bombers, 50 attack and 120 transport helicopters. The Border Force had around another 47,000 personnel. Between them the Soviets and East Germans occupied 900 installations at 400 sites, including 55 airfields and 150 major training areas. About 40 percent of these locations were under, or close to, the air corridors and the Berlin Control Zone. Permanently Restricted Areas, where no unauthorised access on the ground was allowed, denied a large part of the country to ground observation and so it did not take much to realise that air reconnaissance could offer great returns, and the three allied powers duly jumped at the chance – by modifying and flying transport type aircraft.

The Americans modified several types over the years. including the C-54, C-97, C-118 and C-130. Their programme included photo, radar, signals and electronic intelligence collection. The French aircraft types

XL954, one of No 60 Sqn's 'special' Pembrokes.

included the Noratlas, the C-47 and the C160, and were mostly signals and electronic intelligence collectors. In the early years, the RAF used the Lincoln and Anson and, throughout the active corridor programme, concentrated on photographic collection; SIGINT was left to other collectors (airborne and otherwise) and to the Americans. The three national efforts were co-ordinated, closely between the British and the Americans but much more loosely with the French.

As for British activity, since the end of the Second World War there had been a concerted effort to update survey photography of Europe and to conduct flights along the corridors, and this had been a fairly free-and-easy undertaking with operational level authorisation, mostly conducted by the Germany-based RAF communications squadron. For about a year, a hand-held camera in the CinC's personal Dakota was used, and in 1947 the reconnaissance-modified Anson took over the bulk of the task. From January 1956 the Ansons were gradually phased out in favour of the Percival Pembroke. There were also a few 'unofficial' operations by Spitfire XIXs flying above 10,000 feet. However, by the mid-1950s covert reconnaissance was becoming increasingly sensitive as the Soviets detected and objected to overflights of their territory, and in 1955 they rejected the Open Skies initiative that had been proposed by President Eisenhower. Ironically, that rejection prompted the launch of the programme of U-2 flights over the USSR. In 1956 the Buster Crabb affair, and the subsequent diplomatic stand-off between the UK and the USSR, increased the sense of political risk

and caution in Whitehall. So these flights became much more heavily scrutinised and classified. From then until the end of the programme, corridor flights were classified TOP SECRET – UK EYES ONLY.

It was in this spirit that, in December 1960, the Cabinet Secretary minuted the Prime Minister requesting that the RAF be authorised to carry out two reconnaissance flights along the Berlin corridors to, 'take advantage of a unique opportunity to obtain valuable intelligence on Soviet surface-to-air guided weapons.' At the time each individual flight had to be approved personally by the Prime Minister. Three SAM sites were identified, located and photographed and the data was particularly well received by the US Intelligence agencies. Despite some misgivings at Cabinet level about the risk, the Joint Intelligence Committee requested, and was granted, more flights and by 1962 these had become regular weekly missions – covered by an Air Staff Operation Order. It was issued by HQ RAFG and, after several code name changes, was entitled Operation HALLMARK. Authority for approval of each flight was vested in the Commander-in-Chief RAF Germany and, except in very unusual circumstances, there were no more than two operations a week. Even so, the Foreign Office was informed of each flight and the Joint Intelligence Committee in London retained annual oversight.

A typical single HALLMARK operation comprised flights into and out of Berlin, usually via different corridors, with one or two night stops and perhaps a so-called 'Chukka' flight round the Control Zone. The workhorse for this operation was the Percival Pembroke, an aircraft which first entered RAF service in 1953. The C(PR)1, a transport and communications variant modified for air reconnaissance, flew from Wildenrath from the mid-1950s until 1990, initially with the RAF Germany Communications Squadron until it was redesignated as 60 Squadron in 1969. For most of this time the camera configuration comprised three F96 12-inch lens vertical cameras, and two sideways looking 48-inch lens cameras – one on each side – looking through specially modified refraction-free windows. Flying at between 3,500 and 10,000 feet, and making full use of the corridors' lateral limits, it was possible, depending on weather and visibility, to photograph about two thirds of the East German land mass and up to 90 high priority strategic targets. Suitably rigged aircraft were termed 'in fit'.

The crew for an in fit aircraft was a pilot and two navigators. The

The camera hatches on the belly of No 60 Sqn's Pembrokes. Note that the second cabin windows (from the front) was glazed with non-refractive glass to aid photography using a hand-held camera.

front-seat navigator was responsible for the route navigation, crucially ensuring that the aircraft stayed within the corridors. These only extended 10 miles each side of the centre-line and some of the vertical targets lay very near to the corridor edge. There was a very real possibility of being engaged if the aircraft strayed outside. He also had a high-quality pistol-grip hand-held camera which was particularly useful in the descent into Gatow, and within the Berlin Control Zone, as the aircraft flew at relatively low level over a number of significant installations.

The rear-seat navigator controlled the camera fit. He could not see forwards, however, so, for vertical shots, he had to rely on the front seaters to know when to switch the cameras on. He did have a vertical sight, a drift-sight, that could act as a track indicator. If the initial line-up was less than ideal, the navigator could 'talk' the pilot onto the required line, using coarse applications of rudder, while keeping the

wings level. For a last minute correction to the line of sight for oblique shots the pilot again used stick and rudder on advice from the navigator.

Five heavy cameras added greatly to the weight of the aircraft. Each one weighed about 60 kg, and there was also a substantial scaffolding frame to support them, along with heavy-duty electric motors to adjust the depression angle of the 48-inch obliques. Under some conditions the take-off weight precluded non-stop flight between Berlin and Wildenrath, and it could make single-engine operations problematic. With the Pembroke in camera fit the aircrew joked privately that single-engine stabilising altitude should be quoted in fathoms. Had one of the Pembrokes lost an engine halfway down a corridor and not been able to make it to Berlin or to the FRG it would have had to divert into an East German airfield. Fortunately, this never happened during the whole period of the HALLMARK operation, but there were established procedures to cater for this.

Needless to say, the HALLMARK Operation Order addressed the issue of deniability. It was no secret that the Pembroke had a 'photographic survey' capability. Hunting had advertised this option in its publicity material in the '50s. Indeed, the aircraft was genuinely used occasionally for survey work within the FRG for map-making and similar projects and its photographic capability was published in various RAF public relations and recruiting documents, widely available to the general public. Rather than being a disadvantage, this actually provided the basis for a cover story. The crews were briefed, and this was set out in print in the Operation Order, that if they were ever forced to land within the GDR and were interrogated by East German or Soviet authorities, they were to declare that they were carrying an urgent package to or from Berlin. A package was always on board, parcelled with the appropriate conveyance documentation. It was a part for a 3D radar. Had the Soviets or East Germans opened it they would have found the genuine article. As for the cameras, the story was that the aircraft had been on a previous survey mission when this urgent task had come up and there had not been time to change the aircraft fit before take-off.

The F96 cameras had been specially modified with a rapid reverse motor and a selectable bright light within the camera. Exposed film was to be fogged by re-winding it through the cameras and exposing it to the light. To fog the exposed film would take some 4 minutes for a

250 foot magazine and 7 minutes for 500 feet. These magazines would be replaced with cover magazines which contained either blank film or exposed film of Gatow. On 17 January 1972 the crew of Pembroke XL954 was able to put this into practice under pressure. Intercepted by three Soviet MiG-17s and flying close to the edge of the southern corridor they were severely buffeted as the MiGs thundered close by. The pilot lowered the undercarriage and flaps, slowed the aircraft to close to its stall speed, and moved back towards the corridor centreline. Meanwhile, the second navigator was bouncing around in the back, re-winding the film in case they were forced to land. The MiG-17s couldn't compete with the slow speed of the Pembroke so started circling. Shortly after this, a fully armed MiG-21 joined in by approaching on a reciprocal heading at about 2,000 feet. With their excitable R/T breaking through to the Pembroke crew, the Soviets eventually pulled away and there was nothing further to report, but this was not the only incident of its kind.

General security of the operation was partly achieved by the fact that the squadron also carried out the normal tasks of a communications squadron using unmodified Pembrokes, temporarily de-modified 'fit' Pembrokes, and with the Andover. Many of these flights were routine trips to and from Berlin which helped to mask the 'special' sorties. Moreover only a small number of aircrew, groundcrew and station personnel were briefed on HALLMARK. There was no reference to the reconnaissance role during type conversion training or in pre-posting procedures, and it was never openly discussed in theatre. Role conversion was conducted on the squadron. The roughly half of the squadron that was not briefed was required to keep a discrete distance and a studied silence. Even in London the number of briefed personnel was strictly controlled.

A variety of other steps taken to conceal the role and the aircraft modifications, both away and back at base. In addition to closing the sliding camera doors fitted to the underside hatches, the crews blacked out the side windows with thick curtains prior to landing anywhere. At Gatow they would park with the aircraft door opposite the hangar, away from the East German Guards in the nearby watch towers. Once off the flight line, they had access to a locked room where they could talk securely. If there was to be a 'Chukka' flight the pilot would record a fictitious minor 'snag' on the aircraft that would require an air test;

normally scheduled for the next day. The air test would be flown, flying around the Berlin Control Zone close to its edge with the cameras working at 2,500 to 3,500 feet. On arrival back at Wildenrath the aircraft would be towed into a hangar and the film quickly removed. At Rheindahlen the films would be processed within a couple of hours, and the crew debriefed. The take would be interpreted at the co-located RAF Photographic Interpretation/Intelligence Department (PID) and BAOR's 6 Intelligence Company, and the results passed to the intelligence community.

Throughout the duration of the programme there was a constant search for better collection platforms and equipment to enhance performance; there was a need to improve the resolution and reach of the photographic imagery, to upgrade to a night/all-weather capability and, ideally, to extend the collection spectrum. In 1976 a paper was submitted by the squadron through the Joint Headquarters, and in 1978 MOD Air Staff Requirement 408 considered a replacement for the Pembroke which, in old age was beginning to suffer engine seizures, amongst other problems. The single-engine performance was in the spotlight for obvious reasons. The short term answer was engine modifications, and the Pembroke soldiered on in an increasingly fragile state to the end of the HALLMARK operation. In 1980 the Pembroke fit was substantially upgraded to a single panoramic scanning camera, similar to that in the U-2. This gave horizon-to-horizon cover, with greatly improved resolution, although it was more susceptible to vibration in a chronically vibrating airframe! Eventually, after much research and evaluation, a whole new system was approved – the Andover C(PR)1.

The Andover was a much more stable and capable platform, housing a significantly upgraded sensor suite comprising two F96 oblique sideways looking cameras, the Vinten scanning panoramic camera, a sideways looking radar, and low light television. Of the two aircraft that were delivered to 60 Squadron in early 1990 only one was complete with the reconnaissance suite (XS596). The Berlin Wall had just come down, however, and HALLMARK was officially wound up on 30 September 1990. XS596 became the UK Open Skies aircraft.

What was achieved? In brief, HALLMARK complemented a complex information gathering programme involving many agencies, on the surface and in the air, feeding interpreters and analysts with the

Following the end of Operation HALLMARK, its Andover C(PR)1, XS596, became, as seen here, the UK Open Skies aeroplane. (Malcolm Clarke)

material needed to produce intelligence. Much of the product either added to, or depended on, a contribution from others.

For example, the, previously noted, sorties requested by the Cabinet Office in December 1960 followed a number of reports from the British Commander-in-Chief's Mission to the Soviet Forces in Germany (BRIXMIS) and earlier HALLMARK photography. They confirmed that an installation which had been variously assessed to be either a heavy anti-aircraft artillery battery, or an SA-1 site, was actually the first SA-2 site in the region. This was a highly significant development.

In July 1968 a HALLMARK Pembroke overflew the Dallgow-Döberitz Soviet barracks with cameras running, and the film confirmed an unusually high level of activity in the garrison, with reserve transport units joining their parent fighting units. Later that day, a BRIXMIS single-engine Chipmunk flying in the Berlin Control Zone recorded similar activity. The combined reports to agencies, HQs and allies gave early warning of the Soviet 'Prague Spring' intervention in Czechoslovakia. Similar cover by HALLMARK Pembrokes indicated that Soviet Forces were preparing to intervene in Poland in response to the Solidarity movement. In the event martial law, rather than an invasion, was the outcome.

In 1972 HALLMARK imagery at Köthen airfield showed a known amphibious armoured vehicle with an unusual mounting on top. This was compared with BRIXMIS imagery taken at much the same time and, shortly afterwards, the two newly-discovered heat-seeking SAMs mounted on a BRDM-2 were code-named SA-9 *Gaskin*.

HALLMARK was often the first facility to record re-equipment programmes, for example the arrival of the Mig-25 *Foxbat* at Werneuchen, the deployment of the MiG-29 *Fulcrum*, and the arrival of the Mil-24 *Hind*. The imagery could be detailed enough for technical intelligence assessments, and for picking out unit and formation identifiers. Despite the rapidly advancing capability of reconnaissance satellites, HALLMARK could often prove to be the most reactive collector, able to record change as it happened. This steady stream of imagery informed the Indicators and Warning watch, and helped analysts to keep track of the big picture and/or to focus on specifics. And it provided an invaluable archive for use long after the end of the programme.

As for security, it could be that these operations were better concealed from our own side than from the opposition. From the national level down to individuals on the operating squadron the 'need to know' principle was rigorously applied and kept the detail restricted to a few insiders. On the other hand, there is much to suggest that the opposition was well aware that reconnaissance flights were taking place. Suspicious Soviet air traffic controllers, rudely finger-waving East German soldiers, messages in the snow and aggressive Soviet fighters all point that way. What they could not have known, however, was which flights were actually in reconnaissance mode, the quantity and quality of the data that was being collected, and how skilfully it was being interpreted and analysed to result in timely and valuable intelligence.

References:

Wright, Kevin and Jefferies, Peter; *Looking Down The Corridors – Allied Aerial Espionage Over East Germany and Berlin 1945-1990* (The History Press; Cheltenham; 2015).

Hickley, Paul; *Holding to the Heavens – The History of Sixty Squadron RAF 1916–2016* (paul@hickley.net; 2016).

26 SIGNALS UNIT – WINNING THE COLD WAR
(Reflections from the last Commanding Officer)

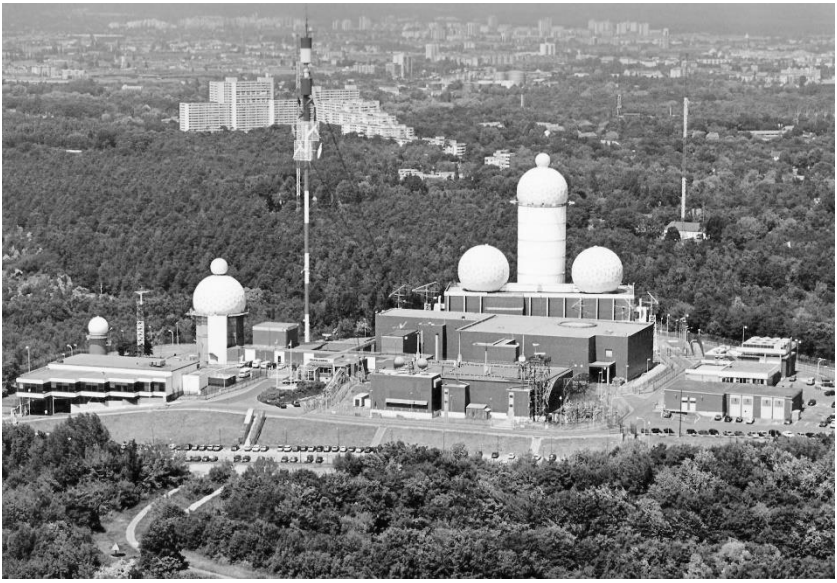
by Air Cdre Bruce Benstead

A Brief History

No 26 SU was formed by the amalgamation of a number of signals units dating back to the early post WW II period. No 365 SU, based in Vetersen in 1948, provided a small detachment of operators to RAF Gatow in Berlin in 1951. It was disbanded in 1953 when 5 Signals Wing was formed at Hambuhren. This was transferred to Gatow in 1953 with detachments at the US Field Station on the Teufelsberg in 1964. No 26 SU was established in 1966 with operations split between Gatow and Teufelsberg. The unit's motto is *Immer Wachsam* – 'Ever Watchful' or, as the unit operations staff would say, 'Always on Watch'

Teufelsberg (Devil's Mountain) was built in the 1950s from the rubble of post-war Berlin. Rumour has it that the Americans had tried to destroy Albert Speer's Wehrmacht Military Technical Academy, which had occupied the site, but judged that too much explosive effort was required and decided to bury it instead. Whatever the truth, it became by far the highest landmark in Berlin, well suited to monitoring a range of line-of-sight communications systems.

The Teufelsberg and Gatow sites were both extensively developed over the years to meet new and emerging operational requirements and the rapid advancements in communications and information technologies. It can be seen from the accompanying photographs that both sites bristled with radomes and antennas. Internally, vast equipment rooms and Faraday cages housed an array of systems, ranging from simple multi-channel radio receivers to some very complex research and analysis equipment. Much of the research resulted in new and novel techniques, along with the adoption of cutting-edge technologies which were adapted and deployed elsewhere within the intelligence community. Although US and UK operations



The Teufelsberg, an American installation located, unusually, in the British sector of Berlin with part of 26 SU as a lodger unit.

on Teufelsberg were generally totally separate there was a very strong relationship and the Americans were excellent landlords. They provided all the physical security for the site and the best American food in Berlin in their fantastic eatery – which also provided the best view over Berlin.

Operations at Teufelsberg ceased at midnight on 29 February 1992. No 26 SU was disbanded in 1994. Gatow was handed back to the *Luftwaffe* on 30 September 1994 to become a national air museum. There were aspirational plans to build a luxury hotel on Teufelsberg and a Cold War museum. These have all foundered, mainly due to cost and the fact that the artificial hill is constantly on the move, due to the inherent instability of what is actually a rubble heap. The 26 SU buildings suffered constantly from settling cracks. Also, the 120m high Rohde and Schwarz mast had to be regularly realigned to ensure that it remained vertical and did not topple. Today the site remains abandoned with the original Field Station installations in a dilapidated condition. It is now a home to graffiti artists and vagrants.

Operations

The main operational targets for 26 SU, throughout its existence, were the Russian, East German and Polish air forces operating at both short and long range. Air-to-ground and air-to-air communications in various forms and technologies were intercepted, recorded and analysed to provide the overall air intelligence picture. The following information on Warsaw Pact air forces was of specific interest:

Air Order of Battle
Call signs
Exercises, Deployments, Training and Tactics
Incidents and Accidents
Communication security
Long range transit of bombers
Trials and new equipment
Other communications systems
Land Forces (No 3 Sqn, 13 Sig Regt)

As technology evolved, the introduction of multi-channel receivers and automated voice recognition systems meant that a vast amount of materiel was generated for transcription and analysis, producing a constant problem of backlogs, much to the chagrin of the operators tasked to transcribe often legacy product. Real time tip-offs of operational interest and special interest reports were raised and disseminated to customers in Europe and the UK, based upon tactical and strategic priorities. New state-of-the art automatic collection and analysis capabilities were introduced at Gatow to unravel the very dense and complex electronic environment prevailing in Berlin. Finding the needle in the haystack, any emitter of specific interest, was particularly challenging, but this capability did allow emitters of interest to be separated from the routine and known systems. Fusion of voice and emissions with track and speed data from the 3D radar at Gatow enabled better and more accurate profiling of air combat manoeuvring and tactics. At the time of the unit's closure, there was particular interest in the Tu-160 *Blackjack* and the MiG-31 *Foxhound* and variants thereof.

Organisation

The unit was organised into five sqns:

1 Sqn – Teufelsberg Operations – Line of site
2 Sqn – Support functions engineering, admin, security, etc

The other 26 SU site – Hangar 4 at Gatow.

3 Sqn – No 3 Sqn, 13 Signals Regiment (Radio) detached from Bergelen

4 Sqn – Gatow 4 Hangar Operations – Long range and DF

5 Sqn – Technical search and capability development

At its peak, 26 SU was manned by some 800 personnel. The MOD provided the people, and the West German authorities underwrote the cost of equipment programme through the Berlin Budget – funding specifically allocated from Bonn for the protection and sustainment of West Belin. The equipment programme and its associated budget was secured and scrutinised by the MOD and other sponsors and requirements were prioritised based upon intelligence needs. This led to a very dynamic procurement and project delivery process which would see the introduction of new and emerging technologies far more rapidly than was the norm. This benefitted the intelligence community at large which gained knowledge and understanding from the insertion of this leading edge technology. At any one time there were some 25 major equipment projects run by the RAF Signals Engineering Establishment.

As the main lodger unit at Gatow, 26 SU provided the bulk of the

personnel on the station. This generated tension from time to time when station and Berlin Brigade commitments for personnel arose. Operations could not be paused to meet surges of personnel required for station duties, parades and other diversions. That said, Gp Capts Phil Wilkinson and Mike Feenan, Station Commanders during my time, were highly experienced in the intelligence community and we always arrived at a sensible compromise; I never resorted to speaking to the Station Commander through my PA as was, apparently, the case for some of my predecessors! However, I do recall that there was one interesting exchange between myself and the then Commander-in-Chief RAF Germany who, as the drawdown in Germany progressed, asked me to consider planning the early and rapid drawdown of 26 SU's personnel and assets – as if it was that easy (and his business!) – but perhaps an understandable pilot's view!

Living in Berlin

My time in Berlin came just after the fall of the wall. It had been a privilege, and fascinating to see history in the making at first-hand. While the demise of the Soviet Union was welcome, it came at a price in Berlin and to the Berliners. The very proud, clean and wealthy city was suddenly overrun by folk from the east exploiting their new found freedom and relative wealth. The presence of noisy, smoky and smelly Trabants contrasted markedly with the previously prevailing BMWs, Audis and Porsches. Graffiti appeared everywhere, as did beggars on the streets. Street crime also increased, and for a time, some West Berliners were heard to say, 'build back the wall and add a few metres on top!'

The Cold War mystique of West Berlin disappeared as quickly as the wall had been demolished, but for us in the military it was still a good place to be. Subsidised fuel, free bus travel, numerous cultural activities and regular trips to the US PX were among the many local advantages. I should also mention the Families Ration Issue System (FRIS) whereby food, stockpiled in case of another blockade, was routinely turned over and sold cheaply to forces personnel. Gatow offered sports facilities, social clubs and specialist societies in abundance to meet all tastes and abilities, generating a real community spirit, the likes of which are now less common in the armed services. Schooling for children was excellent, with many adult education

opportunities as well. The cultural facilities in Berlin were second to none with access to some of the best operas, ballets and orchestras in the world. The momentous events in Berlin also made it a key target venue for high profile popular music bands.

As the wall came down, travel to the east opened up and we were able to see how the communist system had left people living in drab social housing with poor and failing infrastructure. Environmental pollution was rife and the agricultural system was clearly failing. Warsaw Pact troops were living in dilapidated barracks. That said, there were clearly some who had done very well by the system, living in substantial properties with 'high end' vehicles parked on the drive.

Drawdown and Closure

The demise of 26 SU had a massive impact on the RAF intelligence trades. For many years a very high proportion of personnel from these trades were Berlin-based. Indeed, many served their whole careers in Berlin, returning to the UK only for courses and social visits. Apart from redesignating the original ROTs (Radio Operator Telegraph) as CSAs (Communications Systems Analyst) and ROVs (Radio Operator Voice) to CSA(V) (Voice), to make them sound more appealing to potential recruits, little of substance had changed in the trades for many years. It was, therefore, no surprise that the fall of the Berlin wall was to have a massive impact on our people and their families. A major restructuring of the trades was undertaken with overall numbers significantly reduced, so much so that the viability of the trades was of concern, along with future funding for strategic tasks. New requirements, for Serbo-Croat to support tactical operations in the Balkans and Farsi linguists to support Middle East operations, were emerging but in far smaller numbers and these opportunities did not offer the same lifestyle and perks as those that had been available in Berlin – far from it! Many senior and experienced personnel chose to leave the RAF under the voluntary release process and remain living in Berlin to take up new employment opportunities following reunification. Project SAILYARD saw the upgrading of sister units in the UK with monitoring and reporting functions transferred from Berlin as appropriate. The special signals business become more 'Joint Service' and previously single-service units became Joint Signals Units.

There were, of course, many closure events, dinners and parties at Gatow. The most incongruous was when the Russians joined us for a farewell party – the site of *Hind* and *Hip* helicopters on the apron at Gatow was most strange – the world had changed!

Reflections

In the winning of the Cold War it is impossible to overstate the impact and importance of 26 SU's operations. Military intelligence informed and influenced the foundation of the Allied posture, preparedness and responses to the Warsaw Pact threat. West Germany recognised the importance of investment in the necessary technology to keep ahead and spent accordingly. Similarly, the MOD invested heavily in the recruitment, training and development of our intelligence cadre. Importantly, and given the restriction in Berlin before the fall of the wall, families were well provided for from a welfare and social perspective. Our highly motivated and expert operators and support staff knew that they were on the front line and having a tangible impact upon the Western Allies' ability to wage war effectively against the Warsaw Pact, should that become necessary. As an honorary member of the RAF Linguist Association, I find it telling that this remains a very strong and vibrant organisation with, mainly ex-26 SU, personnel holding regular meetings and reunions where they indulge in animated accounts of their time in Berlin, recalling vivid memories and taking pride in their history and in their operational achievements.

The new relationships with former potential adversaries saw the reduction in Cold War intelligence gathering capabilities and redirection to other theatres and units elsewhere. Now, years later, and with an emergent strong and ambitious Russia, one can only assume that the languages and expertise of old will need to be re-energised with our experts and the community once again becoming *Immer Wachsun*.

THE JOINT AIR RECONNAISSANCE INTELLIGENCE CENTRE IN THE COLD WAR 1959-84 – THE FILM RETURN SATELLITE ERA

by Gp Capt Paul Stewart

The origins of JARIC, the Joint Air Reconnaissance Intelligence Centre, lay in the Central (Allied Central 1943-45) Interpretation Unit which was established at Dansfield House, Medmenham in 1941. In 1946, it moved to Nuneham House and, having become the Joint Air Photographic Intelligence Centre (UK) in 1947, it eventually became JARIC(UK) on 17 December 1953.

The rather grand old house at Nuneham, though looking very impressive, was not ideal for the role of strategic photographic interpretation and RAF Brampton was chosen as the site for a purpose-built facility. JARIC took over its new building, and associated Officers Mess, in July 1957. Having its own Officers Mess served to foster a very special *esprit de corps* amongst the unit's staff. JARIC remained

Danesfield House, Medmenham and some of the staff in 1945. Note the USAAF officer standing at far right

Above, the JARIC site at RAF Brampton circa 1999 and (below) the Pathfinder Building at Wyton.

at Brampton until 13 July 2012 when, restyled as the Defence Geospatial Intelligence Fusion Centre (DGFIC), it moved into the new Pathfinder Building at RAF Wyton. There have been more name

changes since then, but today it is the National Centre for Geospatial Intelligence (NCGI). The old JARIC buildings and Officers Mess at Brampton were eventually demolished and the site sold for redevelopment. It is now a housing estate site, with a JARIC Lane.

During the period 1959-84, JARIC was the UK centre for all strategic photographic interpretation. In 1959-60 it relied on its libraries of captured German photographs of the USSR, our own photography and US U-2 photography. This paper does not address the latter, as there are two accompanying contribution dedicated to the U-2. The primary sources of all photography used for strategic photographic interpretation at JARIC between 1960 and 1984, were the US satellite reconnaissance systems, KH-1 to KH-9. This relationship was at that time classified Top Secret 'Handle via Talent-Keyhole control systems only'. The CIA controlled all access to the material and maintained very tight control over the UK people allowed to be cleared into the system. We all had to be vetted to 'Positive Vetting Red Seal' level and indoctrinated into the Top Secret Codeword Talent Keyhole System. Why the CIA involvement? The US National Photographic Interpretation Center at Building 213, Navy Yard, Washington DC, the US version of JARIC on steroids, was part of the CIA.

As with many RAF units, the internal organisational structures of JARIC changed many times between 1960 and 1984. This paper will consider examples from the early 1960s, the 1970s and the early 1980s. JARIC was always divided into two separate areas, the 'Front End', which was only up to Secret and the 'Back End', or Secure Area of Operations (SAO), that worked on the satellite reconnaissance films from the KH-1 to KH-9 systems. In the 1960s JARIC was divided into three sections:

> No 1 Section dealt with the exploitation of conventional photographic reconnaissance films.
>
> No 2 Section handled the production of target material.
>
> No 3 Section was in the SAO which, at the time, was called the Special Secure Area and was the only area of JARIC that could handle and exploit the US satellite reconnaissance films.

JARIC, during the late 1970s and early 1980s, was divided into four wings:

a. Administrative Support Wing.

b. Exploitation Wing, divided into five specialist strategic squadrons in the SAO for the exploitation of KH-1 to KH-9 photography.

c. Target Intelligence Wing, also in the SAO, for the identification and production of targeting materials.

d. Computing Wing, also in the SAO, for the processing of US satellite data and cover-search.

With the tens of thousands of top secret satellite film tins, computer cover-search was essential to finding a specific target. The search program would provide the film tin, the frame number and the position of your target within the frame.

What were the US classified reconnaissance systems and just how good were they? The KH-1 to KH-9 systems have all been declassified by the US and the US National Reconnaissance Office (NRO) has published fourteen books detailing the story of the development, running and exploitation of these systems. The CIA has also produced at least one book covering the story of the Corona project, which covered KH-1 to KH-4b, the world's first satellite reconnaissance camera systems. The basic details of the nine systems are summarised at Table 1.

All of these satellites used film cameras and, after taking pictures of the targets that they had been tasked to collect, the film was returned to earth via a re-entry vehicle that had a small motor and a capsule containing the film. The capsule released a parachute and drogue that was captured as it descended through the atmosphere by specially adapted transport aircraft, usually in the Pacific in the vicinity of Hawaii. The capsule and film were rushed to a top secret Kodak facility for processing and then on to the National Photographic Interpretation Center (NPIC) for photographic interpretation.

The early Corona systems (KH-1 to KH-4) were all launched under cover of the unclassified Discoverer program. The first successful image from space was of the Soviet Bomber base at Mya Shmidta taken by KH-1 mission 9009 on 18 August 1960.

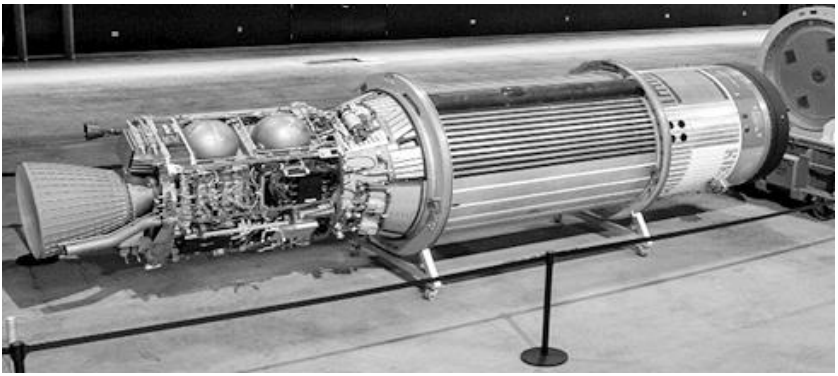
As Table 1 shows, the original KH-1 system of 1960 had a 40 foot resolution, but before the end of the year KH-2's resolution had been

almost halved to 25 foot. The cameras and systems continued to be improved, at a remarkably rapid rate, and within five years the KH-8 could resolve to less than 1 foot at its best. Working at JARIC in the early 1980s you could not get better cover of a target than KH 8 and it was a joy to work on it in stereo!

The most advanced of the film return satellite systems was the KH-9, which was in service between January 1972 and October 1984. It had less than 2 foot resolution with its main cameras and a separate mapping camera. It had four re-entry vehicles, which expanded dramatically the mission durations, with the average being 124 days and the longest 270 days. It provided between 52,000 to 77,500 feet of film per 'bucket'. The system was very reliable and, together with KH-8, was JARIC's main source of intelligence imagery in the 1970s and early '80s. As

Series	Missions and Series Name	Period	Resolution
KH-1	10 × CORONA	1959-1960	40 foot
KH-2	10 × CORONA	1960-1961	25 foot
KH-3	6 × CORONA	1961-1962	12-25 foot
KH-4	26 × CORONA	1962-1963	10-25 foot
KH-4A	52 × CORONA	1963-1969	9-25 foot
KH-4B	17 × CORONA	1967-1972	6 foot
KH-7	34 × GAMBIT	1963-1966	2-4 foot
KH-8	54 × GAMBIT	1967-1984	<1-2 foot and 20,000 ft of film
KH-9	20 × HEXAGON	19 successful from mission 1201 in Jan 72 to mission 1219, between 25 Jun 84 and 18 Oct 84	Less than 2 foot

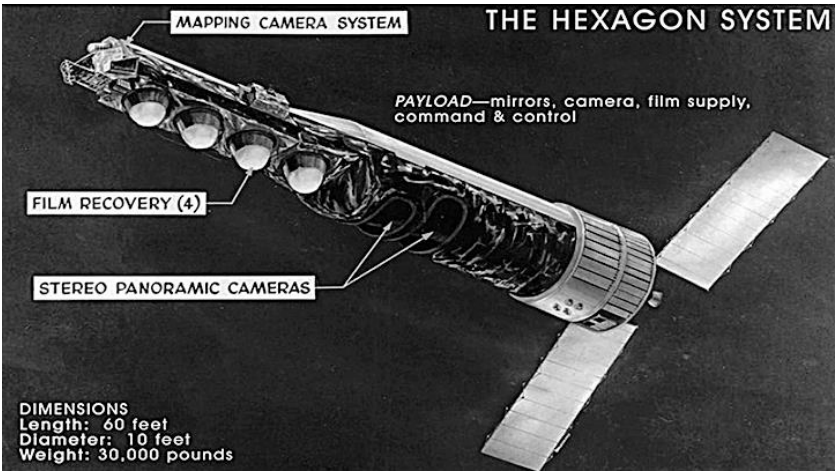
Table 1. Brief details of the KH-1 to KH-9 satellite systems.



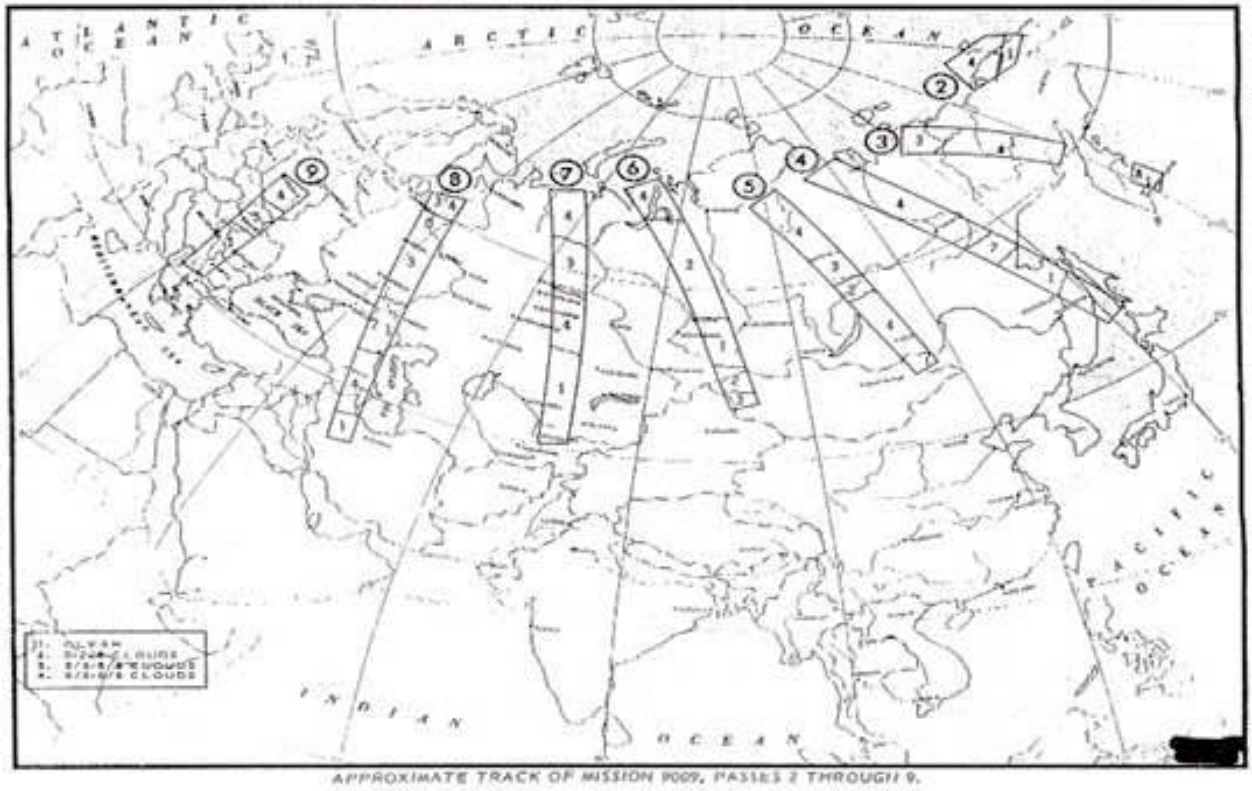
The KH-8 system provided the photographic interpreters with the very best resolution film and in stereo, each of its 54 missions, produced 20,000 feet of film per re-entry 'bucket' and two buckets per satellite.

a junior officer photographic interpreter (PI) at JARIC at that time, they were the systems that I worked on.

The diagram at Figure 1, shows the orbital path that the cameras of the first successful KH-1 mission imaged in 1960, at the height of the Cold War – Gary Powers' U-2 having been shot down on 1 May 1960.



The 60 ft × 10 ft (without the solar panels) Hexagon system provided the PIs with better than 2 foot resolution, in stereo, each mission producing between 52,000 and 77,500 feet of film per bucket.



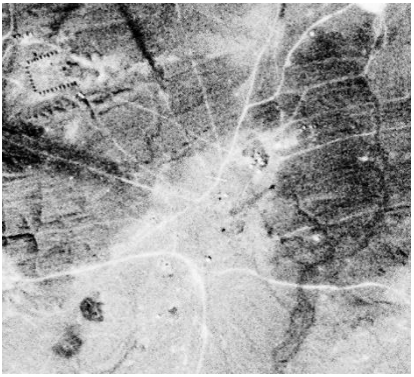
Approximate track of Mission 9009 – Passes 2-9 on 18 August 1960.

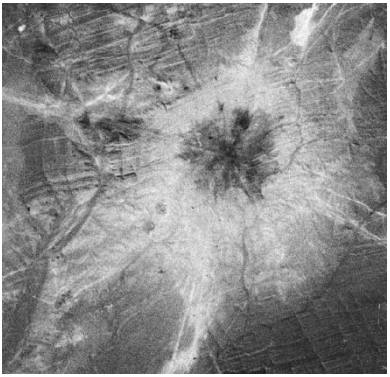
The US had no photographic reconnaissance of the Soviet Union, other than border areas, from then until KH-1 produced its first results on 18 August 1960. It was these early satellite reconnaissance systems, together with earlier U-2 film, that proved that the feared 'missile and long range bomber gap' between the USA and the Soviet Union did not actually exist. The USSR had exaggerated its numbers of ICBMs and long range bombers. Part of that deception had been the annual May Day parade in Moscow, when as many as 250 ICBMs had been displayed. The Soviet trick had been to circle the vehicles and aircraft around many times, to inflate the numbers apparently available. In 1961, film from a Corona satellite, exploited at NPIC, proved that the Soviets had only twelve ICBM sites and of those only six were operational.

The first successful mission by KH-1 on 18 August 1960, provided eight passes over the USSR and included portions of China, some Soviet satellites and Yugoslavia. Only 25% of the coverage was cloud free, with light scattered clouds to heavy cover affecting the rest of the photography. The quality of the images varied from good to very good, for its day, with resolutions of 20 to 30 foot. Intelligence highlights provided by KH-1 included the Kapustin Yar Missile Test Range (KYMTR) and the western portion of the KYMTR impact area, and it revealed the existence of twenty new SA-2 sites and six more under construction. It also covered the Sarova Nuclear Weapons Research and Development Centre, identified several new airfields and covered numerous urban complexes.

By 1964, with KH-4A, there was a constant revisiting of all strategic targets, plus the before and after of the first Chinese nuclear test near Lop Nor. Photography from KH-4A mission 1011-1 on 8 October 1964 showed the test tower in place ready for a nuclear test and the next mission, 1012-1 on 20 October, showed the same site and the after effects of the test that had taken place on the 16th. There is also a KH-7 picture of Lop Nor, taken two years later, showing the rapid improvement of the quality of the photography as the nuclear test tower and its shadow can be easily seen in the picture.

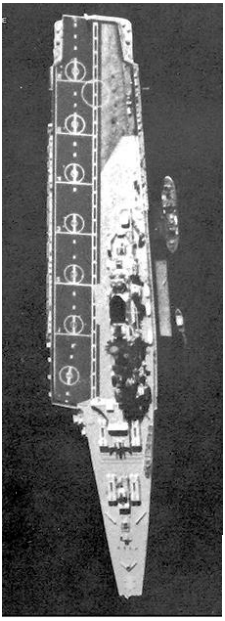
As an aside – I have to confess to my surprise, as a young PI on No 39 Sqn, at the outstanding knowledge of my OC RIC at Wyton who was able to identify every detail on the very poor infra-red line scan





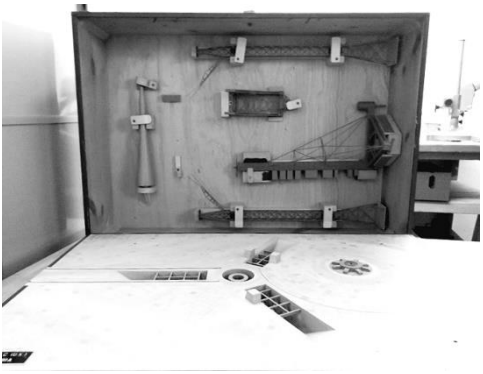
The Lop Nor site before and after the first Chinese nuclear test in October 1964.

imagery we were exploiting of the first sighting of the *Kiev* class aircraft carrier outside Soviet waters. How could he possibly identify the type of ship, let alone that it was a carrier, from the crude line scan imagery? Today the answer is obvious; he had come from JARIC where he would have seen KH-9 photographs of the *Kiev* long before No 39 Sqn acquired its night time IR line scan pictures. Such was the divide between those working at JARIC within the SAO and those not yet in the system working on TAC Recce at Wyton . . .



KH-9 panoramic camera image of the Kiev *in the Black Sea, July 1980.*

The picture on the next page is of the Tyuratam Missile Test Centre in the USSR taken on 19 September 1968. It is a good quality KH-8 photograph of the space booster on the launch pad. On 7 October 1968, JARIC tasked its model section to produce a model of the test site and space booster. The result can be seen in the Medmenham Archive as Model M/691A and is shown here in its transport box. It is the only surviving JARIC model we have that also has the satellite photography used to create it. Note, however, that the Tyuratam photograph was not



Left, a KH-8 image of the Tyuratam Missile Test Centre on 19 September 1968. Right, the JARIC model of the site.

provided by MOD; it is from the NRO.

Thus far we have looked at the photographs from the KH1 to KH-9 film return satellite systems. The photographic interpreters at JARIC worked on all of these systems, producing thousands of reports that were shared with the Americans. The NPIC photographic interpreters obviously had far more timely access to these films than we enjoyed at JARIC. They had whole teams that effectively provided a quick read out of each film for every mission, producing photographic intelligence reports called OAK reports that covered every target covered by each mission. The OAK report for mission 1042-1, 17-22 June 1967, is a particularly interesting example. Passes 9, 25 and 57 covered the Middle East and the accompanying OAK report was classified, at the time, 'Top Secret handle via Talent Keyhole control only'. The report had a table in it showing all the damaged and destroyed Arab aircraft, runways and buildings. It reported a total of 245 Arab aircraft destroyed, excluding cargo and transport aircraft. This was just after the Six Day War and shows how timely it could be, when you had a constant series of reconnaissance satellites launching one after the other. The information from the, now declassified, OAK report is reproduced at Table 2.

This paper has been based on declassified US reports and photography on the satellite systems because, to date, no JARIC imagery or reports from the Cold War era have been declassified. However, JARIC had access to the same photography from all these

TABLE 1. BOMB DAMAGE, ARAB AIRFIELDS

CH	AIRFIELD NAME	PHOTO DATE	PROBABLE DESTROYED AIRCRAFT	RUNWAY DAMAGE	OTHER DAMAGE	AOB	
						FIGHTERS	BOMBERS
EGYPT							
	ABU SUWEIR	18 & 19 JUNE 67	37	24 CRATERS	NONE	NONE	NONE
	AL ARISH	18 JUNE 67	7	6 CRATERS	NONE	7 POSS A/C	NONE
	BENI SUEF	19 JUNE 67	12	AT LEAST 13 CRATERS	NONE	NONE	NONE
	BIR HASANAH NEW	18 JUNE 67	13	NONE	NONE	NONE	NONE
	BIR JIFJAFAH	18 JUNE 67	22	NONE	NONE	NONE	NONE
*	CAIRO	19 JUNE 67	NONE	3 CRATERS	NONE	1 SMALL SWEPT	NONE
*	CAIRO WEST	19 JUNE 67	25	24 CRATERS	NONE	16 SMALL SWEPT	1 BADGER
	EL MANSURA	19 JUNE 67	NONE	9 CRATERS (REPAIRED)	NONE	NONE	NONE
	FAYID	18 & 19 JUNE 67	14	17 CRATERS/ CHARRED AREAS	NONE	NONE	NONE
	GAZA	18 JUNE 67	22	NONE	NONE	NONE	NONE
	HURGHADA NEW	18 JUNE 67	7	NONE	NONE	NONE	NONE
	INCHAS	19 JUNE 67	20	9 POSS CRATERS	PARTIALLY DESTROYED HANGAR	NONE	NONE
	KABRIT	18 & 19 JUNE 67	22	8 CRATERS	NONE	NONE	NONE
	GEBEL LIBNI	18 JUNE 67	NONE	NONE	CHARRED AREA IN SUPPORT FAC	NONE	NONE
*	ALMAZA	19 JUNE 67		NO DAMAGE OBSERVED		7 SMALL SWEPT	NONE
	ISMAILIA	18 & 19 JUNE 67		NO DAMAGE OBSERVED		NONE	NONE
	PORT SAID	18 & 19 JUNE 67		NO DAMAGE OBSERVED		NONE	NONE
	RAS BANAS	18 JUNE 67		NO DAMAGE OBSERVED		NONE	NONE
			TOTAL 201				
SYRIA							
	DAMASCUS	17 JUNE 67	9	PROBABLE, EXTENT UNK	NONE	NONE	NONE
	DUMAYR	17 JUNE 67	9	NONE	NONE	NONE	NONE
	MARJ RHAYAL	17 JUNE 67		NO DAMAGE OBSERVED		NONE	NONE
	DAMASCUS NEW	17 JUNE 67		NO DAMAGE OBSERVED		NONE	NONE
			TOTAL 18				
JORDAN							
	AMMAN	17 JUNE 67	12	17 PROB CRATERS	NONE	NONE	NONE
*	KING HUSSEIN	17 JUNE 67	14	NONE	NONE	NONE	NONE
			TOTAL 26				
SAUDI ARABIA							
*	TABUK	17 JUNE 67		NO DAMAGE OBSERVED		NONE	NONE

GRAND TOTAL OF ARAB AIRCRAFT PROBABLY DESTROYED: 245

* CARGO AND TRANSPORT AIRCRAFT ARE EXCLUDED FROM AOB COUNT

Table 2 – Table from OAK Report 369.

missions from KH-1 to KH-9. JARIC provided the UK with an independent analysis of these films and all the intelligence targets. It also allowed JARIC to produce the target materials that we required as well as working with the US on joint target material production programs. JARIC would also send NPIC copies of all our photographic interpretation reports produced from the KH-1 to KH-9 systems. This was a small pay back for the enormous quantity of Spy Satellite photography given – free of charge – to JARIC.

How did JARIC get the films? It sent SAO-cleared PIs over to NPIC on regular courier runs to collect dozens of boxes of films, hard copy reports and magnetic tape with cover search data and digital NPIC PI reports. These courier runs used the RAF transport flights that went into Dulles International Airport. However, the aircraft went to a special hanger where CIA security men would sign the consignment over to the JARIC PIs, who counted the boxes on board the aircraft and witnessed the hold doors being locked before jumping on board to fly back to Brize Norton. At Brize a specially cleared JARIC ground party would meet the couriers to convey the consignment back to JARIC. As a very junior, and at the time single, officer at JARIC, I was frequently called upon to do the courier runs. They were exciting times, meeting CIA staff on a dark night at Dulles after a few days at NPIC discussing my targets with my NPIC opposite number.

Compared to the amount of material that has been released into the public domain by the USA, if you research JARIC in the National Archives, you will find only a handful of annual reports from 1961 to 1964. These do not provide any detail, or even mention the deep and comprehensive satellite photography relationship between JARIC and NPIC. However, if you read between the lines there are hints that something highly classified was going on at the time, although there are no specific references in any accompanying reports. As detailed in the 1st Annual Report on JARIC in 1961/62, JARIC had 465 staff, including a USAF exchange officer. However, although the report mentions JARIC's work on Arms and Equipment from the USSR, War Plans and Blue Steel targeting, no mention is made of satellite reconnaissance. The report does mention the existence of No 3 Section, but details of its work is in a separate report not released to The National Archives. As we know today, it was the work of No 3 Section, its successors Exploitation Wing, Target Intelligence Wing and all those

other staff who worked in the SAO at JARIC that is the real story of JARIC. JARIC was one of the unsung stars of the RAF and a very major part of the UK/US special intelligence relationship. Hopefully, now that all these Cold War events are over 30 years ago, MOD will allow access to the classified archives and a proper detailed history of JARIC can be written. After all the US, that owned the film return satellite systems, declassified all of them between 1996 and 2012 . . .

Sources (including illustrations):
The National Archives
The Medmenham Collection Archive
RAF Wyton Heritage Centre

Books: National Reconnaissance Office, Center for the Study of National Reconnaissance = CSNR below.

Bridgehead: Eastman Kodak Company's Covert Photoreconnaissance Film Processing Program (CSNR; Chantilly VA; 2014)

Burnett, Maurice G; *Hexagon Mapping Camera Program and Evolution* (CSNR; Chantilly VA; 2012)

Chester, R J; *A History of the Hexagon Program* (CSNR; Chantilly VA; 2012)

Mulcahy, Robert; *Corona Star Catchers* (Washington DC; 2012)

Oder, Frederic, James Fitzpatrick and Paul Worthman; *The Corona Story* (US Govt Printing Office, Washington DC; 1988)

Oder, Frederic, James Fitzpatrick and Paul Worthman; *The Gambit Story* (US Govt Printing Office, Washington DC; 1988)

Oder, Frederic, James Fitzpatrick and Paul Worthman; *The Hexagon Story* (US Govt Printing Office, Washington DC; 1988)

Outzen, Dr James (Ed); *A History of Satellite Reconnaissance* in The Robert L Perry Histories (CSNR, Chantilly VA; 2012)

Outzen Dr James (Ed); *Critical to US Security: The Gambit and Hexagon Satellite Reconnaissance Systems Compendium* (CSNR, Chantilly VA; 2012)

Outzen, Dr James (Ed); *Trailblazer 1964: The Quill Experimental Radar Imagery Satellite* (CSNR, Chantilly VA; 2012)

Peebles, Curtis; *The Corona Project* (Naval Institute Press;1997)

Peebles.C; *Guardians: Strategic Reconnaissance Satellites* (Presidio Press, Novato CA; 1987)

Perry, Robert l; *A History of Satellite Reconnaissance* in The Perry Gambit and Hexagon Histories (CSNR, Chantilly VA; 2012)

Ruffner, K C; *Corona: America's First Satellite Program* (CIA History Staff, Center for the Study of Intelligence; Washington DC; 1995)

Web Sites: (Accessed December 2019)

Central Intelligence Agency – https://www.cia.gov/news-information/featured-story-archive/2015-featured-story-archive/corona-declassified.html

Updated (2021-05-31) CIA Link: https://www.cia.gov/resources/csi/books-monographs/corona-americas-first-satellite-program/

National Reconnaissance Office – https://www.nro.gov/History-and-Studies/Center-for-the-Study-of-National-Reconnaissance/

US Geological Survey KH1 to KH9 images available via USGS website – https://earthexplorer.usgs.gov/

images available via USGS website – https://earthexplorer.usgs.gov/

TONKA RECCE
(Tornado Reconnaissance)

by Peter Durke

Introduction

Alone and unafraid the Tonka[1] Recce crew flew low and fast through the inky darkness seeking their prey, Iraqi *Scud* Surface-to-Surface (SSM) missile launchers. Gulf War 1 (Operation GRANBY) Counter Theatre Ballistic Missile (Counter-TBM) operations heralded the effective introduction of the dedicated low-level Tornado Recce capability, whilst Gulf War 2 (Operation TELIC[2]) would be the low-level capability's finale. Between these campaigns, recce evolved from a niche, specialist capability to a core role that remained pivotal until the demise of the Tornado Ground Attack, Reconnaissance Force (TGRF) in March 2019.[3]

Throughout its life, RAF Tornado reconnaissance (frequently hereinafter Tonka Recce) has been at the forefront of technology, initially moving the role from traditional wet film into the digital age, and subsequently becoming the only tactical fast jet employing an Electro-Optical Long Range Oblique Photography (EOLOROP) pod. Tornado's job was ultimately as much about intelligence-gathering as offensive operations.

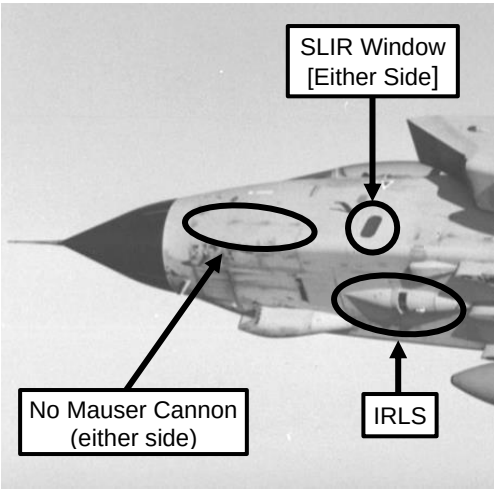
Internal Systems For Dedicated Squadrons

Whilst RAF Tornado strike/attack aircraft were designated GR1 and subsequently, post the Mid-Life Upgrade (MLU), GR4, the dedicated reconnaissance aircraft, with their internally fitted system were designated GR1A and later GR4A. Royal Saudi Air Force (RSAF) Recce Tonkas were designated Interdictor Strike/Reconnaissance (IDS/R).

Whilst based at Laarbruch, No 2 Sqn converted from the Jaguar GR1A to the Tornado GR1A on 1 January 1989. No 13 Sqn re-formed with Tornado GR1As at Honington on 1 January 1990 and No 66 Sqn RSAF operated Interdictor Strike/Reconnaissance (IDS/R) Tornados at King Khalid Air Base, Khamis Mushayt,[4] after Operation GRANBY.

The internally mounted Tornado Infra-Red Reconnaissance System (TIRRS) recorded imagery from three IR sensors on six high-definition video cassettes running at triple speed. Solid-state recording allowed

eleven frames of imagery to be quickly reviewed in the rear cockpit with the ability to rewind the tapes to examine other captured imagery in slower time. Thus, RAF tactical recce had moved on from the era of post-flight analysis of wet film into the digital age with a near real time (NRT) in-cockpit exploitation capability using an IR sensor suite that provided an imagery collection capability at any time, day or night.

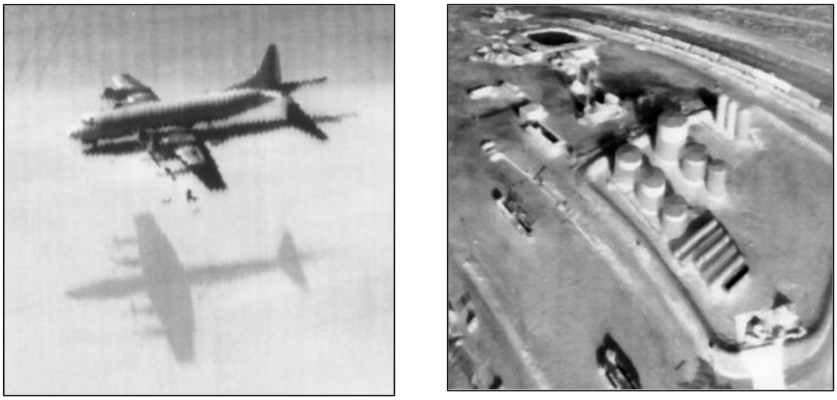


Tell-tale signs of a recce Tonka.

TIRRS was a Cold War capability, optimised to detect armoured personnel carrier-sized targets in Central Europe so, due to the region's prevailing weather conditions, and expected Warsaw Pact defences, it was designed to operate at high speeds at low-level.

IR sensors, which effectively detect temperature differences, provide intelligence information which differs from that derived from an Electro-Optical (EO) sensor, although the images produced do look similar. Whilst military equipment hidden in a camouflaged hide might be difficult to detect using an EO sensor, they would often remain 'visible' to TIRRS. Intelligence information, such as recently arrived or departed vehicles or the content of oil storage tanks, can be detected by an IR, but not an EO sensor.

The three system sensors were an Infra-Red Line Scanner (IRLS) and two Sideways Looking Infra-Red sensors (SLIR). The Vinten 4000 IRLS, housed in a bulge below the rear cockpit was, in effect, the Thermal Observation and Gunnery Sight[5] sensor from a Challenger main battle tank fitted with a line scanner – an anti-clockwise spinning mirror that built up an horizon-to-horizon image from each scan as the aircraft moved forward. Scans were generated from left to right, so if the aircraft flew too fast or too low the right of the image could be degraded. Whilst the product from a line-scanner could therefore be



IRLS images of, left, the 'shadow' left by a P-3 Orion that had recently vacated its parking spot and, right, oil storage tanks revealing their content.

partially compromised, reducing image quality,[6] it allowed the imaging platform to have a high velocity-over-height ratio, that is to say that it could be flown fast and low, which was the Tonka Recce's forte.

The two SLIRs, one on either side of the forward fuselage in front of the engine intakes, were framing units providing 10º of vertical coverage that pointed at 90º to the aircraft flight-path. They provided overlapping imagery where the IRLS quality degraded at its scan extremities. Initially, they were fixed to scan from the horizon to 10º below the horizon, latterly a number of fixed depression angles could be set pre-flight. In effect, the SLIRs worked like conventional cameras, with images collected 15 times a second. Therefore, at a training speed of 500 kt, an image was collected every 56 ft. Whilst SLIRs provided the highest resolution imagery, they were the most difficult to use due to their narrow vertical field of view (FoV). If imaging was attempted too close, the whole objective would not be captured and, if flown too fast, there might be imagery gapping. For example, during an attempt to obtain a SLIR image of a West German communications tower, the first image collected was of the compound fence leading up to the tower and the second was of the compound fence beyond the tower with no imagery of the intended task, the tower itself.

SLIR-pointing, banking the sensor FoV over the task, was often used as it could provide higher quality imagery. To do this successfully, the

A spot-on Op GRANBY IRLS image of an Iraqi Squat Eye *radar, but if you got the speed/height wrong, you could wind up with shots of the desert either side of the mast . . .*

pilot required a visual reference. Canopies could not be permanently marked because the reference was different for every combination of, how tall the pilot was, the height of his seat-setting and the selected SLIR depression angle. The time-honoured hi-tech solution was to place appropriate chinagraph marks on the front cockpit canopy guided by the images being displayed in the rear cockpit.

IR and EO sensors have different operational limitations and considerations. While an IR sensor can image throughout most of the day, meteorological conditions permitting, there are certain times when IR sensors suffer from a phenomenon known, to RAF aircrew, as 'thermal crossover'.[7] Objects and the surrounding terrain heat and cool at different rates. Man-made objects tend to heat and cool more quickly than their natural background, so are hotter by day and cooler at night. Twice a day, roughly at dawn and dusk, the temperature difference between them is insufficient for a sensor operating in the IR window used by TIRRS to produce a usable image. This was highlighted during a post-Operation GRANBY, low-level sortie over Kuwait, when huge quantities of abandoned Iraqi military hardware were seen and imaged, including the road dubbed by the press as the 'Highway to Hell.' Unfortunately, no images were obtained due to the time of day – dusk!

Development flying of what was to become the GR1A-standard aircraft commenced in 1985, approximately two years after British Aerospace Dynamics had been awarded a project definition study for a militarised IRLS. Prior to Operation GRANBY, the embryonic recce capability was unreliable and incomplete: many photographs of early GR1A aircraft are misidentified as GR1s due to the lack of SLIR

windows. One particular TIRRS component was initially prone to catching fire, so it was known as the Flaming, rather than the Framing, Mirror Electronics Unit. The development of TIRRS accelerated within days of Iraq invading Kuwait as it became apparent that the unique Tonka recce capabilities could aid acquisition of vital intelligence. Flight testing of the modifications, known as Granby 2, was conducted between Christmas 1990 and New Year 1991. Although the gathered imagery was sub-optimal, six GR1As, in a hastily-applied 'desert pink' alkali removable temporary finish, deployed to Dhahran in mid-January 1991 with hostilities commencing very shortly afterwards.[8] Subsequently, over 120 night,[9] low-level, unarmed reconnaissance sorties were flown by a composite squadron manned by personnel of Nos 2 and 13 Sqns. Due to their detection of *Scud* SSMs the popular press dubbed the recce detachment, the 'Scudbusters' although they also provided well received support to the ground forces and conducted battle damage assessment (BDA).

Elsewhere, and after Operation GRANBY, until the recce capability improved and was available in most of the Tonka recce jets, crews resorted to hand-held cameras to obtain tasked imagery. These cameras were not 'ruggedised' and they occasionally fell to pieces between collection and crewing in. On one occasion just the lens arrived at the aircraft, the body having detached somewhere between departing the squadron building and the aircraft.

The RAF acquired thirty GR1As, 13% of the total TGRF.[10] Fourteen of these aircraft were conversions of GR1s from production Batches 3 and 5 and sixteen were Batch 7 new builds – see Figure 1. Twenty-five GR1As subsequently became GR4As as part of the mid-life upgrade: four of the original GR1As had crashed and one had been so heavily modified that it could not be upgraded. The RSAF Tonka recce force eventually comprised twelve IDS/R aircraft; six Batch 7 aircraft were supplied as part of *Al Yamamah* (AY) 1, and six Batch 9 jets were provided as part of AY 2. See Figure 1.

Delivering an aircraft to BAE Systems at Warton for conversion allowed use of the full flight envelope, as the standard pylons and external stores, which reduced the cleared flight envelope to preserve aircraft fatigue, were removed prior to these sorties. This rare opportunity to utilise the clean aircraft's full capabilities, a handling experience that was only likely to be encountered otherwise during

RAF GR1A					RSAF IDS/R	
Conversions			New Builds		New Builds	
Batch 3		Batch 5	Batch 7		Batch 7	Batch 9
ZA369	ZA397[11]	ZD996	ZG705	ZG712	6615	6629
ZA370	ZA398	ZE116	ZG706[12]	ZG713	6616	6630
ZA371	ZA400		ZG707	ZG714	6617	6631
ZA372	ZA401		ZG708[13]	ZG725[14]	6618	6632
ZA373	ZA402		ZG709	ZG726	6619	6633
ZA394[15]	ZA404		ZG710	ZG727	6620	6634
ZA395	ZA405		ZG711	ZG729		

Fig 1. Tornado Recce Aircraft.

operational defensive manoeuvring, was usually given to the less experienced crews. While this was a good opportunity to handle a more responsive aircraft, returning to No 2 Sqn in Germany could be a challenge. Crews were often presented with a number of logistical issues. The problems involved in getting to a civilian airport aside, there were complications arising from the fact that we could not take some of our personal flying equipment on a civilian aircraft, so survival aids, like mini-flares, the personal locator beacon and the inflation cylinder, had to be removed from our life jackets before the return flight.

Each Tonka recce squadron was supported by a Reconnaissance Intelligence Cell (RIC). The RIC's roles were imagery exploitation and reporting the intelligence gleaned from it. With the introduction of TIRRS, the exploitation and reporting processes evolved. Photographic Interpreters (PIs), used to wet film exploitation, now had to view video imagery on screens and manipulate it using software, which was initially as immature as the aircraft's reconnaissance capabilities; PIs subsequently became Intelligence Analysts (IA). It had been envisaged that exploitation would be speeded up by using an 'edit tape', containing the imaged tasks, which was created in the aircraft when the TIRRS was shut down. This tape should have allowed the IAs to quickly review the tasks, with an opportunity to look at the other sortie recordings in slower time, if required. In reality, the original recordings were used, because the re-recorded imagery on the edit tape was degraded in comparison to the original. Following imagery

exploitation, the information gleaned from it was disseminated electronically. A sophisticated system, housed in a bespoke hardened building, called the Advanced Reconnaissance Facility (ARF), was intended to support simultaneous exploitation of multiple sorties. Sadly, however, No 2 Sqn's ARF became a very expensive 'swimming pool' when an air conditioning unit pipe became disconnected, causing the electronics to be flooded before it could ever be fully utilised.

Whilst the recorded images were 'high definition', thermal printers were used to produce hard copies. Sadly (again) these images fade (like debit card receipts), so relatively few usable TIRRS images have survived.

When the system became more reliable, one of No 2 Sqn's PIs, who was studying archaeology in his spare time, spent many hours reviewing the recordings on each sortie tape – both the IRLS and the left and right SLIRs. As a result of his endeavours he reputedly made a significant number of archaeological discoveries; buried ruins, invisible to the naked eye, are visible in the IR window used by TIRRS. Today a similar technique, known as Airborne Remote Sensing, is used to identify and monitor the condition of archaeological sites.

After Operation GRANBY, the Tonka recce aircraft of Nos 2 and 13 Sqns and the Canberras of No 39 (1 PRU) Sqn were rebased at RAF Marham. The RICs of Nos 2, 13 and 39 (1 PRU) Sqns amalgamated to become the Tactical Imagery Wing (TIW).

Cold War squadron life differed in a number of ways between Tornado recce and strike/attack squadrons crews but all had to achieve the same NATO weaponry standards. Since the recce aircraft had no gun, pilots had to conduct their strafe qualification using either the squadron's two-stick trainer or by borrowing strike/attack aircraft from one of the bomber squadrons.[16]

All Tonka squadrons commenced the flying day with a meteorological (met) brief, although on a recce squadron this included analysis of the tasks flown the previous day and a daily recognition test of Central Region Warsaw Pact and NATO military equipment. Whilst bombing attack accuracy assessments were carried out amongst the formation immediately after the sortie, recce mission assessments were provided during the squadron met brief. If any crew obtained poor images or, worse still, had not imaged the task, they had to explain to the assembled squadron aircrew why! The daily equipment recognition

test consisted of an image being briefly shown, then a randomly selected aircrew member having to identify it. It was not good for your professional pride to miss a task or get the recognition wrong, so this encouraged new arrivals to get to grips with the recognition syllabus as a matter of priority. This approach aimed to ensure that we were always prepared for operations.

Recce tasking has to be responsive because old information is of little use. Therefore, rather than being allocated 3 hours for the planning of a typical formation attack mission involving a couple of simulated attack profiles and a range session, a day 'singleton' recce sortie, consisting of at least five tasks and a similar range session, was planned in approximately half that time. Each day, all recce crews would generally fly the same tasks which were selected by the duty authoriser in the best area of weather, which was, often, barely acceptable on a good day in Germany! After both crew members, from a wave of five or six crews, had each planned their five tasks, using numerous 1:50,000 ordnance survey style maps, as well as route low flying charts, there was carnage in the planning room. Once we moved to computer-based planning, in the early noughties, there was less planning detritus but, even so, the planning area still looked like a stereotypical teenager's room on a bad day after a wave of recce sorties had been planned.

Recce tasks required imagery, and often a visual assessment, as the swathe collected at Tonka operational heights did not always capture the whole objective and a second overflight might not be the best idea for your health. Tasking could be military, civilian or a combination of both. Therefore, Tac Recce aircrew training included, as it had for many years, structure reporting as well as military equipment recognition.

Tac Recce aircrew were expected to be able to recognise hundreds of pieces of area-specific military equipment. It was especially important to be able to recognise signature[17] equipment as this might indicate the presence, or future presence, of significant capabilities. This might, for instance, be the first appearance of a new SSM launcher or of additional bumps or aerials revealing a difference between signature and general equipment. The ability to recognise military kit required hours and hours of studying available images, some of which were not of the best quality, having been taken by a less than ideal

sensor and/or from an inconvenient angle. Inexplicably, we were often expected to recognise equipment from an image of a wheel – the sort of view we might be unfortunate enough to encounter if we were about to be run over by it – when recce would be the least of our concerns! Before becoming Recce Combat Ready we had to be able to recognise all Central Region military equipment with very little observation time.

Assessing the whole military picture in a single pass is a skill that requires considerable practice. It is all too easy to see and focus on one element, thus missing other, sometimes more significant, details. There was a noticeable skill fade in this area when No 2 Sqn moved from Germany, where there were numerous, accessible military barracks and training areas, to the UK, where there were fewer, and smaller, military facilities.

Tac recce splits the world into a number of reporting categories such as Cat 3, electronics, or Cat 6, military activity. Each category has five reporting criteria ranging from a new target, which has extensive, detailed requirements for something like a Cat 16 industrial site, to BDA. Tac Recce crews needed to become very familiar with the characteristics of each category; industrial sites, for example, could range from a simple conventional factory to a complex petroleum plant with numerous key features.

Flying with recce equipment could be a two-edged sword. When you were quite sure that you hadn't inadvertently overflown an area to be avoided, it just might provide the evidence that you had. Conversely, it could prove useful following an event, such as a flypast over an official function, when scores of hyper-critical colleagues, who had witnessed your performance, would be adamant that you were not on time or even had missed! A recce print bearing the exact overflight time and measurements soon took the wind out of their sails. Recce equipment also allowed well-informed banter, because an image does not lie. For example, when the Alaskan snow was scorched by a stick of neat, fresh bomb craters short of the target after the release had been manually commenced too early, a huge print was plastered around the planning room much to the embarrassment of the responsible crew.

Operational flying differences between strike/attack and recce squadrons could catch out even the most experienced crew. During the initial work-up with Night Vision Goggles (NVGs),[18] the Fast Jet Operational Evaluation Unit (FJOEU) instructor expected us to learn

the features of the single attack he had planned for the demonstration night sortie as it was apparently too difficult to 'thumb our way down' an attack map whilst wearing NVGs.[19] On the subsequent night, when the FJOEU pilot was given five task maps, he realised that maybe memorising the features wasn't a viable option for recce flying.

Although Tonka recce aircraft were used as attack aircraft until the TGRF's withdrawal in 2019, the TIRRS capability was only deployed operationally on two occasions after Operation GRANBY.

On 27 August 1992 GR1As of No 2 Sqn and GR1s of No 617 Sqn[20] deployed to Dhahran to commence Operation JURAL, supporting the establishment of a no-fly zone over southern Iraq.[21] All operational sorties were flown at medium level, so TIRRS was only used during Kuwaiti low-level training sorties, apart from some unsuccessful attempts at SLIR pointing. Thermal Imaging and Laser Designation (TIALD) pods and *ad hoc* recce sensors, such as camcorders were used to record the systematic destruction of the marshes in south-eastern Iraq as well as patrolling below the 32nd parallel.

In 2003, aircraft ZA400/'T'[22] returned to operations as part of the Tonka force participating in Operation TELIC 1 (Gulf War 2). As part of the Combat Air Wing (CAW) at Ali Al Salem, it was utilised in a variety of roles, but was specifically in theatre to support another combined detachment of personnel from Nos 2 and 13 Sqns, this time conducting Time Sensitive Targeting (TST). TST, also known as Counter-TBM, operations, involved night, manually flown[23] low-level sorties searching for *Scud* SSMs. Unlike Operation GRANBY, the aircraft sensor suite was supplemented by a Laser Designation Pod (LDP) and appropriate air-to-surface weapons were carried with an 'on-call' wingman providing a rapid detection-to-attack capability should a suitable target be detected.[24]

The recce Tonkas were also provided with numerous Air-to-Air Refuelling (AAR) brackets, permitting them to operate at greater distances from their operating base or to remain on station longer.[25, 26] Tornado GR4As were specifically used because they had the unique ability, using their Terrain Following Radar, of being able to descend and operate at low-level below the weather, and thus to use sensors that platforms above the weather could not employ.[27] Whilst there were no major combat incidents during these sorties, one GR4A, ZG710, was shot down by a US Patriot missile, and the crew were killed, while

recovering to Ali Al Salem after an attack mission.

Between Operations GRANBY and TELIC 1, the TIRRS capability became more robust with improved equipment availability, although it remained a low-level detection system, when the remainder of the RAF fast jet forces had moved to medium level operations. With this change in mind set, and the TGRF's withdrawal from Germany, there was less time for the dedicated Tonka recce squadrons to focus on low-level Tac Recce which resulted in some skill fade. Nevertheless, and despite being constantly on operations, this capability was still fully tested by NATO during the regularly held Tactical Evaluations.

Consideration was given to improving the Tornado's recce capability by replacing the tapes with a solid state recorder, but the trials only commenced when TIRRS had already been earmarked for withdrawal. Indeed, TIRRS funding had been earmarked as a potential cost saving measure in 2003, possibly even as it was being employed on Operation TELIC 1. The Tonka low-level recce capability was down-declared on 1 September 2004, with the GR4A aircraft designation reverting to GR,4 in 2007.

Reconnaissance Pods For All TGRF Squadrons

The need for a stand-off, day and/or night, real-time reconnaissance system that could be downlinked to the ground became evident during Operation GRANBY and subsequent operations over Bosnia and Iraq.

Unfortunately, the brief interval between Operation GRANBY in 1991 and the start of Operation JURAL in 1992 did not allow the full realisation of this requirement until the end of the decade. An interim medium level imagery collection capability was provided by the acquisition, through an Urgent Operational Requirement (UOR), of Vinten Vicon 18 Series 601 GP(1) pods. Initially these pods were only intended to be used by the Jaguar and Harrier, but when Tornado GR1/1As started covering both the northern (Operation WARDEN) and the southern Iraqi no-fly operations they were also employed by the TGRF.

The Vinten GP(1) pod could image during the photo-light day, like a conventional SLR camera, using two rear cockpit-controlled cameras. Tasks were imaged using a narrow field of view 450 mm Long-Range Oblique Photography (LOROP) camera housed in the pod's rotating nose. The second sensor, a panoramic camera, fitted towards the rear

Tornado GR4, ZA589, carrying a DJRP on centreline under-fuselage pylon, an Enhanced Paveway II, on the right shoulder pylon and a TIALD pod on the left shoulder.

of the pod was also available, but did not to provide useful intelligence information when used at medium level. Whilst the GP(1) pods produced good imagery, the aircraft-to-task stand-off distance was limited to 6-8 nautical miles, which was not necessarily outside any associated threat Weapon Engagement Zone.

As GR1 aircraft, not just GR1As, could now use this reconnaissance capability, attack squadrons were also able to conduct Tac Recce. Even so, there was a difference of opinion between the attack and recce squadrons as to whether a task had been imaged. No 2 Sqn replaced an attack squadron on Operation WARDEN and after their first operational day reported less than 100% coverage. At the command level, this was met with disbelief until it was pointed out that recce squadrons only report a completed task when *all* of the required area has been imaged – not just part of it!

GP(1) pods were replaced by an improved Vinten lightweight pod in the mid-noughties. Initially, named the Jaguar Replacement Reconnaissance Pod it was re-designated as the Digital Joint Reconnaissance Pod (DJRP) on entry into service as it was a tri-platform asset, being used by the Harrier and Tornado in addition to the Jaguar. The DJRP was subsequently purchased by the RSAF for use on its Tornados.

When employed on the Tonka, like the Vicon pod, the DJRP

Example of DJRP images, left, the Ziggurat of Ur and, right, the Baghdad Air Museum.

contained two rear cockpit-controlled cameras, but it now had day and night, low to medium level capabilities. The Vicon rotating-nose camera was replaced by an EOLOROP sensor with a horizon-to-horizon IRLS in the pod rear and digital imagery recording.

In RAF service, Vicon and later the DJRP were carried on the Tornado's under-fuselage centre-line pylon. No air-to-surface stores were carried when a Vicon pod was fitted, but with a DJRP the aircraft often also carried an LDP and air-to-surface weapons such as the Enhanced Paveway II. While the Tonka's DJRPs were optimised for medium level operations, the DJRPs of No 41 Sqn's Jaguars were configured for low-level imaging.

After the demise of TIRRS, No 13 Sqn started looking at low-level DJRP Tac Recce, employing the existing medium level sensors. Whilst these low-level DJRP sorties using the sensors optimised for medium level imaging produced good results, the idea did not progress beyond a trials phase.

The ultimate solution to the medium level imaging requirement required by Operation GRANBY was the Reconnaissance Pod on Tornado (RAPTOR),[28] which was initially employed in 2002 and remained a key Tonka asset until the aircraft's withdrawal from service in 2019.[29, 30] Eight pods and two Data-Link Ground Stations (DLGS) were procured. Pods could be carried by any TGRF aircraft, which, by

A RAPTOR pod beneath a Tornado of No 13 Sqn. (Unclassified Image Courtesy of The History Press © Peter Foster)

the time that RAPTOR was introduced, were designated GR4 and GR4A as they had all received the MLU. Weighing about 1,000 kg and carried on the left under-fuselage pylon, RAPTOR consisted of a dual-band sensor, a recording system and an air-to-ground data-link.

The Dual Band 110 inch focal length (DB-110) sensor[31] allowing Electro-Optical (EO) and/or Medium Wave Infra-Red (MWIR)[32] imaging was an exportable version of the U-2's *Senior Year* Electro-Optical Reconnaissance System (SYERS-2). RAPTOR was the first EOLOROP pod with both long-range and short-range optics, allowing stand-off and over-flight imaging. Swathes of captured high-definition imagery and its associated data were stored digitally, initially on 45 Gb

capacity tapes and latterly on a solid state recorder. During task imaging the whole captured swathe, and a zoomed-in area around the task, were displayed on a rear cockpit display allowing the navigator[33] to conduct a quick assessment, such as whether the task had been collected, or even a limited BDA. Task imagery could be manipulated and searched in-cockpit and/or data-linked, live or delayed, to the DLGS for full specialist exploitation.

Hundreds of separate pre-planned tasks and targets of opportunity could be imaged by RAPTOR on each sortie, including, when necessary, stereo images.[34] Stereo '3D' imagery was used for a variety of purposes, such as allowing troops to 'walk the ground'.

In 1997 a DB-110 demonstration pod was flown by the Aeroplane and Armament Experimental Establishment (A&AEE) to demonstrate project viability. The first RAPTOR flew in February 2001 when BAE Systems began the flight trials from Warton.[35] With the potential requirement for system employment in a forthcoming second Gulf War, there was a need to accelerate the process so in-service trials were handed to No 2 Sqn in 2002.[36] Following an interim clearance in October 2002, No 31 Sqn deployed the capability to Operation SOUTHERN WATCH, the Iraqi southern no-fly zone.

RAPTOR tasking for Operation TELIC 1 included the search for ex-members of the Iraqi leadership, who were characterised on a deck of US playing cards identifying the 52 most wanted Iraqis. As well as detection, the sortie would aim to collect the required information to assist an operation to capture them, should one be detected, whilst not alerting them that they were being looked for by a noisy Tornado. During one of these sorties it was evident that someone of wealth or influence was at the tasked location, as the images were of sufficient quality to identify the car bonnet mascot.

Post Operation TELIC, the DB-110 sensor fitted inside an F-16 Vang pod, with a data-link capability, was trialled on a General Atomics Predator B[37] unmanned aerial vehicle flying over the Californian high desert from Gray Butte Auxiliary Airfield.[38] As well as proving the concept, this served to fix a RAPTOR DLGS issue, and some interesting imagery was collected along the way – images of a vacant stealth aircraft testing facility caused consternation for our American security specialist.

Initially RAPTOR-equipped aircraft carried no offensive weapons,

Operation	Area of Operation	Employment Examples
TELIC	Iraq	High definition reconnaissance including Improvised Explosive Device (IED) detection.
HERRICK	Afghanistan	Support of ground operations and IED detection.
ELLAMY	Libya	Tactical reconnaissance.
SHADER	Iraq and Syria	Surveillance; including Yazidi population protection.
TURUS	West Africa	Search mission.

Fig 2. Operations supported by RAPTOR-equipped Tornado GR4s.

but with the introduction of precision guided munitions, such as the Paveway IV, RAPTOR-loaded aircraft could conduct both reconaissance and attack sorties. RAPTOR was successfully used on several campaigns (see Figure 2) for different tasks, producing high quality imagery and information, often unavailable from other sources.

Tonka's recce capabilities, like its other avionics, evolved throughout the aircraft's lifetime to cater for the increasing importance of reconnaissance, as opposed to offensive operations. Tonka recce utilised three systems, TIRRS, the Vinten pods and RAPTOR. Dedicated reconnaissance squadrons employed TIRRS which became a feasible low-level reconnaissance detection system as the Cold War came to an end and remained in Service until 2006. Medium level imaging, in support of diversifying UK operations, became a core Tornado capability after Operation GRANBY; lightweight pods being used between the mid-1990s and 2007 and RAPTOR from 2002 until the demise of the TGRF in 2019.

Notes:

[1] The Tonka logo was derived from the Dakota Sioux word *tanka*, meaning great or big, which characterised the robust construction of the company's toy trucks. Many in the Tornado community thought that their aeroplane reflected the chunky style of a typical Tonka toy, hence its affectionate soubriquet. **Ed**

[2] The code words and nicknames applied to UK operations are not abbreviations, but TELIC was commonly interpreted as Tell Everyone Leave Is Cancelled.

[3] The TGRF was withdrawn from RAF service on 31 March 2019.

[4] Khamis Mushayt is in south western Saudi Arabia, about 100 miles north of the

Yemini border.

[5] Thermal Imaging Common Module (TICM) Signal Processing In The Element (SPRITE).

[6] During testing, the IRLS sensor was used with and without the line-scanner, achieving higher quality images without, although the test aircraft flew at a more sedentary speed and considerably higher than subsequently used by Tonka recce jets.

[7] Within the electro-magnetic spectrum there are three 'windows' in which IR energy is not absorbed, thus permitting imaging to be conducted. This effect is dependent on the IR window used.

[8] The Operation GRANBY Tonka recce aircraft tail letters were ALPHA, CHARLIE, ECHO, HOTEL, OSCAR and TANGO.

[9] Whilst Tornado offensive operations changed from low to medium level, the recce Tonkas, due to the optimisation of their sensor suite, continued to fly at low-level.

[10] Only twenty-eight of these aircraft entered RAF front-line service. Two became development aircraft with ZA402 remaining with BAE Systems and ZG706 being used by the Aeroplane and Armament Experimental Establishment.

[11] No 2 Sqn's ZA397/'O' was not converted to GR4A standard as it crashed after a mid-air collision with Tornado GR1 ZD844 during a trail from Eielson AFB, AK to Goose Bay.

[12] GR1A ZG706 was not converted to GR4A standard due to its having too many non-standard modifications.

[13] No 13 Sqn's ZG708/'C' was not converted to GR4A standard as it crashed in Scotland while low-level flying.

[14] No 13 Sqn's ZG725/'J' was not converted to GR4A standard as it crashed in Sardinia during an Armament Practice Camp sortie.

[15] No 2 Sqn's ZA394/'I' was not converted to GR4A standard as it crashed following a mid-air collision with a Jaguar GR1A, XZ108, in the vicinity of Leeming.

[16] Tornado GR1As and GR4As did not have Mauser 27mm cannon(s) fitted as the space was taken up by the TIRRS; during the MLU, aircraft converted from GR1 to GR4 had one gun removed to allow accommodation of the Forward Looking Infra-Red (FLIR) capability.

[17] An item of signature equipment reveals its type and nature or those of its operating formation.

[18] Initially only No 2 Sqn's GR1As were modified to have NVG-compatible cockpits. Occasionally an NVG-capable aircraft would be fitted with non-NVG compatible equipment as, at this time, the NATO Stock Number (NSN) did not differentiate between NVG and non-NVG standard equipment. Therefore, crews flying NVG sorties carried a roll of black tape to cover up any display or lighting that was not NVG compatible to stop it over loading the goggles with too much light. Following the MLU, all GR4 and GR4A cockpits were NVG compatible, so all qualified Tonka aircrew were capable of manual, night low-level flying.

[19] 'Thumbing down a map' is the aircrew vernacular used to describe comparing the map and ground features to ensure a point is accurately attacked or overflown.

[20] No 2 Sqn's GR1As ZA398/'S', ZA371/'C' and ZA400/'T' along with No 617 Sqn's GR1s ZA393, ZA462 and ZD849.

[21] The Iraqi southern no fly zone was established by United Nations Security Council Resolution 688.

[22] ZA400/'T' was the only Tornado Batch 3 aircraft flown during Operation TELIC. Combat Air Wing aircraft received nose art of varying standards, with TANGO having a *Scud* launcher symbol and being labelled 'Scud-Hunters'. The Tonka recce aircraft based at Ali Al Salem during Operation TELIC 1 were:

BRAVO	ZG707	'B.A.B.S' with a beaver, spanner in hand, riding a Laser Guided Bomb.
KILO	ZG726	'KYLIE'.
LIMA	ZG727	'LOOK'N FOR TWOUBLE' with a Bugs Bunny cartoon, Elmer Fudd character.
MIKE	ZG729	'MEAN ONE, IT'S A GRINCH THING YOU WOULDN'T UNDERSTAND!' with a Grinch cartoon face.
OSCAR	ZG711	'OH NELL!'
QUEBEC	ZG714	'TRUFFLE SNUFFLERS, IT'S A RECCE THANG' with Scooby Doo and Daphne cartoon characters.

An Al Udeid, Qatar-based Tornado GR4, DELTA MIKE, diverted to Ali Al Salem and, due to the nature of the aircraft's problem, was expected to remain for a while so 'Danger Mouse' nose art was applied. To the artist's surprise, the fault was fixed more quickly than expected and it got airborne on a return flight to Al Udeid with the paint still wet.

[23] NVGs allowed crews to manually fly night low-level sorties.

[24] Whilst a pair of GR4As were usually involved in simultaneous searches they were geographically separated, so effectively operated alone; a 'singleton' in the RAF aircrew parlance. A bomber asset, such as a USAF B-1B operating at medium or high level, could be called on to prosecute an attack should a target be detected.

[25] Prior to Operation GRANBY, most of the TGRF did not conduct AAR because their Cold War tasking did not require it, although UK-based squadrons, and a limited number of RAF Germany Tornado crews, were AAR-qualified. By Operation TELIC, however, AAR had become a core TGRF requirement for all Tonka squadrons and was routinely used on the vast majority of operational sorties.

[26] AAR allowed the Operation TELIC TIRRS sorties to regularly last for up to 8 hours. As no AAR was available for recce sorties during Operation GRANBY, the general sortie durations were 2½ to 3 hours with the longest being 4 hours 25 minutes.

[27] The majority of the Operation TELIC low-level Counter-TBM sorties were flown by Harrier GR7s but, due to poor weather in the search areas during this period, the five crews from Nos 2 and 13 Sqns flew 21 sorties in support of this task.

[28] The final specification was determined in 1996 and defined in Service Requirement (SR) (Air) Operational Emergency (OE) 1368.

[29] The TGRF initially also employed both the DJRP and RAPTOR for medium level imaging

[30] The last operational RAPTOR sortie was flown on 27 January 2019 from Akrotiri as part of Operation SHADER.

[31] Nominally a 110 inch visible and 55 inch IR focal length.

[32] MWIR covers the wavelengths between 3-5 μm (micrometre or microns).

[33] Following amalgamation of the navigator and air electronic officer branches in 2003, newly trained aircrew who operated the attack/recce Tonka rear-cockpit systems became Weapon System Operators (WSOs).

[34] Stereo images are obtained by selecting an increased imagery overlap for the task.

[35] The first RAPTOR pod to be flown was numbered 002, as pod 001 was initially used for build qualification.

[36] The navigators conducting the in-service flight trails were predominately from No 2 Sqn; this writer was the sole representative from No 13 Sqn.

[37] Circa 2007, the MQ-9 Predator B was renamed the Reaper.

[38] Gray Butte Auxiliary Airfield is located about 25 miles east of Palmdale, CA.

RAF REAPER OPERATIONS – THE VANGUARD YEAR

by Wg Cdr Andy Jeffrey

Readers of this paper may expect a technically focused brief covering in detail the systems that are required to come together to successfully employ Reaper on operations. While to do so would be a relatively simple task, it would not do justice to the topic of accurately describing the Vanguard Years of the RAF's Reaper Force. To the uninitiated, many aspects of Reaper World may seem 'different', there are also many that reflect much of the RAF's 100 years' experience of employing airpower.

Technically, Reaper is a relatively simple aircraft that employs an array of Intelligence, surveillance, and reconnaissance (ISR) sensors and then, if required, employs precision guided weapons, specifically GBU-12 laser-guided bombs (LGB) and Hellfire missiles. The crew communicates with the others in the air community over standard aircraft radios using the same language as those flying fast-jets, helicopters and transports or a Joint Terminal Attack Controller (JTAC) on the ground. It is flown and supported by RAF, RN and Army personnel who have successfully completed a training course that qualifies them to perform their roles. They have undergone training, in the air and on the ground, and have then been appropriately supervised as they are gradually introduced to flying and supporting operations. They then fly operational missions every day they are at work.

Nothing in the previous paragraph stands out as being any different to my previous life a Tornado GR1/4 ground attack QWI/EWI, apart from the constant operations and the simplicity of Reaper's systems when compared to the complex fuel, engines, flight controls, weapon aiming systems and avionics of the Tornado! Nothing is that different but the perception tends to be that everything 'must' be different.

The true story of Reaper World is of people and perceptions. Plain and simple – nothing else! It is an area we tend to overlook, as it is far easier to study an aircraft's technical manual and understand the intricate workings of its fuel system than it is to understand how the many people involved with Reaper 'work'. Not just the crews,

engineers and Intelligence staff, but those who find themselves having to execute higher level command and staff roles to support this fledgling capability.

Whilst my opening remarks, that Reaper shares a lot in common with manned aviation, are true, there are some significant differences. First, as a tactical weapon system, it has unprecedented endurance. Secondly, it is 'connected' to, and integrated within, a far wider community which allows the crews (and the many people watching its full motion video (FMV) feed – often referred to as 'Predator Porn') unprecedented levels of situational awareness. These first two traits mean that in Reaper World nothing really has to be rushed, as it invariably is when you are hurtling towards a target in a fast-jet on minimum fuel. Finally, and most significantly, the squadron staff predominately remain at their home base while continually flying operations. Only a single crew, qualified to undertake Launch and Recovery operations, and a small number of engineers are deployed forward. This small contingent, is relatively self-supporting, although, as at Kandahar, it relies on existing base infrastructure and support.

However, in order to maintain the interest of more traditional readers, I will make a brief detour to provide a short description of how Reaper works.

The system comprises several key elements. First, there is the Reaper itself (see Figure 1). It weighs some 10,000 lb and has a wing span of 66 feet. It is powered by a 950 shp Honeywell TPE331 turboprop engine and carries a standard weapons load of two GBU-12s on the inboard wing pylons and Hellfire missiles on the outboard stations. Both the GBU-12s and the Hellfires are precision weapons, guided by a laser from the host platform's own sensor ball[1] or via buddy-lasing from another platform. The techniques used to drop the weapons mirror those used on manned platforms and the results, the circular errors of probability (CEP), are the same – after all the weapons don't care whether they are being dropped from an F-16, an F-15 or an unmanned Reaper; they always function in exactly the same way.

Fuel is carried within the wings and the aircraft is equipped with a Raytheon Multi-Spectral Targeting System – specifically the MTS-B electro-optical/infrared (EO/IR) sensor and laser marker/designator housed in a chin turret. In addition a small, fixed camera is mounted in the nose to provide some situational awareness (SA) and weather

Dimensions:
Wingspan 66'
Length 36'
Gross Weight 10,000lb

Max speed 250 kt

Endurance
24 hrs clean
16 Hrs armed
(initially limited to 10 hrs)

Operating Altitude
20-25,000ft armed
50,000 ft clean

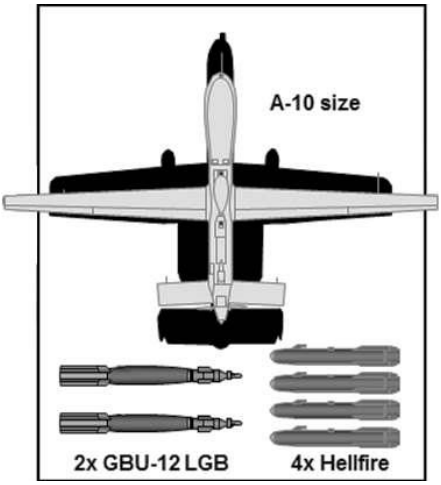


Fig 1. Reaper Specifications.

monitoring. Although our standard Tactics, Techniques, and Procedures (TTP) dictate that the crews will carry out regular weather and airframe icing checks with the MTS-B, the aircraft is not cleared for flight in cloud or icing conditions. In addition, it carries a Lynx synthetic aperture radar (SAR) in the lower portion of the nose, which produces high resolution[2] images and ground moving target indications (GMTI). A Ku-band satcom antenna, in the characteristic bulge on top of the forward upper fuselage, surveys the available satellites that provide the comms links used during the Mission Control Element (MCE) of the mission. Other comms include secure V/UHF radios, similar to those found in manned aircraft, as well as a C-band line of sight (LOS) data link. The latter uses omnidirectional antennas if the position of the recipient is unknown (or there are multiple users), or a directional 'football' antenna if communicating with a more precise location.

A 'clean' Reaper, without weapons, has an endurance of about 20-24 hours dependent on landing fuel requirements. A standard weapon load (Figure 1) reduces the endurance to about 16 hours. However, it should be noted that, in 39 Squadron's early days, the maximum mission endurance was limited to 10 hours. This was due to a shortage of crews and the fact that the UK's Ground Control Station (GCS) was not delivered until sometime after the first aircraft had been deployed

in Afghanistan. Until then, operations were only made possible by our 'borrowing' a USAF GCS. This one was only being used by the USAF in daytime, so No 39 Sqn's crews flew their initial two months of operations on permanent night shift at Creech – which was day time in Afghanistan of course.

There are two identical Ground Control Stations within the system. One at the home base, for controlling the mission portion of the operation via the Ku-band link, and one deployed with the Launch and Recovery Element (LRE) in theatre. The LRE is at the airfield with the aircraft, so that the local crew can taxi, take-off and land all the Reapers at that base to feed the MCEs. The LRE uses the C-band LOS data link which operates the aircraft in real-time, whereas there is a 1-2 sec delay via the MCE satcom link.

The final part of the system is the Predator Primary Satellite Link (PPSL), which takes the control inputs and feeds from all the MCE GCSs and relays them via Ku-band signals to and from the satellites. It is located in central Europe and, as with all satcom capabilities, is subject to disturbance by high winds. Therefore, during the met brief for a Reaper sortie the met conditions in-theatre are briefed along with those at the PPSL but *not* at the MCE location whence the crew will fly the mission! The weather around 'the cockpit' at Creech is, of course, of no consequence.

The concept of operating Reaper is termed Remote Split Operations (RSO) which contains all the parts of a manned mission – although they are not all collocated with the crew flying the mission (see Figure 2). The LRE engineers will have serviced and armed the aircraft. The arming procedures would be familiar to any ground attack pilot or navigator and, as with manned fast-jets, meticulous weapons checks are carried out as part of the walk-round and again once airborne. Having done his walk-round and completed the rest of the Reaper check list, the pilot at the LRE, and the Sensor Operator (SO), will configure the GCS at the deployed location for the nominated aircraft.[3]

At the same time, the MCE crew at Creech will have had a met brief, followed by an intelligence update and then sortie briefs. The pilot will cover the sortie details, such as aircraft tail-number, on-task time (the exact take-off time is not relevant to the mission crew), recovery fuel, weapons load and fuse settings and in-flight emergencies. The mission is then briefed by UK Reaper's third crew member – the Mission

REMOTE SPLIT OPERATIONS.

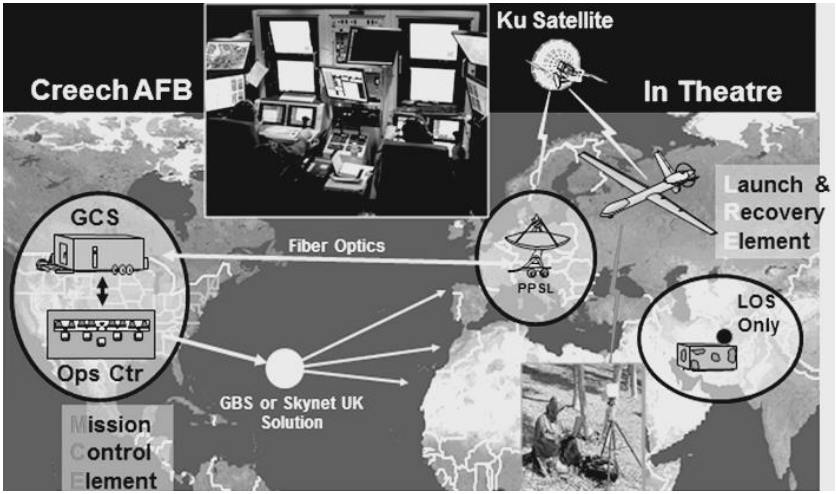


Fig 2. The Basic Building Blocks of a Reaper capability are truly global.

Intelligence Co-ordinator (MIC) – as they are the liaison with the ground units in theatre whom the mission will be supporting. This will include the comms plan, the mission's aims, and will cover the combined air/land scheme of manoeuvre. Any High Value Targets (HVT) will be briefed, using their code name designations. It should be understood, incidentally, that it is not uncommon for crews to have covered the same objective for days, weeks or months. In addition, the crew will review the Rules of Engagement (ROE) and contingencies, exactly as would for a manned mission.

During the out-brief the crew will again be quizzed on the ROE, Emergency of the Day and sortie details will be entered in the authorisation sheets and duly signed by the senior authorising officer present. The crew then make their way to the MCE GCS and 'enter Afghanistan'. They then configure their cockpit to fly the tail number that they have been allocated by the LRE. Once in 'the cockpit' (see Figure 3), both the LRE and MCE crews follow challenge and response checklists and, once comms have been established with the LRE via a 'chat room', the MCE will let the LRE crew know the required post-take off heading and height and height.

Fig 3. The Reaper 'cockpit' in the Mission Control Element at Creech AFB, NV.

Once the aircraft is airborne, the crew at the MCE is able to receive the sensor feeds and feedback from the aircraft's health monitoring system. Then, at a predetermined point of the check list, the LRE crew will break the C-band LOS data link, and allow the MCE at Creech to control the aircraft via a Ku-band satcom channel. Once the aircraft has been safely handed over, the LRE crew will reconfigure their GCS either to get the next aircraft airborne or to recover an inbound Reaper.

Having provided a baseline overview of Reaper operations and, hopefully, satisfied more technically minded readers, I will now move on to discuss some particular facets of Reaper operations. As will become apparent, while Reaper does have some unique characteristics, they all tend to mirror the *modus operandi* of more traditional manned aviation.

Endurance and Enduring Operations

The General Atomics MQ-9 Reaper is a direct decedent of the MQ-1 Predator, which first flew in 2001 and has accumulated more than a million flying hours. The Predator was an experimental system

developed by a private company which took a simple airframe with a snowmobile engine, and added satellite and LOS coms plus a sensor ball able to 'see' by day or night. Following its initial deployment, the Predator was immediately deemed a huge success. Inevitably, the system was soon weaponised, transforming the Predator ISR platform into a hunter-killer armed with two laser-guided Hellfire missiles. Again, it was a huge success in operational theatres where the coalition enjoyed a degree of air dominance. However, Predator was extremely cheap, compared to its manned counterparts, and in some circumstances, such as contributing to SEAD/DEAD (Suppression and/or Destruction of Enemy Air Defenses) missions, was considered disposable.

As an experimental system, Predator was designed with minimal consideration to airworthiness and had no redundant or back-up systems. It has single points of failure and therefore, many airframes were lost to accidents – although some losses can be put down to deliberate attrition.[4] Predator, is relatively small and has a limited payload in terms of the number of weapons it can carry and, more importantly, the sensors required to locate and identify targets for those weapons to destroy.

Any aircraft with a very capable multi-sensor package, plus a considerable weapons load, with an endurance of over half a day is an extremely attractive operational asset. This was especially so in a theatre where targets were often fleeting and where the detection of many threats to our land forces required us to build up a robust picture of the pattern-of-life of an enemy embedded amongst the non-combatant civilian population. However, if there is one urban myth within Reaper World that needs putting to bed it is the fact that this class of unmanned system is *not* manned! It is! – because it takes qualified people to fly, maintain and exploit the intelligence it produces. And it produces intelligence by the bucket load. The availability of Reaper's prodigious ISR product made it increasingly clear that effective tactical decision-making was critically dependent upon what was done with that data and leaving no useful information on the 'cutting room floor'.

Whilst informing commanders that they have just procured a system that can fly for over 14 hours is one thing, understanding the implications that that has on manning levels is very different. The UK's Reaper force was initially provided with a very small cadre of crews.

The first two crews migrated across from No 1115 Flt[5] where they had been flying operations embedded within the USAF Predator force. They were first-class operators and highly regarded by the Americans as crews, supervisors, weaponeers and instructors, some individuals having risen to fill significant posts within the USAF squadrons. They were key staff as far as our US colleagues were concerned, and getting them transferred to No 39 Sqn required sensitive negotiations, which focused on how the UK crews and engineers would help to create a coalition Reaper force. The aspirations at the time were for the USAF to maintain no fewer than 55 Reaper orbits, 24/7 spread across multiple theatres.[6] We were reliant on the USAF, of course, but they needed us to help fill gaps in their capabilities – which led to the development of a very close relationship and extensive co-operation between No 39 Sqn and the USAF's 42nd Attack Squadron (ATKS).[7]

Continual operations on a Reaper squadron are a marathon and not a sprint. I had regular chats with the UK personnel still embedded with No 1115 Flt and, when I looked them in the eye, I saw they were tired. Not only were they tired, but drained and on more than one occasion, I was asked to hasten their move across to 39 Squadron and a more long-term view to enduring operations. Many of them had been flying operations continually for 4 years and, despite some small respite whilst on instructor duties, the pace of operations on the USAF units was relentless. The USAF operated 12 hour shift pattern at work, which did not include any journey time.

Creech AFB lies on Interstate 95 (I95), about 1¼ hour's drive north west of Las Vegas, where most of the squadron's personnel lived. Compared to England's green and pleasant land, the scenery is stunning, particularly as the sun is rising or setting when an orange-purple tint takes over from the daytime dusty hues of the desert. The journey north from Las Vegas takes you through the Nevada desert, with the snow-topped Mount Charleston eventually appearing on your left, and keeping you company for an hour or so before Creech looms out of the heat haze. The large prison complex to the north of Mount Charleston, indicated two things; fifteen minutes left on your journey, and a loss of cell-phone signal until you reach the Main Gates.

The I95 is predominately straight. It has only two shallow bends of about 15 degrees each to exercise one's driving skills but, once the initial wonder of your new existence has faded, driving the I95 becomes

extremely tedious. As the days of hard shift work turn into weeks, which then turn into months, the tendency to lose one's concentration whilst driving was overwhelming. So much so that the USAF were losing around four airmen or women a year in road traffic accidents due to their having fallen asleep at the wheel. On hearing this, my top priority became not to lose any UK personnel in such circumstances. This was common sense, of course, but the duty authoriser would always ask if the team were fit to drive home after their shift. If not, then the buddy-buddy system came into play and cars would be abandoned in the newly laid squadron car park. Again, perception is everything and, even after spending a day and a half in Reaper World, visitors had difficulty comprehending the drudgery of the journey because they were still savouring the initial experience of driving through the Nevada desert. That said, once we had a well-established operational routine, there were days when all of us, at one time or another, used the hour-long desert drive as a time to unwind, think, reflect – to 'decompress'.

Having seen the fatigue in the faces of the 1115 Flight personnel, and with the mind-set that we were in this for the long haul, I issued my first order in the 39 Squadron Flying Order Book. Whenever possible, crews were to have a duty day of 10 hours, which was to *include* their journey time. In exceptional circumstances a Flight Commander or I could extend this to 12 hours but not for extended periods. The last thing I, or the ground troops in Afghanistan needed, was an excessively fatigued crew attempting to employ precision guided missiles (PGM) in potentially 'Danger Close' scenarios. This would not be acceptable on a fast-jet squadron and the same was true on Reaper, especially as the level of oversight to which the delivery of our weapons was subjected was far in excess of anything I had ever experienced before.

Weaponry in Reaper World

Dropping or firing weapons from Reaper is essentially the same as from a Tornado; but there are a few differences. First, there is a 1-2 second delay between moving the laser spot on the video from the MTS-B and that being acted upon by the Hellfire or GBU-12. This is no different from how one acquires and tracks stationary or moving objects oneself, although the human brain performs some magic which removes the delay. Secondly, the Reaper flies at 200 knots (less than

half the TAS of a fast-jet) which reduces the forward throw of the GBUs to about 1·5nm and therefore increases the risk of missing the target due to high sight-line-spin[8] or, in extreme cases, losing the laser spot completely due to the podium effect.[9] Therefore, perhaps more than in fast-jets, the need to fly an accurate post-release manoeuvre is rammed home hard in training and is practised on every sortie. Finally, and most significantly, when releasing weapons from a Tornado I was the only one watching the video from the targeting pod! This is not the case in Reaper World, because the feeds from the aircraft go, not only back to the squadron and wing HQs, but also to the Combined Air Operations Centre (CAOC) – for all to see. This can be a boon – if, for example, one needed specialist advice from the UK's lawyer, you could use a 'chat channel' or a secure phone to talk them through the context of the FMV he or she was watching. However, knowing that many eyes are watching your efforts 'live' can be incredibly unnerving. The pressure of failing in front of your seniors and colleagues is far harsher than the pressure of merely hitting a target, as you have done hundreds of times in training, and then 'surviving the debrief'. Your peers' new-found ability to judge you instantly is a pain but, and more significantly, this facility also permits commanders to employ a tactical 'long-screw driver' which, however well-intended, actually helps no one . . . This sort of well-meant, but ill-advised, interference happened more than once, but I will spare some senior officer blushes. These blushes would have been avoided if all connected to Reaper actually understood (and here I make no apology for repeating myself) that weapons don't care whether have been dropped from a fast-jet or a Reaper. They are guided in exactly in the same way, with the same level of training and supervision and using the same ROE.

Training to Sustain Enduring Operations

Whilst the clamour for Reaper's services was significant, it was important to ensure that expectations of sortie length were managed. The experience of my fellow Squadron Commanders from the USAF side of the house was that, once you had 'surged' – increased the tempo of operations – you were never allowed to revert to a rate of flying that was manageable. This also highlights another important point – the pressures of normal life do *not* go away for people on continual operations *at their home base*. People needed to take leave, attend

career-developing courses; they got sick, had to take their kids to school, etc, etc. Those factors are very real and the ability to manage a squadron on continual operations, while also dealing with routine family business, is very different from a conventional detachment where deployed personnel can focus solely on the task at hand, largely free of domestic concerns.

However, in 2007 39 Squadron's Achilles Heel was (and probably still is?) its lack of trained and combat ready crews. Training places were scarce with only one or two UK crews attending the USAF Operational Training Unit courses run by the 42nd ATKS. However, to 'buy' each crew slot on these courses, I had to contribute an RAF instructor crew. This effectively precluded the instructor crew's participating in operations. If I was lucky enough to be allocated two places that would be tempered by the need to commit two instructor crews, thus further depleting my combat-ready cadre. Given that the manning policy at the time was to stick to 2½ year tours, building up my 'stock' of operational crews was a very slow progress. In addition, I always had one crew in-theatre with the Launch and Recovery Element and another training in preparation for the next rotation to Kandahar.

Whatever the tote board read in Group HQ, the reality was that with leave, courses, etc I was always short of a minimum of three or four crews. The build-up was a painfully slow process which piled more pressure on the original batch of 39 Squadron crews. My aim was to create a sustainable operation but, once again, subtle differences between my objectives and those of other players was lost on some of the latter. As an example, one of my trainee pilots was a good skier and in his past life, as a helicopter pilot, he had regularly attended the RAF Ski Championships. He was a good bet to win a race and was well known by the senior officer who acted as the event's patron. Toward the end of his conversion course, he asked to see me and let me know that he had been asked to represent the RAF in the forthcoming championship. He was about to be certified Combat Ready (CR) and he and the other two crews on his course would (at last!) allow us to permanently increase our flying window/mission duration from 10 to 12 hours a day. We discussed the matter and, given the reliance that had been invested in his crew's imminent coming on board, he agreed to forgo the event for a year. About two days later I received an email

from an air commodore suggesting that I might consider changing my mind – for the good of the Service. Needless to say, said pilot attended the event, and he did very well, but the remaining crews back at Creech were obliged to 'stagger on' once again to cover his shift.

Not surprisingly, I took my experience as a senior supervisor on a Tornado squadron as my baseline on how we would run operations. The roles of the duty authorizing officer, programmer, ops staff and support staff will be familiar to many reading this. However, I needed to ensure that people clearly understood that we were still building up a capability which meant that the long-run was key. In addition we flew, where possible as constituted crews, most of which were formed during their operational training with the 42nd ATKS. Those who came from aircraft without air-to-ground weaponry were crewed with those from the Tornado GR force or with Predator experience.

A Crew of Three and Ever Present

The UK's Reapers are flown as a crew aeroplane with the pilot, sensor operator and Mission Intelligence Co-ordinator (MIC) acting together and practising Crew Resource Management (CRM). All three are located in the Ground Control Station (GCS). This is not the case with our USAF colleagues whose manning policy had dictated a very different approach. There were only two crew in an American GCS and the pilot was the only experienced aircrew member so, in effect, he flew the aircraft as a single-seater apart from having the senor operator make some switches and guide the weapons. Like us, the USAF did provide a MIC per aircraft, but theirs all worked in a single large office, connected to their crews via intercom. Operating as a crew of three on the UK side of the house had many advantages, not least the ability of the MIC to stand between the pilot and SO to observe the input from the MTS-B and the Lynx SAR. Having this third, and eminently qualified, set of eyes on the job was invaluable.

The MICs were the experts on how a Taliban-run Afghanistan 'worked'. Their knowledge of how the civilian population lived, and how the Taliban changed its TTPs, was outstanding and their detailed understanding meant that, on occasion, they were able to cry foul and stop a weapon drop that had already been authorised.

Day after day, we watched and learnt about the Taliban and the Afghan population. Subsequently, and not without some irony, the 39

Squadron crews based on the western side of USA, became the 'ever presents' in theatre. They provided a continuity that simply cannot be provided by units that deploy for only a few months. Of all those in-theatre the 39 Squadron MICs probably knew Afghanistan better than anyone. As this became increasingly apparent, they began to be used by many units as the 'go to' source for tactical intelligence.

As an example of how we learnt quickly about Afghanistan, in the early days of operations we were assigned a pop-up task which involved watching three suspect insurgents. In Afghanistan it was early evening into dusk and we were watching the men digging in the road alongside some open farm land. Immediately, the chat room we were in with the 'customer' lit up as it began to appear that we were seeing a possible IED being planted. We watched patiently and contributed our own thoughts. We had not seen any AK-47s or any other weapons; they were not being particularly covert and they had not posted sentries to cover their activity. Despite the lack of indicators and warnings, however, talk of authorising a strike against these individuals was beginning to spin up. We had to think quickly and, while the pilot and SO continued to provide overwatch, the MIC began reviewing the footage, but using the coverage in the infrared spectrum. We needed to do our best to confirm or deny that an IED operation really was taking place. What we had seen did not actually justify a strike – it just didn't add up, and we were duty bound by our ROE and the overarching need to minimise collateral damage. Then the MICs came up trumps. The IR footage over the past 6 hours showed the field slowly changing colour reflecting a fall in temperature as the soil was irrigated. The 'suspects' had simply been diverting the stream that fed the local village in order to irrigate their crops. Once we had shown snap shots of the IR video to the customer, things calmed down; any thought of a strike was called off and interest moved to the next task. The MICs followed this up, and it was confirmed that the farmers did this at dusk for two reasons. It minimised the loss of water due to evaporation, compared to day time – and the onset of darkness covered their diversion of the water from their fellow villagers!

Still More To Do

In the early summer of 2007, as well as training flights and other preparations for our operational role, my staff were also designing the

Fig 4. No 39 Sqn HQ & Ops Building with the Ground Control Station in foreground.

squadron's building and then overseeing its construction (see Figure 4). In addition, Reaper relies on robust communications, both to control the aircraft in flight and to 'connect' the squadron within the coalition's operational community. Also, we needed the introduction of Defence Information Infrastructure (DII) at both restricted and secret levels, so the burden on our very small Comm/IT engineering team was significant. There was much to do, and the sense of needing to succeed was palpable, so it was all hands to the pump. My Executive Officer led the comms integration team. Another squadron leader oversaw construction of the building and the recovery of some 39 Squadron memorabilia, while my Weapons Leader prepared the squadron for the day that ZZ200, '201 and '202 would fly their first armed missions (see Figure 5). All of them, plus the aircrew, warrant officers, SNCOs and officers alike, performed faultlessly, but the task of convincing our leadership that we were fit to employ weapons was particularly onerous.

Weapon delivery from a Reaper was relatively familiar to those of us who had previously flown combat aeroplanes and we were able to pass on our expertise to those who had come from different backgrounds. The composition of No 39 Sqn's crews reflected pretty much every type of aircrew that the RAF possessed. Their different

Fig 5. ZZ200.the UK's first Reaper pictured in the circuit at Kandahar.

experiences and insights contributed to our overall professionalism and thoughts on how we could best employ our Reapers. As a result, our TTPs diverged from those of the USAF and, even when armed, we still saw ourselves as ISR experts but with the additional ability of being able to deliver a surgical strike in support of our boots on the ground. Again, nothing has to be rushed in Reaper World – 'If I cannot strike with the weapon of choice at my time of choosing with zero collateral damage I will wait until the next time.'

Education, Education, Education

In my just over two years as OC 39 Squadron, I was privileged to host 271 visits to our operations at Creech! The visitors were varied in the extreme, ranging from military 4-stars, Group Staffs, sundry subject matter experts (SME) and members of the media. An enduring memory will be of our two press days. Even with the facilitation and help of HQ Strike Command's media staff, looking after 21 press and TV crews was the ultimate in herding cats. To be fair, they were all extremely interested in what we were doing and generally gave us some well-balanced coverage. Only one newspaper went off-message, writing a piece focusing on pre-conceived and uniformed views on the morality of remote warfare. We were permitted to show them a training mission from the crew's point of view and the look on the face of the 'lad's mag'

reporter, who was slightly the worse for wear, as he entered the ground station and took his first step into Reaper World was something to behold – his previous opinions disappeared as he viewed the many screens, offering the crew unprecedented situational awareness. As many do, he watched the mission unfold before him in stunned silence.

In the early days of summer 2007, hosting visits was a burden, but a vital one that was reaping more benefits than negatives. Prior to taking command, I had been acknowledged as the UK military's foremost SME on unmanned systems across all three Services and industry, and I was ACAS's advisor on Unmanned Aerial Vehicles (UAV) and Unmanned Combat Air Vehicles (UCAV). Part of the personal task I had set myself was to inform and educate senior staff and peers alike on the facts behind Reaper and to dispel the many urban myths that surround Reaper World. Having handed over command, on pleasantly warm late-August evening in 2009, I assessed my performance against this seemingly simple aim – I had failed. There was just too much educating to be done and many folk were simply unable to set aside their previous 30 years' experience of flying; some could not even understand why you could not/should not simply continue to use a fast-jet for this role.

Visitors fell into three broad categories, and I could usually tell within minutes of greeting them at our new pre-fab squadron building which bucket they fell into. There were *'those who got it', 'those who didn't get it'* and *'those who didn't want to get it'.* How different people chose to perceive Reaper is a huge topic, worthy of a paper in its own right. Suffice to say that the success of the UK's Reaper programme was down to a huge team effort.

Our most important visitors, by far, were the Land units that we supported in Afghanistan. This face-to-face liaison was key, both to my people, and to the soldiers and commanders who would eventually put their personal 'boots on the ground' after which they would be at risk every waking moment that they remained in-theatre. It was these visits, and being able to look our Army colleagues in the eye, that caused me to sum up our reason for being in a few simple words. 39 Squadron existed to ***'Save lives and make a difference'***. Through these pre- and post-tour visits we became connected with the soldiers on a personal level, a factor that was not prevalent in my previous operational experience as a Tornado ground attack navigator. We were

very much part of ground operations in Afghanistan, and we were going to make sure, as far as was humanly possible, that we succeeded in our mission which was to support those folk who did not have the luxury of going home to their loved ones every day.

Re-formation of No 39 Sqn

Perhaps a short description of 39 Squadron's re-formation ceremony is a befitting end to sum up the experience of formally establishing the RAF's first Reaper squadron. In a few short months we had moved from being a lodger unit and bit-part player within the USAF's Reaper force to becoming a fully-fledged RAF squadron, parented by Waddington and under the command of AOC 2 Group. We had already proven ourselves to be resourceful and successful in delivering vital air-support to our front-line troops. We had undoubtedly saved lives.

Under normal circumstances, a newly formed unit with a brand new aircraft type would be sheltered from operations for some time until a well-judged Initial, and then Full Operational Capability (IOC and FOC) could be declared. We were not in this boat – far from it. We were a band of brothers and sisters, from diverse backgrounds fighting a war in Afghanistan from the continental USA. At the same time, since we were an innovation, we were under constant close surveillance by our commanders and by the media. Reaper was in many ways the same as any other aeroplane, but it also very different but, either way, we were an RAF unit, and a formal ceremony was deemed appropriate to allow the blessing and presentation of a new squadron Standard.

And here, again, lies a paradox. A new squadron will not usually be flying operations with two different types of aircraft on a three-shift pattern covering 24 hours a day before it officially re-forms. A normal re-formation ceremony takes weeks of preparation for all involved to formally present the squadron Standard. I was adamant that we were not going to compromise our operational footing and so, with the help once again of the 2 Group staffs, we devised a ceremony that contained all of the formality but required very little rehearsal and did not impact on our support of the front-line (see Figure 6).

Given the searing heat of the Nevada desert, an outside parade was a non-starter, so we designed a ceremony that used the floor space of the 42nd ATKS maintenance hangar. We had to minimise costs, so a very small party travelled from the UK. DCinC Ops was to be the

Fig 6. Presentation of No 39 Sqn's new Standard at a ceremony held at Creech AFB.

reviewing officer and he, along with a padre and a few staff officers from 2 Group, and representatives of the Abbey Wood-based Integrated Project Team (IPT) made their way to Creech under the guise of our regular Reaper 'Stand-Up' conference. VIP guests from Nellis and Creech were duly invited and, following three short rehearsals, we held a formal ceremony, culminating in the presentation of our new Standard.

Nothing had been left to chance, and, despite the austere arrangements, no detail was omitted. Post-It Notes with the 'lines' to be delivered by the key players were strategically placed out of sight of the audience To the assembled USAF and RAF visitors, we appeared word perfect – as, indeed, we were! As is evident from the accompanying picture, the drumhead on which the padre blessed the Standard was actually a drum kit borrowed from a local music shop in a shopping mall, just across the street from my house. We wore flying suits and desert combats, reflecting the operational nature of the unit and our key message was that, while we were duly and reverently blessing our new Standard, we still had crews quietly and professionally flying combat operations on both the Reaper and Predator. They were employing air power in a new way. A different way, but somehow the same, and very familiar to anyone who has flown on operations.

Notes:

[1] Curiously, the US Reaper crews always referred to the MTS-B sensor ball as a 'targeting pod'.

[2] For the purposes of this paper 'high' equates to a resolution of about-one-foot, or better.

[3] A GCS can control any assigned Reaper. However, to fly a mission it must be configured for the specific tail number being used. However, once an outbound aircraft has been handed over to Creech, the LRE's GCS is quickly reconfigured to take the next aircraft. This is how a single GCS is able to recover all the Reapers to a single base. It can also handle problems like a weather recall, or a satcom failure, in which case inbound Reapers can be 'racked and stacked' with each aircraft being recovered in turn by the single crew.

[4] During Gulf War 2, TV news coverage showed Iraqi civilians searching an area of a river bank for downed aircrew. The aircraft was in fact a Predator that had been sacrificed to stimulate the missile engagement zone of a mobile SAM system. The missile system's fire control radar illuminated and shot down the Predator, but not before an anti-radiation missile had been fired from a coalition aircraft which 'killed' the launcher.

[5] No 1115 Flt was the designation for the 44 UK personnel embedded within the USAF's Predator Force. They were a mix of pilots, sensor operators, intelligence offices and analysts, and engineers. They served with the USAF's Nos 11 and 15 Sqns hence the adoption of No 1115 Flt.

[6] Back in 2007 the USAF used the term Combat Air Patrol, rather than orbit, highlighting that the Reaper's main function was as a Close Air Support (CAS) asset.

[7] As above, the designation of the 42nd Attack Squadron reflected USAF doctrine in that its Reapers were seen as CAS aircraft rather than mere ISR platforms.

[8] Suffice to say that 'sight line spin' is the rotation of a line projected from a missile to the target. Beyond that it gets really complicated and an explanation is unnecessary in the context of this paper.

[9] Under some conditions, the Reaper may get ahead of the weapon while it is still in flight with its laser seeker 'looking forward' while, having overflown the target, the aircraft's laser is now 'looking backward'. Depending on the nature of the target, this may mean that the laser is now illuminating a 'back' wall, in which case there may be no energy reflected towards the weapon, which will cease to home. This is known as the podium effect.

PROJECT OLDSTER – THE RAF AND THE U-2 1958-60

by Chris Pocock

In May 1956, Prime Minister Anthony Eden reversed his recent decision to allow the new U-2 spyplane to be based in the UK for overflights of Eastern Europe and the Soviet Union by American pilots. The CIA's Detachment A moved to West Germany, and flew its first missions across the Iron Curtain the following month. Two years later, however, the RAF became a full partner in this extraordinary project. The 'special relationship' had prevailed.

The first overflights had provided a bonanza of intelligence. Cruising at 70,000 feet, they had proved invulnerable to interception by Soviet fighters, as intended. But contrary to expectations, they had been detected by Soviet radars. Moscow sent a diplomatic protest, and to the CIA's acute disappointment, President Eisenhower only reluctantly and occasionally approved subsequent missions.

CIA project director Richard Bissell therefore suggested that the UK should make overflights that would be approved in London, rather than Washington. Eisenhower agreed, and an approach was made in October 1957. Discussions followed between CIA Project Headquarters and senior RAF officers in the Air Ministry. An outline proposal was approved by Harold Macmillan, now the British Prime Minister, on 27 February 1958.

Even before detailed negotiations took place, the RAF had selected four pilots for training: Sqn Ldr Chris Walker and Flt Lts Mike Bradley, David Dowling and John MacArthur. They arrived in the US on 19 March 1958 and four days later flew to the famous Lovelace Clinic in Albuquerque for the intensive, week-long medical that was obligatory for prospective U-2 pilots. Then came the fitting of partial pressure suits at the David Clark Co in Worcester, MA, a visit to the decompression chamber at Wright-Patterson AFB, and an escape and evasion course at Camp Peary, VA, the CIA's secret training facility. Then they were then sent to Laughlin AFB in Texas, where the USAF had established its own U-2 squadron.

Meanwhile, talks in London centred on the extent to which the RAF would operate independently of the US. For example, would a couple of aircraft be legally transferred to the RAF? The key British participants were ACAS(Ops), AVM Ronnie Lees, ACAS(Int), AVM

The first four RAF U-2 pilots, L-R, Sqn Ldr Chris Walker and Flt Lts Mike Bradley, David Dowling and John MacArthur. (via Pat Halloran)

William MacDonald, and Sir Patrick Dean, the Permanent Under-Secretary at the Foreign Office. (MacDonald was succeeded by AVM Sidney Bufton in mid-1958).

Eventually, an integrated operation was arranged. The four RAF pilots would be joined by a navigator (Flt Lt Mike Collingwood) and a medical officer (Flt Lt John Clifford), who would all join the CIA's Detachment B, based at Incirlik in Turkey. But the aircraft would remain US property, and there would be no change to the unusual structure of the detachment. This comprised: a USAF commander; between six and eight former USAF pilots, now employed as civilians by 'the Agency'; security and communications personnel, also employed by the CIA; operations officers and enlisted assistants who retained their USAF status; and civilian contractors who maintained the aircraft and their sensors.

Within the Air Ministry, a small office was created in Room 7323 of the Whitehall Gardens building. It was headed by Gp Capt Thomas

Bingham-Hall, assisted by Wg Cdr Colin Kunkler. They reported to DDOps(Recce), Gp Capt Stewart Wise. Wg Cdr Norman Mackie was sent as liaison officer to CIA Project HQ.

By this time, the CIA's codeword for its U-2 operation was CHALICE. But a separate codeword was allocated to the British participation. The first two of these were short-lived, before OLDSTER was adopted.

Project OLDSTER was Top Secret, of course, and only 24 people were cleared for it in the whole of Whitehall. But there had to be an unclassified cover story. After much discussion, 'meteorological research' was agreed, to match the CIA's own cover story. The Director General of the Met Office was briefed, and a short statement was inserted in the *Meteorological Magazine*. It said that the US was loaning two aircraft for flights in the UK by RAF pilots.

But, because knowledge of the project was so strictly confined within Whitehall and the Air Ministry, there was even a separate cover story for those with Top Secret clearances who might become suspicious – radar reconnaissance and the air sampling of nuclear weapons fallout. The U-2 did indeed also perform those missions, but Project OLDSTER was all about taking photos of the Soviet Union.

There was a protracted and convoluted debate about whether the British U-2 pilots should be civilians to aid in deniability, again matching the American practice. The PM favoured this. Eventually, it was agreed that they should remain as RAF officers. But when they were deployed to Incirlik, they would wear civilian clothes and pretend to be working for the Met Office.

On 8 July 1958, Sqn Ldr Walker was killed when his aircraft went out of control at high altitude and crashed in the Texas panhandle. The next day, a USAF pilot was killed in similar circumstances. Walker's autopsy revealed that he had become hypoxic, and inspections of other U-2s suggested that ice had formed in the oxygen system. But further, Walker had used his ejection seat, which had not separated, and there was evidence of a fire in the USAF pilot's oxygen tube. The U-2 was grounded for a month for reliability checks and modifications. As soon as flying was resumed, another USAF pilot died when he stalled on final approach.

Twelve U-2s had now been lost in accidents. Some were pilot error: this was a difficult aircraft to fly, especially at high altitude where the

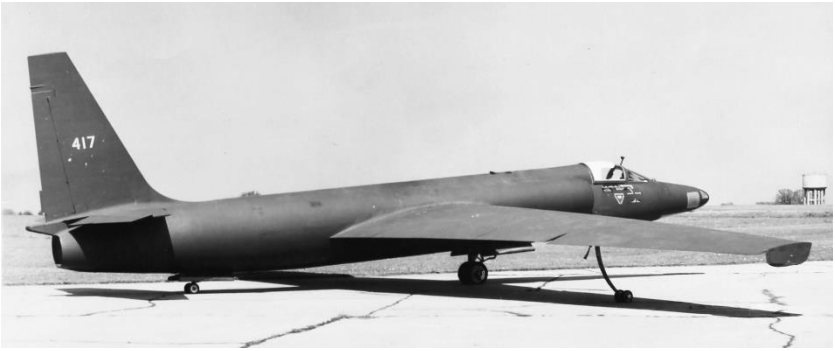
Sqn Ldr Robbie Robinson, seen here in front of the Scorpion rocket-powered Canberra, succeeded Walker as OC the RAF contingent at Det B. (Paul Lashmar Collection)

stall and buffet speeds converged to as little as ten knots. The weight-saving 'bicycle' undercarriage made landing the 80-foot wingspan U-2 a major challenge. There was no dual-seat training version. Instructor pilots first demonstrated some U-2 flying techniques in a T-33. Then came the trainee's first solo, a low-altitude flight which the instructor pilot 'chased' in a Cessna 310, relaying advice by radio. (For more detail on the unique flying characteristics of the U-2, see the following contribution by Ian McBride).

More inspections followed, which delayed the final qualification of the RAF pilots. Sqn Ldr Robbie Robinson joined them in Texas as a replacement for Walker. He was a test pilot who had already flown to high altitude in the rocket-assisted Canberra WK163. This aircraft currently held the world record of 70,308 feet – but only because the U-2's maximum altitude of 75,000 feet remained secret!

In London, a procedure for securing political approval for British U-2 overflights was devised. A provisional programme for each three months would be submitted to the Secretary of State for Air, the Foreign Minister and the Prime Minister. The Air Ministry envisaged two flights over the Soviet Union and two over the Middle East each month. It would provide detailed routes to the three politicians and seek their final approval 24 hours before each scheduled take-off.

These plans were soon to prove unduly optimistic. So was Richard Bissell's idea that a British-flown mission – including political approval – could be considered entirely independent of the US. In practice, Projects CHALICE and OLDSTER were too tightly integrated. For instance, all the targets were agreed jointly, and the detailed mission planning was done by the American staff at Project HQ. The film from



The U-2 that was deployed to Watton in May 1959, to be flown by RAF pilots on 'meteorological ' research' flights. (TNA AIR40/2749)

the U-2's main camera could only be processed in the US. The entire operation relied on USAF aircraft for airlift and passenger shuttle flights.

The final operations plan was signed in London by AVM Bufton and the CIA Deputy Project Director, Jim Cunningham, on 28 October 1958. The three RAF pilots who had qualified arrived at Incirlik in mid-November, plus the doctor. The navigator followed in early January, as did Sqn Ldr Robinson on completion of his flight training. He became commander of the British contingent within Detachment B.

The PM had taken a particular interest in the cover story, and asked that it be reinforced by sending a U-2 to the UK for weather research flights, before any operational mission was flown. (The U-2 could carry a dedicated meteorological package. It had already investigated typhoons over Japan). In early December 1958 therefore, an aircraft was flown to RAF Watton, where a 'Meteorological Experimental Unit' had been established. But severe frost and fog prevented all but one flight in the entire two-week deployment. Det B made two more excursions to Watton, in May and October 1959. Some more 'weather' flights were made over the UK, and these deployments also served to practise the 'Fast Move' technique that had been developed – deploying the U-2 to staging bases with minimum support equipment, to help disguise and speed operations.

On the last day of 1958, an RAF pilot flew the UK's first operational

mission, an eight-hour overflight of Egypt, Syria and Jordan. Previously, coverage of the Middle East had been obtained by Canberra PR7s and PR9s. Imagery from the U-2 flight was shown to the Prime Minister on 4 February 1959 by the Secretary of Stare for Air, George Ward. He reported that the PM was 'greatly impressed'. A further 18 Middle East missions would be flown by RAF pilots from Det B over the next 15 months, all conducted without the knowledge of the overflown countries, which also included Iraq, Lebanon and Saudi Arabia. However, the PM took a keen interest in the routes, and refused permission to overfly Israel.

In early 1959, planning for the first British overflight of the USSR, codenamed Operation MARSHLAND, began. The Soviets had not yet installed early warning radars opposite Pakistan, so the mission planners hoped that a U-2 could enter 'denied territory' from there without detection. The British High Commissioner gained permission from Pakistan's President Ayub Khan for a U-2 to fly out of Peshawar. London did not tell the British diplomat the true purpose of the flight. He – and therefore also Ayub Khan – was told that an electronic intelligence mission along the Soviet border would be mounted. USAF transport aircraft supporting the mission would refuel en route to Pakistan via one of Britain's colonial possessions in the Gulf.

However, political approval for this operation never came. Sir Patrick Dean believed that this was not an opportune time to seek overflight permission from the PM. Nevertheless, Macmillan was informally approached during his tour of RAF stations on 1 April, probably by the Chief of the Air Staff, but to no avail. Throughout 1959, East-West diplomacy, and the possibility of a thaw in the Cold War, served to reduce Whitehall's appetite for the potentially risky and provocative U-2 missions, despite their obvious intelligence value.

Two more pilots had been sent to the US for training: Flt Lts 'Bunny' Austin and Brian Cox. They made their first solo U-2 flights at Laughlin in late January 1959. But, as the prospects for regular overflights diminished, they were never deployed to Det B, and returned instead to normal duties.

Meanwhile, the RAF group at Incirlik was under-employed, although there were occasional training flights of up to five hours over Greece and Turkey, and three T-33s were available for proficiency flying. The group was initially confined to base for security reasons,

living in trailers within Det B's fenced-off compound. When some larger trailers arrived, the wives of the two officers that were married (Flt Lts Dowling and Clifford) were allowed to join them. Later, the group was allowed by London to venture off-base in escorted parties, to enjoy the exotic delights of Adana, the closest town, and the unspoilt countryside and beaches nearby.

The training flights helped to ensure that the four pilots remained proficient in navigation, for which only basic provision had been made in the U-2. The primary instrument was a drift sight offering different levels of magnification looking down. The optical path could be switched to look up, thus becoming a sextant. Otherwise, there was only a radio compass. That was not much use when flying over desolate areas with few stations.

It was essential to study the maps carefully, making annotations to help identify turning points, maintain the desired tracks, and indicate where to turn the main camera on and off. To obtain the best imagery, flight line deviations of no more than a quarter mile were required. In variable crosswinds, it was difficult to fly to such fine limits. The detachment navigators provided the pilots with maps cut into strips which were pasted onto as many as ten double-sided boards. In the cramped cockpit, these were not easy to handle.

The sextant could, theoretically, be used on the flights along the Soviet southern border which were flown from mid-1959, usually at night, to intercept telemetry from ballistic missile test flights being made from Tyuratam. A special sensor replaced the big B-camera in the large bay behind the cockpit. These missions, codenamed HOT SHOP, were alerted when SIGINT from ground stations or other aircraft indicated that a missile launch was coming. But the take-off time was not known in time for the navigators to pre-compute any star fixes. The pilot's only options were the ADF and dead-reckoning.

The targets deep inside the Soviet Union that had been planned for Operation MARSHLAND were eventually covered on 9 July 1959 by an American mission that President Eisenhower approved. Codenamed Operation TOUCHDOWN, it was a complete success, and by taking off from Peshawar, managed to avoid tracking by Soviet radars. The following month, another plan for a British overflight was devised. This time, it was Ward who declined to recommend the mission to the PM, who was involved in negotiations for a summit meeting.

In August, the pilots were sent to El Adem in Libya for a desert survival course. They had already flown 12 missions over the desolate terrain of the Middle East by then! None of them had been detected.

In October 1959 the PM agreed to resume the SIGINT flights that the RAF had been flying along the borders of the Warsaw Pact. These had been paused earlier, again for political reasons. The OLDSTER cell in the Air Ministry sensed an opportunity to finally get a U-2 overflight approved. To reinforce the plan, the CIA sent its top experts on target planning and imagery interpretation, Jim Reber and Art Lundahl, to brief the great and the good in Whitehall. No fewer than 40 were invited to two presentations in late October on the great intelligence value of U-2 missions. They included the Prime Minister, the Foreign Secretary, the director of GCHQ, the US Ambassador, and various officials and officers from the Foreign Office, the Ministry of Defence, the Joint Intelligence Bureau, the Air Ministry, MI6, and even the Treasury. Some of them needed clearance for OLDSTER for the first time.

Ward followed up with a memo to the PM. He listed the main targets that would be covered: the Kuybyshev bomber factories, the Kazan and Saratov/Engels bomber bases, the Kapustin Yar and nearby Vladimirovka missile test ranges, and rail lines that might lead to new. and as yet unknown, missile bases. He explained that the re-engined version of the U-2 was now available, boosting the maximum altitude by 4-5,000 feet. (This was the U-2C with the J75 engine, replacing the J57-powered U-2A).

Like the previous US mission four months earlier, Ward continued, the flight would depart from Peshawar, to avoid detection by Soviet early-warning radars. 'The intelligence prize is great…(and) the flight could be completely undetected,' he concluded.

The British High Commissioner in Pakistan would again be enlisted, to seek permission from Ayub Khan for an ELINT flight along the Soviet border. The President would be assured that the U-2 would be ferried in at night, and take-off at sunrise, to limit exposure.

Detailed planning followed for the overflight, which gained the codename HIGH WIRE. The OLDSTER cell communicated with Project HQ by secure cables, discussing various flight profiles and routes. The range of the U-2C was 3-400 nm more if it levelled off at 70,000 feet or slightly lower, rather than cruise-climbing to as high as

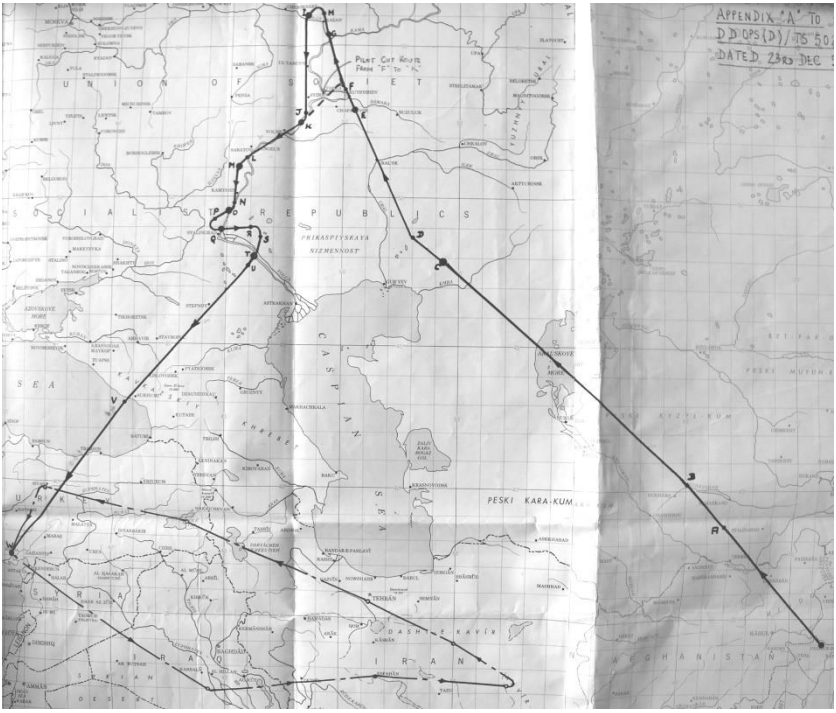
75,000 feet. The latest intelligence was that the Soviets still did not have a fighter-interceptor capable of exceeding 60,000 feet. The favoured option at this stage was a 3,300 nm journey ending at Incirlik after 8 hours 15 minutes. It would level off at 68,000 feet so that the standard fuel reserve of 100 gallons would be available at the start of the descent. Two different range/height options would be test-flown in advance on roundtrips from Incirlik.

There was so much else to consider. Was the sun angle and amount of light good enough for useful photography in late November or early December? What was the likely cloud cover? Would high altitude winds affect the flight? Would tell-tale contrails be generated? What arrangements were necessary at RAF Bahrein or Dhahran, which were the staging base options for the two supporting USAF airlifters, one that would be carrying the special U-2 fuel to Peshawar in drums, the other carrying the mission pilot and support crew? Who would fly the mission? Who would pilot the ferry flight from Incirlik to Peshawar? There was also a deception flight to plan. In order to confuse the Soviet air defence system along the Iranian border, a roundtrip would be flown from Incirlik. This flight was timed and routed so that, if Soviet radars had detected the ferry flight to Peshawar, it would suggest that this was the same aircraft returning westbound.

The OLDSTER cell and its superiors in the Air Ministry agonised over the formal request to the PM for approval. The memo was drafted and re-drafted eight times. The Foreign Secretary approved it on 25 November, and forwarded it to the PM, who gave his assent two days later, provided that the Pakistani President allowed the use Peshawar. The PM's approval covered the first 20 days of December. On 4 December, he was given the proposed route, and told that Ayub Khan had agreed the staging through Peshawar.

Operation HIGH WIRE swung into action. Robbie Robinson would fly the mission, and Mike Bradley the deception flight. The weather was good over the highest priority targets, but adverse winds were forecast. Robinson was briefed to cut the flying time by omitting the very northernmost part of the route, if the aircraft was behind the 'fuel curve', ie below the pre-calculated fuel remaining. The last of several adjustments to the flight profile was made.

The airlift support and U-2 ferry flights were staged without a hitch. Robinson and MacArthur (the backup pilot) managed to sleep on the



Op HIGH WIRE on 6 December 1959. The solid line shows the route of the overflight, from Peshawar to Incirlik. The most northerly section was omitted due to fuel concerns. The dotted line shows the route of the deception flight from/to Incirlik. (TNA file AIR40/2751)

C-130, thanks to sedatives and warm sleeping bags. After arrival at Peshawar, they studied the route and target maps in more detail. On 6 December at 0900 local time, Robinson took off and climbed rapidly to 70,000 feet. There was solid undercast for the first 700 miles, and the pilot had to rely on dead reckoning. The sextant was only useful for checking ground speed, and there were no radio stations. Although contrails ceased at 55,000 feet in the climb, a slight trail resumed at 70,000 feet as the outside air temperature decreased. Robinson climbed to 73,000 feet to eliminate it, until the temperature rose and he could return to 70,000 feet.

But this was much further into the flight, and together with strong headwinds, obliged Robinson to take the cut-off, in order to regain his

Part of the Kapustin Yar test range, overflown on 6 December 1959. (NARA via Lin Xu)

fuel curve. This eliminated the highly secured bomber production factory at Kazan, but he did cover all the other targets, notably Kapustin Yar. In case he ran short of fuel and had to land at one of the airbases in northern Turkey, Det B dispatched a recovery crew and ferry pilot in a C-130. They weren't needed. Robinson landed at Incirlik on schedule at 1415 local time, after 8 hours 15 minutes in the air.

Everyone was delighted. Project Director Richard Bissell cabled, 'Sincere congratulations to all! Outstanding performance by pilot.' The Air Ministry added, 'A first class show all round.'

Now came the waiting. First, for SIGINT indications of whether the flight had been detected. The U-2 carried basic COMINT and ELINT systems, which had to be processed and analysed. But the main indications would come from the ground stations operated by the US National Security Agency (NSA). Then there was the processing and

initial analysis of the 6,000 feet of film from the B-camera. This had to be done by Eastman Kodak in Rochester, NY and at the CIA's National Photo Interpretation Center (NPIC) in Washington, respectively.

On both counts, HIGH WIRE was a success. There was no evidence that the flight had been detected by Soviet radars. The film was yielding excellent detail on Soviet air and missile forces, and much else. On 16 December, the CIA Director, Allen Dulles, cabled the Chief of the Air Staff, MRAF Sir Dermot Boyle: 'The entire intelligence community is extremely gratified by the excellent and timely results. We shall be keenly interested in an early return engagement.'

The RAF was happy to oblige. Planning began immediately on a preferred and an alternative route. Operation KNIFE EDGE was the priority. It would fly north to cover Kazan, the suspected strategic bomber base that had been missed on HIGH WIRE, and then go west to survey aircraft factories and missile facilities. Like the previous British overflight, it would take-off from Peshawar but this one would land at Adana. The alternative, Operation SQUARE DEAL, would fly east from Peshawar, to investigate the nuclear test site at Semipalatinsk and the air defence missile test range at Saryshagan. The landing would be in Zahedan, an airbase in northern Iran, which had been used for the same purpose by Operation TOUCHDOWN the previous July. As with previous overflights, the actual day of operation would depend on a good weather forecast. If the primary route was cloudy, the alternative would be flown.

The preliminary plans ascended the approval chain. On the last day of 1959, PM Macmillan agreed to another overflight.

In the meantime, at Det B the RAF pilots took their turn with their American counterparts in waiting on alert for more HOT SHOP missions. They flew two of the three that were launched in January. One of these produced prized telemetry from the first Soviet ICBM, designated by Western intelligence as the SS-6 *Sapwood*. There was also another flight over the Middle East.

After the same meticulous planning that had characterized HIGH WIRE, Operation KNIFE EDGE was flown, but not until 5 February 1960 because of poor weather over the key target areas. John MacArthur covered 3,000 miles in a flight lasting 8 hours 40 minutes. David Dowling flew the deception flight, lasting 6 hours 40 minutes.

But there was a potentially serious hitch in the operation, when the

Op KNIFE EDGE on 5 February 1960 – a line-up of newly discovered (to Western intelligence agencies) Tu-22 Blinders *on the snow-covered airfield at Kazan.* (NARA via Lin Xu)

first two attempts to ferry the mission U-2 from Incirlik to Peshawar were aborted due to unserviceabilities after take-off. The third attempt was successful, but the aircraft landed at Peshawar only one hour before the scheduled departure of the overflight. The ground crews worked frantically to turn it around, but there was still a short delay, and no time for the navigator to adjust the celestial precomputations. Once again, the pilot had to rely on dead-reckoning across a solid undercast on the first portion of the flight.

Nevertheless, KNIFE EDGE was another success. MacArthur flew over new Soviet radar and missile sites, missile test and launch facilities, a key military shipyard, arms factories and nearly 100 airfields. At Kazan, the U-2's camera captured a previously-unknown supersonic bomber aircraft, later identified as the Tu-22 *Blinder*. The image quality was variable, due to ground haze, cloud cover, and heavy snow in some areas. US SIGINT indicated that Soviet radars had not identified the flight, although they tracked an unidentified aircraft for 15 minutes as the U-2 left Soviet airspace en route Incirlik.

On behalf of Det B and Project HQ, Mackie cabled London from Washington: 'appreciate your backing and confidence in us, in particular during the final difficult stage.'

MacArthur then took leave, but not before he visited the Air Ministry to describe his flight in person. There was little activity at Det B, except for test flights of new 'slipper' tanks on the wings that added a precious extra 200 gallons. One of them, flown by David Dowling, lasted 11 hours 5 minutes – the longest yet with the U-2C.

Despite the success of KNIFE EDGE, the attitude in Whitehall

towards another overflight was to, 'let sleeping dogs lie for a time,' noted Gp Capt Kunkler in the OLDSTER cell. The Foreign Office was more nervous than ever about these illegal missions, even though the Foreign Secretary said that he was 'very impressed' with a presentation by the Air Ministry on 29 March. 'Quite apart from the obviously vital intelligence that these flights produce, they must gain us a lot of credit with the Americans,' he said.

In Project HQ meanwhile, there was renewed optimism that President Eisenhower would approve another American overflight. He was under intense pressure from the US intelligence community, not least because the two recent RAF missions had overflown multiple SA-2 surface-to-air missile sites. This was a new SAM that potentially posed a threat to the U-2, although most analysts believed it was not capable of reaching 70,000 feet. The creation of a widespread SAM network was clearly a Soviet priority. But none of the sites had yet been assessed as operational, and in any case, Soviet air defence radars had failed to detect the flights. Notably, though, one US intelligence assessment warned that a successful intercept was highly probable, 'providing that detection is made in sufficient time to alert the site.'

Therefore, permission to take-off from Pakistan was still the key to success. Wg Cdr Mackie cabled London from Project HQ: 'the feeling here is that Ayub Khan knows a lot more about our purpose for using Peshawar than he has been told.' There was speculation in Washington, that the Pakistani President would extract a price for continued use of the airbase – the US to supply his air force with supersonic F-104 fighter-interceptors.

Planning for Operation SQUARE DEAL continued, mostly in London, with a British pilot to fly. But Project HQ also worked on two more missions, prompted by the latest intelligence indications that the Soviets were developing their first operational ICBM base in the far North, at Plesetsk. More prime targets were situated there, such as naval shipyards and another nuclear test site. One option was to stage a flight out of Thule in Greenland. The other was to take-off from Peshawar and fly all the way across the Soviet Union to a landing at Bodø in Norway. This operation was codenamed GRAND SLAM.

In the event, SQUARE DEAL was flown on 9 April from Pakistan with Eisenhower's approval and an American pilot. But the flight was detected upon entry: the Soviets had now closed their early warning

radar ‘gap’ along the southern border. MiG-19 and Su-9 fighters made multiple unsuccessful attempts to intercept.

The lessons from this episode went unheeded in Project HQ. Planning continued for the GRAND SLAM option, which was also approved by the US President. On 1 May, Gary Powers took off from Peshawar, and was shot down by an SA-2 missile near Sverdlovsk. This was a seminal event in the Cold War, but is beyond the scope of this paper.

There had been much discussion and refinement of cover stories over the previous three years. They were devised for each overflight, as well as the overall U-2 programme. In London, the government agonised about how to keep the RAF participation secret. It was public knowledge that Sqn Ldr Walker had been killed in 1958 during U-2 training. The media suspected a cover-up. The Labour opposition tabled questions in Parliament.

The RAF pilots were withdrawn from Turkey immediately, and quizzed in London on what they thought had happened to Powers, and whether he would reveal the British involvement. They couldn’t provide much help. In fact, Powers did not tell his captors. But the full story of the RAF and the U-2 remained concealed for many years.

Eisenhower banned future U-2 overflights, and the overseas detachments were withdrawn. But a slimmed-down U-2 unit was established by the CIA at Edwards AFB, with the capability to deploy at short notice. The RAF assigned two pilots, a navigator and a flight surgeon to this unit throughout the 1960s and early 1970s.

Notes:

1 Most of the details in this article come from Air Ministry files that were declassified and transferred to The National Archives (TNA) in 2019. There are 24 of these in total, mostly covering the years up to 1960. The TNA reference numbers for those used by the author are AIR40/2734, 2735, 2743, 2744, 2746, 2747, 2750, 2751, 2753, 2754 and 2755.

2 For the wider context, and a comprehensive account of the U-2 program, the author’s definitive history of the first *50 Years of the U-2* (Schiffer; 2005) is strongly recommended. **Ed**

THE U-2 – THE FINAL YEARS OF JACKSON

by Air Cdre Ian McBride

Subsequent to the Powers shoot-down a number of changes understandably took place in the organisation described by Chris Pocock, to whom I am indebted for material covering the early years of the IDEALIST programme. Classified material covering the later years has yet to be released by the MOD so much of what I offer is anecdotal.

Immediately after the shoot-down was confirmed, the RAF pilots were recalled post haste, the flight planner being left to keep our place on the programme warm and the codeword for UK participation was changed from OLDSTER to JACKSON. At the same time, the CIA withdrew from their Middle Eastern bases of Adana and Peshawar and relocated at Edwards Air Force Base in California where it became known as the 1130th Air Technical Training Group (ATTG). The JACKSON detachment hereinafter consisted of two pilots, a flight planner and a doctor well-versed in aviation medicine. We were housed in the local town of Lancaster, some 30 miles away, which enabled us to merge with the aerospace-based community without putting undue strain on our cover. Our postal address was c/o BDS Washington and they forwarded mail in sealed envelopes or bags, depending on the volume. Acquiring credit cards, without which life in California was all but impossible, was a bit of a challenge because we had no credit or residential history. However, the local manager of Sears Roebuck had been persuaded to take us on trust and, armed with his card, many more could be obtained. Any medical problems with team members or family, which were beyond the scope of the detachment doctor, were handled by a CIA-cleared doctor who took care of the funding of any big ticket items.

Edwards was an excellent choice because it was close to Area 51 where a number of 'Company', ie CIA, classified programmes continued throughout and beyond the period that the U-2 operation was based at Edwards. Edwards itself was the mounting base of a number of sensitive programmes so the 1130th did not attract much attention.

The new base was also conveniently located for support from Lockheed teams at the original Skunk Works at Burbank and subsequently at Palmdale. It was known as Detachment G with

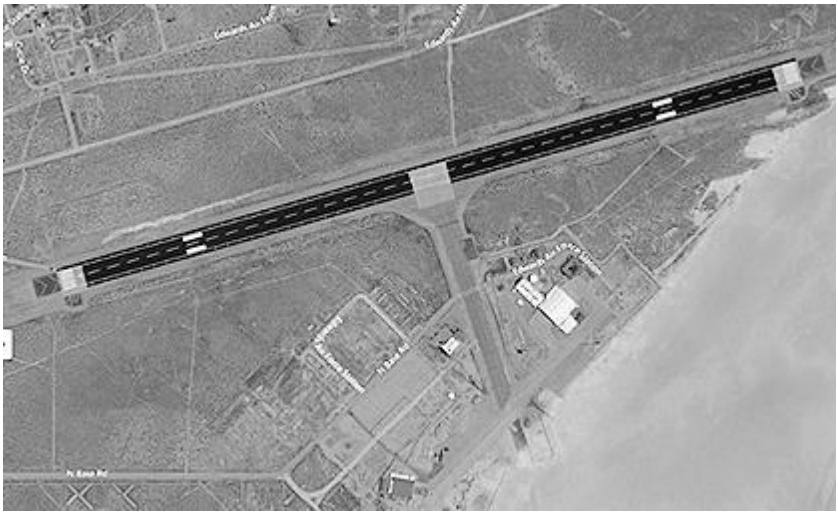
Edwards AFB, with the main site to the left (west) of the lake bed. Right, an indication of the scope for natural surfaced runways; the location of the relatively remotely located North Base is indicated by the star.

Detachment H being in Taiwan. We were unaware of other operational sites.

Edwards Air Force Base is huge, covering about 470 square miles but much of that is the Rogers dry lake bed which forms part of the airfield, as can be seen in the accompanying pictures. Occasional wet seasons would provide enough water to smooth out any ruts caused by landing aircraft, which included the Shuttle's first recovery.

Edwards Air Force Base was host to a large number of units, some military such as the test pilot school, some industrial such as the McDonnell Douglas F-15 development team, and also the NASA Dryden Flight Research Center, since renamed in honour of Neil Armstrong, one of its former pilots. It also hosted fly-offs between aircraft competing for new requirements and in the last few years of the JACKSON programme these included the F-16 versus F-17, won by the former, although the latter re-emerged as the F-18. There was a similar fly-off between the A-9 and the victorious A-10.

The 1130th was housed at North Base, well removed from all other activity. The accompanying pictures show the site as it is now and what it was like in its prime – very compact and well-matched to its task. We used half of the 6,000 ft runway for normal operations, only using the full length for maximum all-up-weight take-offs on trans-oceanic flights. On deployments we were usually supported by C-141s which were able to operate from North Base, quite extraordinary given that



North Base today, one time home of the 1130th ATTG.

The 1130th ATTG's ramp back in the early days of the U-2R. (Lockheed)


Wet dinghy drill – in a full pressure suit.

the airfield elevation was 2,500 ft.

The 1130th was commanded by a USAF colonel who was not necessarily U-2 qualified. He was supported by a CIA deputy who ran the agency support personnel, mainly security and communications. The operations and engineering functions were headed by USAF lieutenant colonels who had a mixed military and civilian workforce. The medical and life support section was headed by another USAF lieutenant colonel who was also a rated pilot. The only people to fly the U-2 were the 'Company' pilots, known as 'drivers' and the RAF pilots. In the early years of the programme, seconded US military pilots would stay on the books until reaching retirement age, whereas in later years they would be returned to their parent service at a higher rank than when inducted. Training, for US and UK pilots, followed a broadly similar path except that the JACKSONs spent some months being familiarised with the US system and procedures. This involved a significant amount of flying in jet trainers and twin-engined propellor driven aircraft, often delivering VIP passengers to aircraft steps at Los Angeles International Airport and other departure points.

Because the 1130th had a global role, the survival training had to match this profile, much of which was not unfamiliar, but usually more extreme than that encountered in UK service. The one significant difference was water survival in a full pressure suit. This was carried out at Lake Mead in Nevada and involved a parachute descent during which the drills were performed. The first picture shows Martin Bee just prior to lift-off under the parachute arranged on the deck behind him. The wooden platform is towed fast enough for him to reach flying speed and his subsequent climb is powered by the motor launch which had by then released the platform. At about 900 ft our hero releases his

Winter and desert survival training.

tow and descends towards Lake Mead. The second photo shows a relieved Ian safe in his dinghy.

Two other survival training sessions are worth a mention – winter training in the high Sierras and desert training in Panamint Valley, a few miles to the west of Death Valley. The accompanying pictures show shelters built by the late lamented Dr John Baird (a lover of his creature comforts) and myself.

Another unusual aspect of the induction process was the medical examination carried out at the Lovelace Clinic in Albuquerque, New Mexico. This was also the venue for the Mercury and Gemini astronaut medical checks upon which the IDEALIST version was based. This was far removed from the legendary 'drop 'em and cough' inspections of yore. We were there for five days and the programme was almost continuous and extremely thorough, although considerably more humane than the version described by astronaut Pete Conrad in *The Right Stuff*. My initial visit concluded with a hairy flight to Los Alamos to be tested in what was believed to be a prototype MRI scanner.

The U-2 is often thought to be a single aircraft type whereas, in reality, it was a family of aircraft with significant differences between each of eight variants, the most numerous by far being the U-2C and its derivatives. Because the British pilots flew mainly, if not exclusively, the U-2C and U-2R I shall focus on these variants.

The headline performance figures for the U-2C and U-2R are summarised at Figure 1.

Conversion to the U-2 began with ground manoeuvring, taxying this

Model	Span (ft)	MTOW (lbs)	Fuel (US gal)	Range (nm)	Endu-rance	Altitude
U-2C (average)	80	23,040	1,520	4,100	10.5	75,000
U-2R	104	37,585	2,950	6,300	15.0	75,500

Fig 1. Core U-2 data.

unconventional aircraft with and without the outriggers, known as pogos, which steadied the aircraft on the take-off run before falling away. The lesson was hammered into tyro pilots that keeping the small twin steerable tail wheels firmly on the ground was essential until either lift-off or coming to a stop after landing. Any relaxation of back pressure would cause the aircraft to pirouette wildly on its main bogey, giving the pilot, and the inevitable gallery, severe palpitations or worse. On landing, the aircraft had to be flown until you reached a standstill. Once airborne it was quite a challenge to fly at low altitude, as desert thermals would throw it around quite a bit. Once clear of these, it was very stable with an excellent autopilot. At high levels the early models provided pilots with a real challenge, as they had to fly the aircraft through a very narrow gap between the low speed and high speed stall. This was known as Coffin Corner as failure to navigate this channel could have disastrous consequences. The airframe and engine balance of the R-model made Coffin Corner a thing of the past. There are complex diagrams in Pilots Notes relating to Coffin Corner, one of

To avoid an inadvertent pirouette, it was essential to have both the main bogey and the twin tail wheels in contact with the runway. This shows an aircraft preparing to take off. Note the pogos and the size of rear steering wheels.

which is reproduced at Figure 2, along with, at Figures 3 and 4, some simplified illustrations of this part of the flight envelope for each generic type of U-2.

The life support equipment was upgraded from a basic partial pressure suit worn by pilots on the U-2C to a full pressure suit on the U-2R. The latter was almost identical to that worn by Gemini astronauts and was not debilitating, even on long flights. There was a feeding

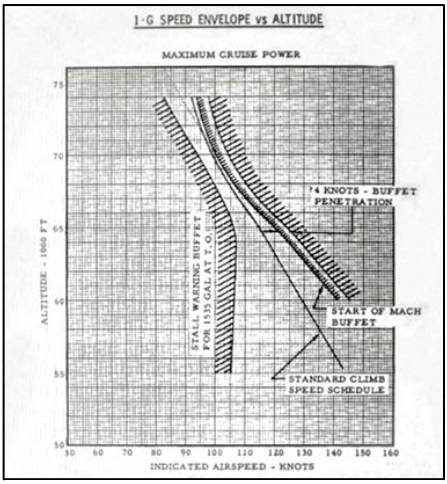


Fig 2. Extract from the C-model flight manual.

Self, at left, and Ron Shimmons, the last two JACKSON pilots, modelling the S-1010 pressure suit.

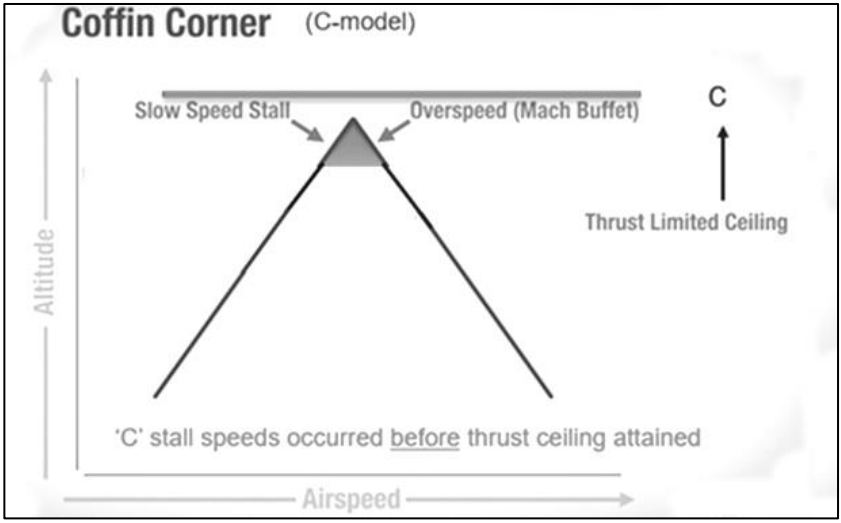


Fig 3. Sufficient thrust to climb into the problem area.

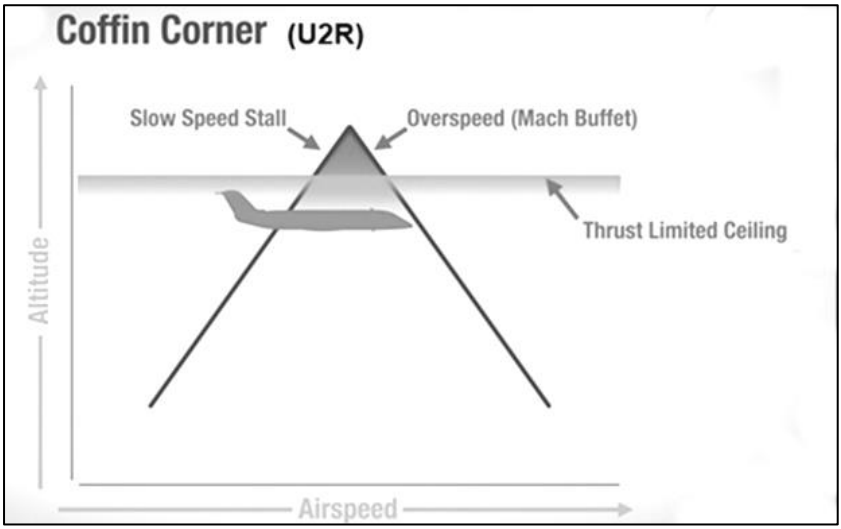
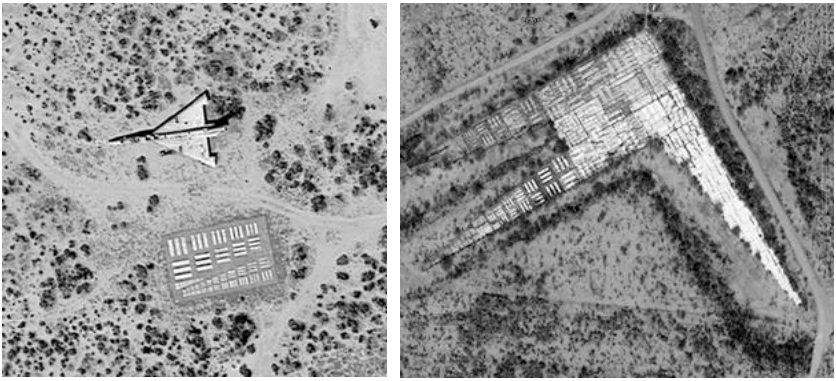


Fig 4. Aircraft unable to climb to the problem area but reaches similar heights to C-model.

Left, the Colorado River, viewed through the drift sight, and right, a camera shot of Lake Havasu taken about a minute later.

port on the helmet through which food and liquid could be passed. The menu was somewhat limited, but low residue. The suit featured a urine collection device which worked well, although some pilots could not bring themselves to use it.

The first three conversion flights, and a later initial night flight, were carried out at low altitude (less than 45,000 ft) but the fourth and subsequent sorties were in the S-1010 pressure suit with all the attendant palaver of pre-breathing. We were also encouraged to take advantage of the in-suit feeding and drinking facilities, plus use of the Urine Collection Device. The early suited flights were intended to be leisurely leg-stretches but my Mission 4 involved close formation with a Palmdale U-2 which needed an external inspection. Thereafter we were sent off on navigation exercises with up to eight 'flight lines' on which our accuracy and stability were assessed using a nose-mounted tracker camera. At certain points along the route we had to activate the *Bird Watch* data link from which our progress could be assessed. The aircraft was equipped with VORTAC and ILS together with a Doppler system which did not offer much assistance at cruising altitudes of over 60,000 ft apart from an indication of drift. There was a radio compass which provided in-flight entertainment and was only used in earnest on trans-oceanic legs. I picked up Timpson and Redhead's excellent BBC programme from just to the east of Gander. The best navigation aid when operating in a clear air mass was the optical drift sight which gave horizon-to-horizon coverage throughout a full 360 degrees field of regard. The accompanying pictures show the Colorado River on a south to north passage. The drift sight picture shows the river meandering on its journey south from the Boulder Dam. The second picture, taken over

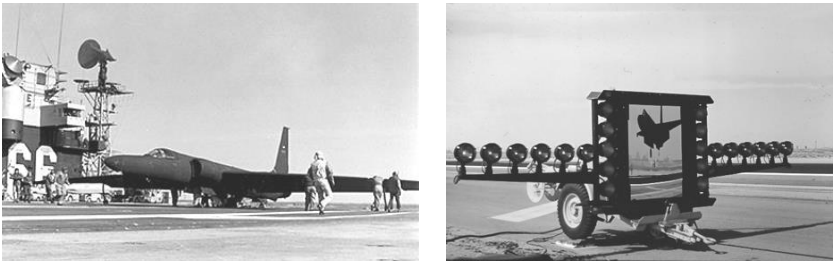


Resolution targets at Edwards AFB (left) and at Fort Huachuca AZ, the latter showing variations in clarity and contrast.

my left shoulder, shows Lake Havasu and, on the promontory, Lake Havasu City, a speculative venture backed by Mr McCullough of chainsaw fame. Crossing a small creek on the peninsula is the original London Bridge, mistakenly bought by Mr McC who thought he had acquired London Bridge.

Much of our routine high altitude flying was in support of the development of systems. Because the EW test elements were generally flown over Area 51, our activities were largely in support of imaging programmes. This normally involved a relatively long 'cold soak' followed by repetitive runs over specialist targets or specific cultural scenes. One such camera, which featured a very significant offset capability, controlled by a hand controller, was particularly challenging to use as we would be (say) flying over the relatively featureless Mojave Desert whilst the camera would be tracking downtown Los Angeles. Repeatability was difficult to attain. Two of the specialist resolution targets are shown above. The one on the left was at Edwards and shows a system performing well whereas the other, at Fort Huachuca in Arizona, shows an under-performing system.

One of the lesser known capabilities of the U-2C/R was its potential for operation from the later generations of USN carriers. The aircraft required relatively minor modification for this role, mainly full flap being extended to 50°, from the standard 35°, and the addition of two spring-steel wingtip skids to reduce the likelihood of the aircraft becoming entangled in unwanted cables etc on the deck. In order to



Left, a U-2 on board the USS America *and, right, framed in the mirror landing aid*. (Lockheed)

accommodate U-2 deck operations most of the organic carrier aircraft had to be hangered or flown ashore – not popular with admirals and Air Bosses! Nevertheless initial deck landing trials, involving RAF pilots, were successfully completed and the capability confirmed. The early trials had been carried out on *Kitty Hawk* class carriers. The final pair of JACKSON pilots trained twice with the USN at Pensacola but CINCPAC would not release a *Nimitz* class carrier for U-2 deck training. Two such cancellations occurred within a day of the scheduled event. The reason given was that the successor capability[1] did not require carrier support although this option was being seriously considered when nations denied overflight and basing for, what became OLIVE HARVEST, surveillance of the Suez Canal area following the Yom Kippur War. At this juncture, the RAF pilots were the only members of the 1130th team who were even remotely current on carrier training.

There were occasional departures from the routine of Test and Evaluation with annual single-aircraft detachments to RAF bases in the UK. The outbound leg was normally flown 'black' with no flight plans nor any radio transmissions until descending into the destination airfield. We then flew a couple of sorties around the UK, usually including a photographic run over central London and intercepts by UK fighters – none of which were seen at our altitude. An unusual task was a series of flights over sites in Puerto Rico where the Federal Drug Administration had created 'ground truth' sites containing a variety of drugs that they wished to detect and identify from overhead imagery and, bizarrely, we were used in a Search and Rescue mode when an American senator's aircraft crashed in Alaska. Another task which the

Brits gladly accepted down the years was providing the pilot for performance displays of the U-2 for the benefit of important visitors, of which there were many.

The activity levels of the pre-Powers era were never matched, or even approached, in later years. During the period following the Six-Day War in 1967, nations, including the UK, were reluctant to grant basing or overflight clearances in the wake of Arab-Israeli hostilities. Doctor Kissinger finally got agreement for flights over the Canal Zone based on the use of RAF Akrotiri in Cyprus. The timescales were very tight and two US pilots were immediately deployed to Upper Heyford in order to ferry the aircraft to Cyprus. The aircraft were to have been flown to the UK by two JACKSON pilots who started to prepare. At the very last minute, permission for the JACKSONs to be employed on this ferry flight was withdrawn by the UK Government and two US pilots were substituted, one of whom had already been airborne for several hours that day on a high altitude mission. In order to meet pre-ordained timings, this pilot was recalled, topped up with coffee and launched with the other to Upper Heyford. Not a good time for the RAF team. Some years later, after the Yom Kippur War and considerable diplomatic activity, it was eventually agreed that the 1130th would mount a single aircraft detachment at Akrotiri.

Despite the fact that the JACKSONs had only recently been in full sight at Wattisham, the pilots were not able to take part in, what became known as, OLIVE HARVEST. The RAF doctor went in support of the US pilots. Earlier, because U-2s had been prevented from deploying to the Middle East, Strategic Air Command had mounted a single SR-71 mission, based upon Griffiths AFB in New York, to overfly the combat area, routing through the Straits of Gibraltar. This mission involved a round trip of 10 hours and probably sounded the death knell of the CIA U-2 in its original role. The 1130th closed within a year. On the plus side, the final months of the programme was a good period for the JACKSONs as we were the only pilots regularly available at North Base. Many test programmes needed to be wrapped up and a high success rate was essential if all this was to be achieved. Uniquely one of the test series involved EW systems which required regular flights into Dreamland (aka Area 51), hitherto not authorised. At our farewell dinner in Washington, General Bevan, Director of the CIA Office of Special Activities, paid tribute to our work over this period stating that

Left to right, Sqn Ldrs John Baird, Ian McBride, Harry Drew and Mike Jackson.

the timely introduction of the unspecified follow-on capability[1] had been due in no small measure to our efforts.

The UK made a significant investment in the JACKSON programme, illustrated by the personnel in the above picture of the penultimate team setting off on a winter survival exercise. One of them would reach group captain rank, another became an air commodore, a third retired as an air vice-marshal and the fourth as a full air marshal. Three of the last four doctors on the team went on to head up the RAF Medical Branch, and two of them became MOD Surgeons General. A remarkable level of investment which, in turn, became a powerful and unique operational capability.

Acknowledgements. Unless specifically annotated, the illustrations are from the collection.

1. The term ‘capability’, rather than a specific platform, has been used here, because there were a number of options, all of which are beyond the scope of this submission.

POSTSCRIPT

The Canberra PR9, which eventually acquired a U-2-sensor system.

Twenty years after leaving Edwards, and now with FR Aviation Ltd, I stumbled across an initiative to fit a U-2R sensor into the RAF's Canberra PR9. By good fortune, I knew many of the US and UK players, and FR Aviation (already performing Canberra majors) got the job. In order to meet strict image resolution requirements, we carried out extensive vibration studies on the flare beam, to which a Rapid Deployment Electro-Optical System (RADEOS) camera, derived from the *Senior Year* Electro-Optical Relay System (SYERS) of the U-2S, was to be attached, and on the camera windows in order to minimise distortion. It was, by all accounts, a very successful programme which brought a huge capability uplift to the UK ISTAR community. Interestingly, an optical wet-film predecessor of this sensor had frequently been flown in U-2Rs by JACKSON pilots during its development which had been conducted at the 1130th ATTG during the 1970s.

THE SELECTION AND PRESERVATION OF SQUADRON NUMBERS 1918-2018 – PART I

by Wg Cdr Jeff Jefford

The Early Post-WWI Years

Having considered, and discarded, a succession of more ambitious suggestions, the CAS, Sir Hugh Trenchard, eventually proposed that the permanent peacetime air force should have an initial strength of twenty-three and a half squadrons. On 11 December 1919, Winston Churchill, in his capacity as Secretary of State for War and Air, laid this proposal before Parliament, as the Trenchard Memorandum.[1]

In devising this scheme some thought had been given to the means of identifying the units involved. While we now take the RAF's squadron number plates for granted, the perspective would have been very different in 1919. Military aviation was only seven years old. The RAF, not yet two years of age, consisted of a handful of run-down, post-demobilisation cadres facing an uncertain future. Some considered this a poor foundation on which to build, and some early thought was given to making a completely fresh start by introducing a uniquely 'air force' system of nomenclature – as had already been done with ranks. On the other hand, there were those who thought that the new Service should acknowledge its antecedents and, by so doing, stake an RAF claim to the heritage represented by the exploits of the RFC and RNAS. One means of doing this would be to preserve selected wartime squadron identities. To capitalise on this idea to the greatest extent possible, it was suggested that squadron number plates might also be applied to non-operational units, such as flying training schools. However, CAS noted that he was, 'not in favour of allotting numbered squadrons to any of the Schools or Training Wings.'[2] The upshot was that it was decided to sustain the RAF numbering system of 1918 but to confine its use to squadrons – which established what became (until relatively recently – see Part II) the fundamental policy underpinning the use of number plates.

It remained to be decided which numbers to preserve. Appropriate guidelines had been laid down by CAS as early as May 1919, his aim being to, 'retain the identity of Squadrons which have played a conspicuous part in the various theatres of war and have a distinguished record.'[3] At the time, it was still being conjectured that the air force

might have as many as 100 squadrons, but over the next few months these ideas were progressively cut down to size. The, specifically provisional, programme proposed by the Trenchard Memorandum envisaged that by 1923 the RAF would have built-up to a strength of thirty-two squadrons which would, 'preserve the numbers of some of the great squadrons who have made names for themselves during the war.'[4]

CAS's guidance served to ensure that the number plates that were eventually selected would include the half-dozen squadrons with which the RFC had gone to war in 1914, plus others which would reflect (almost) all of the theatres in which the wartime air services had fought and the variety of roles in which its aeroplanes had operated. Where several units were eligible for consideration, selection was to be based on seniority.[5] The emphasis on seniority, rather than on perceived comparative degrees of excellence, established one of the two principles underpinning the subsequent allocation of squadron number plates – that they should be selected by essentially objective means, since any other approach was vulnerable to patronage, partisanship and other undesirable forms of bias.

Working to these rules, a set of proposals was drawn up and the final selection was made at a meeting held in December 1919. The approved numbers were: Nos 1, 2, 3, 4, 5, 6, 14, 20, 24, 25, 27, 28, 30, 31, 39, 47, 55, 56, 60, 70, 84, 100, 202, 203, 205, 207, 208, 210, 216, 230, 238 and 267 Sqns. The meeting had introduced three changes, deleting Nos 8, 186 and 201 Sqns from the draft list, in favour of Nos 208, 210 and 203 Sqns, respectively.[6] The identities which were to constitute the permanent air force were announced in March 1920.[7] Note, incidentally, that while the selected numbers had been chosen to commemorate wartime activities, it did not follow that their peacetime namesakes would operate in the same roles. Thus, for instance, while the original No 24 Sqn had been a fighter unit, its successor was to provide an air taxi facility. Similarly, the new No 25 Sqn was to fly fighters, although it had established its reputation as a bomber squadron, and No 210 Sqn was to be equipped with torpedo-bombers, rather than the fighters which it had flown during WW I. This established the second principle governing the use of number plates – that they could be reassigned with total flexibility. While some attempt might be made to associate a unit with a specific role, this would not be

Initially reconstituted in India as B Sqn in January 1920, the unit was redesignated as No 1 Sqn on 1 April and moved to Iraq a year later. Its Snipes are seen here at Sulaymaniyah in 1925. (P H T Green)

an over-riding factor.

The announcement of the permanent numbers was followed by a series of directives explaining how the Service was to be reorganised in order to achieve the desired result. The lowest point in the RAF's fortunes came on 1 March 1920 when it had just twenty-seven squadron number plates in use (Nos 2, 4, 6, 12, 14, 20, 24, 30, 31, 39, 47, 48, 55, 56, 70, 97, 99, 100, 114, 203, 207, 208, 210, 216, 230, 238 and 267 Sqns to which could be added the nuclei of two fighter units in India, temporarily labelled as A and B Sqns, but soon to become Nos 3 and 1 Sqns respectively). To create the selected range of squadron identities, it would be necessary to disband one of the existing units, to renumber six others and to re-form four from scratch. Most of the changes were implemented on 1 April, although the final arrangements were not in place until August, by which time a requirement had been identified for two more squadrons to be based in Egypt. CAS selected the two additional numbers from a suggested short-list. The staff recommendations had been Nos 8 and 151 Sqns, whose unique claims to fame were, respectively, co-operation with tanks and night-fighting in France. Trenchard concurred in the choice of No 8 Sqn but directed that the second selection was to be No 45 Sqn.[8]

Early changes in maritime organisational policy and commitments soon led to the disbandment of several of the 200-series squadrons. This aside, however, Trenchard's selected number plates constituted the core of the RAF during the 1920s while the case for a separate air force was being fought and won. These squadrons therefore represent the very cornerstone on which the Service was built, hence their very special significance, especially those which served overseas on colonial policing duties.

The Fifty-Two Squadron Plan

Meanwhile, in 1923, the government had sanctioned an expansion of the RAF with the aim of creating a 'Home Defence', ie metropolitan, air force of fifty-two squadrons.[9] This project embraced only bombers and fighters; it did not include maritime aviation, neither did it include squadrons stationed overseas nor those units, of which it was envisaged that there would eventually be eight, which were earmarked to co-operate with the Army and to accompany any expeditionary force. The Home Defence Scheme, which was expected to take several years to implement, would require the reinstatement of many more unit identities and work on the selection of number plates for these had begun as early as the summer of 1922. Using the original selection criteria, and after final endorsement by CAS, this exercise served to add Nos 7, 9, 11, 12, 15, 17, 19, 22, 29, 32, 41, 58, 99 and 111 Sqns to the Order of Battle during 1923-24 (plus, for army co-operation duties, Nos 13 and 16 Sqns). An analysis of this list clearly shows that seniority was still the dominant consideration, with the history of an individual unit and/or sustaining its original role taking second place.

Apart from nominating the first wave of squadrons that were to be re-formed, the original fifty-two-squadron plan of 1923 had forecast ahead to 1928. As envisaged at the time, the additional units that were expected to re-form between 1925 and 1928 were:[10]

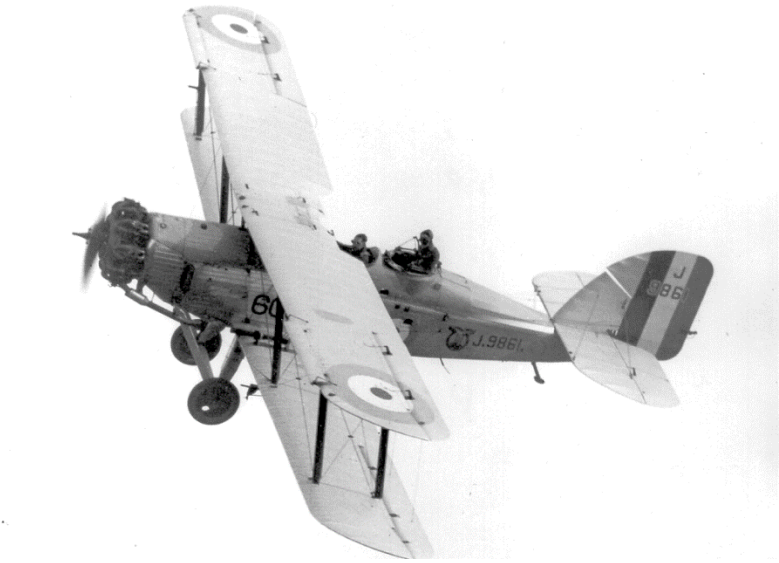
a. Fighter: Nos 23, 43, 46, 54, 64, 65, 66 and 151 Sqns.
b. Day Bomber: Nos 104, 18, 57, 103, 104, 110, 142, 206, 21 and 34 Sqns.
c. Night Bomber: Nos 10, 83, 97 and 101 Sqns.

The programme subsequently underwent annual revision and was subject to constant slippage. As a result, what actually happened bore little resemblance to the plan as originally conceived. In the specific

context of the Home Defence Scheme, only six units, Nos 10, 23, 33, 35, 43 and 101 Sqns, had been added by the end of the decade, although No 26 Sqn had been re-formed in the army co-operation role and Nos 36 and 201-205 Sqns had been reinstated for maritime duties. Despite its slow progress, the plan was kept under review and in 1927 AHB compiled a 'List of War Time Squadrons whose numbers have not been allocated to existing squadrons or projected Home Defence Squadrons'.[11]

Another aspect of the fifty-two-squadron scheme was that it was to include units of the Special Reserve (SR) and Auxiliary Air Force (AAF).[12] Provision for an Air Force Reserve and an Auxiliary Air Force had been a feature of the Air Force (Constitution) Act of 1917 and in 1920, when consideration was being given to their eventual establishment, it had been suggested that these units might use the identities of dormant number plates from WW I. This was still the case in 1923, by which time there were firm plans for the eventual formation of a total of seven Special Reserve, ie cadre, squadrons and six Auxiliaries.[13] It will be recalled, however, that CAS had decided not to apply such number plates to non-operational units, like flying training schools, and this principle was extended to embrace the various reserve squadrons. Rather than allocating them number plates with an operational heritage, therefore, it was decided to introduce two dedicated series of numbers, 500s for the Special Reserve and 600s for the Auxiliaries.[14]

Like the rest of the plan, the rate at which it was intended to form reserve and auxiliary units was revised annually, along with their anticipated locations and, in passing, it may be of interest to note some of the intentions that were subsequently abandoned. Of the Special Reserve units, only Nos 500-504 were actually taken up, although No 505 Sqn had at one time been pencilled-in against Peterborough. By the end of 1925 this had changed to Thornaby and No 506 Sqn had been allocated to Norwich. In 1929, however, it was decided to increase the number of auxiliary squadrons to eight at the expense of two reserve units. Nos 505 and 506 Sqns, neither of which had yet materialised, were accordingly deleted from the plan in favour of Nos 606 and 607 Sqns which were earmarked for Newcastle and Thornaby, respectively. Curiously, the 1930 edition of the original 1923 plan acknowledged the previous year's references to the projected Nos 606 and 607 Sqns but



Once firmly established, the Wapiti became an early mainstay of the AAF squadrons, typified by J9861 of No 605 Sqn. (RAF Museum P021133*)*

went on to announce that, in practice, No 607 Sqn had been formed at Usworth (ie Newcastle) while No 608 Sqn had been formed at Thornaby.[15] So, while there is documentary evidence to establish that the 606 number plate had been assigned and then withdrawn, the rationale (if any) underpinning this decision remains obscure. What is clear, however, is that, once it had been mysteriously 'leapfrogged', it was never reallocated (not, at least, until 1999 when the long-neglected 606 number plate was finally allocated to the RAuxAF's Benson-based Helicopter Support Squadron.[16])

While the Air Ministry had spent ten years attempting to create the fifty-two home defence squadrons to which it was entitled, it still had not managed to achieve this aim before the goal posts were moved by political developments in Germany. Nevertheless, some progress had been made, although, through deft manipulation of number plates, some of this was more apparent than real. For instance, while Nos 15 and 22 Sqns had been re-established as nominal day bomber units, in 1924 and 1923 respectively, they were neither equipped nor trained as such, their

actual functions being to act as the flight testing element of the Aeroplane and Armament Experimental Establishment. In much the same vein, it is worth noting that, although they were neither fully trained nor fully manned, nor permanently available, the projected thirteen SR and AAF squadrons were regarded as being an integral element of the overall total of fifty-two. Then again, while they were not included within the Home Defence Scheme, the same sort of sleight of hand was apparent within the maritime world where the reinstatement of the 201-205 number plates in 1929 appeared to have added five new units. In fact, four of them had been created by the expedient of re-designating existing flights as squadrons. In other words, it was an exercise in window-dressing which had not had any tangible effect on the RAF's actual strength.

The Pre-War Expansion Schemes and WW II

The emergence of Nazi Germany led to a succession of RAF Expansion Schemes from 1934 onwards in place of the, still incomplete, fifty-two-squadron scheme. It was anticipated that eleven additional squadrons would be formed in 1935, the selected number plates being Nos 21, 34, 42, 46, 48, 66, 74, 83, 97, 104 and 151 Sqns.[17] However, although this selection had been approved by CAS, and publicly announced,[18] someone must have had second thoughts, because only six of the nominated number plates, Nos 21, 34, 48, 74, 97 and 104, actually materialised during fiscal 1935 plus those of the un-nominated Nos 38, 49, 64, 214 and 215 Sqns. Of the recommended 1935 list, Nos 42, 46, 66, 83 and 151 Sqns would not appear until later in 1936.

Meanwhile, in 1935 the AHB had been asked to produce a list of *all* ex-WW I squadrons which had yet to be re-formed and, moreover, to put them in order of merit. This was no easy task, as most of the significant 'seniority gaps' had already been filled by reactivating those squadrons which had made any kind of a name for themselves. Once a few fairly obvious omissions had been elevated to the top of the list, there was little to choose between what was left.[19] Most of the 'also rans' had been coastal patrol units of one kind or another which had accumulated a few months of active, if unspectacular, service or were squadrons that had been formed in 1918, but which had never mobilised. Nevertheless, the exercise was completed and practically all

A Hurricane I, V7608, of No 71 (Eagle) Sqn at Kirton-in-Lindsey displaying the Sky fuselage band and spinner introduced in November 1940 but still sporting the black underside to the port wing which was retained until the following April. (IWM CH2412)

of the ex-WW I numbers had been reinstated by the summer of 1940. After that it became necessary to break new ground.

While the indigenous RAF continued to expand, a substantial boost was provided by an influx of refugee airmen in the wake of the collapse of the governments of continental Europe in 1939-40. These men arrived in the UK in sufficient numbers to permit the formation of squadrons manned largely by allied personnel. Such units were allocated numbers drawn from the 300-series which was divided into blocks allocated to each nationality. In addition, volunteers from the USA began to join the RAF and three fighter squadrons, Nos 71, 121 and 133, were formed from this contingent. These American-manned units were eventually transferred to the USAAF in 1942.[20]

Under the terms of the Empire Air Training Scheme, which had been established by the Riverdale Agreement of December 1939, Australia, Canada and New Zealand each undertook to train aircrew, both for their own air forces and for service with the RAF.[21] Article XV of the Agreement had also committed these Dominions to forming additional squadrons and it was subsequently arranged that some of these would be assigned to serve under RAF control. These arrangements were given substance in 1941. The rate of formation of Dominion squadrons planned at that time envisaged that by May 1942 there would be twenty-

five RCAF, eighteen RAAF and six RNZAF squadrons serving with the RAF.[22] To cater for these units, three sub-sets of numbers were allocated within the 400-series. To avoid confusion with existing RAF units, Nos 110, 1 and 2 Sqns, RCAF, which had already arrived in the UK, were renumbered on 1 March 1941 as Nos 400, 401 and 402 Sqns, respectively. For the same reason, and at the same time, independent RAF flights numbered in the, then current, 400-series had 1000 added to their designations; thus, for example, No 430 Flt became No 1430 Flt. By contrast, Australian squadrons already serving under RAF operational control all retained their original RAAF numbers. These units were: No 3 Sqn in the Middle East, No 10 Sqn in the UK and Nos 1, 8 and 21 Sqns in the Far East. No 75 (New Zealand) and No 242 (Canadian) Sqns were other possible candidates for renumbering but, while these units were substantially Dominion-manned (insofar as their aircrew were concerned), they were actually RAF squadrons and, since there was no risk of their numbers being duplicated, it was decided to retain their current identities, although it was intended that they would continue to be manned by New Zealanders and Canadians whenever possible.

It is interesting to note that when the AHB had been producing its lists of recommended new number plates during the 1930s it had specifically omitted Nos 67, 68, 69 and 71, all of which had been associated with the AFC during WW I. None of these numbers was re-used until it became clear that they would not be required by the RAAF. A similar respect for this sort of national association concerns No 75 Sqn whose number plate was transferred to the RNZAF in perpetuity on 1 April 1946, in recognition of the unit's wartime exploits. No 75 Sqn continued to fly with the RNZAF until that air force was emasculated in 2001. The introduction of 'foreign' units into the RAF had been accompanied by an extension of the practice of 'naming' squadrons in compliance with a variety of officially sanctioned schemes.

Meanwhile, more and more British squadrons had continued to form. Even allowing for the numbers reserved for Allied and Commonwealth air forces, however, there was ample room for expansion and (with the curious exception of 188 which has never been used) all of the remaining numbers within the 100- and 200-series were eventually taken up while some limited use was made of 'spare'

numbers within the 300-, 500- and 600-series (both of the latter having effectively lost their original significance when the AAF had been mobilised in 1939). Within these mid-war allocations, some sub-sets are apparent, as a result of batches of units being formed in response to a new tactical or administrative requirement. For instance: Nos 275-284 Sqns were air-sea rescue units; Nos 285-291 Sqns were for anti-aircraft co-operation training; Nos 295-299 were airborne forces squadrons; Nos 530-539 were the short-lived Turbinlite units; Nos 540-544 and 680-684 Sqns satisfied the need for photographic reconnaissance at home and abroad respectively.

In this context it should be noted that, in 1940, to counter a possible invasion of the UK, a contingency plan was conceived which envisaged using the resources of fighter OTUs as operational squadrons. These were to have had the numbers 551-566, most of which would have been created by adding 500 to an existing OTU designation. This plan was never put into effect, although there was some desultory use of some of these numbers by the OTUs, eg the element of No 51 OTU that operated from its satellite at Twinwood Farm used No 551 Sqn for a time. Even though they were never formally activated, however, this block of numbers has never been reallocated for use by other units. The final significant sub-set was 651-673. These numbers were used by Army-oriented units formed within the RAF. The first sixteen were operational AOP squadrons, three of which were RCAF- and one Polish-manned. The other six were assault glider squadrons which were formed in India, although they never saw any action.

The allocation of squadron numbers, including Commonwealth and Allied units, runs from 1 to 699. Of these, 538 number plates have been used at one time or another, the highest individual number being No 695. While it is strictly beyond the scope of this paper, it is worth recording that the allocation of numbers ran on to 1999 in a joint sequence embracing the Fleet Air Arm. Almost inevitably, there is an anomaly. Although it was inappropriate for it to do so, No 1435 Flt, a large and active fighter unit operating in the defence of Malta in 1942, assumed the title of No 1435 Sqn. Oddly enough, rather than rule against this malpractice, officialdom decided to endorse it and the RAF acquired a squadron number which it should never have had.[23]

There is another wartime oddity that is worth noting. It will be recalled that, in order to ensure that the number plates of the squadrons

Spitfire 16, TE180, of No 695 Sqn – the highest unit number ever used in the RAF squadron series.

that had been selected to constitute the 'permanent' air force remained in use, it had been necessary to renumber several units in the early 1920s. As we shall see, there were further waves of renumberings in 1946 and in 1957-61, but it only happened once during WW II. It was in India in May 1942 when, in the aftermath of the retreat from Burma, No 5 Sqn's HQ was at Dum Dum, but most of its Mohawks were deployed forward at Dinjan to supplement No 146 Sqn, which had a rear element at Dum Dum. This lop-sided arrangement was rationalised by combining all of the assets located at Dinjan to become No 5 Sqn while those at Dum Dum became No 146 Sqn.[24]

In September 1943 it was announced that, 'To mark the occasion of the twenty-fifth anniversary of the formation of the Royal Air Force, the King has signified his intention of awarding a ceremonial flag, known as "The Standard" to RAF operational squadrons.'[25] This had been preceded by a submission to the Palace by the Secretary of State for Air, Sir Archibald Sinclair, identifying those squadrons which had already completed twenty-five years of service, including time spent in the RFC or RNAS.[26] They were Nos 1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 14, 20, 24, 25, 27, 28, 30, 31, 39, 45, 47, 55, 56, 60, 70, 84, 100, 207, 208 and 216 Sqns.

Early Planning for Peacetime

Although the war was not yet over, by the autumn of 1944 the end was sufficiently certain for long-term planning to begin. At the time, it

was anticipated that the war in Europe, 'Stage I', would end in 1945 but that it would go on in the Far East until well into 1946. While 'Stage II', the defeat of Japan, was the first priority for the planners, some early thought began to be given to the post-war years. In late-1944 the RAF fielded 363 squadrons and a dozen-or-so operational flights plus another 150 Dominion and Allied squadrons which were fully integrated within the RAF's organisation and operating under its direct control. An early projection forecast that Stage II, ie maintaining post-conflict occupation forces in Europe and elsewhere, while continuing to prosecute the war against Japan, would require only 246 RAF and 81 Dominion and Allied squadrons. Following the post-war withdrawal of the latter, it was anticipated that the peacetime RAF would eventually require a global establishment of 262 squadrons.

The initial reduction was expected to require the disbandment of some (363 - 246 =) 117 squadrons, which raised the question of how this should be handled with respect to number plates. Apart from possibly wishing to recognise the exploits of notably successful units by sustaining them, it was anticipated that there might be an adverse reaction from colonial administrations if the number plates of 'Gift and Named Squadrons', of which there were about fifty by 1945, were to be withdrawn. The options suggested were: preservation on grounds of longevity; random disbandment of any unit once it had become surplus to requirements; renumbering of units to preserve selected number plates; inviting Commands to identify which of their units they would prefer to sustain.[27]

Within a matter of days, the number plates issue was resolved at a meeting of the recently-established Re-Deployment Committee. There was no enthusiasm for renumbering. The overriding priorities were considered to be:

a. Operational efficiency.
b. The suitability of a unit's current equipment for Stage II.
c. The percentage of its personnel available to continue to serve into Stage II, both at home and overseas.

Where a choice had to be made, the older units were be retained, along with AAF, 'gift' and 'named' squadrons but, beyond that, number plates that had to be withdrawn would simply be preserved for future use.[28]

Broadly speaking, these principles served to guide the selection of

units for disbandment during the run-down which actually began in early 1945, well before the war in Europe had ended. While it was not practical to apply these 'rules' too strictly, where possible, the first squadrons to go were supposed to be those which had been formed for the first time since 1939, ie those which had the shortest histories, and which had not established any sponsorship arrangements in the sense of having been 'gifted' or 'named'. Nevertheless, because it had been based primarily on the need to finish the war against Japan, the 1944 policy had the slightly odd effect of preserving some relatively junior squadrons, on the grounds that they happened to have been serving in the Far East at the time, at the expense of some much more famous and long-lived number plates that were being withdrawn from use in Europe.

Another development worthy of note was a March 1945 decision not to include squadrons with auxiliary number plates in the Target Force for Stage II. It was intended instead to disband these units with a view to making their identities available for the early re-establishment of a peacetime Auxiliary Air Force at its pre-war locations. A policy statement to this effect was made in July and the last of the nominally auxiliary number plates ('nominally' because there were precious few ex-Auxiliary Air Force personnel still involved) was withdrawn in September.[29]

The Early Post-WW II Years

By the summer of 1946, although the contraction programme was still not complete, something resembling a steady state could be discerned. By that time the 262-squadron post-war requirement that had been anticipated two years earlier had been trimmed to a 'Target Force' of 134 by the end of the year (1946). Since it was thought unlikely that this would change much before 1950, it was considered that it would be appropriate to rationalise the constitution of the RAF's peacetime Order of Battle. Applying the principles devised in November 1944,[28] and as directed by AMSO, the AHB produced a recommended selection of 134 number plates in July 1946.[30]

Looking back at AHB's recommendations today, two observations are worth making. Although it had not been one of the specific criteria used, by emphasising length of service, the AHB had ensured that its list would automatically include the thirty squadrons which had

qualified for the immediate award of a Standard when these had been introduced in April 1943. With hindsight, it might seem a little surprising that no specific attention had been paid to Standards but, at the time, although some had been *awarded*, none had actually been *presented*. This was largely because Standards were to feature scrolls on which a unit's battle honours would be displayed and it was, therefore, necessary to determine which campaigns should be recognised.[31] As early as October 1945, therefore, the Standards and Battle Honours Committee had set up a Battle Honours Sub-Committee to delve into this issue. Until its work was complete, it was simply not possible to manufacture any Standards and, since none existed, they were a somewhat ethereal concept, and this continued to be the case until the early 1950s when they finally began to take on a more tangible form.

While it involves a short digression, the topic of battle honours warrants examination. By 1947 the Battle Honours Sub-Committee had compiled a proposed list of campaigns, broken down into World War I, the inter-war years and World War II. Among its many detailed recommendations were that the list should be submitted to the Palace and that only honours associated with 'major wars' should actually be emblazoned on a Standard, each of which was expected to cost £170 – £6,695 in 2020.[32] Having first been endorsed by the Air Council, the proposed list was forwarded to the Palace after which it would, 'for all purposes be the Battle Honours of the Royal Air Force.'[33]

The ball was then passed to the AHB who were tasked with examining the records of the thirty squadrons awarded Standards in 1943 to ascertain the battle honours to which each was entitled. This took until 1951, complicated by the fact that by that time another twenty squadrons had completed the qualifying 25-years of service.[34] The resultant lists highlighted a problem.[35] In considering WW I, the Battle Honours Sub-Committee had identified a total of seventeen campaigns on a broadly geographical basis as in, for instance, 'Italian Front 1917-1918'. By contrast, in WW II it had identified more than twice as many by specifying, in addition, specific notable actions, as in 'Italy 1943-1945' but also, 'Salerno', 'Anzio and Nettuno', 'the Gustav Line' and the 'Gothic Line'. The Air Council considered that the latter yardstick should have been applied equally to the First World War.

Fortunately, although the WW I list had already been formally

A Hastings C2, WD499, of No 511 Sqn at Blackbushe in 1956. No 511 Sqn's numberplate was one of four earmarked for permanent preservation in 1946 and it remained in the line until its Britannias were withdrawn in 1976. (MAP)

approved by the Palace, it had included a non-specific eighteenth honour expressed as 'Further battles to be selected from Army Battle Honours as required (to be agreed with the War Office).' Using this loophole, an additional twenty specific WW I actions were added. In the case of Italy, for example, these were 'Isonzo', 'Piave' and 'Vittorio Veneto'. In view of the latitude provided by the 'eighteenth honour' however, it was not considered necessary to advise the Palace of these additions. AHB went back to the drawing board and re-examined all fifty squadrons to produce the final allocations.[36]

The second point arising from the selection of number plates reflected in AMSO's July 1946 paper is that, notwithstanding the importance attached to longevity, room would eventually be found for a number of units with very short histories. While AHB had been influential in selecting the number plates to be preserved, AMSO had vetoed three that had been specifically nominated by AOCinCs. These were Nos 120, 172 and 511 Sqns on the grounds that they were, respectively, the first Very Long Range General Reconnaissance Squadron (not, as is sometimes stated, because it had sunk the greatest number of U-boats – but see below), the first Leigh Light Squadron and the first Long Range Transport Squadron. While AMSO had rejected these number plates because of their short periods of service, he had,

somewhat inconsistently, concurred in the retention of the short-lived No 297 Sqn as the first Airborne Forces Squadron. When his paper was considered by the Air Council, it recommended that the cases of Nos 120, 172 and 511 Sqns should be reviewed and in due course only No 172 Sqn failed to be reprieved.[30] Although there does not appear to have been any specific reference to No 617 Sqn at the time, it was clearly another number plate that was considered worthy of long-term preservation.

When Standards had first been introduced in 1943, apart from their being awarded after 25 years' service, there was, in addition, provision for a unit to gain a Standard earlier for 'having earned His Majesty's appreciation of specially outstanding operations.'[37] In the course of the flurry of activity over battle honours in 1951, this clause was used to sustain cases for the relatively junior Nos 120 and 617 Sqns to be awarded their Standards in recognition of their exceptional achievements in anti-submarine warfare and precision bombing, respectively.[38]

This discursive consideration of Standards and battle honours has extended the timeframe to 1952, so it is now necessary to backtrack to 1946 to pick-up the central theme. Less than a fortnight after the proposals for a 134-squadron force had been submitted,[30] the number plates had been reviewed and approved by the Air Council Standing Committee (ACSC).[39] In order to achieve the recommended selection of 'permanent' number plates, there followed a spate of disbandments and renumberings. During the last five months of 1946 the number plates of some forty squadrons were withdrawn, but twenty-three of these units were only nominally disbanded. They were actually renumbered – given new identities to fill gaps in AHB's list.

The defunct number plates which were restored to use in the course of this exercise were (with the 'disbanded' donor unit in parentheses): 8 (114); 13 (680); 18 (621); 23 (219); 34 (681); 36 (248); 42 (254); 47 (644); 53 (187); 58 (540); 63 (164): 66 (165); 77 (271); 81 (684); 82 (541); 113 (620); 120 (160); 202 (518); 210 (179); 238 (525); 257 (129); 266 (239) and 511 (246). In some cases, this had involved a change in the role with which a number plate had been traditionally and/or most recently associated, eg from single-seat fighter to photo-reconnaissance in the case of No 81 Sqn and from light bomber to transport in the case of No 47 Sqn, but this was a small price to pay for

continued existence.

Despite the best efforts of the Organisation Staff, however, post-war instability prevented some of the preferred number plates from appearing as intended. Examples of planned units which failed to materialise included Nos 27 and 87 Sqns in the Far East in the maritime strike and meteorological reconnaissance roles, respectively (see Annex A), and No 55 Sqn which was to have been a night fighter unit in the Middle East. These, and other nominated units, were short-listed for early re-formation as and when new number plates were required. In the meantime, the reconstitution of the Auxiliary Air Force in May 1946 had permitted a number of additional squadrons to be re-formed, although this was a slow process as recruiting had first to take place.[40] In December 1947 the prefix 'Royal' was granted to the 'week-end flyers' who then became the RAuxAF.[41] A further accolade came in 1951 when the Air Council decided that RAuxAF, and RAF Regiment, squadrons which satisfied the qualifications should be entitled to the award of a Standard.[42]

The 1948 Numbering Policy

By 1948 the British had withdrawn from India and there had been a further contraction of the front-line elsewhere. As a result, the following thirty-five squadrons, all of which had featured in the scheme influenced by AHB in 1946,[30] had been disbanded: Nos 5, 10, 11, 17, 20, 21, 22, 31, 34, 36, 39, 42, 43, 55, 69, 70, 76, 79, 87, 102, 103, 104, 105, 111, 144, 145, 150, 151, 152, 217, 218, 220, 240, 253 and 269. Thought was now being given as to how best to restore these numbers to use, but this proved to be a contentious issue. The proposals on offer were:

a. to repeat the 1946 exercise by redesignating some active squadrons to give them more famous, but presently defunct, number plates;

b. to apply squadron number plates to second-line units, eg communications and anti-aircraft co-operation squadrons;

c. to 'link' a dormant number with an active one or

d. to lodge defunct number plates with stations for safe-keeping.[43]

There were drawbacks to all of these ideas. Feedback from the extensive renumbering programme conducted in 1946, indicated that this procedure was sometimes resented by the losing unit and thus had

a detrimental effect on morale. Linking was another unpopular solution, Bomber and Coastal Commands being particularly opposed to the idea.[44]

Nevertheless, the ACSC opted for linking and a Squadron Number Plates Committee was set up to determine which inactive units should be grafted onto which active ones.[45] It had been envisaged that this would be a relatively straightforward task but, the deeper the committee delved into the background, the more complex it became. For example, a close examination of AHB's, necessarily hastily compiled, 1946 list had revealed many inconsistencies and inaccuracies, rendering it an unreliable means of prioritising units. Then again, this list had made some allowance for 'gift' and 'named' squadrons. On investigating these concepts, however, the committee was unable to determine a definitive policy and, since as many as nine offices (several of them external to the Air Ministry) had been involved in the past, it was not even possible to say who was ultimately responsible for such matters. Since no one knew whether these arrangements had been intended to be permanent or merely wartime expedients, the committee was uncertain as to whether they ought still to be recognised. If these associations were to be acknowledged, however, it would place significant constraints on potential pairings. In view of the communal violence that had followed Britain's recent withdrawal from India, it would be essential to avoid linking units sponsored individually by, for example, mainly Hindu Madras, and Hyderabad, where the remaining Muslim population had been scarred by a massacre inflicted in 1948.

For these, and other, reasons the committee soon concluded that linking was impractical. It therefore elected to exceed its original terms of reference and proposed a completely different approach. It devised a mechanism which would, after examining the histories of all squadrons, permit the identification of those which had the strongest claims for preservation. This, it maintained, could be achieved by using the following formula:

a. Longevity was to be recognised by the award of one point per year for peacetime service and three per year in wartime.

b. Up to twenty points could be awarded for a unit's operational record.

c. Up to ten points could be awarded for participation in the Battle of Britain, the Battle of the Atlantic or the bombing of targets in

Europe by home-based units.

d. Up to ten points could be awarded for 'other distinctions', eg the winning of a VC by a squadron member, participation in pioneering air mail services and so on.

Allowing that long-serving units could accumulate as many as 60 points under the first provision, this proposal would create a common 0-100 scale against which each squadron could be measured. With hindsight, one can see that this formula had two inherent flaws: it was excessively Eurocentric, and it inevitably required the exercise of a degree of subjective judgement, making it prone to partisanship. Nevertheless, it was a practical approach and a trial application of these rules to a random selection of units, indicated that the majority of the most deserving squadrons were already in existence. Arguing that renumbering was the least undesirable of the available options, especially as only a few units were expected to be affected, the committee recommended that the numberplates in question should be reinstated by applying its formula. The remaining, ie surplus, number plates were to be graded in order of seniority, categorised by their predominant role (based on an interpretation of their historical record) and then allocated to the most appropriate of four lists, individually dedicated to Fighter, Bomber, Coastal and Transport Commands. Any new number plates required in the future would then be drawn from the top of these lists.

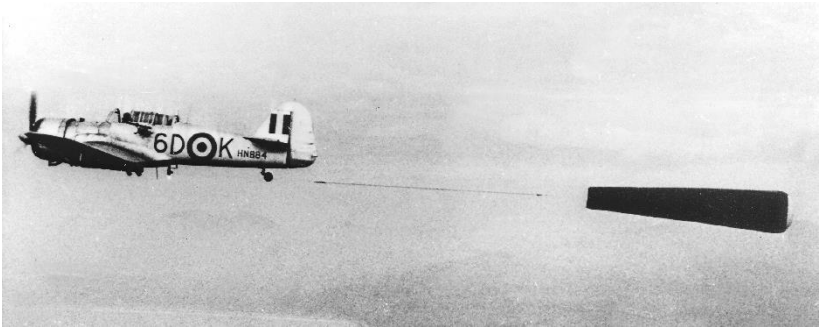
While devising its new approach, the committee had not neglected to attempt to discharge its original mandate. This had served only to underline the unsatisfactory nature of the linking idea, however, as it had proved virtually impossible to persuade the various Commands to adopt the inactive units which had been offered to them. Bomber and Coastal, and to a lesser extent Fighter, Commands, were all disinclined to accept for linking, number plates which did not have a substantial record of service in a relevant role.

From this reaction, it is plain to see that, while it never appears to have been specifically stated, it was generally assumed that all squadrons should have a clearly identifiable association with a specific role. This principle was rapidly absorbed into the decision-making process and by 1950 it had, in effect, become one of the essential criteria to be considered in the selection and allocation of number plates and it continued to be an important factor until 1957. Unfortunately, the

After more than 30 years in India, a place for No 31 Sqn in the UK was found by applying its number plate to Hendon's Metropolitan Communications Squadron in 1948. This is one of its Anson C19s, VL337. (MAP B26397)

presumption that a unit needed to have some historical link with a Command and/or role immediately created difficulties with fostering long-serving, but currently defunct, squadrons from the pre-war 'colonial' era, many of which had never served more than a few months in the UK, notably some of those thrown up by the withdrawal from India. A case in point was that of No 31 Sqn, which, despite its long service, no one wanted. In the light of all this, although it would mean the loss of thirty-five, less important, number plates, and despite its terms of reference, the committee specifically recommended abandoning the linking proposal.[46]

It took more than three months to thrash out, what amounted to, an unsatisfactory compromise and another five before the arrangements were finally in place. Coincidentally, while the Number Plates Committee had been grappling with the problem of unwanted identities, Transport Command had requested that the Metropolitan Communications Squadron be given numbered status. This had initially been denied but the Command subsequently appealed, arguing that, apart from being an exceptionally large unit, the squadron's role was substantially the same as that of the inter-war No 24 (Communications) Sqn and cited the existence of that unit as a clear precedent. This time the Air Ministry was happy to concede, not least because it found a home for the number plate of the recently orphaned No 31 Sqn.[47]



One of No 20 Sqn's Martinets, HN884, 'dragging a flag' over Cardigan Bay. While serving a useful function, this sort of thing hardly reflected the unit's traditions – but it was better than nothing. (Andrew Thomas)

Meanwhile, No 39 Sqn had been re-formed from scratch and the number plates of Nos 10, 11 and 70 Sqns had already been restored to use by renumbering Nos 238, 107 and 215 Sqns, respectively. In February 1949, Nos 266, 595, 631, 691 and 695 Sqns[48] were all renumbered to become, respectively, Nos 43, 5, 20, 17 and 34 Sqns.[49]

These measures had taken care of ten of the thirty-five problematic number plates but, in view of the general distaste for renumbering, this was as far as the idea was taken and, despite the recommendations of the Squadron Number Plates Committee, the remaining moribund numbers were restored to use by the equally unpopular device of linking. The committee's innovative points formula was endorsed by the ACSC, however, and adapted to provide a relatively dispassionate means of deciding which pairings were most appropriate. The linking arrangements were eventually introduced in 1949 – see Annex A.

As had been feared, the linked number system proved to be unsatisfactory. It was all very well giving a squadron responsibility for sustaining the ethos of an *alter ego*, but it could do this only at the expense of diluting its own identity and at the risk of developing a split personality. Since linking was so unsuccessful, it was fortunate that it also turned out to be short-lived, most of the, at the time twenty-seven, (relatively) silent partners in these associations being reactivated in their own right during the expansion of the RAF which followed the outbreak of the Korean War – see Annex A.[50]

Command	Planned Number Plates
Bomber	10, 18, 21, 27, 40, 50, 76, 102, 103, 104, 144, 207
Fighter	17, 34, 46, 111, 151, 152, 253
Coastal	22, 36, 42, 206, 217, 220, 228, 240, 269
Transport	623, 624, 625, 626
2nd TAF	5, 20, 79, 68, 87, 96, 145, 234, 256, 266
MEAF	55, 185, 225, 238, 241, 242, 250
No 90 Gp	192, 199
Mobile Reserve	255

Table 1. Number plates nominated in October 1951 for reactivation in response to the Korean War.

The 1950s – Expansion, Contraction and 'Shadow' Squadrons

By 1951 it was envisaged that the increase in international tension associated with the Korean War would require the RAF to be expanded by more than fifty squadrons, many of which would be created by the aforementioned 'de-linking'.[51] The specific number plates that were initially earmarked to be reactivated, and allocated to appropriate Commands, are listed at Table 1.[52]

All of this was supposed to happen before the end of 1952 but, with such an ambitious programme, there was almost bound to be some slippage. Nevertheless, much of the plan had been realised by the end of 1953. The only major deviation being the expansion of MEAF, most of which did not happen. The CinC had expressed reservations over the number plates that he had been allocated but, in the event, his Command would gain only two additional units, Nos 185 and 219 Sqns. The only other planned number plates that were not taken up at the time were those of No 144 and 255 Sqns and the four transport units.

The planned transport squadrons were an extension of an experiment, begun in 1950, which, it had been hoped, would provide additional RAuxAF units. It had been decided to see whether it was a practical proposition for a civil aviation company to sponsor an auxiliary transport squadron.[53] No 622 Sqn was set up at Blackbushe under the auspices of Airwork who were to fly and maintain the squadron's two Valettas, the company committing ten Vikings, and all of the necessary support personnel, if and when the squadron were ever

mobilised. There was some initial enthusiasm for this concept, and it was intended to form four more such units, Nos 623-625 Sqns, in 1951, and No 626 Sqn in 1952. Three of the additional units were to fly Yorks, and the fourth, Valettas; the host organisations were expected to include the Lancashire Aircraft Company, Hunting Air Travel, Scottish Aviation and (probably) Eagle Aviation. Unfortunately, because all commercial flight deck crew had broadly similar social status, whereas the RAF proposed to commission the pilots and palm off the rest with three stripes, the idea foundered on the rock of recruiting. By late 1952 No 622 Sqn had twenty-three of its intended twenty-six pilots on strength but could field only five radio officers and a solitary air engineer against a requirement for thirteen of each. The prospective sergeants, who were all ex-RAF of course, had already 'been there, done that' and they were not going to accept NCO status again. Furthermore, less than a third of the required ground crew had signed-up, because, unsurprisingly, most of the company's technical staff were not prepared to spend their weekends doing, what amounted to, their normal day job for considerably less pay.[54] The scheme had to be abandoned and No 622 Sqn was disbanded in 1953.

Application of the unwritten, but widely accepted, 'rule' that number plates should be associated with particular roles or regions became increasingly commonplace during the 1950s. For instance, when it was decided to establish a squadron to support the Fighter Command Control and Reporting School in 1953, it was assigned the number plate of one of the wartime anti-aircraft co-operation units, No 288 Sqn. Similarly, at much the same time, rather than being given the next most senior available identity, a helicopter unit formed for rescue duties was given No 275 Sqn's number plate to establish a role-based link with its wartime predecessor. It happened again three years later when a similar unit, No 284 Sqn, was set up in Cyprus, this time reflecting links to both role and region. Other instances of regional affiliations are represented by Nos 155 and 194 Sqns which, having established their wartime reputations in the Far East during the Burma campaign, were re-formed in Malaya in 1953-54. The choice of No 543 Sqn for a strategic reconnaissance unit set up in 1955 was another example of the role-based philosophy.

The same thinking could also be seen at work in the context of the projected Seamew MR 2 squadrons, four of which were to have begun

A Seamew MR 2, XE175, in overall, Shackleton-style, Dark Sea Grey in anticipation of its being issued to No 221 or 233 Sqn, but it was not to be. (Shorts)

forming in 1956. Rather than simply assigning the next most senior number plates, HQ Coastal Command was offered the choice of Nos 200, 221, 233, 235, 236, 248 and 254 Sqns. Northwood deferred a decision on the third and fourth squadrons but selected Nos 221 and 233 to be the first pair.[55] In the event, the Seamew programme was cancelled before any entered service and a major review of squadron numbering policy soon afterwards reversed the drift towards regional and/or role-associated number plates.

Having completed the build-up of the front line in response to the Korean War, that crisis had passed and, by August 1954, it was expected that the RAF would have to lose some thirty squadron over the next twelve months. To assist the Organisation Staff in deciding which units would have to go, AHB was asked to provide, 'the following particulars of all squadrons which are, or have been, in the RAF Order of Battle:'[56]

a. Date of formation.
b. Original role.
c. Subsequent role(s), and dates of change.
d. Employment, with dates, under these headings:
    i. Command in which served.
    ii. Periods of 'linked' service.
    iii. Periods disbanded.
e. Battle Honours.

f. Date of award of a Standard.
g. Period left to serve to qualify for a Standard.
h. Brief history, to include notable events.

Since the task covered, in effect, *all* squadrons, that was a very tall order. The information would be available, of course, but in a piece-meal form and it would take some time to extract and collate it in order to present the result in a readily accessible format. Eight months later it was still a work in progress, but it was hoped that the project might be finished by June 1955, 'unless some unforeseen requirement arises.'[57] The task was completed, eventually, but there does not appear to be a record copy of the final result, at least not as single document, on file at The National Archives. Nevertheless, this exercise must have made it relatively easy for AHB to answer questions, compare seniorities and so on as and when the need arose. In the event, the swingeing reduction in the front line that had been anticipated in 1954-55 had not materialised, but it was only a stay of execution. When the axe did eventually fall it would inflict more than twice as much damage.

Meanwhile, another innovative use had been found for redundant number plates. Until the later-1950s, the air threat to the UK was an attack by manned bombers. In 1954, as a means of reinforcing the front line, it was decided to provide the option of mobilising selected second-line units. Number plates were earmarked for these makeshift reserve, or 'shadow', squadrons, but they were intended to be used *only* when and if the squadron was embodied. Since, until mobilised, reserve squadrons did not exist, they were not to submit a F540, would not be reflected in the SD155 or SD161[58] and, for routine administration, the unit's peacetime title was to be used exclusively. Time spent as a reserve squadron did not count towards the twenty-five years required to qualify for a Standard and units were not permitted to display the badge, or hold the property, of their notional wartime identities. Furthermore, the allocation of a number plate was not permanent, ie it could be withdrawn if needed for an operational unit.[59, 60]

By 1957 it had been concluded that the future threat would be represented by ballistic missiles and, since there could be no effective defence against these, that it was pointless to try to provide one using aeroplanes. That year's White Paper on Defence announced that the strength of Fighter Command was to be considerably reduced, that the remaining air defences were to focus on the protection of the deterrent

Represented here by a Vampire FB 9, WR266, of No 607 Sqn, the RAuxAF ceased to be a flying organisation when all of its twenty-five squadrons were disbanded in 1957. (E Taylor)

forces and that, in the long term, it was intended to replace fighter aircraft with surface-to-air missiles (SAM).[61] This major shift in policy led to the early disbandment of large numbers of fighter, and light bomber, squadrons based in the UK and Germany. Even before this, however, twenty-five number plates had already been obliterated at a stroke as a result of the disbandment of the flying units of the RAuxAF on 10 March 1957. Three more were lost on 1 September, when the remaining regular AOP units were transferred to the control of the Army Air Corps. Although they were now army units, they retained their original number plates and these, along with those of other erstwhile RAF AOP squadrons, are still in use today.

Annex A

Linked Squadrons

Linked unit numbers were first used, albeit sporadically, in the Middle East during WW II. This usually occurred when the air echelon of a squadron detached from the UK, eg No 10 Sqn, was combined with the ground echelon of a locally-based unit which had, as yet, received no aircraft of its own, eg No 227 Sqn. The combined unit operated, in this case, as No 10/227 Sqn until it was incorporated, with No 76/462 Sqn, into an independently established No 462 Sqn. A particularly unusual example of this practice was the merging of an RAF unit with one from the FAA to form No 33/806 Sqn, this link being formally constituted between 8 June and 28 July 1941.

As the RAF contracted, from 1945 onwards, many of its squadrons were disbanded completely, but some of those with longer, or more distinguished, histories were reduced to 'Number Plate Only' status in anticipation of their early re-establishment, either as additional new units, or by the relabelling of existing squadrons. For a brief period in 1946-47, in an effort to give these potential squadrons more substance, some number plates were appended to existing units as their 'B Flights'.

An example of this is provided by the association of Nos 27 and 45 Sqns. Notice had been given, by SD 155/1946 No 1365, of an intention to re-form No 27 Sqn at Seletar, where it was to serve in the maritime strike role. This plan was cancelled shortly afterwards but, in order to sustain the No 27 number plate, SD 155/1946 No 2201 applied it, from 1 November 1946, to No 45 Sqn in Ceylon where it was to serve as that unit's 'B(27) Flight'. This arrangement was sustained until 1 October 1947 when the designation was withdrawn, on the authority of SD 155/1947 No 997, since an independent No 27 Sqn was about to be formed in the UK. Similar arrangements led to a B(18) Flight serving within No 38 Sqn from 15 September 1946 until the end of the year, when its designation was changed to B(87) Flight in the expectation that a new No 18 Sqn was likely to form, the '87' being withdrawn in turn on 31 August 1947.

This approach to sustaining inactive squadron number plates was not very successful since, in practice, the 'parasite' squadrons were scarcely acknowledged by their parent units. It was not widely used, but it was still felt that a system was needed which would prolong the effective

service, and thus extend the histories, of selected squadrons from among those which had been disbanded after WW II. A further attempt was made to provide some of these with a 'spiritual', if not a physical, existence by the creation of 'linked squadrons'. The system was introduced from February 1949 on the authority of AMO A.86/49. In each case the inactive squadron was the second element of the linked pair. This also proved to be a rather unrealistic concept and it never gained much popular support. Although the upper echelons of the RAF bureaucracy tended to acknowledge the *alter egos*, at squadron level they received scant recognition. Despite its somewhat intangible nature, time accrued as a linked unit was considered to be reckonable (by both squadrons) towards the 25 years' service needed to qualify for the award of a Standard. The linked squadron concept was overtaken by the expansion of the RAF during the period of tension associated with the Korean War in the early 1950s, which allowed most of the dormant numbers to be re-established in their own right. Units linked together under this scheme, with dates, were:

Sqn	From-To	Sqn	From-To
7/76	1 Feb 49 – 8 Dec 53	74/34	20 Jul 51 – 31 Jul 54
15/21	1 Feb 49 – 20 Sep 53	83/150	1 Feb 49 – 1 Jan 56
19/152	11 Feb 49 – 31 May 54	85/145	11 Feb 49 – 28 Feb 52
23/151	11 Feb 49 – 14 Sep 51	109/105	1 Feb 49 – 1 Feb 57
29/22	11 Feb 49 – 20 Dec 54	115/218	1 Feb 49 – 1 Mar 50
41/253	11 Feb 49 – 15 Apr 55	115/218	13 Jun 50 – 1 Jun 57
43/17	13 Mar 51 – 31 May 56	120/220	15 Feb 49 – 23 Sep 51
44/55	1 Feb 49 – 14 Jul 57	141/42	11 Feb 49 – 27 Jun 52
45/33	31 Mar 55 – 14 Oct 55	203/36	15 Feb 49 – 30 Jun 53
49/102	1 Feb 49 – 19 Oct 54	205/209	1 Jan 55 – 1 Nov 58
50/103	1 Feb 49 – 30 Nov 54	210/217	15 Feb 49 – 13 Jan 52
50/40	1 Feb 57 – 1 Oct 59	224/269	15 Feb 49 – 1 Jan 52
56/87	11 Feb 49 – 31 Dec 51	230/240	15 Feb 49 – 30 Apr 52
57/104	1 Feb 49 – 14 Mar 55	240/204	20 Feb 53 – 1 Jan 54
61/144	1 Feb 49 – 31 Mar 58	245/266	11 Feb 49 – 13 Jul 52
66/111	11 Feb 49 – 1 Nov 53	264/79	11 Feb 49 – 14 Nov 51

Notes

[1] AIR1/17/15/1/84. Cmd 467; *Permanent Organization of the Royal Air Force*, 25 November 1919. This plan envisaged an initial strength of twenty-three and a half squadrons, plus five independent flights, rising to thirty-two squadrons plus two flights by 1922-23.

[2] AIR2/1524. At Minute 50 of 27 November 1919, the Director of Training and Organisation (DTO), Air Cdre P W Game had proposed the allocation of squadron number plates to a variety of training units. CAS vetoed that idea the next day.

[3] *Ibid*. Memo 11232(O2) of 8 May 1919 from CAS to GOCs at home and abroad.

[4] From the Trenchard Memorandum – see Note 1.

[5] AIR2/1524. An instance of this constraint being applied is at Minute 18 of 24 July 1919 on this file in which Brig Gen P W Game had deleted several potential units on the basis of seniority.

[6] *Ibid*. In a loose minute of 3 December 1919 Air Cdre Game, summoned the Heads of the other three Air Ministry Directorates to attend a meeting to be held on the 8th at which, 'CAS wished to decide the numbers of the Squadrons to be retained.' DTO's note covered a list of the proposed number plates along with their previous roles, aircraft types and, on a broadly theatre basis, an indication of their wartime and proposed peacetime locations. The file copy has been hand-amended to reflect the three changes that were agreed.

[7] AIR2/119. An initial announcement was made, to a long list of official addressees, by Air Cdre Game's Air Ministry letter 165000/20 (O1) of 30 January 1920 with a follow-up public statement in Daily Routine Order No 111 of 17 March 1920.

[8] AIR2/1524. CAS's scribbled Minute 55 of 26 August 1920 on this file simply states, 'I would rather (*illegible*) No 8 & No 45'; he does not provide a rationale for the latter.

[9] AIR2/1267. ND37; *The Expansion of the Royal Air Force for Home Defence*, dated 1 June 1923.

[10] AIR2/1523. These number plates emerged from correspondence conducted between 14 November 1923 and 16 January 1924 as Minutes 20-25 on this file.

[11] AIR2/1522. AHB's detailed survey of the remaining unallocated ex-WW I number plates was submitted to AMP by the Director of Staff Duties, AVM Sir Ivo Vasey, on 16 November 1927. This list included those squadrons numbered in the 100-series which had formed, but not been mobilised, prior to the armistice, but it did not acknowledge the many short-lived, mostly coastal patrol, squadrons numbered in the later 200-series.

[12] The essential difference was that the core of an SR unit, including the CO and one flight, were regulars with one or two additional flights of part timers, whereas an AAF unit, was manned almost entirely by volunteers. In practice, the former concept proved to be less successful and during 1935-36 the five SR squadrons were all reconstituted as AAF units, although they retained their original 500-series number plates.

[13] *Ibid*. As late as 14 November 1923 it was still intended to assign redundant WW I number plates to the thirteen projected SR and AAF units; Minute 20 on this file anticipated that they would be Nos 21, 34, 48, 52, 53, 59, 63, 114, 115, 206, 214, 215 and 217 Sqns.

[14] AIR5/302. Air Ministry letter 440744/23 (O1) of 23 July 1924 assigned Nos 500-

506 and 600-605, although the intended locations for only six of these units had been identified at that stage.

[15] AIR8/73. Home Defence Expansion Scheme (7th Revision) dated 1 April 1930.

[16] This was a very curious decision, as there were several dormant RAuxAF number plates available for reactivation, any of which could have provided an historical foundation upon which the new unit could build. Or was there, perhaps, an aversion on the part of 'the authorities' to using a number plate with a previous regional association in an inappropriate location?

[17] AIR2/2750. These squadrons, and the rationale behind their selection, were nominated by DofO, Air Cdre W L Welsh, in his M1 of 14 February 1935.

[18] *Ibid*. DofO's list having been endorsed by AMSO, CAS indicated his concurrence at M3 on 18 February. The 'numbers allotted to the squadrons forming in the financial year 1935' were announced in AMO N.187 of 4 April 1935, some of the planned locations later being amended by N.337 of 20 June.

[19] *Ibid*. The resultant tables are on this file covered by AHB letter 385426/35/O1 dated 22 July 1935.

[20] These transfers involved only those pilots of Nos 71, 121 and 133 Sqns who were US citizens; the groundcrew were predominantly (possibly exclusively?) British and had, in any case, since November 1941 been constituted separately as Nos 3044, 3016 and 3017 Servicing Echelons, respectively.

[21] AIR2/3160. 'Memorandum of Agreement between the Governments of the United Kingdom, Canada, Australia and New Zealand relating to training of pilots and aircraft crews in Canada and their subsequent service' dated 17 December 1939, aka 'The Riverdale Agreement'.

[22] AIR20/6306-6308. Memoranda of Agreement with Canada dated 7 January 1941 and with Australia and New Zealand dated 17 April 1941.

[23] AIR10/3928. SD155 317/43 of 3 April 1943 formally recognised the unit's squadron status.

[24] AIR10/3927. SD155 17/1942 noted this rationalisation with effect from 5 May 1942.

[25] AMO A.886 of 9 September 1943. Five days later this 'in-house' announcement was amplified by an article in *Flight*.

[26] AIR30/275. This document was initialled by HM King George VI on 9 August 1943 to become King's Order for the Royal Air Force No 516.

[27] AIR20/5173. All of this, the projected numbers of squadrons required and the suggested options for dealing with number plates, was laid out by the DGO, AVM G C Pirie, in his Note RDC1, 'Re-allocation of Squadrons and Retention of Number Plates' of 21 November 1944, which included an appended list of the 'gift' and 'named' squadrons.

[28] *Ibid*. Appendix A to the minutes of the 3rd Meeting of the Redeployment Committee held on 24 November 1944. This document would later resurface as Annex A to ACSC Memorandum SC(46)44 of 12 July 1946 (see Note 30).

[29] AMO A.758 of 26 July 1945 announced the intention to 'withdraw from active service all the auxiliary squadrons.'

[30] AIR6/136. AHB's recommendations were presented to the ACSC by AMSO (Air Mshl Sir Leslie Hollinghurst) at Annexes B and C to his Memorandum SC(46)44 dated

12 July 1946. They were approved, with only one reservation, on 27 July 1946 at Meeting 6(46) (see AIR6/90).

[31] AMO A.886 of 9 September 1943 noted, at para 3, that Standards would have 'scrolls added as requisite for recording battle honours.'

[32] AIR6/135. The sub-committee's proposals were submitted to the Air Council as an Annex to Memorandum AC57(47), dated 28 October 1947, jointly sponsored by AMP, Air Mshl Sir Hugh Saunders, and VCAS, Air Mshl Sir William Dickson. The submission was endorsed by the AC on 21 November 1947 at its Meeting 14(47) (see AIR6/76).

[33] AIR30/280. Submitted by the Secretary of State for Air, Arthur Henderson, on 19 January 1948, and promptly approved by HM King George VI, it became Kings Order No 622.

[34] AIR30/283. A request for an additional twenty squadrons to be permitted to 'possess and carry Standards' was submitted to the Palace by the Secretary of State for Air, Arthur Henderson, on 23 April 1951 and duly approved as King's Order 698 by HM King Georg VI.

[35] AIR6/88. The battle honours associated with the original thirty squadrons, and the additional twenty, were submitted to the Air Council for its approval by AMP, Air Mshl Sir Leslie Hollinghurst, in his Memoranda AC13(51) and 14(51) respectively, both dated 14 February 1951. They were rejected at Meeting 3(51) on 2 March which considered that the lists for WW I and II were out of proportion and directed that the former be revised (see AIR6/80).

[36] AIR6/88. The revised allocation of battle honours, for all fifty squadrons, was submitted to the Air Council by AMP in his Memorandum AC57(51) dated 1 November 1951. It was duly approved on 8 November at Meeting 16(51) (see AIR6/80).

[37] AMO A.886 of 9 September 1943, para 2(ii).

[38] AIR6/88. The case for Nos 120 and 617 Sqns to be awarded their Standards on special grounds was submitted to the Air Council by AMP in his paper AC58(51) dated 1 November 1951. This proposal was endorsed on 8 November at Meeting 16(51) (see AIR6/80).

[39] AIR6/90. Conclusions of ACSC Meeting SC8(46) on 24 July 1946.

[40] AIR10/5216. SD155 948/46 of 3 May 1946 authorised the re-formation of Nos 500-502, 504, 600-605 and 607-616 Sqns with effect from 10 May. The commencement of, initially internal, recruiting was not announced until AMO A.454 of 8 June 1947 and external recruiting did not begin until as late as 7 November (see, for instance, *Flight* for 8 November 1947).

[41] AIR30/279. King's Order 611, initialled by HM King George VI on 6 September 1947, approved the prefix 'Royal', making the initialism RAAF. It would appear, however, that it had subsequently been acknowledged that this would infringe a long-standing *de facto* Australian copyright, because it was three months before a public announcement was made, by which time the initialism had become RAuxAF. See *Flight* for 18 December 1947 and AMO A.35 of 15 January 1948.

[42] AIR6/88. The case for the award of Standards to Nos 502, 600, 601, 602 and 603 Sqns RAuxAF and No 2 Armoured Car Sqn was included in AMP's Battle Honours paper, AC58(51) of 1 November 1951 (see Note 36). This proposal was endorsed on 8 November at Meeting 16(51) (see AIR6/80).

[43] AIR6/95. These options were set out by AMSO, Air Mshl Sir Leslie Hollinghurst, in his Memorandum SC(48)13 of 30 January 1948.

[44] AIR2/1521. The idea of adding selected, dormant number plates to existing units had first been suggested by AHB's H A Jones, in an unreferenced letter to CAS's office as long ago as 11 September 1930. Although given due consideration, this idea was eventually rejected by DOSD, Air Cdre F W Bowhill, in another unreferenced later dated 2 October 1930.

[45] AIR6/91. The decision to set up a Squadron Number Plates Committee was recorded in ACSC Conclusions 2(48) of 3 February 1948. It was established under the overall auspices of AVM N Carter, the Director of Organisation (Forecasting and Planning). Following appropriate guidance, minuted by AMSO, Air Mshl Sir Leslie Hollinghurst, the committee's terms of reference were issued as 4750/48/DO(FP) on 20 February (AIR2/10244). Apart from members of the Air Ministry's Organisation Staff, the committee included representatives from Bomber, Fighter and Coastal Commands and the AHB.

[46] AIR2/10244. The committee's recommendations, including the points system, was laid out by its Chairman, Gp Capt H A Constantine, on 15 June 1948 in a paper, DDO(F)/A.965371/48, which covered a 16-page 'Report by the Squadron Number Plates Committee on the principles and methods of selecting squadron number plates for inclusion in the front line'.

[47] AIR2/10245. After several exchanges of correspondence, Air Ministry letter A.965371/48/II/DO(FP) of 7 July 1948 notified AOCinC Transport Command that the Metropolitan Communications Squadron had been assigned the No 31 Sqn number plate. This decision was put into effect by SD155 472/48 of 19 July 1948.

[48] Although they all existed at the time, presumably because they were non-operational second-line units, Nos 595, 631, 691 and 695 Sqns had not featured in AMSO's Memorandum SC(46)44 of 12 July 1946 (see Note 30).

[49] AIR6/95. Significant milestones in the negotiations over number plates were represented by submissions SC(48)39 and SC(48)41 made by Air Chf Mshl Sir George Pirie, as AMSO, to the ACSC and (in AIR6/91) the Conclusions of its Meeting (10)48, all at various dates in September 1948.

[50] AIR6/154. Although some of the detail would change, the broad scope of the expansion anticipated in 1951-52, that would restore most of the linked squadrons and the re-formation of several others, was presented to the ACSC by AMSO, Air Chf Mshl Sir William Dickson, in his Note SC(51)15 of 10 September 1951.

[51] *Ibid*.

[52] AIR2/11422. The allocation of number plates to Commands was announced by Air Ministry letter MS 1100/51/DDO2 of 23 October 1951.

[53] AIR6/86. The transport scheme, which had originally been proposed by Airwork, was submitted to the Air Council by VCAS, Air Mshl Sir Arthur Sanders, in his paper AC53(49) dated 13 July 1949. The idea was promptly endorsed in principle at Meeting 14(49) (see AIR6/78).

[54] AIR6/100. The problems that had been encountered were presented to the Air Council by DCAS, Air Mshl Sir Ronald Ivelaw-Chapman, in his AC(53)27 of 16 June 1953; his recommendation, that the scheme should be abandoned, was approved on 29 June at Meeting 9(53) (see AIR6/97).

[55] AIR/12982. The suggested number plates were offered by the Org Staff via its A.2241 8/88 O.5 of 19 September 1955; HQ Coastal Command signified its preference in its CC/S.2012/Org of 24 September.

[56] AIR2/14387. Memo MS1100/51/DofO of 13 August 1954 from the Acting DofO, Gp Capt J Worrall, to Head of AHB.

[57] *Ibid*. Minute on file AHB5/40 of 7 April 1955 from Head of AHB, J C Nerney, to DofO.

[58] An RAF Form 540 is a unit's Operations Record Book, a monthly diary; the Secret Document (SD) 155 contained Organisation Memoranda and successive editions of the SD161 presented the 'Location of Units in the Royal Air Force'.

[59] AIR2/15220. All of these conditions were first proposed in a loose minute C.117042/59/OG1 dated 25 November 1959. They were subsequently implemented and periodically reiterated, eg in MOD letter, AF/CT2844/64 dated 14 March 1966 (see AIR2/17537). The essence of this policy was still evident as late as 8 November 1978 when it was spelled out in a letter, CAS.91171, from PSO to CAS to OC RAF Lossiemouth in the context of an, unsuccessful, bid for a squadron identity for the Jaguars No 226 OCU (see DEFE71/829).

[60] For more detail on this, see *Reserve Squadrons*, in RAF Historical Society Journal No 74, pp132-154.

[61] Cmnd 124; Defence, Outline of Future Policy, April 1957.

ERRATUM

In Journal 76, p121, your Editor observed that, '. . . while W E Johns saw fit to grant Biggles technical support, in the shape of Flight Sergeant Smyth and Ginger, he never saw the need to provide him with any dedicated back-seat aircrew.'

Guy Warner has written to point out that, 'When Biggles served in 169 Squadron flying the FE2b, his observer was Lt Mark Way from New Zealand. The FEs were soon replaced by Bristol Fighters. Biggles was subsequently transferred to 266 Sqn, flying Pups first of all. Mark was invalided home after losing a hand and an eye to a beastly Hun bullet and flying glass, shot at on the ground following a crash landing with Capt Mapleton.'

Game, set and match to Guy. **Ed**

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BOOK REVIEWS

Note that the prices given below are those quoted by the publishers. In most cases a much better deal can be obtained by buying on-line.

RAF's Centenary Flypast by Wing Commander Kevin Gatland OBE MA RAF. Air World, 2012. £25.00.

Connoisseurs of large flypasts will be aware of such events as the 155 aircraft that flew over Duxford on 6 July 1935 to mark King George V's Silver Jubilee, the 500+ Desert Air Force flypast over Campoformido on 28 May 1945 and the 307 aircraft that participated in the Victory Flypast over London on 8 June 1946 in weather conditions that turned distinctly marginal at the very last minute with a cloud base of less than 1,500 ft and poor visibility in rain; they still managed to pull it off so GASOs must have been a bit more relaxed in those days. More than twice that size was the 641-aircraft Coronation Flypast (with another 318 on the ground) over Odiham on 15 July 1953. At first glance these figures might appear to make the 103-aircraft flypast over London on 10 July 2018 relatively small beer. But that was most definitely not the case. As we all know, it's not size that counts; it's what you do with it and, in the context of flypasts, it's the complexity that makes the difference and, as this book makes clear, doing this sort of thing in the 21st Century is a lot more difficult than it used to be.

So why? Several reasons, first the need to comply with, and/or negotiate concessions to circumvent, airspace constraints imposed and policed by the civil aviation authorities, whereas in days of yore the RAF pretty much ruled the roost. Secondly there is the need to deconflict from commercial traffic, of which there is a lot more than there used to be – and then there's the need to abide by the RAF's own rules and regulations, which are also a lot more stringent that they used to be. As an example of the latter, there is simply no way that the Centenary Flypast would have gone ahead if the weather conditions on the day had been as they were in 1946. As it happened, the weather in 2018 wasn't a problem but that does not mean that it hadn't been a planning factor. Indeed when a scaled-down 50-aircraft version of the flypast was laid on for RIAT at Fairford just three days later – an event also covered by this book – it had to be cancelled due to an untimely and inconvenient thunderstorm. Cancelling at such short notice –

literally a few minutes – meant that the various participants needed to be able to abort and climb out safely on deconflicted tracks. That they were able to do so was because it was a contingency that had been planned for, and contingency planning is one of the threads that runs throughout this book.

The weather aside, during the eighteen, initially relatively leisurely, months that it took to plan the Centenary event, there were many issues that had to be resolved as the tempo increased. Which aeroplanes would actually be available, particularly the newer ones – F-35, Prefect, Texan, Phenom? How many Hercules? How to keep general aviation traffic out of the way? What about a terrorist with an IR missile or an idiot with a drone? What temporary airspace reservations, if any, would be needed and for how long? The various participants would need 'holds' – where could they be conveniently located to create the minimum inconvenience to other aviators? There's still the weather issue; if conditions are marginal, might it still be possible to lay on something less ambitious? What about short-notice aborts – which way should each formation turn at each stage of the route? Some relatively short-legged aeroplanes would need to launch from, or recover to, other than their home airfields – which should go where – and can they accept them? Can we devise an appropriate one-off formation of Typhoons to mark this very special anniversary? Can we actually shut down Heathrow for possibly approaching half an hour? – in the middle of the day!

The narrative, while detailed and providing the answers to all of these questions, and more, against the shifting background of who will and who won't be playing on the day, reads without any trace of rancour. Much of this will have involved liaison with a variety of agencies, many of them outwith the RAF, which must have required some skilful diplomacy and one suspects that the author's OBE was very well-earned. There was, however, one tool that must have made planning the routes and timing a lot easier than it had been in the past. Today's software would have permitted almost instant replanning to examine alternative routes and options compared to the straight edge, pencil and Dalton computer of old.

This nicely produced, 181-page hardback, is well-written, and typo-free. The text is supported by sundry diagrams and planning charts and an annex provides the serial numbers of all of the participating aircraft.

There are more than 100 colour photographs of the actual flypast, many of them taken from a helicopter showing individual aircraft or formations against the backdrop of the Palace or of the Mall, packed with spectators. Wg Cdr Gatland's book provides, at first-hand, an insight into the complexities that underpin the planning of such an event and as such it makes a very worthwhile addition to the annals of the RAF. Strongly recommended.

CGJ

Britain's Aircraft Industry, *Triumphs and Tragedies since 1909* by Ken Ellis. Crecy: 2021, £27.95.

Following the success of his outstanding two-volume *Testing to the Limits*, biographies of British test pilots since 1910, renowned aviation historian and writer Ken Ellis has turned his attention to the British aircraft industry in his latest book.

The author has a long-standing and deep interest in aviation heritage, in particular British-built aircraft. This led to a thirty-year career in publishing before concentrating on writing and lecturing. There can be few better qualified to investigate the history of the British aircraft manufacturing industry.

In his introduction, the author poses the question, What makes an industry? He decided that the construction of five original, individual types and a grand total of at least 250 machines built were the qualifications to merit inclusion. He does not include sub-contractors, some of which built thousands, particularly during World War Two. As a result, he has outlined the history of thirty-seven companies, and these are arranged alphabetically.

Each chapter is given an appropriate title, which cleverly summarises the company's characteristics. For example de Havilland is 'Founding Father, Folland is given the title 'Bantamweights', and Handley-Page is 'Dogged Independence'.

As a backdrop to the narratives of each company, there is a very helpful chronology, which helps to place in context the various developments and production schedules of each company. Included in every chapter are simple tables providing basic information, dates, total aircraft produced, engines etc.

Whilst there are many books that deal with aircraft built by individual companies, not least the seminal Putnam series, this book

offers a more general approach. The extensive bibliography provides the reader with a comprehensive list of other titles across the whole spectrum of British aircraft companies.

The industry began with the world's first aircraft factory in Britain, Short Brothers in 1909. The author covers the 112 years that followed and reminds us of some iconic names, sadly many long gone. Beardmore, Martinsyde, Sopwith followed later by Bristol, Fairey, Vickers and many others.

One realises the scale of the industry in the inter-war years with individual companies producing numerous types, and in a timescale that is a wonder when compared to the last few decades. The rush to meet the Government's Expansion Plan in the run-up to World War Two produced some of the greatest aircraft ever built, the Hurricane, Spitfire, Lancaster and Mosquito to mention just a few.

The decade of the 1950s, which brought the Canberra, Hunter, and the V-Bombers, together with some ground-breaking designs of civil aircraft, the Viscount, Comet and the graceful VC 10, was to see the steady, and irreversible change in the industry with amalgamations and consolidation taking place, to be followed in more recent years by international collaboration, the latter resulting in the Puma helicopter, Jaguar, Tornado and Typhoon with Airbus providing a vital way forward for civil airliners.

This A4-size book, printed on high-quality paper, is an evocative volume full of wonderful photographs and illustrations but, above all, it is a reminder of the brilliance of British designers, the skill of this country's work force and the influence that Great Britain has had in the world of aviation.

This book will be at the front of my bookshelf, and I have no doubt that I will be constantly referring to it as I wallow, and enjoy, the nostalgia that Ken Ellis has so eloquently related.

Air Cdre Graham Pitchfork

The Men who flew the English Electric Lightning by Martin Bowman. Pen & Sword Aviation, 2021. £25.00.

Although Martin Bowman's recent book from Pen and Sword is not one of his best, it provides another opportunity to record, from the cramped cockpit, some adventures from the Lightning's lengthy career. These include long ferry trips and extended QRA activities to

immediate landings having experienced the bells and flashing caution lights indicating a fire warning shortly after take-off. The contents are not just confined to pilot stories and there are several personal accounts from air traffic controllers and groundcrew about Lightning-related matters, all of which make interesting reading.

Over 60 photographs and 250 pages of narrative help to remind the reader of this slice of RAF history about a fighter which was described by Dave Seward, then OC 56 Sqn, as 'superb to fly, a bitch to maintain and always short of fuel' to which I would add 'and an inadequate fighting machine' where its pitifully small weapon load and short range limited its combat capability. However, as a QRA interceptor in peacetime it served the country well, particularly with the longer-legged F6 and its tanker support, providing stout air defence of the UK Air Defence Region for over a third of the life span of the Royal Air Force, until 1988, when the last two squadrons were disbanded.

For dedicated aficionados of the jet, it's a worthwhile addition to personal book collections, alongside the *Lightning Boys* series and Peter Caygill's *Lightning from the Cockpit* but it has a number of shortcomings, such as inadequate editing and far too many typos. There are four in the first five pages where, describing the wing's thickness chord ratio as 50% and the Fairey research delta as the FDz, certainly didn't inspire confidence in the accuracy of the remainder of the book. Descriptions of the same events are often repeated, so why was the proof reading so inadequate? There are errors and repetitions of events and facts such as, 'The F6 was a modified F3 with cambered wing leading edges and a large non-jettisonable 600 gallon ventral tank'; true, but it isn't necessary to continue reminding the reader. Verbatim quotes, from contributors, some anonymous, lead to a patchy writing style. Errors include describing my fellow Cranwellian, Ted Nance (OC 11 Sqn), now sadly deceased, as Wg Cdr Stewart (Stu) Nance, although there was a Stu Rance also a Lightning pilot. Neither is there any excuse for the author misidentifying Flt Lt Alastair McKay (RAF), who was forced to eject from a burning F6, as a Canadian pilot serving as an exchange officer with one of the Binbrook squadrons.

There is a depressing chapter on accidents which makes dismal reading where too many aircraft crashed and too many lives were lost caused mainly by poor design. Undercarriage legs unable to lock down, engine fires and hydraulic failures were the main causes but regrettably

some were due to mishandling by the pilot. From the early loss of a development batch Lightning of the Air Fighting Development Squadron in 1960, when the undercarriage failed to lower, to the last Lightning F6 fire in 1988 almost a third of the aircraft delivered to the RAF crashed, with 1971 being a spectacularly bad year with ten aircraft Cat 5.

Relevant and interesting are the accounts from Gp Capt Tony Barwood, of the Institute of Aviation Medicine, with his analysis of ejection seat and safety equipment failures where lives were lost. On a more positive note, the lengthy account from a USAF exchange pilot of survival at sea takes three pages and is fascinating. The engineering and design of the Lightning challenged the groundcrew throughout its life and it is ironic that the last aircraft to fly, a T5 from Thunder City in Cape Town in 2009, suffered the customary pattern of a jet pipe fire and hydraulic failure before crashing with the loss of its highly experienced pilot where maintenance shortcomings were identified.

Setting aside these observations, the book is a miscellany of stories where the writing styles vary depending on quotes from contributors and there is evidence of 'cutting and pasting' where some of the tales have been published elsewhere and are merely repackaged. However, it does contain a collection of memorable stories, some new, about the iconic Lightning. The annexes contain a helpful description of all the units to which the aircraft was assigned, author's endnotes which expand on sources, and a comprehensive index. Because of the many mistakes and poor editing, *The Men who flew the English Electric Lightning* is open to justifiable criticism and isn't recommended as one for the personal bookshelf, but no doubt the loyal devotees of Britain's last Mach 2 fighter will want a copy.

Gp Capt Jock Heron

English Electric Lightning – Genesis and Projects by Tony Wilson. Tempest Books, 2021. £12.99.

The author generously acknowledges that the origins of this book lie in the two presentations he delivered at this Society's Lightning-themed October 2018 seminar. Since those were reproduced in Journal 72, members will already be aware of their content, so I can keep this short. This 149-page softback covers the same ground as the Journal but, while much of the text is the same, it has been refined and expanded

and there are many more diagrams, graphs and artists' impressions. It is printed on coated paper and the 25mm × 18·5mm page size permits a slightly less cramped presentation of the narrative and the illustrations are larger.

A word of caution – for any members who have not actually read their Journal 72. This book is not about the RAF's use of the Lightning; it is the story of how the aeroplane, and its radar and its weapons, came about and of variants that might have been. As such it is a valuable case study of how an aviation project is conceived, developed and extrapolated (or was in the 1940s and '50s) and it provides some insight into the interactions between the players involved within the industry and the ministerial bureaucracy.

Well worth the price, even if you have Journal 72 – and it is available for less than £10 if you shop around.

CGJ

To Defeat the Few by Douglas Dildy and Paul Crickmore. Osprey; £30.

This 355-page hardback is a top quality publication that provides a rigorous examination of, as its sub-title proclaims, *The Luftwaffe's campaign to destroy RAF Fighter Command, August–September 1940.* It opens with an analysis of German thinking and strategy, leading to the planning of an invasion to be known as *Sealion*. There is substantial scholarly use of German and UK/Allied documentation with copious endnotes and references. The book delivers an impressive record of the unfolding story across the political, military and human aspects, illustrating the courage, skill and leadership, as well as the failings, of both sides

The German *Blitzkrieg* attacks on Holland, Belgium and France were rapidly successful. The air forces of Holland and Belgium were decimated. Führer Directive (*Führerbefehle*) No 13 required the *Luftwaffe* to prevent the escape of the British Expeditionary Force (BEF) from Dunkirk. There is an examination of the political tussle within Whitehall about sending more RAF fighters across to France. It was a lost cause and the niceties of politics, as ever, intruded into sound military advice. We may never know why Hitler issued his *Halt-Befehl* on 24 May 1940; maybe it was Goering's assurance that the *Luftwaffe* would destroy the BEF from the air. We see here one of the conflicts

between Goering and his senior commanders, about the ability of their units to deliver his promise to the *Führer*.

Flushed with victory over the French, Hitler sought some conciliation with Churchill. Rejected out-of-hand, the intention to invade the UK became a possible solution to the 'British problem', but this was complicated by uncertainty about Stalin's intentions in the East. The German High Command was substantially opposed to a Channel crossing, but on 13 July Hitler was briefed that it was possible. He issued Führer Directive No 16 that all preparations were to be completed by 15 August. The essential prerequisite was air superiority over the Channel and southern England. That was fully and solely the responsibility of Goering and the *Luftwaffe*.

The German Intelligence assessment was that the British economy was dependent on imports and sea routes; and that the RAF would be able to defend the London area, but not all of England. There is a striking analysis that the *Luftwaffe's* intelligence, prior to and during the Battle of Britain, was fragmented because of the lack of a command-level planning staff. The doctrine of air and land forces operating together was the fundamental characteristic of *Blitzkrieg*, but *Sealion* would involve the *Luftwaffe* operating independently until air superiority had been secured. It was not organised to do that.

Air Intelligence in Whitehall was unprepared for the conflict and, as a result, there was a failure to fuse information from multiple sources and there was far too much hide-bound protocol as to 'who could see what?' Signals intelligence was a new tool and some people did not trust – or understand – that information.

Goering designated the initial targets as Fighter Command and its infrastructure, and the harbours and shipping that provided supplies into the UK. The *Luftwaffe* attacks on shipping along the Channel were very successful and Fighter Command gave little timely support. This was regarded as a promising opening to the coming siege of the UK. However, there were contentious discussions within the German High Command as to the planning of mutually incompatible invasion requirements. The outcome was that the invasion should establish a beachhead 12-20 miles deep, capture Brighton and Dover and hold against British counter-attacks for 7-10 days as the second wave was landed. The *Luftwaffe* would need to provide close air support and battlefield interdiction during and after the landings, under an umbrella

of air superiority.

There is a detailed day-by-day record and analysis of the progress of the Battle, comparing German records against British archives. The story is made more graphic by introducing the names of the commanders at all levels, down to the identification of aircrew on both sides with their post-mission debrief reports. This provides an impressive and very readable account of the Battle, as seen by the combatants themselves, and of its progress as assessed by commanders up to the highest levels, including Goering and Dowding. By the end of August, damage to Fighter Command's airfields, the radar and tracking system plus combat losses, made Dowding consider withdrawing 11 Group from south-east England.

Issues discussed include the inadequacy of RAF air combat tactics, almost through to the last weeks of the Battle. Single squadron raid interceptions had often been overwhelmed by far greater *Luftwaffe* numbers. With painful experience, those tactics were changed early in September when interceptions were made with two, three and up to five squadrons formed into a 'wing'. The *Luftwaffe's* raid planning also changed to multiple smaller raids, dispersed both in time and target, to saturate 11 Group's command and control resources. There is consistent evidence that combat claims of kills and damages, by both sides, were unreliable and often very different compared to actual losses.

The weather obstructed the *Luftwaffe* at critical stages, granting Fighter Command a few days of respite in which to make some recovery. But the fundamental German error in the second week of September was changing bombing targets away from Fighter Command's assets and onto London and its associated infrastructure. Such a change was never going to help secure air superiority. Hitler eventually postponed the invasion indefinitely, a decision based on a variety of factors.

The result of any air campaign can only be determined by whether or not it achieved its objective. The *Luftwaffe* failed to achieve air superiority. Analysing the Battle in its entirety from the German perspective, the authors make a powerful addition to the aggregate knowledge of an epic conflict that changed the course of World War Two.

Wg Cdr John Stubbington

Britain's Glorious Aircraft Industry by J Paul Hodgson. Air World; 2021. £30.00.

The author of *Britain's Glorious Aircraft Industry*, a new hardback from Pen and Sword, is J Paul Hodgson, a retired BAE Systems chief designer who spent some thirty seven years with the Company, principally as an AVRO man. His detailed knowledge of the history of the industry and his lengthy experience as a designer from 1964 until his retirement, followed by eight years as a lecturer at Manchester University, lend authority to his observations. His own definition of the title is, 'British industrial activity for commercial gain in the design, development and manufacture of heavier-than-air aeroplanes' and is subtitled, '*100 years of success, setback and change*', in that order. Today's 'change' is subjective and not necessarily positive, in the light of the use of the wording 'commercial gain', but 'Glorious' is a subjective word referring to the exceptional work of the aerospace industry over the years. However his views about its future is less positive.

Within its 481 pages, the final 150 are appendices devoted specifically to references, lists, tables and statistics, and there are additional diagrams and numerous photographs embedded within the narrative, illustrating the aircraft which were the products of British industry. A wealth of information is included by type, role, dimensions and performance with the production numbers of each. Over the years through to 2020, some 282,000 aircraft and over 1,170 types, not all of them notable, emerged from Britain's factories.

After its remarkable output during the Second World War, British industry was too large and diverse for the much reduced needs of the armed services and ill-equipped to respond efficiently to the expanding commercial market. He describes the outcomes of several failed attempts to improve efficiency by consolidating the industry but does not attempt to allocate responsibility or blame for previous failures, merely observing where opportunities might have existed. The restructuring in the late 1950s, forced the industry to begin the final move to rationalise, coinciding with its nationalisation in 1977 and the amalgamation of the British Aircraft Corporation with the Hawker-Siddeley group. This step led to the creation of British Aerospace, the nation's sole aircraft manufacturer, apart from the small Britten-Norman constructor of light transport aircraft. Aero engine

developments merit only a brief mention in a short chapter which spans from the early piston engines to the modern high-bypass turbofan. Other chapters describe the circumstances leading to the merger between Bristol-Siddeley and Rolls-Royce in 1966, the dilemma facing the company over the choice of engine for the emerging Airbus and the later tribulations of the bankruptcy in 1971.

In its eleven chapters, in chronological order, it covers the entire one hundred and twelve years of the aerospace industry's existence from the slow and hesitant beginnings in 1908 through the confident years of the 1950s to 2020, when the book went to press. His considerable research lists all known attempts in Britain to start an aircraft company where the author describes the products of these endeavours, some of which in the early days of aviation barely got off the ground.

He goes on to describe the many individual activities which were underway during and after the Second World War where the recommendations of the Brabazon Committee provided industry with guidelines for the emerging busy and competitive airliner market. At the same time, the military needs of the Royal Air Force and Fleet Air Arm were set to match the rapidly changing needs for the defence of British interests at home and abroad. More recent issues are addressed in greater detail such as the weakness of the government's negotiating stance with France after the negative outcome of the 1965 Plowden Committee's recommendations that Britain should abandon national projects in favour of collaborative arrangements, primarily in Europe. The failed attempts to pursue such a policy for future generation airliners came to naught through failures by government to recognise the strategic challenge and industry's vacillation over the British participation in Airbus.

The politics surrounding numerous defence reviews escape detailed scrutiny, but all had a negative influence on industry's aspirations to strengthen and expand the business, including the cancellation of the Nimrod MRA4, a project in which I suspect the author had some involvement towards the end of his career with BAE Systems. The circumstances surrounding that aircraft's development and ultimate disposal for scrap are described in detail. Its cancellation, after the 2010 defence review, left the country without airborne protection against the threat to its Trident boats posed by Russian submarines.

The editing is sound; I found the very occasional typo and only a

few minor errors where, in the main text, the RAF's F-4M Phantom is described as having no nuclear capability and that it replaced the Hunter 'FGA10' for close air support. In an appendix, the Hawker P1081 is described as a development of the P1052 with reheat. During its relatively short life, from June 1950 to April 1951, the single prototype P1081 flew only with the standard unreheated Nene before being lost in a fatal accident.

This remarkably detailed, and hugely informative, compendium is recommended strongly for anyone with an interest in the history, politics, relationships and divisions involving British industry, national carriers and the armed services. At £30 it is an outstanding reference book and a thoroughly enjoyable canter through the decades, from the days of wood and fabric to the modern composite structure of the wings of theA400 Atlas.

In his foreword he dwells on 'what might have been?' and closes by postulating that by the fourth or fifth decade of the 21st century Britain's ability to lead in the design of a significant complete aircraft project might be no more. Perhaps a pessimistic view, but he reflects on the industry's glorious past, for some of the people and some of the time, while observing that a successful future depends on foresight, desire, investment and leadership, plus an element of luck.

Gp Capt Jock Heron

Darwin's Air War 1942-1945 by Bob Alford**.** Casemate; 2020. £39.95.

The Japanese air attacks on Darwin and north western Australia during 1942 and '43 had a profound effect on Australia. For some months, the defence of the strategically important port of Darwin and the Northern Territory largely rested with the USAAF. However, from July 1942 RAAF fighter squadrons took over and by early 1943 a Spitfire Wing, comprising two Australian squadrons and one British, assumed the mantle. Through 1943 they fought off the Japanese raids and these had ceased by the end of the year. By then the area around Darwin boasted a clutch of airfields from which squadrons of RAAF Beaufighters, Beauforts, Hudsons, and later Liberators, conducted an effective campaign across the Timor Sea into the islands of the Dutch East Indies. This very well researched and presented book, which is profusely illustrated with relevant photographs of the men and

machines involved from both sides, covers the campaigns fought over and from Darwin. The narrative is complemented by a selection of pilot profiles and a number of highly detailed appendices tabulating, for example, every Japanese raid on the Northern Territory.

Published by the Aviation Society of the Northern Territory, this 260-page softback is as authoritative an account as we are likely to see and is well-written in a style that makes it an easy read. Although expensive, it is well worth the investment for both serious air historians and the more casual reader.

Andrew Thomas

Skunk Works by James C Goodall. Osprey; 2021. £50.00.

In the years since WW II the Lockheed Aircraft Co (now Lockheed Martin) has produced some of the most iconic and/or enduring aircraft such as the F-104 Starfighter and the C-130 Hercules. However, it is its famous 'black' projects such as the U-2, SR-71 and F-117 that have always captured the imagination and led to the design bureau being dubbed 'the Skunk Works'. This sumptuously produced 384-page hardback is a credit both to the author, a former USAF technician, and the publisher and describes in detail all the post-war designs and projects of this famous company starting with the P-80 in 1944. Each is described in detail and illustrated with a breath-taking array of photographs. Informative, this book also delights the eye, and, like the company's latest F-35, the book exudes high quality, and, also like the stealth fighter, it comes at a hefty price. A number of these Lockheed aircraft served with distinction in the RAF for many years whilst others will have been flown by RAF aircrew on exchange tours, so it has some relevance to our history. Despite the high price, it is worth the cost and is certainly one to add to the list for a birthday or Christmas!

Andrew Thomas

Luftwaffe Special Weapons 1942-45 by Robert Forsyth. Osprey; 2021. £35.00.

In any book with this author's name on the cover the reader may be assured of original and high quality research underpinning the content. In this, beautifully produced, 272-page hardback, he covers the fascinating and little known topic of the, usually advanced and often highly innovative, special weapons devised by the *Luftwaffe* during the later years of WW II. Most were developed to counter the devastating

heavy bomber raids and ranged from heavy cannon and unguided rockets to primitive air-to-air guided missiles. Similarly, air-to-surface guided bombs were developed, as were air-launched variants of the V-1 flying bomb. The author has described in detail the technical intricacy of these weapons with a clarity that is complimented throughout by diagrams, photographs and some colour artwork. Readers can be assured that this is no dry techno-read, but a concise and well-written account, liberally laced with first-hand accounts, compiled by a real expert in this field. Whilst not a specifically 'RAF' subject, the effects of these weapons were certainly felt by the Allies. Moreover, Society members will doubtless find the technical description of these early advanced weapons of great interest.

Andrew Thomas

ROYAL AIR FORCE HISTORICAL SOCIETY

The Royal Air Force has now been in existence for one hundred years; the study of its history is deepening and continues to be the subject of published works of consequence. Fresh attention is being given to the strategic assumptions under which military air power was first created and which largely determined policy and operations in both World Wars, the interwar period and in the era of Cold War tension. Material dealing with post-war history is gradually becoming available under the 20-year rule, *although in significantly, and disturbingly, reduced quantities since the 1970s*. These studies are important to academic historians and to the present and future members of the RAF.

The RAF Historical Society was formed in 1986 to provide a focus for interest in the history of the RAF. It does so by providing a setting for lectures and seminars in which those interested in the history of the Service have the opportunity to meet those who participated in the evolution and implementation of policy. The Society believes that these events make an important contribution to the permanent record.

The Society normally holds two lectures or seminars a year in London, with occasional events in other parts of the country. Transcripts of lectures and seminars are published in the Journal of the RAF Historical Society, which is distributed to members. Individual membership is open to all with an interest in RAF history, whether or not they were in the Service. Although the Society has the approval of the Air Force Board, it is entirely self-financing.

Membership of the Society costs £18 per annum and further details may be obtained from the Membership Secretary, Wg Cdr Colin Cummings, October House, Yelvertoft, NN6 6LF. Tel: 01788 822124.

THE TWO AIR FORCES AWARD

In 1996 the Royal Air Force Historical Society established, in collaboration with its American sister organisation, the Air Force Historical Foundation, the *Two Air Forces Award*, which was to be presented annually on each side of the Atlantic in recognition of outstanding academic work by a serving RAF officer or airman, a member of one of the other Services or an MOD civil servant. The British winners have been:

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1996	Sqn Ldr P C Emmett PhD MSc BSc CEng MIEE
1997	Wg Cdr M P Brzezicki MPhil MIL
1998	Wg Cdr P J Daybell MBE MA BA
1999	Sqn Ldr S P Harpum MSc BSc MILT
2000	Sqn Ldr A W Riches MA
2001	Sqn Ldr C H Goss MA
2002	Sqn Ldr S I Richards BSc
2003	Wg Cdr T M Webster MB BS MRCGP MRAeS
2004	Sqn Ldr S Gardner MA MPhil
2005	Wg Cdr S D Ellard MSc BSc CEng MRAeS MBCS
2007	Wg Cdr H Smyth DFC
2008	Wg Cdr B J Hunt MSc MBIFM MinstAM
2009	Gp Capt A J Byford MA MA
2010	Lt Col A M Roe YORKS
2011	Wg Cdr S J Chappell BSc
2012	Wg Cdr N A Tucker-Lowe DSO MA MCMI
2013	Sqn Ldr J S Doyle MA BA
2014	Gp Capt M R Johnson BSc MA MBA
2015	Wg Cdr P M Rait
2016	Rev Dr (Sqn Ldr) D Richardson
2017	Wg Cdr D Smathers
2018	Dr Sebastian Ritchie
2019	Wg Cdr B J Hunt BSc MSc MPhil

THE AIR LEAGUE GOLD MEDAL

On 11 February 1998 the Air League presented the Royal Air Force Historical Society with a Gold Medal in recognition of the Society's achievements in recording aspects of the evolution of British air power and thus realising one of the aims of the League. The Executive Committee decided that the medal should be awarded periodically to a nominal holder (it actually resides at the Royal Air Force Club, where it is on display) who was to be an individual who had made a particularly significant contribution to the conduct of the Society's affairs. Holders to date have been:

Air Marshal Sir Frederick Sowrey KCB CBE AFC
Air Commodore H A Probert MBE MA
Wing Commander C G Jefford MBE BA

SECRETARY
Gp Capt K J Dearman
1 Park Close
Middleton Stoney
Oxon
OX25 4AS
Tel: 01869 343327

MEMBERSHIP SECRETARY
(who also deals with sales of publications)
Wg Cdr C J Cummings
October House
Yelvertoft
Northants
NN6 6LF
Tel: 01788 822124

TREASURER
John Boyes TD CA
70 Copse Avenue
West Wickham
Kent
BR4 9NR
Tel: 0208 776 1751

EDITOR and PUBLICATIONS MANAGER
Wg Cdr C G Jefford MBE BA
Walnuts
Lower Road
Postcombe
Thame
OX9 7DU
Tel: 01844 281449