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**Ex Officio*

ABBREVIATIONS

Note. When Strike Command was established in 1968, the word 'strike' had meant merely to deliver a blow. By the late-1970s, however, British (but not NATO) military *patois* tended to associate the adjective 'strike' with nuclear operations, as distinct from 'attack' which implied the delivery of conventional weapons; if it was necessary to make the point, a dual-capable unit would be described as a strike/attack squadron. Although it was not recognised universally, this convention remained in use thereafter within those elements of the community where such distinctions were of significance, and it is reflected in some of the following presentations. It has presumably become redundant within the RAF now that the Service no longer has a nuclear capability.

BCAS	Bomber Command Armament School (later RAFASU)
BCATP	British Commonwealth Air Training Plan
BCMC	Bomber Command Modification Centre
BMEWS	Ballistic Missile Early Warning System
BNDSG	British Nuclear Defence Study Group
CIA	(US) Central Intelligence Agency
CSDE	Central Servicing Development Establishment
EMP	Electromagnetic Pulse
GRU	*Glavnoje Razved-yvatelnoje Upravlenie* – the Intelligence Directorate of the Red Army
ICBM	Intercontinental Ballistic Missile
IRBM	Intermediate Range Ballistic Missile
JARIC	Joint Air Reconnaissance Intelligence Centre
JIC	Joint Intelligence Committee
KGB	*Komitet gosudarstvennol bezopasnosti* - the (Russian) Committee for State Security
LABS	Low Altitude Bombing System
LOX	Liquid Oxygen
MoA	Ministry of Aviation
MoS	Ministry of Supply
MRBM	Medium Range Ballistic Missiles
NORAD	North American Air Defence (Command)
NRC	Nuclear Reporting Cell
ORB	Operations Record Book (the RAF Form 540)

ORBAT	Order of Battle
QRA	Quick Reaction Alert
RAFASU	RAF Armament Support Unit (ex-BCAS)
R&D	Research and Development
SACEUR	Supreme Allied Commander Europe
SASO	Senior Air Staff Officer
SBAC	Society of British Aircraft Constructors
SIOP	Single Integrated Operational Plan
SIS	(British) Secret Intelligence Service
SLBM	Submarine Launched Ballistic Missile
SOP	Standard Operational Procedure
SSA	Supplementary Storage Area
UKAIR	A High Wycombe-based NATO Headquarters responsible primarily for maintaining the integrity of the UK Air Defence Region and exercising control over UK-based nuclear forces assigned to SACEUR.
UKWMO	UK Warning and Monitoring Organisation
WST	Weapons Standardisation Team

THE RAF AND NUCLEAR WEAPONS, 1960-1998

RAF MUSEUM, HENDON, 11th APRIL 2001

WELCOME ADDRESS BY THE SOCIETY'S CHAIRMAN

Air Vice-Marshal Nigel Baldwin CB CBE FRAeS

It is a pleasure to see so many members gathered this morning - nearly 150 - probably a record. As always, I will begin by thanking, on all of our behalves, Dr Michael Fopp and his staff at the Museum - as a Society we are most grateful for the use of their facilities and for their ever-ready help.

It is a special pleasure for me to introduce our Chairman for the day, Air Chf Mshl Sir John Willis. When I joined No 9 Sqn at Coningsby in the spring of 1963, as a pilot officer Vulcan B.2 co-pilot, John was the youngest captain on the squadron and thus an inspiration to me and to many others. Nuclear weapons and QRA - Quick Reaction Alert - dominated our lives then and, I suppose, helped shape our subsequent careers. With much experience of the definition and subsequent implementation of defence policy - not least at SHAPE - Sir John was a natural choice for his final Service appointment - that of Vice Chief of the Defence Staff. So, a career nicely spanning the period we are going to talk about today.

Sir John - thank you for agreeing to steer us. Over to you.

INTRODUCTION BY SEMINAR CHAIRMAN

Air Chief Marshal Sir John Willis KCB CB

Thank you, Nigel, and good morning Ladies and Gentlemen. It is a real privilege to be here today because this is a topic which seems, one way or another, to have dominated my forty-two years in the air force, from my early days at the sharp end, right through to my retirement when we were still working with Trident, regretfully abandoning our air delivered capability, and at all stops in between. I must say that if I had known that you were going to show the video that was playing in the Art Gallery I might not have come. It was an ITV horror called *The Deliverers* and, since my crew had fourteen children between us, it seemed to have some resonance! (*Laughter*)

Today's event is the second part of what TV would call a two-parter, except that in our case there has been something of a gap between the parts because the first episode was some 11½ years ago when the Society looked at the origins and development of British Nuclear Deterrent Forces between 1945 and 1960. Today we are going to take the story forward, by looking at the RAF and its nuclear weapons during the 1960-1998 timeframe. The 1998 cut-off was decided by the fact that, since then, and I say this with some regret, the RAF has not been directly involved in the nuclear business.

It was a period during which a lot of very important things happened. During the 1960s the strategic element operated by the RAF realised its full potential as *the* deterrent force of the United Kingdom. Towards the end of that decade responsibility for deterrence passed to the Royal Navy and its Polaris submarines, we in the air force retaining the sub-strategic, or theatre, nuclear role. By this time, of course, the V-Force was assigned to NATO in the nuclear role, and that was to have its ramifications in the 1970s when we had the great debate as to whether the Polaris replacement should be an air delivered system. I had much to do with that one but air delivery was not the best option and in the end we went for Trident; nevertheless, examining the options before coming to that conclusion had been a very necessary and worthwhile exercise. By the late 1980s we were considering acquiring an air delivered missile system to preserve our sub-strategic capability, but when the Cold War ended, economic considerations prevailed and the RAF withdrew from

the business, leaving the UK still a nuclear power, but with only one system - which does beg some questions. But, while the last forty years or so saw these practical developments, it was also a period during which the whole concept, the underlying philosophy and psychology, of deterrence was refined and developed in a far more coherent form and later this morning we will hear from one of the leading personalities involved in that process.

That is, I think, enough from me for now so I will make way for our first speaker.

SUMMARY OF THE PREVIOUS RAFHS SEMINAR ON THE ORIGIN AND DEVELOPMENT OF THE BRITISH NUCLEAR DETERRENT 1945-60

Air Vice-Marshal Michael Robinson

Michael Robinson had three tours associated with the V-Force. The first was as the first CO of No 100 Sqn when it re-formed at Wittering with Victor B.2s in 1962. The second was as Group Captain Off Ops at HQ Strike Command 1970-72 and the last as SASO, No1 Group 1977-79. The latter permitted him to qualify on the Vulcan and to renew his acquaintance with the Victor, albeit now in the tanker role.

Although the October 1989 seminar was entitled 'The Origins and Development of the British Strategic Nuclear Deterrent Forces 1945-1960' this synopsis will start 'In the Beginning…' which was 1st September 1939 as Margaret Gowing pointed out, the day the Germans invaded Poland. On that day the basic theory of fission was published. The potential of Uranium 235 to create an atomic reaction was set out by two refugee German scientists working at Birmingham University. Two French scientists working at Cambridge University were the first to discover that a chain reaction was possible. The discoveries of these four led to the British Maud Report of 1941 which showed how and why an atomic bomb was possible. The report was given to the American scientists working in this field and the outcome was the US Manhatten Project.

Having begun this review prior to the seminar start date of 1945 you will also have to tolerate one or two personal inputs post the nominated end-date of 1960.

The original invitation by the Americans to co-operate in the Manhatten project was rejected by us and it was not until 1944 that Roosevelt accepted Churchill's bid for British involvement. The Americans maintained a need-to-know attitude. For example, neither Dr William Penney, who had worked alongside the Americans in the Manhatten Project, nor Leonard Cheshire were allowed to witness the atomic assault on Hiroshima on 6th August - the Feast of the

Transfiguration - but they did see the second strike, on Nagasaki, from the follow-up photographic B-29 on the 9th. It has not been definitely established who ordered the two Britons off the first strike. I quote from the recent biography of Cheshire: 'When all is said and done, Cheshire and Penney were prevented from going to Hiroshima not because they were inessential, or too important to lose, but because they were British.'[1] Maybe.

All hopes of continuing co-operation were dashed by the McMahon Act of August 1946 which denied the British any further research alongside the American scientists. Doors in Washington, which had been welcoming during the war, were now firmly closed. The US Administration under Truman suspected Attlee's Labour Government of being closet communists and the security lapses of Alan Nunn May, Klaus Fuchs and Bruno Pontecorvo, all convicted of being Soviet spies, did nothing to persuade the Americans that the sharing of their nuclear secrets would be in safe hands. I note that the establishment of an atomic research centre at Harwell had been proposed in the previous year, 1945, so there may already have been some apprehension that the wartime 'Special Alliance' might not survive the peace.

The dramatic ending of Lease Lend was a talisman of America's new attitude to our bankrupt economy and the now unnecessary wartime alliance. Others might say that this was merely a further expression of a sustained policy to undermine the fabric and concept of the British Empire and our status as a major world power.

In the meantime, in November 1944 the Chiefs of Staff had looked ahead. The ensuing Tizard Report of July 1945 had envisaged the development of a 500kt jet bomber, flying at 40 000 ft. and the concept of nuclear deterrence was first enunciated; 'the best method of defence against the new weapon is likely to be the deterrent effect that the possession of the means of retaliation would have on a potential aggressor'. Attlee had become Prime Minister on 26th July and on 10th August he set up a committee of senior ministers, GEN 75, to determine an atomic energy policy.

Humphrey Wynn mentions the GEN 75 consultation process with leaders of the Government and of the Civil and Military Services. It would be interesting to know who of the Labour Leaders were *not*

[1] Richard Morris, *Cheshire, The Biography of Leonard Cheshire, VC, OM* (Penguin, 2000) p.214.

consulted! It was the GEN 75 committee which recommended the setting up of Harwell and in January 1946 Att1ee appointed Prof John Cockcroft as its Director and Lord Portal as Controller of Production of Atomic Energy. So the principal personalities were in place but, in the meantime, on 9th August 1946, the Air Staff had already issued OR 1001 for a bomb 'employing the principle of nuclear fission', and thus anticipated Portal's Note to Attlee of mid-November asking for a decision on the development of atomic bombs in the UK.

In December the Air Staff finalised OR 229 for a four-jet bomber to deliver a 10 000lb 'special' weapon over a range of 1500 miles at 50 000ft and 500kts. Responding to Portal's Note on 8th January 1947 the GEN 75 Ministers agreed to the development of UK atomic bombs.

Humphrey Wynn commented that the Attlee government took a long time to reach this decision; but did it, when considered against the background of Labour's pre-war attitude of pacifism and Britain's post-war austerity? In 1948 the Americans responded to the Berlin Blockade and the threat to Western Europe by their first peacetime deployment of fighters and B-29 bombers to England, a recognition that our location as an off-shore island to Europe could revive our usefulness. The seeds of a 'Special Relationship', particularly between airmen were resown.

If the government can be accused of tardiness Wg Cdr (as he then was) John Rowlands was certainly not slow to respond to his oral brief to head a RAF team which was to oversee the development of a British atomic bomb, with all of the attendant implications for training and safety, and the preparation of all of the associated regulations and procedures for storing, servicing and operating such weapons. The first British atomic bomb was exploded underwater in the Monte Bello Islands on 3rd October 1952. Note that Russia had detonated her first version in 1949 and the Americans tested their first hydrogen weapon a month after our atomic system.

Another first was Operation GRAPPLE, the dropping of a UK megaton-range hydrogen bomb from an aircraft, a Valiant, at Christmas Island on 13th May 1957. This was something never attempted by the Americans in any of their post-war trials - possibly due to the cock-up in the inaccuracy of the Nagasaki bomb which Cheshire reported as having been some four miles north-east of the aiming point; General Groves,

Manhatten's Director, gave the error as about one-and-a-half miles.[2] Dr Penney's criteria for Wg Cdr Hubbard's Valiant had been plus or minus 300 *yards* in any direction.

The logistic demands for GRAPPLE had required the conversion of a derelict WW II airstrip with a broken-down jetty and shallow water alongside, into a Class 1 airfield capable of operating seven different types of aircraft and accommodating 4000 people with a harbour able to unload up to 1000 tons/day. That this was all achieved within twelve months was a most impressive feat. It is amazing what can be done given the resources and brilliant organisation

The two talks given at the 1989 Seminar by Sir John Rowlands and AVM Oulton are well worth re-reading to appreciate the speed of reaction and scale of achievement. Please note that the original atomic bomb, BLUE DANUBE, required the loading of the fissile material to be done *in* flight! The first in-service bomb was delivered to the Bomber Command Armament School at RAF Wittering in November 1953, only thirteen months after the first Monte Bello trial.

The success of GRAPPLE convinced the Americans that the British had indeed entered the thermonuclear age and the constraints imposed by the McMahon Act began to be loosened. Instead of the social welcomes given to visits by the Chief of Air Staff, Sir John Slessor, in 1952 and by the CinC Bomber Command, accompanied by one of his AOCs, Air Mshl Broadhurst and AVM Cross, in early 1957 prior to GRAPPLE, operational and joint planning doors began to reopen.

I quote Sir Kenneth Cross: 'The Americans deal with everything strictly on a business basis and if you can contribute then they are in it and they are with you, if you can't then you will get all the kindness but you won't get any work done.' AVM Oulton has also offered comments which are pertinent: 'There was no question of repealing the McMahon Act until the Americans saw that we were going to succeed with GRAPPLE. Without the repeal of that Act there would have been no close relationship. Without the close relationship there would have been no moderating British influence on the American side of the superpower confrontations. Without that moderating influence Gorbachev and *perestroika* might never have happened. GRAPPLE may well have been a turning point in history.'

[2] *Ibid*, p.221n.

GRAPPLE may have been such a moment but personal contacts, as pointed out by Cecil James, revived the special relationship, initially at the CAS level where Sir Dermot Boyle got an agreement with US Joint Chiefs of Staff at the turn of 1956-57, a few months prior to GRAPPLE, that joint nuclear planning should go ahead. There was also the exchange of staff appointments and aircrew contacts through the annual 'home and away' Strategic Air Command and Bomber Command bombing competitions

There was a tendency during the earlier seminar, with its end-date of 1960, to imply that 1960 represented the climax of the V-Force and that thereafter it was downhill, not in military performance, but in the concept of air delivered nuclear deterrence. Sir Frank Cooper identified the peak of the operational effectiveness of the V-Force as being in the early l960s. Professor Lawrence Freedman asserted that the peak was in 1958, once the British had demonstrated our hydrogen bomb; I quote - 'the rot seems to have set in 10 years later.'

Perhaps both were implying that the RAF's 'rot' was already well set when, in June 1969, we handed over responsibility for the UK deterrent - that element which was judged to be immune to a pre-emptive nuclear strike - to the Royal Navy and its Polaris system. We who were in the V-Force in the early 1960s, with our improved Mk 2 versions of the Vulcan and Victor, were not aware of any decline. The pattern of QRA - Quick Reaction Alert - commitments, frequent no-notice alert exercises and the demanding training schedules kept us all very much on our toes. This regime also produced its own stresses as Air Cdre 'Cyclops' Brown identified in his presentation on the realities of commanding a V-bomber station, Waddington.

We remained very committed to our SACEUR assignment and in 1972 when I was Gp Capt Off Ops at Strike Command I remember being most concerned that we were one aircraft/weapon system below our assignment whilst awaiting the arrival of a bomb being airlifted back from Cyprus to one of our stations. I knew exactly where it was whilst airborne in a VC10 but the Supply staff subsequently 'lost' it for a few hours when they committed it to surface transport. They incurred my displeasure, not helped by being taunted that the bomb was last seen being loaded onto a British Rail flat wagon!

Even later, in 1979, our Vulcan squadrons finally started to train at very low level at night, practising over Newfoundland. Your Chairman

can tell you more. Remember that the acquisition of a weapon does not of itself offer a capability. This is only achieved when the whole weapon system is practised by front line squadrons, given the resources and the necessary clearances. It was thus only in the *final* phase of the V-Force that the most experienced crews were authorised to fly at very low level at night. Surprise, surprise, they found that the radar picture of the Canadian tundra was very similar to what the winter plains of western Russia were expected to look like.

For me, as a V-Force Squadron Commander, a peak of the RAF's nuclear story was reached on the afternoon of Saturday 27th October 1962 when all available Victor aircraft and crews at RAF Wittering were brought to cockpit Readiness 05, Each aircraft was loaded with one free-fall thermonuclear weapon, the crews had their Go-Bags with all of the necessary route and target information and authorisation codes. More will be said later about the RAF's involvement in the Cuba crisis. Suffice to say that we remained in our cockpits for several hours before being ordered by the Bomber Controller to revert to Readiness 15. It had been a *long* afternoon!

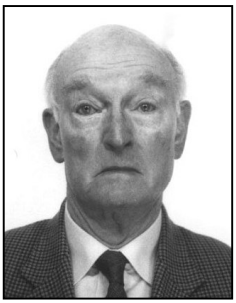
The fact that we were not ordered into the air says something about the nature of the RAF's deterrence. The more evidently, or visually, efficient and ready we were (as is possible with aircraft if not with submarines) the less likely we were to be committed to war. For those who do not know the geography of RAF Wittering, the whole of the QRA pan and the concentration of aircraft could be easily seen from a conveniently sited lay-by on the adjacent A1 road. Anyone observing from there could both *see* the aircraft and *hear* the changes in Readiness State as they were broadcast over the station Public Address System.

Hence my claim as to 'evident' efficiency. Much later I learnt that our deterrent posture was to discourage the Russians from a Berlin adventure. Was there military intelligence of such a possibility, or was it a question of intelligent political second-guessing?

The V-Force, in its nuclear role, was an instrument of peace-keeping for the *whole* of its operational life.

A VIEW FROM WHITEHALL

Peter Hudson CB



After war service in the Royal Navy, Peter Hudson joined the Air Ministry in 1947. From 1948 to 1951 he was Private Secretary to the Permanent Under Secretary, the civilian member of the Air Council. From 1953 until the end of 1961 he served in the Air Staff Secretariat. He was a student at the Imperial Defence College in 1962. Shortly after returning to the Air Ministry he was posted to the MOD central staff, and in 1969 to the Cabinet Office. In 1974 he joined the Air Force Board as a Deputy Secretary.

I shall be trying to show how things looked to the Air Staff at what proved to be a critical period in the life of the RAF's nuclear forces, whose continued existence, we believed, would contribute to the continuance of a stable East/West relationship.

In 1950, as Private Secretary to the PUS at the Air Ministry, I became involved, for reasons which do not now matter, in the processing of a manuscript produced by the new CAS, Sir John Slessor, setting out, for what I believe was the first time, the role, build-up and deployment of the proposed strategic bomber force of 240 aircraft. How that strategy came to be accepted by the Government was discussed at our meeting ten years ago. It wasn't merely that, as Frank Cooper pointed out, Jack Slessor could write and think faster than his colleagues. His overwhelming advantage, it seems to me, was that he could, at a time when NATO was little more than a paper concept, point to a Joint Intelligence Committee (JIC) appreciation, that the Soviet armies were capable of reaching the Channel ports in X days, and ask his colleagues what they would propose to do about it.

But, despite Slessor's success in his years as CAS in establishing the nuclear deterrent as the essential feature in our national strategy, attacks on it, most significantly by the other Services, had, by 1960, become pretty intense. At our last seminar Lawrence Freedman said, 'I fear the Society will not be quite so cheery in looking at the next decade.' In fact, in l960, it was by no means a foregone conclusion that the V-Force, as

such, would continue in existence for that decade at all.

By the late 1950s I was head of the Air Staff secretariat division concerned with long-term planning. When the House of Lords was having one of its annual defence debates I was summoned to attend the First Lord, Lord Carrington, who was to be in charge of the debate. I had provided him with that part of his speech which dealt with the nuclear deterrent. The discussion was all very amicable but when we came to a paragraph claiming that the cost of the force was no more than 10% of the Defence Budget the First Lord said, by way of commentary, that the Admiralty had produced a paper showing how much could be done to improve conventional capabilities if the V-Force were given up. He turned to the Admiralty briefers to confirm this, only to be met by a lot of clearing of throats - I was not meant, I gathered, to be told about this….

The other big change by 1960 was that in the preceding years we had been compelled progressively to abandon our 240 aircraft target, ostensibly as a result of external criticisms, which we had resisted. I fear though, that we should have been obliged to cut the planned force even without such pressures.

One of my jobs was to concert a cost assessment of the department's long term plans over a five, and later a ten, year period, and to help work out ways in which they could be adapted, if necessary, to be acceptable to ministers, including the Minister of Defence in Storeys Gate, and to the Chancellor. This was all part of obtaining agreement to the next year's Estimates, and hence the cash with which to continue in business.

Even though the Defence Budget was at that time, in terms of GDP, about three times larger than it is now, the pressures were intense. Apart from world-wide commitments, we had a highly ambitious equipment programme outside the strategic nuclear field - not only the TSR2, but two aircraft which would not look out of date today - a high subsonic V/STOL transport, the HS681, and a very advanced version of what was later to become the Harrier.

Figures for those aircraft appeared of course only in the later years of the costing, but much more immediate in its effect was the US Mutual Defence Assistance Program. Under it the US paid for weapons destined for the defence of the NATO area, provided that they were additional to what we would have bought for ourselves anyway. This aid certainly enabled the RAF to punch above its weight. Some hundreds of Hunters

were acquired under the programme and the USAF would have been prepared to do the same for the ill-fated Swift. The downside was that even though the Americans picked up the bill for the aircraft and their spares, the other running costs - airfields, personnel, etc - came out of Air Ministry Votes. These, and other inevitable pressures on the Budget – cost-escalation over the whole field and emergencies of various sorts - would alone have compelled us to lower our sights and by 1960 our planned 240 had shrunk to 144.

More importantly, critics of our nuclear posture were becoming more vocal. We had for several years clung to a painfully agreed JIC appreciation that 1963 would be the midpoint of the period in which the air threat to this country would change from being predominantly from aircraft to predominantly from missiles. That mantra had implications for both our defensive and our offensive postures. Moreover, various Soviet moves, from the first Sputnik onwards, together with increasing doubts about the viability of BLUE STREAK, led ministers to decide to set up a committee which was in the event to examine our whole nuclear stance. This committee, the British Nuclear Defence Study Group (BNDSG), was to play a crucial part in our story from its inception in 1959 until it was pre-empted by the Nassau Conference decisions of December 1962.

The Group had the Permanent Secretary of the MOD as its chairman, with members from the Treasury, the Service Departments and the Ministry of Aviation. VCAS, Edmund Hudleston, was our representative. Its first task, which proved to be more political than military, was to consider the future of BLUE STREAK. It came to the somewhat curious conclusion that the weapon should continue in development 'provided that a fire-first weapon is acceptable.' It was curious, because every member of the Group knew that a fire-first weapon was *not* acceptable. Anyway, after a few more twists and turns, not unrelated, I suspect, to the known views of Duncan Sandys, BLUE STREAK was in due course cancelled.

Before dealing with the Group's deliberations on the V-Force, I need to go back for a short time to deal with one key element - early warning. During 1958, some very informal links were established between my branch and the General Counsel of the USAF - a lawyer who masterminded their overseas negotiations. Our first exchanges on early warning - we had met earlier on the Thor agreement, which I am afraid I have had to squeeze out of this talk - concerned a system, long forgotten,

called MIDAS, under which it was proposed to place a vast cloud of steel needles in orbit to act as a radar reflector with which Soviet missile launch sites could be kept under surveillance. Fortunately for the future of space exploration, this scheme proved to be a non-starter. The airfield designated as a MIDAS read-out station is, as I speak, a vast burial ground for animal corpses.

The second scheme, floated soon after, concerned BMEWS. The deal was similar to that for Thor. In return for providing the site, carrying out the construction programme and meeting the UK running costs, including manning, at Fylingdales, we would be given full access to the data we needed. The aim, which was achieved, was to have a fully reliable system operational by 1963.

The detailed negotiations went smoothly. We had our own Works and Lands Departments in those days, so that all the action was under one roof. I remember that when the Treasury queried the works costs it was explained that with radars of such range the base had to be stable, 'not like that building, for instance,' pointing to County Hall over the river, 'that goes up and down with the tide.' As of course it does.

The upshot, so far as the V-Force was concerned, was a bargain that benefited both sides, enabling us to show that we would have, by 1963, a warning system that would give us a minimum of four minutes' notice of a land-based missile attack.

It was a natural consequence of the close relations between the two air forces that the Americans looked first to *us* for a BMEWS site in this part of the world. It was lucky for the V-Force that they did. If the station had been sited elsewhere - and they had had in any case to approach the Danes (over Thule) - we would not have had such a strong claim to receive vital early warning data, and we would certainly not have been able to provide it for ourselves.

Now, back to the BNDSG. In parallel with the BLUE STREAK discussions, the validity of the V-Force as a deterrent was being questioned. The key virtue of the manned aircraft over BLUE STREAK - that it could take off under positive control on radar warning - was accepted. But the Group, and its working parties, argued at length on two immediate questions - could the force be pre-empted, and could it reach its targets? The Air Ministry was usually in a minority of one in the arguments, and we were fortunate in having Teddy Hudleston as our representative on the main Group. I was lucky to be part of his briefing

team, which consisted of the late lamented Digger McGill, Director of Bomber Ops, Jock Henderson, our scientist, and me.

The first of these disputed points - vulnerability on the ground - required us to show that we had enough warning time in which to react. At first it seemed doubtful whether the four minutes which BMEWS would give us would be enough - its primary role was, after all, that it gave the *US* bases up to half an hour. But the development of QRA by Bomber Command, and the robustness of the Vulcan, in particular, in the low level role, on which others here can speak more knowledgeably, enabled us to leap that hurdle.

The second concern - reaching the target - entailed some vigorous argument about low level penetration, stand-off weapons, both actual, like BLUE STEEL Mk 1 and Hound Dog, and projected, like BLUE STEEL Mk 2 and Skybolt. Broadly speaking though, we were able to show that, until the SLBM threat became real, possibly not until the end of the decade, the V-Force would remain a valid deterrent. And so it continued in the front line in the strategic role until 1969.

It was a near thing. Despite our relative success in the BNDSG, its chairman, Sir Robert Scott, separately minuted the Minister of Defence in July 1961, without the Air Ministry's knowledge at the time that, 'the time has come to consider……giving up control of British nuclear weapons and their delivery systems…..and negotiate the best terms possible with the Americans in return for handing over control to them.' This advice was rejected, but the fact that it was given at all is an index of the cross-currents running at the time.

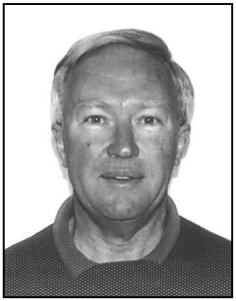
My story ends with the arguments about Skybolt and Polaris which preceded the Nassau agreement, when as Jack Slessor said, two politicians and a zoologist decided on the future of British strategy without any help from the Chiefs of Staff. The Air Staff had from the first been keenly interested in acquiring Skybolt, and at Camp David in March 1960 the two governments had agreed that, if it proved technically feasible to develop the weapon, we could buy it. The two air forces were, for different reasons, enthusiastic about the arrangement, but the US administration was divided as the months went by. In the summer of 1961 the Defence Counsellor of the US Embassy took the extreme measure of taking me out to lunch to emphasise the doubtful status of Skybolt in the US R&D programme. This of course I faithfully reported, but there were conflicting noises coming from elsewhere in

Washington. There were questions over Skybolt; but equally there were question marks over any other solution to the problem, which the BNDSG next addressed, of maintaining a British deterrent in face of a submarine-launched missile threat.

The problem was to devise a second strike force which would be credible in the virtual absence of early warning. The Air Staff, in seeking a feasible RAF alternative to Polaris, concluded that we needed a force capable of maintaining a constant air patrol, implying an aircraft with a designed-in high utilisation rate, that is, of the order of 250 hours a month. Hence the decision to field for discussion a force of thirty-six VC10s, each able to carry four Skybolts. It was not until December 1962, at the Kennedy/Macmillan summit at Nassau, which was dominated by the consequences of the US decision to cancel Skybolt, to the great embarrassment of the British Government, that a conclusion was reached. By this time I had moved on, and my only personal knowledge of the event comes from a very informal lunchtime debriefing from the then ACAS(OR), Christopher Hartley, who was at Nassau. It is clear that, in bidding for Polaris, the Prime Minister skilfully deployed all the arguments, notably the difficulties created for him by the cancellation of Skybolt. The unique record which Richard Neustadt has assembled of those discussions shows convincingly that, without that cancellation, it is unlikely that we would have been able to acquire Polaris, and later Trident, on anything like the terms agreed. Another example, perhaps, of the law of unintended consequences.

THOR

Wing Commander Colin Cummings



Colin Cummings joined the RAF in 1963 as a supply officer but was fortunate enough to undertake a number of out-of-branch appointments; he was, for instance, responsible for the Jaguar multi-disciplinary support organisation during the Gulf conflict. After retiring in 1994, he worked for a business consultancy in London. Having long had an interest in many aspects of military aviation, he has written three books cataloguing post-war RAF aircraft accidents and another about airborne forces at Arnhem. His latest venture is an account of Operation VARSITY, the airborne attack across the Rhine.

At midnight on 30th June 1969, the Royal Navy's Polaris submarine fleet, assumed responsibility for the UK's nuclear Quick Reaction Alert (QRA), a commitment which the RAF had met since 1st January 1962.

When the new arrangements were made public, some newspapers, principally those noted more for the presence of scantily clad young ladies within their pages than for the cerebral rigour with which they debated matters of national defence, offered the view that the British forces had at last entered the ballistic missile era. The fact that the RAF had commenced operations with a fleet of Intermediate Range Ballistic Missiles (IRBMs), more than a decade earlier, becoming, in the process, the first major power to do so, and that these missiles had provided a significant element of our nuclear deterrent forces in the late 1950s and early '60s, seems to have escaped the notice of the popular press and, with it, that of most of the rest of the population.

This paper deals with some aspects of the RAF's involvement with ground launched nuclear missiles by considering:

a. the political initiatives surrounding the decision to deploy intermediate range nuclear-armed missiles;

b. the missiles themselves and their supporting infrastructure;

c. aspects of the logistics involved in deploying a nuclear missile force in UK;

d. the way in which the RAF operated its missiles and

e. concludes by looking at the reasons for their demise.

If asked when they believed that our so-called 'special relationship' with the USA was at its lowest ebb, I am confident that the average audience would say 'during the Suez crisis and its immediate aftermath'. It is interesting to realise, therefore, that it was during precisely this period of significant official 'coolness' that the British government began to discuss with the Americans the potential for basing a nuclear missile force in the UK.

The Americans had two intermediate range missiles under development at the time. One, rather inappropriately christened Jupiter (the bringer of jollity), was being managed by an Army project team whilst the other, the more robustly named Thor (the god of thunder) was being controlled by the USAF with Douglas as the prime contractor.

The United States owed much of its expertise in rocket technology to the presence of a significant number of German scientists and engineers, some 500 of whom had voluntarily gone to the USA after the war to be employed under normal commercial arrangements within the aircraft industry and/or by the government.

The basic problem faced by the US authorities was that the capability of the rockets they possessed or were developing endowed them with a limited range of *circa* 1500 miles which was not enough to permit targets deep within the Soviet Union to be attacked from the continental United States. The only way that the US could make practical military use of such rockets would be to locate them in friendly countries, preferably those of their more reliable allies, where they could be manned and supported by their own personnel.

When the initial proposal was made to the British, the outline was for the deployment of four squadrons of nuclear-tipped missiles, each squadron comprising fifteen missiles, located at a single base. Two of these squadrons were to be manned by the USAF and two by the RAF. The missiles were intended to be operational by 1960, thus giving the RAF a head start of some five years on the availability of the home grown option, BLUE STREAK, which was not expected to be in-service much before 1965.

Having been panicked by the Soviet's Sputnik programme, the Eisenhower administration was so anxious to get its missiles into service

that it was prepared to absorb a considerable element of the expense involved in deploying them and to underwrite much of the subsequent logistic support and training costs required to operate them.

The British, for their part, thought that acceptance of US missiles on UK soil would open up the doors to access to modern US military combat aircraft. At the other end of the scale, however, there was considerable concern that the presence of nuclear missiles would render the country more susceptible to attack.

As the high level sparring intensified, the US offered to install, deploy and operate the first squadron themselves until the British could take-over. The British became more defensive, however, taking the view that the whole deal was being designed to suit US needs rather than their own. The UK was also concerned about the financial implications, notwithstanding the significant contribution which the US would make in providing the weapons, specialist equipment, training and so on. The £10M price tag for the UK-provided element of the infrastructure plus a wage bill for 4000 personnel was considered, in some quarters, to be prohibitive.

Since the initial negotiations were being conducted before the rocket vehicle had even flown, it would clearly involve a considerable 'act of faith' on the government's part for it to commit the UK to such a project. Furthermore, there were some in Whitehall who feared that if Thor proved to be a success it might hazard the completion of the national BLUE STREAK programme.

I will not bore you with a blow-by-blow account of the negotiations. Suffice to say that, during 1957, the two governments agreed a five-year initial deployment beginning in 1958, rather than 1960.

The original concept of operations, which had involved two USAF and two RAF units, gave way to all four units being run by the RAF. There would, nevertheless, still need to be a substantial US presence and the 705th Strategic Missile Wing was established at Lakenheath to provide the umbrella organisation for this. Furthermore, there was also a significant US civilian involvement via the agencies working with Douglas Aircraft.

Perhaps the easiest problem to resolve was the basing issue. The original concept of four fifteen-missile squadrons quickly gave way to that of a wing organisation with one squadron collocated with the HQ and four others at dispersed sites, each squadron being responsible for

three weapons. The great advantage in the UK was that there were hundreds of airfields on land which, having originally been commandeered during WW II, could be used again as Thor sites.

Inevitably some of the initial airfield choices needed to be rethought in the light of practical or perceived problems. For example, the USAF had intended to put a squadron at Brize Norton but the British could not contemplate the prospect of a missile breaking up after launch and depositing its warhead and 100 000 lbs of fuel on the dreaming spires of Oxford. The fact that the missile's very launch would herald the nightmare of a nuclear winter, seemed somewhat irrelevant to those who felt unable to countenance the demise of such a bastion of British culture. Clearly, the powers that be had no such compunction about the dangers to rustics living in the towns and cities of eastern England, where all the missiles were eventually based.

The sites selected for wing HQs were Feltwell, Hemswell, Driffield and North Luffenham. These bases each spawned four satellites. Each HQ was responsible for providing administrative, logistic and second line engineering support for the five squadrons under its command and the operations centre for its subordinate bases. Each missile unit was allocated a squadron identity, thus creating the largest single increase in the number of operational squadrons in the line ever achieved in peace.

The missile wing HQs needed to be adjacent to an airhead so that the missiles and all the ground support and other equipment could be flown in to a location as close as practical to the operating sites. The airheads selected were Lakenheath for Feltwell, Scampton for Hemswell, Leconfield for Driffield and Cottesmore for North Luffenham.

Work on preparing the sites began in late 1957, with Feltwell as the lead site. British contractors constructed the fixed elements of the installations, such as the concrete launch pads and the revetment blast walls, together with underground conduits, security fences and lighting facilities. Each of the HQ sites also had modifications undertaken on at least one of its hangars to provide the administrative, technical and operations control facilities required, including uprating existing servicing bays for the sensitive equipment such as guidance and gyro stabilising systems.

On completion of this work, teams of US contractors from Douglas Aircraft, carried out the installation of the specific-to-type equipment and, following the acceptance tests, the sites were available to receive

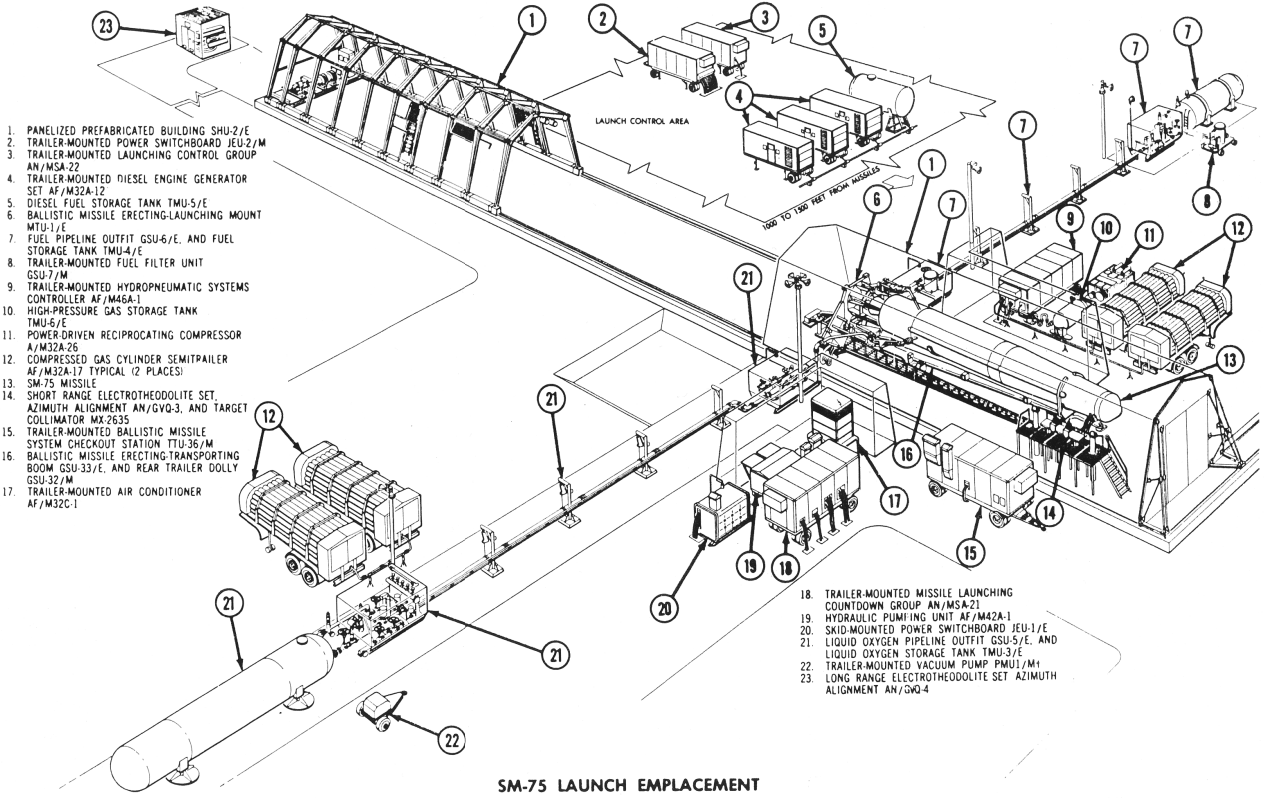


Figure 1. Thor Launch Site.

the missiles. Figure 1 shows the general configuration of a launch pad. Each missile was stored horizontally in a prefabricated, rail-mounted shed which provided both cover from the elements and first line maintenance facilities. The shed was drawn back before the missile was erected. Two pipelines supplied the missile with liquid oxygen and kerosene from storage tanks located at a safe distance as were other ancillary facilities, such as compressed gas storage. Reflecting a much earlier concept, which had envisaged the system's having a significant degree of mobility to offset the vulnerability of fixed sites, most of the support services and equipment were trailer mounted.

The more impatient reader might by now be wondering when this paper will actually mention the missile system itself. If he is, he will be in a similar position to the RAF of the mid-1950s. The weapon was first offered to the British when it was still on the drawing board and by the time that most of the detailed plans and agreements had been hammered out, it was still in the development phase.

Its formal designation was the Douglas SM-75 Thor. It was 65 feet long with its nose cone fitted and 8 feet in diameter. Its launch weight was 109 000 lbs and it had a range of between 1500 and 1725 miles. Its single stage Rocketdyne MB-3 engine was fuelled by a mixture of liquid oxygen and kerosene to develop 150 000 lbs of thrust. Directional control was achieved by mounting the rocket motor jets on gimbals permitting the thrust to be deflected. Two 1000 lbs thrust Vernier rockets were also provided to assist with directional control and to make minor corrections to the missile's trajectory. The missile had a maximum speed of 10 000 mph and reached a height of up to 300 miles. Navigation was handled by an inertial system which gave the single one-megaton warhead, which was carried in an Atlas re-entry vehicle, a circular error of probability on impact of 2 miles at maximum range.

The system proceeded from concept to first flight in the remarkably short time of a little over twelve months but the initial trials were not very encouraging. The first rocket failed to lift off the pad; the second flew for 35 seconds before being destroyed by the Range Safety Officer; the third exploded before the countdown was even complete and the fourth broke up after 90 seconds. Thereafter, however, things began to improve and most of the remaining batch of development firings were successful or partially so, several long flights and accurate splashdowns eventually being achieved.

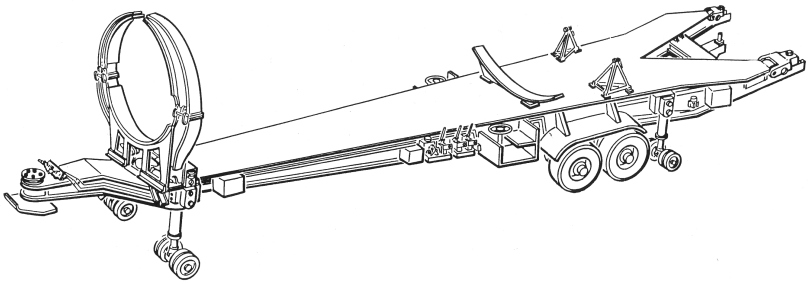


Figure 2

I have already alluded to an initial concept of tactical mobility but there was also a key requirement for strategic mobility and the missile was mounted on a trailer launcher (see Figure 2) which was connected to the erector jacks at the firing point and to which the services tower was also linked. The missile had to be capable of being airlifted by C-124 Globemasters or C-133 Cargomaster aircraft and all of the ground support equipment was similarly air-transportable.

The movement of the missiles and the mass of support equipment from Santa Monica in California to the UK was a major undertaking carried out by the 1607th Air Transport Wing of the USAF's Military Airlift Command. Besides the sheer volume of the task, involving the USAF moving some 6000 tons of equipment in the course of about 300 sorties, there was a host of special requirements to safeguard the expensive or sensitive equipment. For example, when carrying a complete missile, in order to prevent damage to the empty rocket fuel tanks, the pressurisation of the freight bay had to be closely controlled and special procedures had to be adhered to during the climb and descent phases. Similarly, because some of the gyroscopic units were suspended in temperature-controlled lubricant, it was necessary to ensure that the switch from ground power to aircraft power was performed without a hitch, the subsequent drain on the aircraft's electrical supplies being such that its engines had to be kept running thereafter to keep the generators on line with the attendant risk of overheating in the event of take-off being delayed.

I need hardly add that, with a weapon like Thor, safety and security were both major considerations. Each site of three missile pads was

A 'Thor haul' C-124 at Hemswell, its nose expertly sliced off by the editor when he took the picture on 7th April 1959.

secured by a close protection team of three RAF policemen equipped with a Land Rover and radio. Their primary responsibility was the immediate enclave, area security being supplemented at night by dog handlers. In addition, the specialist buildings at wing HQs were guarded by further groups of RAF policemen over and above those normally assigned to a station..

One of the tasks placed on the officers and men of the Thor squadrons, in part to provide them with some variety of employment, was to test the security of other sites and, as you might imagine, this was a chore that was often carried out with some enthusiasm! Ingenious methods were devised to break into other bases and to 'get one over' on another unit. On one occasion the intruders applied the Trojan horse principle and concealed themselves within a trailer being moved from one site to another, emerging after dark when safely within the perimeter of the rival squadron. Another successful entry was achieved because a dog handler stayed in a warm office block and allowed his dog to go free. As an owner of four German Shepherds, I am pleased to report that, whilst the policeman was disciplined by his CO the dog escaped without a blemish on his escutcheon! At Hemswell, a police corporal received a Queen's Commendation for Brave Conduct for engaging and apprehending an 'armed intruder', who turned out to be an officer from another unit, pushing his role to the limit.

The potential for a major conflagration and catastrophic explosion with large quantities of JP1 kerosene, LOX and compressed gases was

very real, whilst the thought that the blaze would have a one-megaton nuclear weapon, cooking quietly away somewhere in the middle, doesn't bear contemplating.

The launch sites were initially supported by their own fire crews which consisted of four men per shift with a tender. It was realised quickly, however, that this was embarrassingly inadequate and a ring water main was installed, fed from a 20 000 gallon tank. Electric pressure pumps could be activated from each alarm point and fire hydrant within the complex. In addition, special safety drills were developed to deal with accidents involving the warhead or any supplementary radioactive material and these procedures were regularly practised.

It will be apparent that the training of personnel to operate and maintain Thor was a departure from anything that the RAF, or anybody else for that matter, had been involved with. Initial training was provided by the RAF Flying College at Manby whence, having gained some understanding of what the weapon was all about, personnel moved to various Douglas plants in Arizona and California. As things progressed the RAF began to assume more and more responsibility for its own training from Douglas and a strategic missile school was established at Feltwell with an element at Hemswell. For its part, as previously mentioned, the USAF, provided the 705th Missile Wing to assist the RAF in all aspects of managing Thor and also to provide a parent unit for the US authentication officers who were an integral part of the system, sitting alongside the RAF launch controllers under the dual key rules.

With the passage of time, and with their understanding of the system deepening, launch crews gained steadily in proficiency. Once the warheads had been mated with the missiles in 1960 the Thors were absorbed into Bomber Command's alert and readiness system and the categorisation of crews was formalised on lines similar to those applied to the V-Force. Thereafter, the missile crews mounted QRA until the five squadrons of the North Luffenham Wing were stood down on 15th August 1963. There were five eleven-man crews per site, their readiness being frequently tested to a pattern that will be familiar to veterans of the V-Force, except that the Thors did not disperse and, thankfully, they never had to fly!

In the early days of the programme, a number of missiles were

retained for test firing by crews on completion of their training at Vandenburg AFB but only a few crews were able to participate in these 'combat training launches'. The first such firings took place on 16th June 1959 when OC No 98 Sqn, based at Driffield, and one of his crews launched a missile successfully. A later refinement of the combat training launch procedure was to take a missile from the RAF stock, ship it back to the US and, with the minimum of work, erect and fire it at Vandenburg. The purpose of this exercise, of course, being to prove the continuing viability of missiles which had been deployed in the field for some considerable time and in pretty horrid weather conditions. Again it fell to Driffield to take the lead and to provide Thor missile No 31 for firing on 22nd June 1960. The rocket flew for 1375 miles and the dummy warhead impacted one-and-half miles short and half-a-mile to the left of its target.

The basic launch procedure for Thor required fifteen minutes, the launch crew being responsible for all three missiles at their site. The launch cycle had five phases:

a. On receipt of the appropriate launch message, the countdown began with all equipment and target data being checked and confirmed.

b. Phase Two saw the end doors of the shelter collapsed or moved aside and the shelter withdrawn. The target data was entered into the guidance system and the missile was erected. This procedure took about six minutes and was the point at which a peacetime alert practice usually stopped – a 'Phase Two Hold' in the parlance of the day.

c. If the launch continued to Phase Three, as it did when the crews were judged capable, the fuels were loaded and the target parameters were rechecked and confirmed.

d. At Phase Four, the external systems gave way to the missile's internal power systems, the services tower was withdrawn and the LOX, which was constantly boiling off, was topped up.

e. Phase Five involved the RAF launch controller and his USAF counterpart confirming the authentication codes, turning their keys and starting the engine. At one rated countdown the USAF authentication officer failed to appear, so his RAF counterpart simply

pushed a screwdriver into the lock to complete the cycle!

The search for improvements in readiness and methods by which the length of the launch cycle could be reduced exercised everybody as the four minute warning became the 'time to beat'. It was technically possible to keep the missiles fuelled and at two minutes from launch for a period of two hours. After this, however, the LOX propellant caused valves to freeze and it was calculated that to cater for the rate at which it boiled off it would have been necessary to provide a seventy-fold increase in LOX storage capacity. After defuelling, it took some six hours to recover the system and for the maintenance crews to recycle the missile. It follows that actually to have held the force at two minute's readiness would have been prohibitively expensive and that, paradoxically, it would have led to a significant diminution of capability.

There can be little doubt that the most tense of times for the western alliance came during the Cuban missile crisis in the autumn of 1962. I shall leave it to the next speaker to cover these events and will confine myself to saying that the Thor force was brought to a high state of preparedness with fifty-nine of the sixty missiles installed at the time being made ready, the 60th round being the missile normally used for training at Feltwell.

During 1961 the RAF began to explore the implications of extending the Thor missile deployment beyond the current five-year agreement. The system had proved to be reliable and the crews were well trained, efficient and effective. The weapon added the equivalent of more than half-a-dozen V-bomber squadrons to the ORBAT and there was a realistic prospect that changes to its propellant, coupled with other modifications, would update the system while reducing countdown time and allowing the missiles to be held, fully fuelled, a few minutes from launch without the problems previously encountered with LOX.

Approaches to the US government revealed that they were unwillingly to provide the substantial level of follow-on funding. Furthermore, the successful development of the Titan and Minuteman inter-continental ballistic missile programmes represented a quantum leap in range capability and Washington no longer needed to have its missiles operated by proxy by its allies.

From the RAF's viewpoint, there were several considerations:

a. The system was inherently vulnerable, since it could not be

located underground.

b. Continued operation would be expensive without the US underwriting some of the costs.

c. With an all-regular air force, and hence limited manpower, the Thor force would demand a disproportionate number of staff and would lead to undermanning in a number of trades.

d. The system's continued presence in the ORBAT would increase pressures for paring down other elements of the RAF's strategic deterrent.

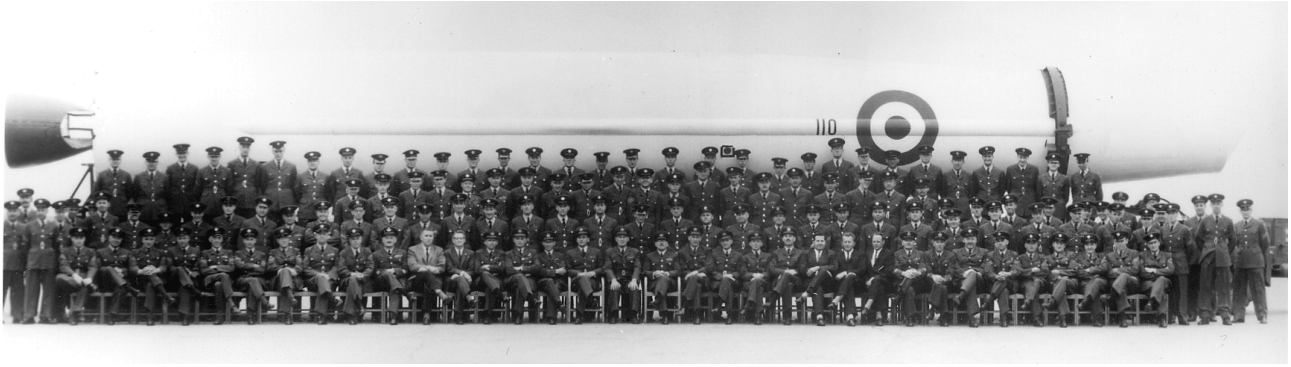
Reluctantly, in the late spring of 1962, the Air Council accepted that Thor would have to be withdrawn from service.

I shall not dwell upon the complex operational, technical and logistics issues associated with taking Thor out of service, returning the weapons to the USA, dismantling the sites and returning those bases not required to civilian use. Suffice to say that on 1st December 1962, emplacement No 40 - located at RAF Breighton - was taken off standby status and Thor No 43 was moved to RAF Driffield prior to being shipped back to the USA, in a carefully monitored programme which served as a 'proof of concept' for the ensuing rundown.

Within eight months, three of the Thor wings had gone and it remained only to take the five North Luffenham squadrons off standby to close down the western alliance's first ballistic missile system; this occurred on 15th August 1963.

Of the rockets themselves, one is at the RAF Museum but most became examples of swords into ploughshares as they were used in space exploration, either as single-stage boosters or in combination with various upper stages, notably in association with the Telstar, Pioneer and Discoverer programmes.

Although Thor may have lacked much of the glamour and public recognition accorded the V-Force, in its day it represented a potent weapon system which, whilst vulnerable due to its static siting and above ground location, provided an effective component of the RAF's nuclear forces at the height of the Cold War. It was a significant contribution and one which is often overlooked and undervalued.



A lost generation? Not a topic that was raised at Hendon but it is interesting to note that the sub-committee which planned the seminar reviewed a list of all forty-four officers who had commanded Thor squadrons. No one was familiar with any of the names on the list. Since these were, presumably, among the brightest and best that the GD branch had to offer circa 1960, one would have expected to have spotted the odd air officer of 1975 among them but few, if any, of these officers appear to have achieved any prominence. Was this, perhaps, an overlooked consequence of the 1957 White Paper? The RAF's wholehearted commitment to guided weapons, Bloodhound as well as Thor, lasted only five years or so. When the first-generation systems were withdrawn, apart from a relatively small force of Bloodhound Mk 2s, they were not replaced. In other words, the missile era had failed to materialise as advertised. Could it be that the careers of officers who had commanded Thor squadrons had been irretrievably distorted because they had been obliged to spend their executive 'flying' appointments on the ground? Did a posting to Thor turn out to be a matter of being in the wrong place at, what should have been, the right time? ***Ed***

BOMBER COMMAND AND THE CUBAN MISSILE CRISIS

Dr Len Scott

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Let me begin by saying that I was honoured to have been invited to address the society, and was very pleased to accept, not least as a way thanking various members of the RAF who helped my then colleague, Stephen Twigge, and me in our study of the command and control of British nuclear weapons from 1945 to 1964.

The events of October 1962 are generally agreed by historians to have been the closest we have come to thermonuclear war. Just how close we came and why the world drew back from Armageddon, are questions that continue to excite historians, nuclear strategists and, more recently, Hollywood film producers.

The study of the missile crisis has been a veritable industry for historians and other scholars. It has generated an academic literature at least, if not more, significant than for any other event of the twentieth century. We certainly know more about the minutiae of American decision-making than about probably any other episode in foreign policy making. One aspect of this is that President Kennedy secretly recorded his colleagues and officials so that posterity has an extraordinary record of who said what and when. As an historian one can only applaud this kind of duplicity in one's political leaders. Whether that record of the words that were spoken, and indeed whether other written records, tells us enough about the minds (and souls) of decisions-makers contemplating the risk of nuclear war remain important questions for historians.

The missile crisis has also been at the forefront of recent advances in studying the Cold War based on access to Soviet officials and Soviet

archives. Indeed we have also learned a good deal of Cuban perspectives, including where they differed from Moscow's. These new sources bring with them various challenges for historical interpretation, but we are beginning to acquire the story from the other side of the hill (or hills) compiled in the way that the story was compiled from the western side for thirty years or more.

There are a number of things about which do not know enough. There are some things we may never know – but which could be critical to our understanding. This is good news for historians who get paid to endlessly debate and reinterpret the past. Yet the question of how close we were to disaster in 1962 remains important, not least for those contemplating risks and hazards in the post-Cold War - but still very much nuclear - world in which we live.

There are debates about the risk of war, lessons for deterrence and lessons for diplomacy to be drawn from 1962. One interpretation is that that during the crisis political leaders grew to understand and fear the potential consequences of their actions and acted accordingly to draw back from the brink. It is also now clear that at certain points both Kennedy and Khrushchev reacted with instinctive belligerence, and had decisions on the use of force been necessary at specific times the risk of escalation could have been very high. Yet, through archival research and other historical sources, we can trace the process whereby both political leaders sought to accommodate the fears of the other and recognise that the avoidance of war was the overriding objective. Not everyone - then as now - had the same view of the risks and consequences of war. Both Fidel Castro and Curtis LeMay had very different views. That is not to suggest that Dr Castro and General LeMay agreed on very much – but that they advocated actions that raised the risk of war and escalation to levels unacceptable to Kennedy or to Khrushchev (or indeed to Macmillan).

The argument that political leaders grew to understand the risks and were more determined to avoid nuclear war may be reassuring. There is a case for believing that had a diplomatic settlement not appeared by 28th October Kennedy would have avoided an attack on Cuba and pursued other diplomatic options. And there is a case for believing that if Kennedy had attacked Cuba, Khrushchev would have cut his losses in the Caribbean and not have moved against Berlin; the route to escalation that most troubled British (and indeed many American) leaders and

officials.

Less reassuring is the body of evidence and scholarship emerging about the actions and events below the level of political leadership – in particular at the operational level. It has long been assumed that the most likely path to Armageddon in 1962 (and indeed subsequently) lay in a concatenation of misperception, miscalculation, misunderstanding and sheer bad luck. Indeed in 1962 both Kennedy and Macmillan had themselves read a history book that showed how war came in 1914 in this way and both are claimed to have been influenced by this account. Having said that, Kennedy and Macmillan adopted very different approaches to nuclear readiness. Macmillan was adamant that no actions should be taken that could be misunderstood by Moscow. Kennedy put the Strategic Air Command on the unprecedented alert state of DEFCON 2.

What has emerged in recent years is considerable evidence of problems at the operational level, in particular concerning the command and control of nuclear weapons. Much of this evidence concerns American activities. We also have an amount of disquieting information about the deployments of Soviet tactical nuclear weapons in Cuba for use against an American invasion, about which American decision-makers knew nothing. We have also learned of various European dimensions, including the activities of Bomber Command. Some of these revelations can be made to sound dramatic and exciting. Thanks to an American scholar, Scott Sagan, for example, we know that on the morning of Sunday 28th October American radars detected a missile launched from Cuba targeted at the United States – something to be set in the context of Kennedy's televised statement six days earlier that 'any missile launched from Cuba will invite a full retaliatory response against the Soviet Union.' The incident, it quickly emerged, was the result of someone inserting a simulation tape into a machine at Moorestown Air Force Base.

Potentially more significant was when, on 27th October, a SAC U-2 on a scheduled high-altitude air-sampling mission from its base in Alaska strayed off course and into Soviet air space. We now know that the American fighters scrambled to support this aircraft were equipped with nuclear air-to-air missiles. And it is possible to devise plausible scenarios of how the threshold of nuclear use might have been crossed in the skies around Siberia had American and Soviet fighters come to

blows.

The most significant aspect of the straying U-2 has been known for some time. When news that the aircraft had flown into Soviet airspace reached the Pentagon there was genuine concern that the Soviets might misinterpret what had happened and assume that the aircraft was on pre-SIOP reconnaissance. In other words, that the Soviets might believe that this was a premeditated mission being flown to identify mobile Soviet targets ahead of an American nuclear strike. There is, indeed, now evidence that Khrushchev was told by the Soviet General Staff that this could be the case. Under such circumstances, and with what was a very small force (of no more than twenty-four) ICBMs, the Soviet General Staff might have perceived a 'use them or lose them' dilemma and argued for what they would have erroneously believed was pre-emption.

A second risk arising from this situation is that the potential consequences of Soviet misperception and miscalculation were understood in Washington, including by Defense Secretary McNamara and President Kennedy. If the Americans believed that the Soviets were about to pre-empt a non-existent American attack then the Americans could have reasoned that American pre-emption of an imminent Soviet launch was essential. The United States possessed massive strategic superiority, and there is strong reason to believe that air force generals were confident that they could achieve a decisive outcome. No evidence has emerged that this option was considered at the political level or at the military level. Our understanding of this incident and how it was viewed in Moscow and Washington - in particular at the military level - are areas where we await further disclosure.

Coincidentally, 27th October was also the day that Bomber Command was moved to Alert Condition 3: its precautionary pre-dispersal state of preparedness. We also know that fifty-nine of the sixty Thor missiles were at 15 minutes' readiness, with some missiles configured to be held at T minus 9. And on 29th October the number of bombers on Quick Reaction Alert was doubled. Again, in the hands of unscrupulous historians, like myself, this readiness posture can be portrayed in a highly dramatic, and arguably inappropriate, fashion.

Nothing has yet emerged to suggest there were any serious problems of command and control within the RAF, although specific questions remain, concerning, for example, deployment of the BLUE STEEL missile which was released to the Air Ministry in September 1962, in

advance of its being fully approved for operational deployment.

The issue of how we should interpret and understand British military preparations involves some broader questions about British political-military relations and about relations with the Americans and, perhaps most intriguingly, about Soviet perceptions of the British. It is to these three aspects that I now turn.

Of crucial importance to political-military relations was the attitude of Harold Macmillan. Macmillan told General Norstad, the Supreme Allied Commander Europe, on 22nd October, that mobilisation sometimes caused war. The Prime Minister was strongly opposed to taking action in Europe that risked the modern equivalent of August 1914. At the same time Macmillan strongly supported the mobilisation of American forces for an invasion of Cuba as an appropriate instrument of 'coercive diplomacy'. Yet on Saturday, 27th October, when Macmillan met the Chief of the Air Staff, Sir Thomas Pike, he was clear that overt preparations should be avoided. Bomber Command was, therefore, not dispersed.

There has been speculation that CinC Bomber Command in some way exceeded his authority in the measures that were undertaken. The archival record shows that this is not the case, and that the actions of Air Mshl Cross were within his authority and indeed in accord with the specific instructions of the PM. The question nevertheless remains as to how far Macmillan was fully cognisant of military activities: whether he was aware of, or remembered, the exact status of the Thors at readiness or of the bombers on QRA.

After the crisis Sir Kenneth Cross was very happy with how arrangements for the Thor squadrons had worked and he subsequently, but unsuccessfully, tried to persuade the government to extend their deployment. He was less happy with the arrangements for the rest of Bomber Command. For his part, the Prime Minister was anxious that the Government War Book should be reviewed in the light of the events of October 1962 to permit the system to respond more quickly and more appropriately to an emergency.

A second aspect of interest concerns Washington. By 1962 the relationship between SAC and Bomber Command was an intimate one, encompassing co-ordinated targeting, the dual-key Thor deployment, integrated Quick Reaction Alert, and the provision of American nuclear weapons for British bombers (Project E). There remain questions about

relations at the military level between SAC and Bomber Command, not least arising from Air Mshl Cross' intriguing revelation that SAC made no attempt to contact him during the crisis. There is also a broader point here about differences in outlook between Washington and Europe. The Thors seemed peculiarly invisible to Washington. The only point when they entered the political debate was when Macmillan made an offer to Kennedy to demobilise them to help the Soviets save face in Cuba. In contrast, the Americans were greatly exercised by the readiness state of the missiles in Cuba, and although the CIA erroneously believed that no nuclear warheads had arrived on the island, the readiness condition of the thirty-six Soviet MRBMs in Cuba was crucial to arguments about whether and when to strike militarily.

Whether Kennedy would have acted in such a fashion is a matter for debate. But the point should be made that these specific circumstances which could invite an American attack on Cuba were precisely those that obtained in NATO Europe where the fifty-nine Thors and thirty-seven of the forty-five Jupiters in Italy and Turkey stood ready. President Kennedy himself was exercised over the missiles in Turkey and Italy and gave orders to ensure that unauthorised launch by host-country air forces was prevented. No evidence has emerged of any such expression of concern about the missiles in Britain.

The third aspect concerns Soviet perspectives. And how the actions of Bomber Command were viewed from Moscow. Here we know very little. One account is provided in the 1992 memoir of Yevgeny Ivanov, a Soviet Military Intelligence officer working under diplomatic cover in Britain in 1962. Ivanov claimed to have secretly toured British and American bases where he saw 'pilots mindlessly drinking beer and flirting with local girls. I did not detect any alarming signals, and duly reported this to Moscow Centre.' It is not for me to comment on the credibility of this claim, save to say that if anyone wishes to unburden a conscience after thirty-nine years it would be an opportunity to advance the historical record on this matter.

We do not know what Soviet intelligence picked up during the crisis, either through signals intelligence or GRU and KGB base-watchers (or other sources of human intelligence). Nor do we know the extent to which such information was understood back in Moscow.

While we do not know how the Soviets saw things at the military level we do know that at the diplomatic level the activities of the RAF

did not unduly exercise the Soviet leadership. In particular the Thor missiles were not raised by the Soviets, either directly with the British government or indeed with the Americans. This was in stark contrast to Soviet concerns about the Jupiter IRBMs deployed under NATO auspices in Turkey (and Italy). One reading of this might be that there was a tacit Soviet acceptance of the special relationship. How the Soviets saw the British deterrent is a fascinating question on which the events of 1962 might yet yield some interesting insights.

One further dimension of the Soviet aspect concerns when and why Bomber Command was moved down from Alert Condition 3 on 5th November. SAC remained at DEFCON 2, with all that that implied for the number of B-52 bombers on airborne alert and for the operational readiness of its ICBMs, until 21st November. This was the point at which Moscow had sufficiently overcome Cuban objections to reach a negotiated agreement with Washington to withdraw the missiles from Cuba. The significance of 5th November is unclear (aside from the fact that it was Bonfire Night). What had happened a couple of days earlier may (I emphasise *may*) be of significance.

For seventeen months before the crisis the British Secret Intelligence Service had, in co-operation with the CIA, been running an agent from within the Soviet defence establishment. Colonel Oleg Penkovsky was a colonel in the GRU who supplied a very considerable amount of information to the west about the Soviet military and Soviet intelligence. In 1961 Penkovsky had known about the Berlin Wall four days before public construction began, but could not contact his case officers. In 1962 an SIS-devised procedure had been established to enable Penkovsky to alert the west in case of emergency. We know much of the details of this because the CIA has declassified many of its records. On 2nd November the procedure whereby Penkovsky was to alert western intelligence of an imminent Soviet attack was activated. We know that the Director of the CIA was immediately informed and that he personally briefed President Kennedy on 3rd November. The KGB later stated that they had arrested Penkovsky on 22nd October and that by 2nd November he had been helping them with their enquiries for some time. The activation of the warning procedure was, therefore, under KGB control and initiated by someone who appears to have been keen to start a war against the system he had been betraying for some considerable time.

We do not know how this warning was received and assessed in

London. Either London took the same view as Washington and discounted the warning - and the change in alert condition was simply coincidence. Or - and this is no more than a highly speculative hypothesis - I would ask whether the British government took a decision to reduce the alert status of Bomber Command on 5th November deliberately to reduce tension with Moscow.

Let me conclude that, had war come in 1962, the United Kingdom would have been in the front-line of nuclear warfare. Whatever the paucity of Soviet *strategic* forces, the Soviets had a formidable force of nuclear-armed bombers plus land- and sea-based missiles which would have been capable of wreaking devastation on the UK and western Europe. The forces deployed from British bases would have exacted a level of destruction on the Soviet Union and the Warsaw Pact that equally defies the imagination. How close we came to nuclear war is a question that remains worth revisiting. So too is how and why war did *not* come. Any sanguine conclusion about the educative effects of mutual deterrence on political leaders needs to be set against the more disconcerting conclusion that an essential ingredient was considerable good luck. A fully-considered account of Bomber Command's activities needs more detail from the people who were there. Clarification of Soviet perceptions is also potentially crucial. And, of course, all of this needs to be put in the context of a crisis that was in its diplomatic phase. What role, militarily and politically, Britain might have played in American counsels of war, had diplomacy *not* succeeded, remains an issue critical to debates about the special relationship and about Britain's ownership of nuclear weapons.

MORNING DISCUSSION PERIOD

Sir Michael Quinlan. I should like to offer, as initial inputs to stimulate or provoke discussion, a thought or two about equipment and then a comment about nuclear policy and planning.

My first point is about Skybolt. Its demise in 1962 was seen when it happened as being a very bad blow to the Service, and I was fully among those - I was Private Secretary to Tom Pike during this period - who played whatever part they could in the effort to avoid the cancellation somehow. But as I now look back, I have little doubt that what happened was in the long run a blessing, even if well disguised at the time. Our case for Skybolt was directed essentially at solving the problem of 'penetrativity'; it did nothing for that of pre-launch survival. If Skybolt had entered service we - and governments - would have encountered more and more difficulty about that, and notions like airborne alert, whether permanent or during time of tension, would have become more and more awkward to sustain credibly with both professional and public opinion. The hard fact is that for a country of relatively small geographical size, and able to sustain to top standards only one type of strategic delivery system, the case for going to submarines was fundamentally inescapable.

I have a markedly different view about the F-111 cancellation (driven more by domestic politics than by finance) five years later. I did not regret the F-111's replacement of the TSR2 in our programme in 1965 - the TSR2 was out of control cost-wise and might well have drained our budget dry - but the operational function itself was an important one, and the absence of a modern reach longer than Tornado's left a real hole in the spectrum of UK nuclear (and, for that matter, conventional) capability as the V-Force aged. I became very conscious of that during the later 1970s in the context of NATO's Intermediate Nuclear Force modernisation.

My point about nuclear policy and planning is a general one which some of you may find contentious. In my opinion there came to be a strange and regrettable disconnect between nuclear policy or doctrine, as elaborated progressively (and with very active UK participation) in NATO's Nuclear Planning Group, and the target planning and tasking done by the Service's operational planners. I remember being very disconcerted as DUS(P) - and persuading Neil Cameron, then CDS, to

share my unease - to find in the late 1970s that contingency planning for national use of the Vulcans showed virtually no trace of options for the carefully limited and selective war-termination use of sub-strategic capability on the lines of the concepts which had been shaped in NATO as part of the flexible response approach. Yet, despite the difference in scale, there was, in strategic logic, no reason why these concepts should not have applied in the context of national action. We came, in the end, to a tolerably coherent view; but it took us a pretty long time.

I sometimes wonder indeed - and here is another contentious thought - how far we had really worked through and taken on board, outside a very small circle of nuclear-doctrine theologians, what the point of UK operational nuclear independence really was. A further recollection: during one of NATO's wargames in the l980s - a WINTEX or the like - I recall SACEUR requesting, in what was called 'follow-on' nuclear use, a small-scale but fairly deep strike mission. The US players in Washington, taking the scenario seriously, refused it (presumably on escalation-risk account) and SACEUR turned to us. The initial reaction of at least one very senior UK player was that there could surely be no question of our undertaking a nuclear strike against US wishes; and it took quite a bit of debate in the Exercise Chiefs of Staff meeting before the idea was accepted that if US objection was to be regarded as a conclusive bar to UK action there was no point in our having an independent capability at all. On that occasion we did, incidentally, in the end agree to SACEUR's request.

Sir John Willis. Thank you very much for that Michael. I would certainly confirm what you say about concepts being ill-defined at times. I recall a conversation I had with a US artilleryman as late as 1986; it was positively frightening in terms of what he understood his nuclear role to be. Essentially, it amounted to, 'When them mothers get close enough I'm going to put some of these babies up the tube and you just watch 'em dance!' - which was not quite my understanding of the plan. (*Laughter*).

Mike Meech. While the V-Force clearly had a positive impact on the RAF, did it also have negative effects, on its conventional air support capability, for instance? What impact did this have on the RAF in the context of NATO's policy of flexible response?

AVM Mike Robinson. If you have a fixed slice of the defence cake and you decide to invest most of your allocation in one force, others will inevitably be less capable. Some of that was offset by the retreat from empire, which reduced our commitments and permitted squadrons to be brought home and disbanded. But, overall, I think that I would have to say that conventional forces were of little significance in terms of fighting a European war. I would take the view, therefore, that the money was spent wisely.

To pick up a point raised by Sir Michael Quinlan, it is, I suppose true that in establishing what we might term an inter-dependent arrangement with the USA, our national independence did get rather swallowed up. Nevertheless, I think that this was a sensible approach and the close special relationship which it fostered with the USA, especially the USAF, yielded several bonuses which we have not talked about. For instance, I venture the thought that our support at the time of Cuba may have paid dividends in the support we received from the Americans at the time of the Falklands.

Sir John Willis. I would add to that the thought that the later shift in policy from massive retaliation to flexible response did change the whole approach to a conventional capability. We have to understand, as Sir Michael Beetham reminded us last time, that the concept of massive retaliation is, in part, a consequence of having a nuclear force which would not survive a first strike; you simply *had* to use it. On the other hand, it did allow governments to make dramatic economies on conventional forces because they were of little consequence. If the Russians put one foot across the Inner German Border everything was launched. Flexible response implied something entirely different, and far more intellectually cogent. It assumed that one would survive an initial attack and that you would, therefore, have to fight at a conventional level. There was, of course, considerable argument over how long you would be able to do that for but you certainly needed to fight for long enough to permit the Ministers to get together in Brussels to decide what they were going to do. Flexible response therefore led to an enhancement of conventional capability and a recognition of the importance of the role that it would have to play.

Sir Michael Quinlan. Clearly money spent on one thing is money *not* spent on another and there were certainly some Americans who were

opposed to our staying in the nuclear business at all. I have in mind Bob McNamara, for example, who would very much preferred to have seen us spend our money on conventional forces.

Nevertheless, I would have thought that once we were committed to maintaining a nuclear force, it was bound to absorb a very large slice of the budget and there was clearly a balance to be struck but I don't think that, at any stage, the rest of the air force was ever disembowelled to keep the V-Force going.

Sir Michael Beetham. There are two aspects on which I would like to comment. First, whether or not we had a doctrine. Well, the original doctrine was simply one of massive retaliation - one foot over the line and it was Armageddon - and under those circumstances there was little that conventional forces could have done. Later on, when we adopted the more measured 'flexible response' approach, there was seen to be a role for conventional forces but I always suspected that that philosophy lacked a certain realism. The problem was that we never had much confidence in our ability to hold the Russians by conventional means so it followed that we would eventually have had to resort to using tactical nuclear weapons. Once such an exchange had started, communications between the front line and London and Washington being what they were, it would have been very difficult to control the situation and prevent its escalating into a General Release. I don't think that too many people believed that 'flexible response' represented anything more than a pause before the inevitable.

In this context, I don't think that many politicians really understood some of the implications of, or indeed were even aware of, the very high states of readiness which nuclear forces routinely maintained. It was, for instance, very rare for a minister to take any interest in an exercise like WINTEX. The only one that I can recall during my time as CAS was Margaret Thatcher. She demanded to know what was going on and actually attended the exercise; I think the experience taught her a great deal. Then again, Jim Callaghan had been PM when I was CinC in Germany. He paid us a visit and we took him to Brüggen where we showed him the QRA force, on state with live weapons. He was quite taken aback; could hardly believe it. He was very thoughtful at dinner that evening as, I think, the realities of what we had been saying to him during the day began to sink in, that, as Prime Minister, he might have to

make some very difficult decisions - and make them at very short notice.

So I think that there was a lot of truth in what Sir Michael Quinlan was saying, that when we did move on from the simplicity of massive retaliation it took us some time to think through what we were doing thereafter.

The second point I would like to address is Cuba. I think that that experience served to focus the minds of people like John Willis and Mike Robinson who were then in the front-line. Until then they had gone through the motions of loading weapons on exercises but it suddenly became very apparent that they just might really have to use them. At the time I was Group Captain Ops at Bomber Command, with 'Bing' Cross as CinC. As soon as the missile crisis began to develop we got the message from the Government, from Macmillan, that no overt action was to be taken. So, anything that we did decide to do had to be done quietly. We couldn't, for instance, use the BBC to recall people from leave as we would have liked to have done. In fact, we were so successful that nothing ever seemed to appear in the Press, despite the fact that we had generated the entire V-Force to a very high state of readiness. We even put the crews in their cockpits at one stage but basically they were held at 15 minutes' notice. Ideally, once the bombs were on board, what we wanted to do was to move on to the next stage in our pre-planned alert procedures which would have dispersed the force. We were forbidden to do this, however, so the aircraft had to stay on their main bases.

I am, incidentally, quite sure that Cross never exceeded his authority. He certainly gave his staff no indication that he ever did; we were with him all the time and he was constantly in touch with Whitehall. On the other hand, I was a little surprised to hear Dr Scott say that Cross was not in contact with SAC. I was never present when he had any conversation with CINCSAC but they were close personal friends and Cross dealt with General Power on a regular basis. We were fully aware of the state of the DEFCON, of course, and of the state of SAC's airborne alert but I cannot actually say whether or not the CinCs were talking. I have a feeling that Cross would have told his staff or, at least SASO and me, if he had been having difficulty with the Americans.

Looking back, Cuba was certainly a very traumatic experience for those involved, both at station level and at the Headquarters. But, strangely enough, the rest of the nation seemed to be quite unaware that there was a crisis at all. When we went for a meal or took a break

outside, the sun was shining and the media was obsessed with some football match! It all seemed quite unreal.

Gp Capt Ian Madelin. Perhaps I could offer a general comment. First, a purely personal comment. I suggest that it should not surprise us at today's seminar when we hear remarks like the one we heard just now, that there are questions here which, even forty years after the event, have still not been answered. Because with this subject there are questions which can never be answered. With the advent of the nuclear age someone coined the phrase 'thinking the unthinkable.' That's about it. We've heard from people in this room this morning about Russian cities whose street plans they knew by heart and which, had they completed their missions in a nuclear war, simply would not be there any more. Nor, afterwards would there have been anywhere for them to return to. It is impossible to comprehend that in any rational way. It is hard to get one's mind around Armageddon. So it is not surprising that politicians and their like, even if they had had more knowledge of the details, should have shown an unsure grasp of the implications. But the trouble is that, for nuclear deterrence to work, the politician's grasp of the matter needed to be as intimate and responsive as the readiness states themselves, and my reading of this in the documents now released in the PRO is that Macmillan's - and even that of the Air Staff in Whitehall - fell a long way short of that.

Before taking this further let me clear up one point of fact. The story that Air Mshl Cross was not in touch with SAC in the week that these events unfolded came from Air Mshl Cross himself. (A transcript of his remarks is held by the Air Historical Branch.) He had a very close relationship with General Power, CINCSAC, as he'd had with Power's predecessor Curtis LeMay. Usually he was in touch with him by phone frequently, sometimes even a couple of time in a day. But that week, for reasons which he never understood, the General was never on the other end of the line. At a previous symposium on this subject in the States I suggested that the Americans may have preferred it that way. If you were playing poker for the highest stakes the world has ever known, eyeball to eyeball with the other guy, seeing who is going to blink first, then you'd rather have one person on your side of the table than two. But that is just conjecture. (But in similar vein, note that, although Kennedy's first confirmation of the Cuban missile sites came on 14th October, he did not

inform Macmillan until 21st October.) General Power would in any case have known about the steps that Bing was taking through feedback from SAC's own people over here who were custodians of the dual-key weapons

To return to the matter of the connection here between Whitehall and the front line at HQ Bomber Command, most of what one reads about it today looks like 'situating the appreciation'. Some years later Macmillan told his grandson that, looking back, it all seemed like a dream. I reckon that is probably truer than he'd meant it to be - and it aptly fits Mac's character don't you think? Despite all that one reads of very statesmanlike manoeuvrings, there is no corroborating evidence of this in any of the Cabinet minutes. Macmillan was first informed of the crisis by Kennedy on Sunday 21st October; Khrushchev capitulated on Sunday 28th. So we are talking about just one week. There were two Cabinet meetings in that week. There was no discussion of alert states or indeed of specifically military matters at either. Peter Thorneycroft, Defence, was present at both but made no submissions at either. Hugh Fraser, Air Minister, was not present at either meeting. The PM reported to the Cabinet that he had offered President Kennedy our support, both legal and in the UN. We had to be alert to possible Soviet countermeasures in Europe, for example, by Khrushchev engineering a crisis in Berlin. There was a feeling that the US was perhaps overreacting to the fact of finding itself within range of Soviet missiles. After all, that had been the state of affairs in Western Europe for years and we had got used to it.

I have also checked the meetings of the Defence Committee, of which there was one on 24th October, attended by Thorneycroft, Fraser and Pike. Astonishingly, there was no reference to Cuba at all, and it does not appear anywhere in the subject index for the Committee's minutes of that year.

Peter Hennessy, in his recent book *The Prime Ministers*, says that Macmillan would certainly have understood the implications of nuclear alerts because many years before he had watched a V-Force scramble at Scampton. A newsreel shot showed him on the pan, '..with his bowler hat and his umbrella by his side, standing erect, like the Guardsman he once was.' 'In short,' Hennessey adds, 'Macmillan was neither naive nor a novice when it came to transition to war.' I put it to you that having been a soldier in the First World War would not have provided him with any understanding of nuclear alert procedures. In fact when Macmillan

used the word 'alert' he understood Royal Proclamations and General Mobilisation. He did not show a grasp of what the V-Force's readiness procedures entailed. As example, whenever he was travelling around the country, whether by car or by train, he was not even directly contactable. With this, as with all other matters in the political arena, it was obviously assumed that there would have been time for his staff to brief him and bring him up to speed if that were ever necessary (which in turn assumes there were people on his staff who were sufficiently 'up to speed' themselves.) For anything else that may have been true, but not here. Here there is a difference in kind, outside anyone's experience and without precedent in all of previous history.

So what I have said is not meant as a criticism. It is rather in the nature of the matter. On the other hand we heard a reference here this morning to the biennial Exercise WINTEX, the annual paper exercise whose purpose was precisely to practise awareness and implementation of NATO alert procedures up to the highest political level. The participation at that level would not have called for more than about three hours of time at the conclusion of the exercise, once a year; not a lot, given what was at stake. But my own experience confirms what was said by the earlier speaker. From my desk in the SHAPE Ops Centre I have to say I never detected any high-level political participation. Now that is a criticism.

To return finally to the timetable of that week, on the morning of Saturday 27th October, one day before the crisis ended, Macmillan called the CAS, Tom Pike, in to see him, and put to him the question: 'What is the readiness state of our forces?' I thought that Tom Pike's reply, (on record), was worthy of Peter Sellers. He said, 'Prime Minister, I have asked the Chiefs of Staff to hold themselves at one hour's readiness for a meeting.' (*Laughter*) The PM said that he did not want any overt steps 'such as mobilisation', nor did he want Bomber Command to be alerted, but to be ready to take appropriate steps if necessary. He said that if the situation deteriorated he intended holding a Cabinet meeting the next afternoon (Sunday 28th). The CAS called Bing Cross up to London that afternoon for a meeting at White's. I think Fraser was there too. Bing was asked what he had been doing (which incidentally he had been reporting to the VCAS, Kyle, all along). Bing reported on the Command's Readiness State and said there had been no recall of aircraft on detachment and no dispersal (which he would have

been strongly against).

In the event there was no need for the Cabinet Meeting the next day because news came through on the radio at lunch-time that Khrushchev had backed down.

I'll give the last word to Bing. Summing up the activities of the week he said: 'From me downwards everything worked perfectly. From me upwards, nothing worked at all.'

Dr Scott In the context of dispersal it is interesting to compare Bomber Command's approach with that of Strategic Air Command and the decision of the American political authorities to increase the overall alert state to DEFCON 2. As a result, SAC's bombers were dispersed within the United States and the proportion on airborne alert was increased from twelve to sixty-six sorties a day. There was, therefore, a sharp contrast between the British and the American responses to the specific issue of dispersal, another significant dimension being added by the fact that the change in the DEFCON was transmitted *en clair* by SAC and we know that, having heard that message, on the 25th October Soviet Military Intelligence informed Moscow. It seems very likely that this will have had some influence on Soviet thinking and on Khrushchev's decision to pull back from the brink. We shall not know for certain, of course, until we have obtained a better understanding of the military element within the Soviet decision making process.

Sir Michael Quinlan. I was in Tom Pike's office as his Private Secretary at the time of Cuba and I would offer the thought that, in those days, ministers were far less apt to micro-manage affairs than they are today. Part of the reason for this is the focus that the modern media provides. If the Cuba crisis were happening now we would have the Press outside every single airfield reporting on everything that was going on. In the 1960s ministers did not expect to be involved in the fine detail. The political guidance was 'Nothing overt, please' and the military were largely left to get on with it. Sir Frank Cooper may have a view on this.

Sir Frank Cooper. The last micro-manager of that generation was Anthony Eden who never ceased to be a platoon commander but I do agree with Michael. On the other hand, I think we have been a bit unfair to Macmillan because, if you remember, the CND was rampant at the time particularly around the Thor sites. That caused quite a bit of bad

press and publicity and there was a lot of criticism of the Americans who were 'over here' with nuclear weapons. Macmillan suddenly decided to put a stop to all this; it would have been in about 1958, I think. He delved in great detail into the question of the control of British-based American bombers; when they could take off, under what conditions and so on. All of this was done in close co-operation with the Americans. Indeed Maj-Gen Johnson, who was then commanding the USAF in the UK, actually went across to the House of Commons with me to listen to the whole thing. Macmillan really had gone into the control of nuclear weapons.

I do appreciate that there is a difference between 'control' and 'readiness' and it was the latter that I don't think that ministers really understood. I think that they probably saw demonstrations of V-bombers getting airborne in double-quick time as a publicity stunt laid on for special occasions. On the control side, however, I think that Macmillan really did understand it. On the other hand, as Sir Michael Beetham has pointed out, nobody else ever showed much interest until Mrs Thatcher took part in one or two exercises in the Cabinet War Room; exercises which were, incidentally, pretty shambolic.

One last thought - on the Russians. I remember a telegram in 1953 from our *Chargé d'Affaires* (Frank Roberts, I think) who had been to see Zhukov who was then the Defence Minister. The gist of the message was that Zhukov had told him that he had been reading the scientific reports on the development of nuclear weapons and that he had concluded that war could never be the same again. That gave me considerable comfort and sustained my personal belief in the deterrent for the next 40 odd years because I think that the Russians understood nuclear war and its ramifications very, very clearly. I was also always reassured that a dialogue was kept up between us over the years as a result of which the understanding grew greater. It may well have been, therefore, that the Russians backed off at the time of Cuba because of their appreciation of the potential realities underlying the situation.

Cecil James. We've been talking about a period which was, I think, as historically important for the Royal Air Force as any period. There are two things I would like to say. First, to support what Sir Frank Cooper has just been saying, I think that those who always believed in the deterrent can take great comfort from the Cuba crisis because it proved

what the Chiefs of Staff had said as early as 1949, that the atomic bomb had outlawed global war. Our prime consideration thereafter was to ensure that it did not happen. The basis of deterrence is that the key players are the men who run great States, men who, when it comes to the crunch, will always decide *not* to 'go'. There can be a very tense period, as was the case over Cuba, but in the end the decision was not to go and it was taken by both sides. In other words, the deterrent had worked.

The second comment I wish to make concerns BLUE STREAK, which was eventually blackballed by all the Chiefs of Staff as a first strike weapon which led to its being cancelled. Looking back over this episode in his memoirs, Macmillan, the Prime Minister at the time, said that he was not sure that it had been a good decision. I think that he was realising that, in the last resort, nobody is going to take the risk of launching a first strike against a nuclear power. The case against BLUE STREAK was that it could have provoked the Russians into making a pre-emptive strike. To have been effective, however, this strike would have had to have been on such a scale that it would have triggered an American response. I think that Macmillan may also have had in mind that, through cancelling BLUE STREAK, we found ourselves involved in the awful can of worms of Skybolt and Polaris, which has, with its successor, been an enormously expensive system. We could have done it all a lot more cheaply.

V-FORCE OPERATIONAL DEPLOYMENT AND READINESS

Wing Commander Andrew Brookes

Educated at Leeds and Cambridge Universities, Andrew Brookes subsequently trained as a pilot, his operational flying including tours on Victors, Canberras and Vulcans. He held staff appointments in Hong Kong, at HQ Strike Command and with the Inspectorate of Flight Safety and was the last RAF Commander at the Greenham Common cruise missile base before joining the staff of the RAF Advanced Staff College and the Joint Services Command and Staff College. He is currently the aviation specialist at the International Institute for Strategic Studies. He has had ten books published, one of which, V-Force*, is a history of the British airborne strategic deterrent.*

Looking at my log book, I see that I first went solo in one of Her Majesty's aeroplanes when the RAF had around forty Canberra and V-Force squadrons divided between Bomber Command, Near East, Middle East and Far East Air Forces, and RAF Germany. Moreover, back in 1964 there were more British troops East of Suez than in Germany. I mention these facts to make the point that, forty years ago, Britain still had serious pretensions to being a world power.

Over the next thirty minutes I will cover aspects of V-Force basing and operational readiness. Let me start with operational deployment. I trace the birth of the V-Force from the appointment of Sir Harry Broadhurst as CinC Bomber Command in 1956. His command was divided into two groups, No 1 Group, with its HQ at Bawtry Hall near Doncaster, was responsible for bases in Yorkshire and Lincolnshire, and No 3 Group, at Mildenhall, which looked after the Midland and East Anglian airfields. Designated '1st Division North' and '3rd Division South' by irreverent 1 Gp personnel, Sir Harry decided to put a jerk into Bomber Command 'by bringing in a few fighter people, like myself.' He gave the Valiants and Victors of 3 Gp to AVM Kenneth 'Bing' Cross, an air defence expert used to working with short reaction times. To balance Cross, however, the CinC gave 1 Gp with its Vulcans to AVM Augustus 'Gus' Walker, the ex-England stand-off and famous Second World War

one-armed bomber leader.

At station commander level, 'Broady' gave the first Victor station, at Cottesmore, to the top-scoring Allied fighter ace of the Second World War in Europe, Gp Capt J E 'Johnnie' Johnson. The initial plan was for the Valiants, Victors and Vulcans to be divided between twelve Class 1 airfields – Gaydon, Wittering, Wyton, Marham, Honington, Waddington, Coningsby, Finningley, Cottesmore, Scampton, Bassingbourn and Watton. There was an element of musical chairs in all this. Johnnie Johnson told me that he went to do the Valiant OCU because Valiants were slated to go into Cottesmore, but by the time he had finished someone had decided to put Victors into Cottesmore instead, so then he had to go and do the Victor conversion!

In the end the V-Force concentrated on ten Class 1 airfields, with dispersal in tension to forty-five other airfields in the UK. It is a measure of the number of active airfields then in the UK (as distinct from foot and mouth burial sites) that the Finningley Vulcans could be spread around Hampshire and the Coningsby Vulcans around Somerset.

But dispersal on its own did not suffice for long. In 1958, the Vice-Chief of Air Staff, Air Mshl Sir Edmund Hudleston, commenting on the efficiency of Bomber Command at a Pathfinder Association dinner, revealed with pride that in a recent surprise alert the time from bunks to getting airborne in a V-bomber at night had been 11 minutes. But low-trajectory, nuclear-tipped medium-range missiles, which appeared in Soviet satellite territories after 1958, could hit the UK within 4 minutes of launch. The 1958 Defence White Paper revealed that measures were being taken to raise the bomber force's 'state of readiness, so as to reduce to the minimum the time needed for take-off.'

Sqn Ldr C Dixon, a Bomber Command engineering staff officer, designed the 'Simstart' trolley, which, with its great array of batteries, enabled an aircraft crew chief to start all four engines virtually simultaneously while the crew was strapping in. After starting engines at the end of the runway, all the V-bombers had to do was to roll forward and 'scramble' in quick succession.

Bomber Command dispersal exercises began in April 1958 with squadrons being sent to pre-planned bases and then, when the 'scramble' order was given, getting airborne as if for an operational mission 'in the shortest possible time'. The early pioneer days on dispersal could be chaotic and, as one pilot recalls, 'more like going on a holiday than

going to war'. Communications abounded back at base, but an alert message en route to a tented bivouac in the middle of an obscure airfield could easily get corrupted or never get through at all. 'There was a great deal of inane running about,' says one captain. 'Chaps would slither around in mud or on ice, or jump from moving lorries encumbered with heavy bags and twist ankles, all in the cause of trying to get airborne five minutes ago.' More haste and less speed led six aircrew to get into one aircraft and four in the other, resulting in the unedifying sight of two co-pilots fighting over one seat. Then, with the older men still croaking and gasping for breath, garbled messages would come through so that aircraft scrambled when they should have taxied or crews got out when they should have carried on. Dispersals were sometimes more akin to the Keystone Cops until concrete aircraft hardstandings known as Operational Readiness Platforms (ORPs) were laid leading straight onto the runway threshold; permanent crew accommodation, in the form of special caravans, was positioned close by and temporary command posts with efficient lines of communication were established. In the end, twenty-six dispersal airfields ranging from Lossiemouth in the north to St Mawgan. in the south west and Aldergrove in Northern Ireland were added to the ten main bases, and the money was found to put ORPs on all but six of these.

The nuclear weapons themselves came from No 92 Maintenance Unit at Faldingworth airfield, north of Lincoln, the main weapon storage base for the V-Force until the early 1970s. Such was the air of secrecy which surrounded these matters that the airfield's name did not even appear on Ordnance Survey maps until 1980. A generally well informed observer, Leonard Beaton, published a pamphlet in 1964 in which he speculated that the current British nuclear stockpile consisted of perhaps 300 thermonuclear and 1,200 atomic weapons. Whatever the actual figures, it can be said that, in 1962, Bomber Command with its total of 24,409 officers and men had a striking power equivalent to tens of *millions* of wartime Lancasters.

Operational Effectiveness

There was no denying that the plans of US Strategic Air Command and RAF Bomber Command closely dovetailed. In consequence, Bomber Command had the advantage of knowing that its progress in a war would be facilitated by American missiles, but it was not just a one-sided

arrangement. ‘Some of our targets,’ recalled one AEO, ‘looked as if they were clearing the way for someone else,’ and in the words of former DCAS, Air Mshl Sir Geoffrey Tuttle, ‘we taught the Americans a hell of a lot. We had to face many of the problems first - we were nearer to the USSR, we were threatened long before the Americans were and, therefore, we had the incentive to survive much sooner than they did.’

By 1962, therefore, given the standard of V-bombers and their equipment, the megatonnage within their bomb-bays and the fact that its crews had now come to grips with the practicalities of waging strategic nuclear warfare, Bomber Command felt confident that it was in a position to live up to its motto of ‘Strike hard, strike sure.’ Yet the only way to test the claim is to hypothesise on how the V-Force might have gone about its business had the nation been drawn into a third world war by the Cuban crisis of October 1962.

At the end of October 1962 Bomber Command had approximately 140 Main Force bombers divided among seventeen squadrons and the OCUs.[1] Of these 140 aircraft, the Air Staff decreed that squadron engineers should be capable of having 60% serviceable within six hours and 80% within twelve hours, so aircraft were never dismantled to such an extent that the required percentage could not be reassembled within that time schedule. But, allowing for the worst case, Bomber Command could always be said to have had at least 110 strategic bombers available to go to war within twelve hours.

Eventually the international situation would have become so strained that High Wycombe would have been told to disperse the whole V-Force in groups of four. There the individual quartets of aircraft would have stayed at 15 minutes’ readiness until tension reached the point at which

[1] The following were at full strength: Nos 49, 148 and 207 Valiant Sqns at Marham; Nos 44, 50 and 101 Vulcan B.1A Sqns at Waddington; Nos 10 and 15 Victor B.1A Sqns at Cottesmore; Nos 55 and 57 Victor B.1/1A Sqns at Honington; Nos 27, 83 and 617 Vulcan B.2 Sqns at Scampton and No 139 Victor B.2 Sqn at Wittering. The remainder - Nos 9 and 12 Vulcan B.2 Sqns (No 35 Sqn did not re-form until 1st November 1962) and No 100 Victor B.2 Sqn - were operational but were still in the throes of re-equipping; although No 9 Sqn, for instance, had received its first Vulcan B.2 in April 1962, it was not up to full strength until the following February. Nevertheless, they, and the OCUs, had quite a few aircraft and experienced crews between them and they would all have been capable of going to war if necessary.

Representative of the V-Force at its numerical peak, Valiant BK 1 XD874 of No 148 Sqn in 1963. (MAP)

the crews would have been required to man their aircraft. Each aeroplane was connected to reality by an umbilical telescramble link to the Bomber Controller at High Wycombe, who, on receiving the command from the War Room in London, would have been instructed by his CinC to order the V-Force to start engines and then to 'Scramble'. On airfields from the north of Scotland to Cornwall, sixteen engines would have started simultaneously. Throttles would be opened and four bombers would take off in quick succession until, long before four minutes had passed, there would be nothing left to show where they had been save some turbulent and darkened air and the pungent smell of burnt aviation fuel.

From the north and south, east and west, bombers would have met timing points and specific positions in order to comply with the co-ordinated raid plan. Radio silence would be maintained to prevent detection, leaving only the dull whine of the electrics to act as background music instead of the heroic strains of forgotten wartime films. The crew of a V-bomber needed no chatter to go about their business - the blinds would be down behind the pilots, leaving the rear crew with the feeling that they were 'facing backwards in a broom cupboard at midnight.' Fuses could blow, equipment go on the blink, even engines fail - it would have made no difference; staccato responses and practised hands would have sorted it all out. The systems were so duplicated as to carry on regardless and the Nav Plotter could work by 'astro' from the unjammable and infallible heavens if need be. All the years of toil and training with simulated equipment failures had been endured in preparation for just this moment, and there would have been

nowhere else to go but forward so long as the wings remained attached, there was some measure of control and at least two engines were working.

The great advantage of the manned bomber over the missile is that the former could be dispatched in safety to make a potential aggressor withdraw from the brink, whereas there is no way of bringing back a missile. However, once the politicians let the V-bombers off the leash, it would be all or nothing. Over the hills and plains, fjords and seas, the V-bombers would forge on to enter Soviet airspace anywhere from Novaya Zemlya to the Caspian Sea. By now the Mk 2 Victors and Vulcans would have been above 50 000ft - aircraft would gently 'cruise climb' upwards as fuel was used and weight reduced - although the Valiant would take up to five hours to reach that height.

Unfortunately, the higher an aircraft goes, the earlier the ground radar can detect it, so carefully pre-planned routes were essential. If Soviet radars could pick up a bomber 200 miles away, it made sense to try to avoid them and the fighters they controlled for as long as possible, even if this meant flying a longer and more circuitous route than might otherwise have been necessary. Eventually, though, the bombers would have to run the gauntlet of the opposing air defences; intelligence sources tried to predict the points where the defences might be weakest but those targets worth attacking would also be those that were best protected, and this was where jamming came in.

The electronic countermeasures equipment in the back of the latest V-bombers could be divided into two categories: a warning receiver to detect when the bomber was being illuminated by enemy radars plus a tail warning radar to observe enemy fighters attempting to move into a firing position, and jamming devices to do something about them. The offending radars in question were Soviet early warning and missile and fighter control radars, and the main British countermeasure was to jam these with noise. Noise jamming was a 'brute force' expedient in that it relied on 'out-shouting' rather than deceiving the opposition, but it was the best solution at the time.

Once the barrage noise jammers were turned on, the V-bombers would try to sneak through the confusion undetected. However, the ground controllers would eventually find gaps in the barrage jamming through which they would endeavour to feed in their fighters for the kill. Each Soviet early warning radar area was subdivided into fighter control

sectors and the controllers aimed to position their charges some five miles behind the bomber and heading in such a direction that the fighter pilot could see his target either visually or on his aircraft radarscope. Fortunately for Bomber Command, Soviet fighters of the time used only four VHF channels for their radio communications, and the V-bombers carried GREEN PALM, which was a VHF jammer tuned to those four frequencies. There was a good chance, therefore, that the AEO might be able to prevent the Soviet fighter from ever receiving enough instructions to attain radar or visual contact by using GREEN PALM, which emitted a deafening noise like a cross between a continental police siren and the bagpipes.

'The argument at the time,' says Alfred Price, an AEO on Vulcans during the Cuban crisis as well as being an expert on electronic warfare, 'was that if you are short of money, go to jam out the ground control. The Soviets could point their fighters straight at the high flier if they'd got good radar control from the ground to put them there, but if they hadn't got it, the interception of a 50 000 ft Mach 0.93 bomber became a bit of a lottery.'

Some fighters would invariably get through, and then the V-bomber crew had to rely on manoeuvre to try to avoid destruction. The bomber's H_2S radar had a modification called Fishpool which under certain circumstances could detect fighters around and below, so the Nav Radar could sometimes see the fighter climbing. He would pass this information to the crew and the AEO could take over the running commentary as the fighter swept in behind and into the ken of his backward-looking tail warning radar. Even if the interceptor pilot got into a tail position, bundles of 'Window' might confuse him if he was relying on his airborne radar, and it was no easy task to keep a turning V-bomber in the firing sights. The main Soviet radar-guided air-to-air missile, for example, had to be launched when its fighter's wings were virtually level, otherwise the missile fell out of the directing beam. 'One must not exaggerate the advantages of these new [rocket] weapons,' wrote Soviet missile expert General Pokrovsky. 'The more automatic any procedure becomes, the easier it becomes for the enemy to jam that procedure; these missiles can be used only when precise advance knowledge of all the conditions of the combat situation is present. Manoeuvre can easily fool such automatic weapons.' However, it must never be forgotten that a bomber, turning to avoid a fighter (and a V-

bomber could out-turn all of them above 50 000ft), was being prevented from flying towards its target and that any Soviet fighter pilot worth his salt would ram his opponent in the last resort if it meant stopping a hydrogen bomb from falling on his homeland.

Thus, as the V-force roared in at top speed and at the highest altitudes cruise climbing could reach, some bombers would have gone down against the first-line fighter defences. Countermeasures and surprise, however, should have bought enough time to get most of them through. The V-bombers, after all, would have gone in *behind* the Thors and other long-range missiles, which if they did not hit air defence centres would certainly have played havoc with telephone lines and fragile aerial arrays when they exploded. As Sir Harry Broadhurst observed in France in 1940, all the sophistication in an aerial defence system goes to the wall when the lines of communication are down and everyone goes underground.

Those V-bombers that survived would have passed through the fighter sectors and into the missile zones. Despite all the prophets of doom, the anti-aircraft missile did not make the bomber obsolete overnight; Gary Powers in his U-2, for instance, flew straight and level without any jamming or evasive manoeuvres deep into the heart of the USSR before he was shot down. The V-bomber crews knew where most of the SA-2 SAM sites were located; they could also hear the SAM radars looking for them and, consequently, they could detour around them. But by 1962 there were too many SA-2 sites in existence to avoid them all, so the AEO would try to barrage jam the missile radar and feed it false 'Window' targets while the pilot weaved around track to prevent the missile-control computers from ever having enough steady and reliable information on which to base a launch.

There are many imponderables in any air battle and it would be just as foolish to pretend that every bomber crew would outwit every SA-2 site as to proclaim that every SAM would automatically dispose of any bomber. The trained men at the SA-2 site would have been more difficult to fool than a machine and the barrage of three missiles they fired would have undeniably increased their chances of overcoming jamming, but suffice to say that the SA-2 system needed a good 60 seconds from initial acquisition to the end of the engagement and that continuously effective jamming for any 15-second period within that time would probably be enough to avoid destruction. In addition, despite the

demarcation between missile and fighter zones, some Soviet fighters would have hung on to their bombers as the latter entered the SAM radar cover and this would have complicated the issue for missile controllers on the ground.

Nevertheless the SAMs too would have taken their toll of the V-Force, especially as the groups of aircraft would by now have split up to go towards their respective targets. More deltas and crescents would have gone down in flames, but those that survived would now be starting their straight run-in to weapon release.

The Nav Radar could often see his aiming point from 160 miles away and the usual procedure was to home to an easily identifiable Initial Point some 60 miles from weapon release, where the navigation and bombing computers could be finally updated accurately. At 40 miles to weapon release, the Nav Radar would change over to his larger bombing scale and place the target under his aiming markers by means of his 'joystick'. If the target response was weak or impossible to identify, the bombing run could still be pressed home provided there was an identifiable reference point close by. The co-ordinate distances of the target from the reference point could be set on 'offset' dials and the aircraft automatically homed to the correct release point.

Once the target or 'offsets' were in, the computers could do the rest down to feeding steering information directly into the autopilot. But aircrew are only human, and at this most crucial part of the mission most men would have bombed manually, if only to take their minds off other things. At this stage in the operation a mixture of efficiency and high tension must have reigned. Outside the fighters might have been temporarily shaken off, but the warning receivers would have been chattering frantically as they picked up a crescendo of radar signals. The windscreen blinds would have been down, but even so the occasional flash of light might have crept in underneath from an exploding bomb or missile. It would have been claustrophobic in that small cockpit - muttered instructions, shrieked warnings and spurious alarms blanketed by sheer unadulterated fear. Nevertheless the Navigation and Bombing System was a marvellous piece of equipment which even opened the bomb doors automatically just before the point where it computed that the bomb should be dropped. As the weapon left the bomb-bay the pilot would have racked his bomber round into the escape manoeuvre and beaten a retreat.

Where did the crews go from there? 'Your best bet, old man,' said one squadron leader to an inquiring mind, 'is to keep on flying east, come down somewhere deep in the country, and settle down with a nice, warm Mongolian woman.' On a more serious note, crews were expected to try to get home. They were given return routes that were every bit as detailed as the outbound legs, and although the problems of co-ordinating the returning aircraft back through outbound waves of SAC bombers and into Western airspace without being shot down were not insuperable, no one postulated how many of them would get back and there was never any intention of sending the remnants back over the USSR on the morrow. With a host of alerted Soviet fighter and SAM bases, all powerless to prevent the destruction so recently wrought but now driven by thwarted rage to avenge it, the best hope for survival probably lay in closing down two engines to conserve whatever fuel was still lapping the bottom of the tanks and heading for the British Mediterranean bases to the south.

On the basis of this generalised summary of V-Force high-level tactics, what proportion of the British strategic bomber element would have got through? There is one valid pointer to the V-Force's chances in 1962, and that is Exercise SKYSHIELD against the might of North American air defences. Back in 1951 the USAF had contracted with the Massachusetts Institute of Technology to work on what Secretary of the Air Force Finletter described as the 'Manhattan Project of air defence'. Its conclusions in the summer of 1952 recommended the construction of a distant early warning radar line across northern Canada to give three to six hours' warning of approaching enemy bombers, an integrated and fully automatic communications system, and improved fighters and SAMs for interception.

This culminated in the merger of the US and Canadian air defence systems within the North American Air Defence Command (NORAD) on 12th May 1958. Co-ordinated from Colorado Springs in the Rocky Mountains, the Americans and Canadians had every right to be proud of NORAD, and to prove it fully they decided to mount a massive air defence exercise in October 1961 which was to be fully realistic and to which Bomber Command was invited. High Wycombe was more than happy to oblige, especially as it gave them an opportunity to test the new Vulcan B.2 under virtually operational conditions, and Nos 27 and 83 Sqns were detailed to send four aircraft each. The 83 Sqn aircraft were

sent to Lossiemouth to attack from the north while the 27 Sqn element went to Kindley AFB, Bermuda, to penetrate from the south. On October 14th both groups set off. The northerly wave began with B-47s going in at low level from 500ft upwards, jamming out the ground radars. Behind them came the B-52s between 35 000ft and 42 000ft supported by B-57s, while finally at 56 000ft came No 83 Sqn's Vulcans in stream. Electronic countermeasures proved so effective that only the first Vulcan heard an F-101 Voodoo lock-on and, although numerous fighters were scrambled, they all concentrated on the B-52s so that by the time the Vulcans came through the interceptors did not have enough fuel left to climb to 56 000ft for another battle and the British penetrated unscathed to land at Stephenville, Newfoundland.

The southern wave too came in 'using all jamming equipment and passive defence systems'. No 27 Sqn's aircraft penetrated on a broad front but, as they approached fifty miles from the coast, when the fighters were unleashed, the southernmost Vulcan turned and flew north behind the jamming screen provided by its compatriots. Thus, while the F-102 Delta Daggers concentrated on the three lead aircraft, the fourth Vulcan crept round to the north and sneaked through to land at Plattsburgh AFB, New York.

SKYSHIELD obviously had its limitations in that the only way to see how a Vulcan would have coped against a MiG-21 was to send a MiG-21 up against it, but there was no disputing that several Vulcan B.2s at height were no sitting ducks, even when the opposition knew they were coming, and that a few resourceful crews could hold their own against the strongest and most sophisticated air defence system in the world. And the V-Force continued to hold its own throughout the 1960s and '70s by introducing improvements such as a self-contained rapid engine start capability, updated ECM and operating at low level in an effort to sneak round all the SAM sites that mushroomed across the Soviet Union and other nations of the Warsaw Pact.

International Impact

Finally, The *Sunday Times* revealed on 31st December 2000 that nuclear weapons had been based in Akrotiri, Cyprus and Tengah, Singapore. These weapons were not just for the V-Force, but the point I want to make here is that these nuclear weapons were there to help allies in the area. Australia and New Zealand were obvious friends that Britain might

want to protect after China exploded her first nuclear device on 16th October 1964, but when Prime Minister Shastri of India visited London in December 1964 he too was said to have discussed the question of nuclear guarantees in the Far East. Senior RAF officers who served in the area found little evidence of enthusiasm in New Delhi for a British nuclear umbrella, but Whitehall was ready to provide some form of nuclear guarantee in order to deter a Chinese nuclear strike or a massive Chinese conventional attack on India's northern border. The V-Force certainly had the capability to strike at the centre of Chinese nuclear technology from Indian air bases and, remote as the chances of India asking for it might have been, Bomber Command might have been more acceptable to the Indians and would have run less risk of reviving the Sino-Soviet alliance than an American nuclear presence. Whitehall also hoped that such a guarantee would dissuade India from building her own atomic weapons, thereby inhibiting the spread of nuclear capabilities in Asia. The 1965 Statement on the Defence Estimates summed up the British approach when it observed that, pending 'international agreements to prevent the dissemination or acquisition of nuclear weapons....*our nuclear policy must help to provide some reassurance to non-nuclear powers'* (my italics).

All of which contributed to British prestige and influence overseas. I recall the first time I flew a Victor 2 across the Atlantic. There were two reinforcement routes to the Far East: eastabout through Turkey and Iran, which was quickest, and westabout through the US and Pacific, which took longer but was more politically reliable. On this occasion, we were going westabout, and when I say 'we' that was illuminating in itself. When I joined my first five-man Victor crew as a young copilot, I brought the average age down to 45! The Air Electronics Officer had been one of the many aircrew shot down in Fairey Battles over France in May 1940, while the captain had nightmares in Hawaii about being chased by Me 109s over the desert. It was all very surreal, as was touching down in Guam at the height of the Vietnam War. 'Being there' mattered. After I shut down at Guam, a USAF Top Sergeant came up to me and said, 'Excuse me sir, is that a Vulcan?' 'No,' I replied, 'it's a Victor,' and I went on to explain that whereas SAC had opted for the B-52 to fill their strategic needs, the British had bought two aircraft in the shape of the Vulcan and Victor. 'Gee,' he said when I finished, 'I wish we could have afforded to do that,' and he walked away mightily

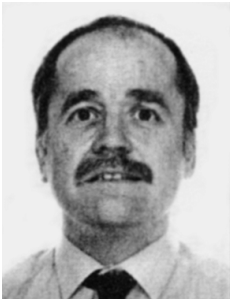
A Vulcan B.2 at the point of touch down.

impressed by the RAF. Whether it was right that he should have been so impressed, given that SAC bought four times as many B-52s, was debatable, but there was no denying that the sight of V-bombers regularly hurtling skywards off bases from Goose Bay to Wake when a fully-laden B-52D used all of Guam's 13 000-foot runway to get airborne, did wonders for British prestige abroad.

During the 1970s and much of the '80s, I was involved in the business of controlling and practising delivery of 'baskets of sunshine'. Looking back, the international leverage exerted by V-Force nuclear weaponry was considerable. Hordes of people came to admire the Vulcan wherever I displayed it, including a Soviet air attaché in 1981. Walking straight past the shiny Jaguar, Harrier and Tornado without so much as a glance, he made straight for the elderly Vulcan because, as he admitted candidly, 'that is the only one that can reach my homeland'. Power alone is one thing, but it has to be 'projected' if it is truly to impress friends and overawe potential adversaries. And the V-force did that to the very end.

THE ROYAL OBSERVER CORPS IN THE NUCLEAR AGE

Stephen Rickitt



Stephen Rickitt was educated at Ermysted's Grammar School, Skipton and Liverpool University. He was a member of the Royal Observer Corps from 1982 until the organisation finally stood down in 1995, serving in the Nuclear Reporting Cell at RAF Boulmer and as a group officer for six posts located in Northumberland. He is currently the Principal Solicitor for Northumberland County Council specialising in environmental issues and sits on the Council's emergency co-ordination team in the event of a major incident.

The role of the Royal Observer Corps (ROC) in WW II has been well-documented; less well-known is the part it played during the Cold War. My aim today is to provide some background information, details of the infrastructure, a description of the method of operations and, finally, some thoughts on effectiveness.

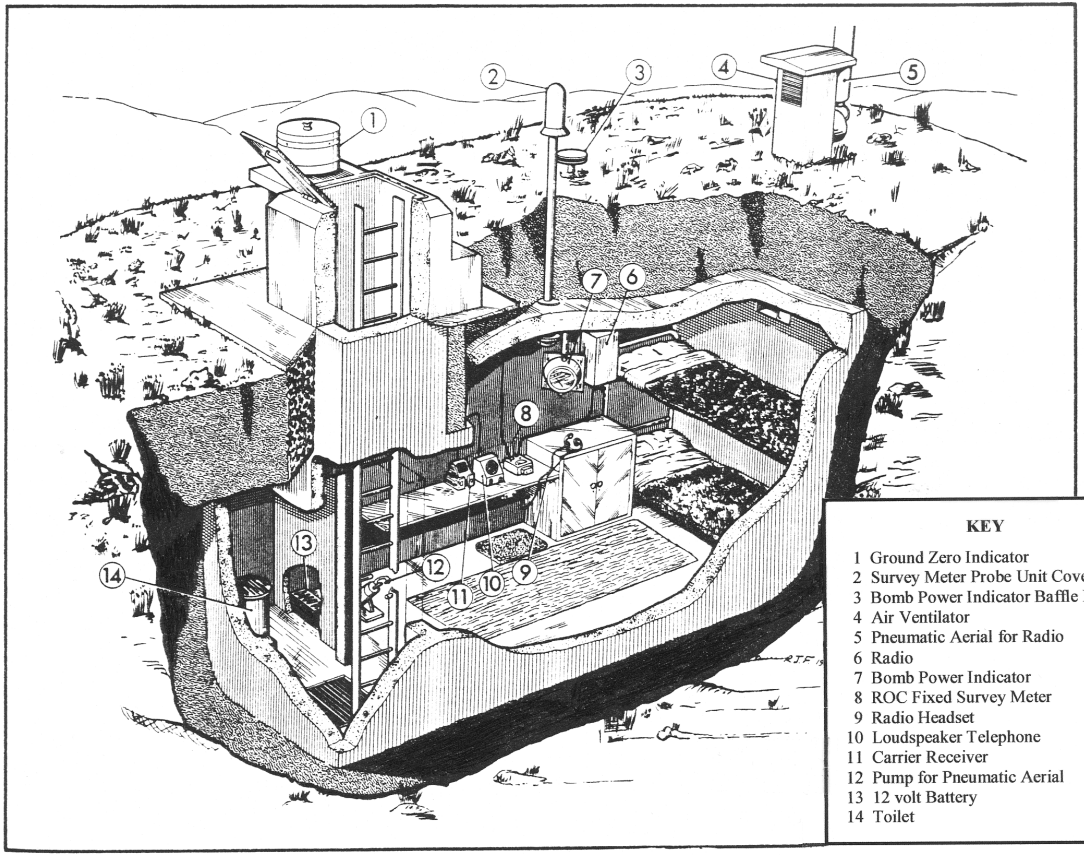
Background

Although it had been stood-down at the end of WW II, the ROC resumed active training on 1st January 1947. Aircraft recognition, plotting, tracking and telling were undertaken, little different from the war years. In 1954 the first radioactive fallout study was undertaken at the Civil Defence Staff College. The study showed the need for the large-scale monitoring of fallout levels for the whole country. The ROC emerged as the body most suitable for this role.

On 15th June 1955 the Home Secretary made the following announcement:

> 'I am glad to be able to inform the House that arrangements are being made for the Royal Observer Corps, in conjunction with the air raid warning organisation, to undertake this important new function (reporting fall-out) in addition to their existing duties.'

The role of the Corps subsequently moved slowly but surely away from aircraft recognition until, in 1965, it was announced that the



KEY

1 Ground Zero Indicator
2 Survey Meter Probe Unit Cover
3 Bomb Power Indicator Baffle Plates
4 Air Ventilator
5 Pneumatic Aerial for Radio
6 Radio
7 Bomb Power Indicator
8 ROC Fixed Survey Meter
9 Radio Headset
10 Loudspeaker Telephone
11 Carrier Receiver
12 Pump for Pneumatic Aerial
13 12 volt Battery
14 Toilet

reporting and tracking of aircraft would cease.

Although commanded by an air commodore and administered by the RAF, operationally the ROC was part of the United Kingdom Warning and Monitoring Organisation (UKWMO) and was, therefore, within the Home Office during its later years.

Infrastructure

Aircraft reporting and fallout monitoring are not the happiest of bedfellows. Accordingly, with the first prototype monitoring post being constructed in 1956 (2/N1 at Farnham), the ROC began to move underground.

The standard monitoring post was a reinforced concrete structure. A fifteen-foot vertical shaft dropped down to two rooms; a small store/chemical closet and a main room measuring 15 feet by 7½ feet. A pair of bunks, a cupboard, a table and chairs were provided. As the years passed, some became more user-friendly than others, depending upon the post members. Ventilation was through louvered ventilators with no mechanical assistance. Illumination was battery powered. Facilities, even with the most resourceful of members, could only be described as basic. No heating was provided and dampness was usually a problem. Ex-colliery conveyor belting was laid during the 1980s in a, sometimes successful, attempt to counter this.

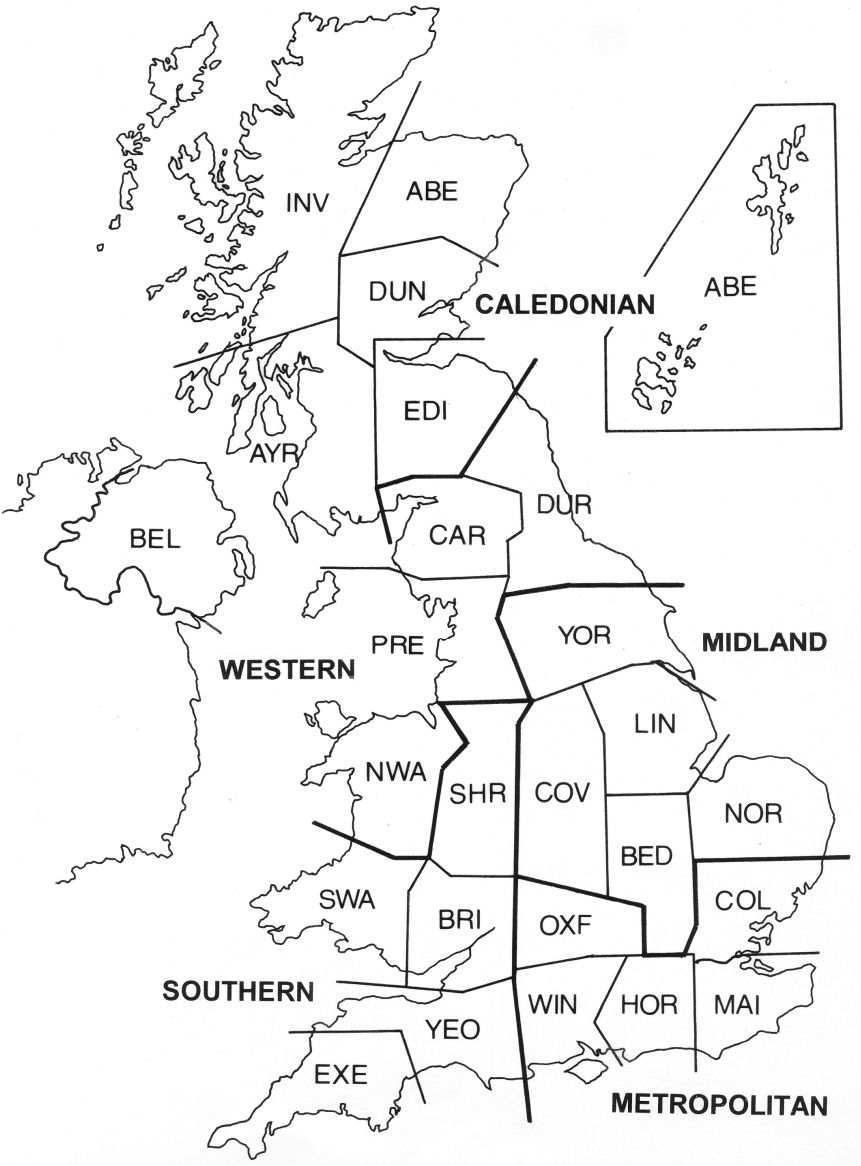
Within such an environment, a crew of three would have been expected to operate for up to three weeks. For those posts equipped with radio, the officer in command of the group of posts would have been a fourth member of the team.

The post establishment was up to twelve, a chief observer (equivalent to a flight sergeant), a leading observer and ten observers. There was no bar to women, although selecting crews was always potentially difficult. All post personnel were spare time, usually living in the area of their post and arrangements for families were made locally.

In 1968 686 monitoring posts and some controls were closed and the establishment of the ROC reduced by half to 12 500 personnel. The remaining 870 posts continued to provide nation-wide coverage at intervals of approximately 10-15 miles.

For command and communications, posts were grouped in clusters of between two and six, one of them having a radio, although it is worth noting that the command and communications functions did not always

UK WARNING & MONITORING ORGANISATION
SECTORS AND GROUPS



coincide. The other posts within the cluster were connected to the master-post and the group control via landlines. Like the personnel manning the posts, group officers were also spare timers, the ROC having only a very small full-time cadre of officers.

From the posts messages were passed to a series of purpose-built group controls, thence, through sector controls, to central government departments, local authorities and the armed forces. When the bulk of the reporting system stood down in 1991, its operational organisation had comprised five sectors, each sector having five groups.

The group controls were based on three crews of up to thirty personnel each. Manning in wartime would have been based on a crew-and-a-half. UKWMO volunteers would also have been present at the group controls. The UKWMO Group Controller commanded the group, although the ROC Group Commandant was responsible for the administration of the ROC personnel and posts.

At Controls the teleprinters of the 1960s and '70s had been phased out and replaced by VDU systems before the 1991 stand-down.

The ROC was a civilian, uniformed organisation; it was not, in law, part of the reserve forces. Its uniforms were based on those worn by the RAF, the only additional clothing for post personnel being a set of overalls.

Peacetime Exercises

Each group would conduct a series of regular 'Contact' exercises on training evenings. There were normally at least two national exercises each year for the whole of the UKWMO while the Nuclear Reporting Cells (NRC) located on RAF stations participated in TACEVALs and PRIORY exercises.

Method of operations

If the ROC had been called out, the posts would have been manned with a crew of three when a nuclear strike occurred on the UK. The post personnel would not see the flash of an explosion, the first they would have known was a reading on the Bomb Power Indicator (BPI). This was an above-ground baffle plate, mounted on a steel pipe which led to an indicator unit within the post. The indicator unit contained bellows connected to a pointer on the dial. The blast wave from the explosion would travel down the pipe and show pressures of up to 5 lbs/sq in on the non-return dial. The reading was then immediately passed to group

headquarters as a priority message coded TOCSIN. At the control the post display plotter taking the message would immediately shout 'TOCSIN' to alert the control room. With experience, it was possible to estimate the approximate location of the burst by triangulating the BPI readings received from the various posts.

One minute after the indication of a burst on the BPI, the number three observer would scale the ladder and change the photo-sensitive cartridges in the Ground Zero Indicator (GZI). The GZI was, in effect, four pinhole cameras. It was a cylinder, ten inches high, with four small holes at each of the cardinal points. Inside, photographic paper was placed in cassettes with a marked graticule. The image of the fireball would have been projected through one (or more) of the pinholes and marked the paper. From examination, the post would be able to report the bearing of the explosion and, from its elevation, whether it had been a ground or an air burst.

Posts would then await the arrival of fallout, detected by a fixed survey meter, and subsequently pass readings to the control every five minutes. There was also some capacity for carrying out mobile fallout monitoring using portable survey meters. Maroons and hand cranked sirens were available at all posts to permit them to publicise a local fallout warning.

Analysis of the data took place at the group controls. From the BPI readings, the power of the burst was calculated. The precise location of the ground zero was found by triangulating the readings from the GZIs. UKWMO Group Controllers would issue fallout warnings to the public and provide information to the various customers. In addition, some sector and group controls had Atomic Weapons Detection Recognition and Estimation of Yield (AWDREY) equipment to detect EMP.

Operational links with the RAF remained, as a small number of ROC units operated as NRCs in RAF Sector Operations Rooms at Boulmer, Buchan, Neatishead and Bentley Priory, plotting burst and fallout data on totes and increasingly providing analysis and advice to RAF commanders.

Group controls and NRCs would also plot details of continental bursts if that information was available. Once fallout levels had peaked, plots were prepared showing burst location and type, together with actual and predicted areas of fallout based on windspeed and direction.

The ROC would also have undertaken countrywide meteorological

reporting of wind direction, cloud cover and height, humidity, temperature and local weather conditions in the post-attack phase.

In 1991 however it was announced that the vast majority of the Corps would be stood-down. The remaining 870 monitoring posts then in existence were scrapped, together with the twenty-five group/sector controls. Today, sites have either reverted to the landowner, been sold off or are used for some other purpose. The NRCs remained in being until 31st December 1995. Although it had been given an NBC reporting role, the structure of the ROC, as a uniformed civilian organisation with no overseas commitment, was not felt to sit comfortably within the UK's post-Cold War defence needs.

Effectiveness

Fortunately, the ROC's nuclear role was never tested in anger. My personal view is, notwithstanding, and perhaps because of, the simple equipment, bursts and fallout would have been reported. Furthermore, the existence of small, uniformed, disciplined units throughout the country could have assisted post-strike recovery. The effectiveness of the spare time members of the ROC was understated but never doubted.

Last links with the RAF

Even after aircraft reporting had ceased to be a primary task, the ROC was proud of its links with the RAF which it retained to the end. The first Sovereign's Banner for the ROC hangs in St Clement Danes, the current banner is lodged in the rotunda at RAF Cranwell. The last ever volunteer meeting of the ROC took place in the Chapel at RAF Boulmer at 3.00pm on 31st December 1995.

Sources

Attack Warning Red by Derek Wood (Carmichael & Sweet, 1992) from which the sketch at page 69 has been reproduced.
Recollections of members of the Royal Observer Corps Association (23 Group – Northumberland & Durham).

NUCLEAR WEAPONS TRAINING - GROUNDCREW

Squadron Leader Michael Hely

Having been trained at the RAF Technical College and Cambridge, Michael Hely's first productive tour as an engineering officer was spent at the Bomber Command Armament School in 1960-62. He later served at El Adem, at HQs Signals and Fighter Commands and at Malvern and Coningsby. He left the Service in 1974 to pursue a second career as a barrister, subsequently specialising in Company, Commercial, Contract and Intellectual Property Law until his final retirement in 1999.

During the October 1989 seminar[1] Air Mshl Sir John Rowlands referred to the formation of the Bomber Command Armament School (BCAS) at RAF Wittering in 1953, tasked with the introduction into service of BLUE DANUBE (and subsequently other weapons) and the training of RAF aircrew and ground staff in the storage, servicing and operation of nuclear weapons.[2] My brief today is to describe the training regime that had been developed at the school. Obviously that training was based on the designs of the weapons, (or, where the design was hidden, on the aircraft control system) and some outline of the progress that had been made in weapon design is a necessary introduction.

I arrived at Wittering in January 1960, at the very start of the period under consideration today. My post at BCAS was that of a newly-established, additional electrical engineering project officer for the introduction into service of YELLOW SUN Mk 2. This weapon was built around RED SNOW, the first 'hydrogen' (fission-fusion-fission) warhead, which was also used in BLUE STEEL. First, as an introduction to the nuclear world, I attended the basic Nuclear Weapons Course, which was based on BLUE DANUBE technology. I was then introduced to RED BEARD and YELLOW SUN Mk 1, before spending some time at the Armament Research Laboratories at Farnborough, and visiting Aldermaston and a variety of contractors to meet YELLOW SUN's big brother. The training programme and the appropriate aids could then be

[1] See *Proceedings* of the RAF Historical Society, Issue No 7, Feb 90.
[2] *Ibid*, page 18.

prepared.

The training organisation at the school was still evolving at the time. A squadron leader Tech Arm headed the department, with two flight lieutenants GD/Nav.[3] They were responsible for planning the courses and for some part of the instruction, but the project officers and their NCO staff were called upon for the main part of the training effort on technical aspects. None of us had been given any instructional training, as far as I know; I had certainly had none!

We 'fairies' (or Weapons Elect, as we were more formally known) were concerned with the electrical system of the weapon, the aircraft's weapon control system and their interconnection. There was a heavy mob (Weapons Arm 1 and Weapons Arm 2) to look after warheads, casings, hoisting into aircraft and so on. The electrical system in all of the weapons had two main design objectives: to ensure that the weapon *would* detonate when required, and (at least as important!) to ensure that it would *not* detonate at any other time. The twin aims of reliability and safety were evident in the electrical design of all weapons, but the design approach developed dramatically from BLUE DANUBE onwards.

The BLUE DANUBE system was immensely complicated in comparison to what followed. Reliability was ensured by duplicating (or more; there were *four* radar fuses) and interconnecting all down the line, so that, finally, each detonator on the implosion sphere had two independent electrical initiators; the trick was to ensure that, whichever set went off first, they all went off *simultaneously*. Every system was backed up. The air burst fusing system included time and barometric parameters, as well as radar, and there were three different types of impact fuse. (All of this is from memory, incidentally; I have not seen any atomic documents since I left Wittering in April 1962). The support equipment on the ground, and the aircraft control system were correspondingly complex.

Gradually, the advantages of simplicity came to be appreciated. RED BEARD had a single radar fuse and a barometric switch, (in its tactical and naval versions, the radar fuse was not fitted, an air burst being achieved by barometric switching only). YELLOW SUN and BLUE

[3] The engineer in post at the time was additionally qualified as a pilot and had completed an exchange tour flying in SAC B-47s, so he was able to bridge any GD/Tech barriers with ease.

STEEL had no radar fusing, relying on barometric switches for an air burst. RED BEARD had three kinds of impact switch, YELLOW SUN Mk I (YS1) had two but YS2 had only one.[4]

The improvement in the safety aspects of design were even more marked. BLUE DANUBE was powered by eight large lead-acid batteries; so you had live power sources, high explosives and fissile material in close proximity. There were many safety interlocks and cut-outs, but the basic risk remained. The power source for RED BEARD and both YELLOW SUNs was a wind-driven generator which was locked until release; it could not turn until the weapon was falling and was thus inherently safer. YS1 had lead-acid batteries to power BLUE STONE, the neutron source, but YS2 had a wind-driven generator only. BLUE STEEL used batteries, but these were fuel cells, inert until initiated after release.

The timing of the arming sequence was also made safer. Immediately after release, RED BEARD received a large pulse of electricity to power a timing circuit; by contrast, YELLOW SUN counted the revolutions of the generator to determine when it was a safe distance from the aircraft (although there was still a small pulse to free the generator locks).

The shape of the weapons also contributed to safety. The casings of BLUE DANUBE and RED BEARD were aerofoil-shaped in profile. This led not only to instability in the ballistic path, needing flip-out fins for any accuracy in aiming,[5] but to a fast fall to the detonation point. The casing for the YELLOW SUNs was blunt nosed, leading to a more stable, and slower, fall.[6]

Finally, the last minute preparations became markedly safer. For BLUE DANUBE, a lump of plutonium, (probably the most poisonous substance on the planet!) on the end of a stick of explosive, had to be inserted into the warhead. *Not* a nice job on a cold dispersal with the imminent expectation of a four-minute warning of an incoming missile! One shudders to think of what the Health and Safety Executive's reaction might have been. RED BEARD required the insertion of a lump

[4] The flat 'radome' nose on a YELLOW SUN was a crumple zone, to protect the warhead from the shock of impact when a ground burst was selected.

[5] *Proceedings*, Issue No 7, page 15.

[6] By keeping the weapon subsonic, the blunt nose also improved the reliability of the barometric fusing system. That was its primary purpose; the added safety a welcome side effect.

of plutonium, without the explosive, which was some improvement. YS1 was a uranium bomb, much nicer than plutonium, but it still had the explosive attached. RED SNOW, and as far as I know all subsequent warheads, came sealed, so no last minute handling of fissile material or explosive was involved.

Against this, the GREEN GRASS warhead in YS1 and the RED SNOW warhead included high explosive and radioactive material at all times. In the earlier weapons the radioactive components had been kept apart until the Last Minute Loading procedure.[7] This had clear implications for nuclear safety, particularly in storage; you could not, for instance, store two YELLOW SUNs in the same room, although, without their radioactive components, four RED BEARDs could be safely stored together.

While there were many different courses at the school, with differing degrees of detailed instruction, there were three main groups of students:

a. aircrew from the V-Force and the nuclear-armed Canberra squadrons of RAF Germany (and later Cyprus and the Far East);

b. technical officers, NCOs and airmen (electrical and armament specialisations) from the squadrons, the Supplementary Storage Areas and Maintenance Units that were responsible for the care of nuclear weapons and

c. personnel involved in convoy safety procedures.

The training for aircrew at BCAS was threefold. GD officers taught weapon effects, as a guide to the appropriate tactics, and aircrew procedures. Electrical engineers (strictly speaking we were still technical officers in those days) were responsible for teaching the workings of the electrical system and the aircraft control system. Armament officers dealt with the care of the warhead, in sickness and in health.

The weapons which followed BLUE DANUBE used the same aircraft control system, the EP system, as I recall; YS1 had an additional control system, EY, I think, for the neutron source.[8] A control panel would be fitted into a classroom rig, and the aircraft and weapon electrics imitated by a simple simulator, designed and constructed in the school. For day-

[7] *Proceedings*, Issue No 7, page 16.
[8] I regret that I have no idea what 'EP' and 'EY' stood for!

to-day training on the squadrons there had been a BLUE DANUBE simulator, a 'black box' which could be carried in the aircraft, and which imitated the weapon's electrics, but the later weapons were so simple that there was little to imitate.

Training rounds, identical to the real thing, but with inert explosive and radioactive components, were provided and these were invaluable aids, particularly for training on the final preparation stages.

Ground crew training was primarily aimed at safety. It is one of the pillars of the law of negligence that the greater the consequences of any mishap, the greater the care that would be regarded as a reasonable precaution against mishap.[9] The radar fuses (in the early weapons), the generators and their arming switches, and the aircraft control systems could be, and were, tested regularly. Other tests were carried out on the fusing switches, but ensuring that the weapon was handled safely in all circumstances was the cardinal point. Precautions that would be adequate for handling iron bombs, or even kiloton weapons, were quite inadequate for the megaton range weapons that were coming into service, even allowing for the difficulty of starting a nuclear bang when you want to! In his paper, Gp Capt Taylor will describe the system of quality control, with all of the work done having to be supervised by qualified personnel, ie by BCAS graduates, and a 100% check of all records subsequently being made by the standardisation teams from the school. That system in its entirety was not yet in place in 1962, but it was evolving and, in practice, nuclear work was never undertaken by other than qualified personnel.

The servicing schedules were written by CSDE, but proved and checked by the school, with emphasis on the safety aspects. Likewise Air Publications dealing with each weapon were written by the MoA, but checked for technical accuracy and safety by the school. Those responsible for this proving and checking process were also responsible for passing on the knowledge to the trainees. Project work and the development of the course material moved together.

The need for proper earthing and bonding, and, more esoterically on

[9] In this connection, I could, as a barrister, cite Northwestern Utilities Ltd v the London Guarantee & Accident Co Ltd [1936] AC 108, per Lord Wright at 126. On the other hand, it should be said that the normal legal starting point is to presume that everything has been done properly ('Omnia rite ac sollemneter esse acta praesurnuntur', to coin a phrase), although this has no application in this context!

RED SNOW, regular checks for tritium leaks, were central to the training programme. The test equipment and tools used for ground servicing were of the highest quality then available to the air force and set the standard for a long while thereafter.

The movement of weapons by road gave rise to the third requirement for training, the Convoy Safety Courses that were a regular feature of the school programme. In the movement of weapons, of course, safety became not merely a means to an end but the end itself. The safe delivery of the weapons components, or even complete weapons, to their destinations was the only test of success. Movement of the GREEN GRASS and RED SNOW warheads, which incorporated both their conventional explosive and radioactive elements, called for a very high level of safety training.

The school also provided training on those USAF weapons which were available to the Royal Air Force under Project E. We did not, however, train on Thor. Under Project E, weapons were made available to the SACEUR-assigned squadrons of Bomber Command and RAF Germany. Bomber Command squadrons were originally trained on the Mark 5 (‘Big E’), but at the start of the period under consideration this was replaced by the Mark 28 and, after my time, by the Mark 45. The Canberra squadrons were equipped with the Mark 7 (‘Little E’) for low altitude delivery. The Marks 5 and 7 were kiloton range weapons; the Mark 28 had a variable yield up to megaton range.

Under US legislation, custody of American weapons had to remain in USAF hands until their release had been authorised by SACEUR. At each base where US weapons were involved, therefore, the Supplementary Storage Area included a ‘Little America’. The rigid custodial procedures involved had a considerable impact on the planning of dispersed operations but these complications had to be accepted as they were unavoidable under United States law.

No US warhead information was available for the same reason, which obviously had some effect on the training that the school could provide. We were told of the weapon responses to various control actions and the school then devised aids for training those aircrew who were posted to the squadrons concerned but we were guessing at what actually went on inside the weapon’s casing. Ground crew training was easier, because the aircraft side of the weapon system was an RAF matter and full details were available.

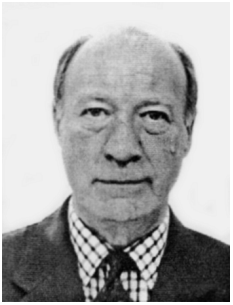
BCAS provided instruction on the weapon control system, the release system and the loading procedures to be used for the American bombs. Again, we designed and constructed rigs that could mimic the weapon responses and we proved the various test routines for the ground crew. However, we had to treat the weapon throughout as a 'black box' with known responses to signals, although we had no knowledge as to how that response was generated or, sometimes, even of what it meant, other than 'right' or 'wrong'.

The Mark 28 was carried in pairs. The bomb carriers were a USAF design, featuring two hooks and a pilot-controlled safety pin. This was a way of ensuring that two persons were always involved in the release process.

Training is, of course, only the first stage in achieving operational efficiency. It is necessary to follow up training to ensure that the lessons, particularly those relating to safety are put into practice. From 1962 onwards, therefore, shortly after I left, BCAS began to fulfil the final part of its remit, ie to act as a standardisation unit. Teams from the school visited units in Bomber Command, Germany and elsewhere to put ground crew through their paces and to improve standards in the field. Gp Capt Taylor will describe the work of the standardisation teams as it affected the engineering side of a strike squadron. In the second part of this presentation, Ralph Devereux will describe the formation of the standardisation teams and their work with aircrew at squadron level. I now hand over to him.

NUCLEAR WEAPONS TRAINING - AIRCREW

Squadron Leader Ralph Devereux



Ralph Devereux qualified as a GD(Nav) in 1965, his first productive tour being on BLUE STEEL-armed Victor B.2s. Many of his subsequent appointments were closely associated with nuclear weapons, including tours in strategic and tactical mission planning, as a member of both 2ATAF's and UKAIR's TACEVAL teams and as OC Training Squadron at the RAFASU (1977-80). Having soon discovered, on taking early retirement in 1990, that there were few civilian employment opportunities for Nuclear Bomb Aimers, he set up a successful company which provides financial and legal services for schools.

Thank you Mike. Interesting times for all involved during those early days. I will pick up from there and try to take us through how it all appeared to a very green and somewhat awestruck young Navigator Radar and, through a long association with nuclear weapons, until my early retirement in 1990. This will be a bit of a personal tale but it will, I hope, serve to illustrate the practicalities of the training machine. The first, and perhaps the most surprising, point to make is that very little time was devoted to *formal* training in the nuclear aspects of the role. On the other hand, to put this into perspective, there was, right until the cessation of training, great reliance on continuation training with external validation.

It would be useful to remember the length of time required to reach a V-Force squadron. For a BLUE STEEL Nav Rad there were three post-graduate courses:

a. A five-month Navigator Radar Course (it was much longer in the early days, and much shorter later on).

b. A five-month OCU Course.

c. A two-month BLUE STEEL Course.

Allowing for complications, like leave and course phasing, it actually took about eighteen months to reach a squadron. During the Nav Rad Course no attention was paid to *nuclear* training. Whether in the

A Victor B.2 of No 139 Sqn gets airborne with a BLUE STEEL, the latter's ventral fin being folded safely out of the way. (MAP)

simulator or airborne, it was all to do with the technicalities of the radar and computers that constituted the Navigation and Bombing System (NBS); it was all very procedural and high level oriented. Similarly, the flying phase of the OCU course concentrated on aircraft equipment and crew co-operation; there was no weapons training whatsoever. After the OCU came the BLUE STEEL Course which concentrated on the capabilities of the missile and provided an introduction to delivery techniques but the weapon itself remained a dark secret. Compare that eighteen months with what followed.

My own first tour and contact with the nuclear training machine began in 1966. Initial weapon training was provided at BCAS during a course on the warhead and weapon effects; this lasted two days and was intensive. Medical effects were explained by the SMO at Wittering. Most of us didn't really want to think about that too much, but it was necessary. The initial course covered the specific weapon by lectures, training rigs and practical demonstrations, including LMLs - Last Minute Loading – slotting the batteries home and checking the barostatic settings for detonation height. The latter procedure was an extremely undignified process; the ground clearance of BLUE STEEL on a Victor, particularly a heavy operational round, was precious little so the Nav Radar had to roll about on the ground with an Allen key in order to do what he had to do, often to the amused amazement of the RAF policeman on guard!

Even at this stage there was no practical training in techniques that were, in later years, to become second nature. There was, for instance, no

formal consideration of, or explanation of the need for, route and timing deconfliction or even of escape manoeuvres. These matters were, presumably, the responsibility of the specialists at JARIC and the Wing Weapons Office. The importance of these aspects did not appear to register with many crews, however, and this was a weakness in the system.

On arrival on the squadron initial weapons training continued during the run up to Combat Ready status. On achievement of this classification crews entered the Continuation Training phase, which would last throughout the tour as part of the six-monthly training cycle. The wing staff and the various Leaders on each squadron had responsibility for bringing on new crews and supervising their intensive training, the BLUE STEEL Trainer (a simulator, of sorts) and the Flight Simulator being the basic tools for the practical aspects. This programme ran in parallel with instruction in associated subjects, not the least important of which was familiarity with the authentication procedures governing a nuclear release.

The BLUE STEEL Trainer, which was in Ops Wg HQ, accommodated only the two navigators. The pilots and the AEO would 'fly' in the Flight Simulator which was located elsewhere. Although some limited links could be established, there was little integrated crew simulation and this too was a weakness. Furthermore, some of the naivety mentioned earlier began to affect us; we were advised that if the missile had to be released in the ballistic mode (because of a failure to go powered) and we could not make the primary target we should go for another (not even necessarily our secondary) target to achieve some result. No deconfliction considerations were mentioned. At around this stage some flying sorties were completed with the cockpit anti-flash screens in position; one of the pilots would, thank heaven, act as safety pilot with both eyes uncovered. It was apparent that the practicality of the famous eye-patches was regarded with some cynicism but, having no alternative, they were accepted.

Having become Combat Ready, a crew continued training on the weapon system through a succession of airborne and ground-based Basic Training Requirements (BTRs). The flying commitment involved completion of Group Approved Profiles (GAPs) and periodic Group- and Command-sponsored Exercises including, of course, the famous MICK and MICKY FINN which practised generation and dispersal procedures.

Ground BTRs included regular BLUE STEEL and Weapons Trainer exercises. Combat Ready crews would hold QRA and training continued with sessions of Target Study in secure and secluded rooms set aside for this purpose. Combat Ready crews could also expect visits from the Weapons Standardisation Team (WST) based at the BCAS. These standardisation visits were dreaded, with some justification as they really were truly awful. They comprised oral and practical sessions with real weapons and simulators. This continued until the end of RAF nuclear training.

By this time crews were able to fly GAPs with aplomb and were well practised at all three possible methods of carrying out an operational release. I should, perhaps, point out that BLUE STEEL crews were very well provided with navigational aids on the way to their targets but less well placed for getting home because the inertial platform disappeared with the rocket!. Operational rounds were flown from time to time and, whilst these were much better than the much used training rounds, a single full-stop landing, to avoid damage to the platform, reduced training for the front end. Our phased BTR training was complemented by trips to Goose Bay where the full range of capabilities could be explored in realistic conditions. The Victor 2 squadrons disbanded in 1968 to allow conversion of the aircraft to the tanker role, but just before disbandment some live firings of BLUE STEEL were completed and the crews involved had some startling tales to tell. But that's another story.

Nuclear training continued in this manner, although no longer involving BLUE STEEL, and by 1974 the pattern was still much the same as had existed eight years before. However, the weapon now generally in use, the WE177, was far less daunting and much easier to understand. Initial training still involved only two days at Wittering, where the BCAS had now become the RAF Armament Support Unit (RAFASU). Continuation training at squadron level, validated through WST visits, remained largely unchanged. Since the V-Force was no longer holding QRA, however, its crews were no longer obliged to spend those days on alert which had previously provided convenient opportunities to complete much of their ground BTR commitment. On the other hand, airborne weapon training was now considerably less demanding, as the lay down delivery and straight through, run-like-hell, escape manoeuvre was by now SOP.

By 1977 RAFASU's Training Squadron was providing initial training

for all engineering tradesmen and aircrew destined for the strike role. OC Training was a GD officer who oversaw the conduct of some thirty-two different courses. The basic pattern of aircrew training remained as before but the strike force now included Jaguars and Buccaneers based in Germany and the introduction of single- and two-seat crews into the role brought fresh thinking to some of the accepted wisdom; not least in relation to release authentication procedures. The pressures of holding QRA were still present in RAFG and the continuous assessment of Combat Ready crews began to overload the squadrons. At this stage a limited degree of peripatetic training was introduced with some on-site instruction being provided by RAFASU personnel. Generally, however, weapons training continued to be a largely wing/squadron responsibility and the WST visits continued; these still being loathed by all.

The depth and breadth of knowledge required by single-seat strike pilots and the never-ending sequence of checks, both airborne and ground, was certainly stressful and the problem was exacerbated by the ever-present threat of TACEVAL. Evaluations of strike units posed particular problems, since national security interests excluded all save national personnel from certain sensitive areas. It was, therefore, decided to use the staff of the RAFASU Training Squadron as specialist weapon evaluators for 2ATAF's British strike bases; this proved to be a successful ploy. This widening of the Training Squadron's responsibilities, although not specifically a nuclear *training* function, proved to be of particular value when the UKAIR Tornado and Buccaneer squadrons adopted SACEUR's nuclear procedures. One notable advance during this period was the introduction of the Aircrew Manual of Nuclear Operations, a single document that drew together all associated references by aircraft type.

All of this represented a significant success story, despite the odd minor limitation that I have mentioned. Thereafter, in essence, the pattern and style of training were to differ little over the years that remained until the RAF finally withdrew its last nuclear weapons.

ENGINEERING ON A NUCLEAR STRIKE SQUADRON

Group Captain W J Taylor

Bill Taylor joined the RAF via Halton in 1967, attaining the rank of sergeant before being commissioned into the Engineer Branch in 1973. Since then he has been involved in aircraft maintenance at first and second line and has filled aircraft maintenance-related posts at both command and ministry levels. He has had first-hand experience of nuclear operations with Buccaneers, Jaguars and Tornados. Just five days ago he left the RAF to take up a new appointment as the Chief Executive of a new Duxford-based company which acts as the Type Design Organisation for the majority of the de Havilland range of civil aircraft.

This afternoon I would like to look at some of the engineering implications of RAF nuclear operations, particularly at station and squadron level where the strategies and the policies we have heard about today were put into effect. As for myself, following a brief acquaintance with nuclear operations whilst stationed at Honington and then at Brüggen in the 1970s, I became more intimately involved in 1983 when, as a squadron leader, I became the first Senior Engineering Officer on No 27 Sqn at Marham. As the RAF's third Tornado GR1 unit, No 27 Sqn was destined to be declared to SACEUR in both the strike and the attack roles. Like our fellow Tornado squadrons, No 9 Sqn at Honington and No 617 Sqn, also at Marham, we were given just under a year to work up in the strike role before adding the complexities of an attack declaration six months later. In those days I used to keep a fairly detailed daily diary and I have consulted these to recall some of the day-to-day activities and concerns. I left the squadron sixteen years ago and it is with some relief that I now realise my diaries are no longer NATO SECRET!

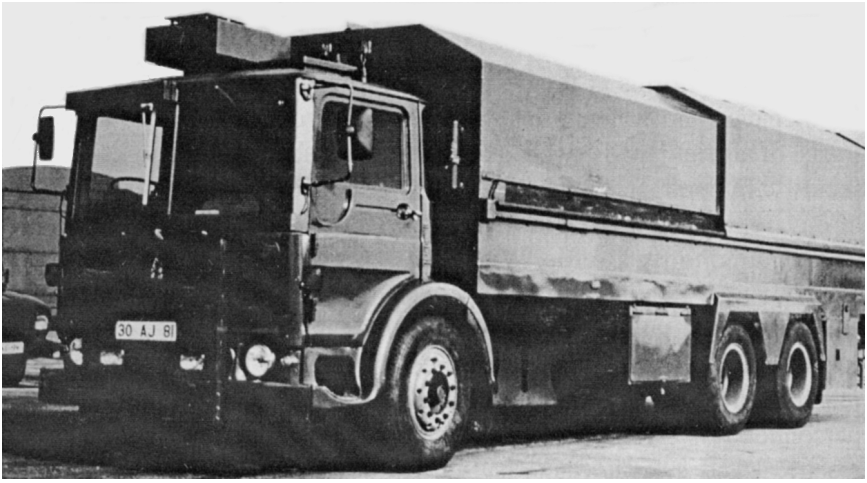
Before exploring in a little detail the engineering activities on a Tornado strike squadron, I would like to reflect on some of the contrasts between nuclear operations at the start of the period covered by this seminar compared to those which became the norm in the Tornado era. First and foremost, in the 1960s the aircraft spent most of their time

standing in the open, exposed to the elements and the gaze of anyone passing on the public highways close to the dispersals or the Operational Readiness Platforms at the ends of the runways. As a result, all aircraft maintenance and weapon loading was carried out in the open and large tracts of airfield had to be guarded to provide the required level of security. In contrast, a strike-loaded Tornado would seldom see the light of day, remaining housed in its Hardened Aircraft Shelter (HAS) until it was required to fly a sortie. Whilst the HAS concept introduced a whole series of new 'management challenges', access to the aircraft could be controlled by a guard at the HAS door. Therefore, as well as providing greater physical security for an armed aircraft, the HAS also provided a much improved working environment for the aircraft and its attendant personnel. It is certainly my view that the vulnerability of the Tornado to electrical and avionic faults caused by water ingress, especially in the cockpit, would have caused immense problems if it had been required to live in the open like the V-bombers.

Similar developments extended to weapon storage, with Supplementary Storage Areas (SSA) being built to house V-Force weapons in earthed-over concrete storage buildings. Excessive humidity was the arch enemy of the nuclear weapon and the storage buildings were heated up to 70^{o}F by a combination of warm air circulation and electric underfloor heating. However, such luxuries were not afforded to BLUE STEEL. Scampton's High Test Peroxide (HTP) refuelling building made use of a relocated equipment storage shed of 1941 vintage whilst the Missile Servicing and Storage Building was a relocated T2 hangar which also dated from WW II. In complete contrast, during the latter years of the RAF's nuclear capability, WE177 strike weapons were housed in WS3 Weapon Storage Vaults (WSV) built into the floor of some HASs.

Even the means of weapon transportation changed over the years, albeit very slowly. In the earliest days of the nuclear deterrent, weapons were transported on converted Queen Mary trailers or ten-ton lorries. However, in 1968 the Truck, Cargo, Heavy Duty (TCHD) was introduced to carry the WE177 and its transit container. These lorries soldiered on for almost thirty years before being replaced in the mid-1990s by the TCHD Mk 2, a heavy-duty articulated vehicle which remains in use today.

Turning to look at the Tornado era in a little more detail, No 27 Sqn



The Truck, Cargo, Heavy Duty (TCHD) of 1968 which was introduced specifically to carry the WE177.

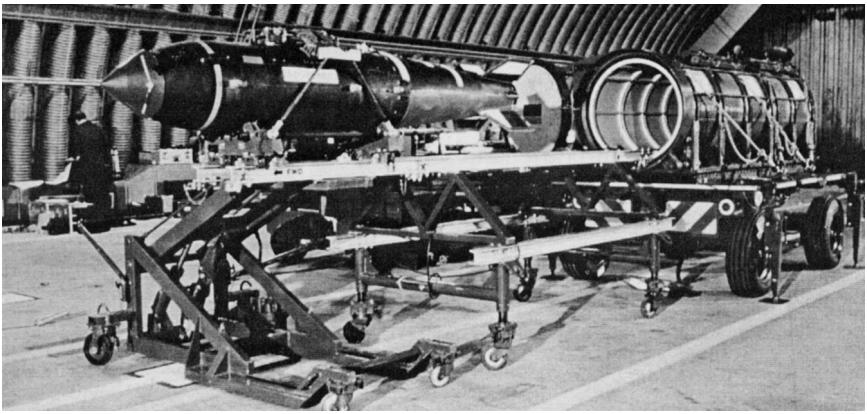
had an establishment of twelve Tornado GR 1s and about 150 groundcrew and we were allocated the second of two new hardened-shelter sites at Marham. When we began to form in March of 1983 the site was a quagmire with mud *everywhere*. The Tornado force was starting to build up and Tornado-experienced engineers were very thin on the ground. At the start only 20% of my men had any previous Tornado experience and we had to carry the absence of the others while they were away on training courses at Cottesmore. As a brand new HAS site, there was no site perimeter fence nor were there any guard posts - so, as well as learning about our new aeroplanes and trying to fly some sorties, we had to lay barbed wire entanglements and fill sandbags. To cap it all, four of our twelve shelters were taken over for several months as an alternative SSA to store all of Marham's special weapons. During this period, the main SSA was fully refurbished after years of neglect following the demise of the Valiant's nuclear role some twenty years earlier.

From my diaries I note that we flew our first ever sortie on 6th April and the hooter went for our first MINEVAL on the 28th! At this stage we had only a handful of aircraft and we faced major shortages of manpower, tools, ground equipment and spares. We could cope with only two or three sorties a day and it was not until 6th May that we

dropped our first practice bomb. Things then started to accelerate, however, and by the end of that month we were flying as many as eight sorties a day. In parallel with the build-up of flying we were training people in the many procedures for strike operations - weapon loading teams, armament electricians and the aircraft handlers who would have to maintain the strike-loaded aircraft. Our first ever strike load was carried out on 19th July in the midst of a three-day MINEVAL; this was some four months after our work-up had begun.

Looking at the hardware, the nuclear element of the Tornado's armament electrical system was hard-wired into the aircraft. A WE177 could only be loaded onto the centre station of either of the two underfuselage shoulder pylons, where it was carried by a special weapon heavy duty ejector release unit. All work carried out on the armament electrical system had to be undertaken by specially trained and authorised electrical tradesmen and every job card had to be vetted to ensure that this rule was observed to the letter. The scrutiny task fell to the squadron's Unit Certifying Officer (UCO), who was usually the Junior Engineering Officer (JEngO). Every six months the armament electrical system on each aircraft had to be recertified. This required the UCO to supervise electrical tests of the installation having first examined *every* job card raised over the last six months to check that all work carried out on the aircraft had been completed by fully qualified tradesmen. With several hundred job cards to check on every recertification the poor UCO faced a daunting and thankless task.

The squadron's weapon tradesmen were formed into four-man load teams led by a SNCO. Initial and continuation training for these teams was carried out at the Armament Training Cell in the Armament Engineering Squadron of Engineering Wing. Such was the training burden at Marham, both nuclear and conventional, that each of the two squadrons took it in turn to provide a dedicated HAS and aircraft for weapon load training throughout the year. The initial training of the load teams involved a series of classroom lectures followed by an exam. Each individual then had to carry out three supervised training loads before being signed-up by the Station Armament Officer. The squadron also had two Weapon Load Supervising Officers (WLSO), usually the Squadron Warrant Officer Engineering and the JEngO, who were required to oversee the work of the load teams and supervise the movement of weapons around the squadron site.



A WE177 and its transit container inside a Hardened Aircraft Shelter.

I have already referred to the daunting and thankless nature of the UCO's task of checking job cards but the accuracy of his work was thoroughly checked every year during the annual visit of the Weapon Standardisation Team, the feared WST. From an engineering viewpoint, the WST carried out a 100% check of all aircraft job cards to ensure that everyone who had worked on an aircraft nuclear weapons installation was properly trained and authorised. If necessary, the WST tracked job cards between units when aircraft were reallocated or sent for major servicing. The WST would also check that all tooling and test equipment had been checked every three months by properly trained and authorised staff. During its visit the WST would also examine 50% of the certified load teams and 50% of the UCOs. Needless to say, if a load team or UCO failed the check they were decertified immediately. Depending on the nature of the problem, one or more aircraft could have their nuclear certification withdrawn. I believe that such instances were infrequent but when they did occur the chain of command would respond very quickly.

Maintaining the security of the squadron site during strike operations was paramount. The construction of our tall perimeter fence was, therefore, a welcome relief, as was the decision to send personnel from the station's Electrical Engineering Squadron to act as perimeter guards whilst weapons were on the site. Each HAS was allocated its own dedicated guard and an RAF policeman; this was in addition to the aircraft maintenance crew of three under the command of a corporal. Weapons could not be brought onto the squadron site until it had been

designated as a Follow-On Area (FOA). For this to occur required the presence of the RAF Police, restriction of access to the site to named individuals only, the guards to be live-armed and mobile security patrols to be mounted within the site. As soon as a FOA had been declared it was normal to convoy a number of weapons from the SSA to the site for temporary storage in the hardened bowser shed. On arrival at the shed custody of the weapons was handed to the WLSO. The doors of the building were then secured by two padlocks, the key to one being held by the WLSO and the other by the RAF Police. This tactic gave greater flexibility for weapon movements within the site, which had to be timed to avoid reconnaissance satellite overflights. Moreover, having some weapons on site reduced our vulnerability to movement constraints caused by thunderstorms or periods of lightning risk.

As you might imagine, the weapon load process itself was no simple affair. Before it could be strike-loaded the aircraft had to be fully serviceable, all job cards cleared and an After Flight and Before Flight Servicing carried out. In essence, the aircraft had to be ready for flight. Next the electrical pre-load checks had to be carried out and only then could a weapon be loaded. When the aircraft and the HAS were ready the weapon allocated to that aircraft would be convoyed from the bowser shed to the HAS and handed to the custody of the load team SNCO. The load team SNCO would brief the RAF Police guard to allow no one to enter the HAS without his face-to-face approval. With the arrival of the weapon the HAS became a No Lone Zone and everyone in the vicinity of the weapon had to be accompanied by someone with appropriate training so that incorrect actions could be spotted immediately. On completion of the load the aircrew allocated to the mission would be taken to the HAS to accept the aircraft and custody of the weapon. During their walk-round checks the crew would set the yield of the weapon before boarding the aircraft and checking-in with the Force Commander on telebrief.

As we practised all these complex and inter-related procedures so the number of aircraft on the squadron slowly grew. At the time, however, there was an overall shortage of aircraft and when No 617 Sqn reached its initial NATO declaration at the end of October 1983 we had to send some of our aircraft across to help bolster its numbers. We had our own ‘Microval’ at the end of November when we strike loaded six aircraft and flew seven aircraft simultaneously on a so-called ‘R-Hour’ launch or

A Tornado GR 1 of No 27 Sqn in front of its HAS.

survival scramble; this was a record achievement for the squadron at that time. The pace of exercises continued until No 27 Sqn was declared to SACEUR in the strike role at midnight on 29th February 1984; the TACEVAL team hit us at 0520hrs the following morning. By then we had ten aircraft on the squadron and the Tornado Weapons Conversion Unit at Honington sent us two more to make up the dozen we had to load to meet the SACEUR requirement. For once everything fell into place and we strike-loaded all twelve aircraft in the then record time of ten hours. This was perhaps the most rewarding point of my tour on the squadron, having started with literally nothing more than a bare HAS site and achieving an 'Excellent' grading for performance just eleven months later.

I have tried to convey some impression of the highly regulated and procedural nature of aircraft engineering in the nuclear era. It is perhaps fortunate that the RAF was never required to make use of its nuclear capability and that eventually the weapons could be withdrawn from service and dismantled. The last four WE177 weapons were convoyed out of Marham on 22nd April 1998, so drawing to an end one of the RAF's most significant post-war tasks. Given the years of training, and practice during exercises, it is my view that of one thing there was never any doubt - if put to the test the RAF's nuclear strike squadrons were ready, willing and very able.

AFTERNOON DISCUSSION PERIOD

Gp Capt Richard Bates. I would like just to add a footnote to the very comprehensive presentation we have had on the generation and dispersal procedures of MICKY FINNS and the like. Speaking as a 'truckie', I would like to record that these exercises were always given the highest possible priority and that the transport crews who took the ground crew and their equipment to their dispersal bases were very excited and pleased to be involved. It was more than just doing what they were told, I think they genuinely felt that they were backing-up the national deterrent. In that context, I would point out that there was only one priority higher than AOG (Aircraft On the Ground) and that was VOG, a V-bomber On the Ground; whenever that one cropped up it was given our full attention to the extent of cancelling training and even diverting casevacs.

Alan Pollock. In 2nd TAF at one stage, it would have been about 1959, it was planned that all the Hunter squadrons would get airborne in support of the V-Force, or perhaps it was the Canberras, but either way we were going to end up 100 miles east of Moscow. I remember drawing it all up and the Boss saying that if the rest of the squadron, and the other squadrons, saw it we would have a riot on our hands. Is there anyone in the room who was planning 2nd TAF missions at the time? It all seemed very odd if we were going to be used in support of the deterrent when we actually spent our time training in the DFGA (Day Fighter Ground Attack) role. (*No one present could shed any light on this*.)

AVM Nigel Baldwin. This morning Mike Robinson made some reference to the stresses and strains on the crews and most particularly on the commanders - Squadron Commanders, probably AOCs and even Commanders-in-Chief. I recall that, when I was a flight lieutenant captain on No 35 Sqn at Cottesmore our Station Commander had a nervous breakdown and disappeared. It happened again some years later when I was at Waddington; during my two years there as a Squadron Commander, two other wing commanders had nervous breakdowns and during an earlier stint, as a squadron leader, as Staff Officer to SASO at Strike Command, these things seemed to be happening to wing commanders and group captains right across the Service. What I *don't* remember happening, however, is flying officers and flight lieutenants

having nervous breakdowns. With the insouciance of youth, or whatever it was, perhaps we/they just didn't worry too much. Looking back on it now, one can see that the real pressures were applied at the wing commander/group captain level. After all, a wing commander had to be able to do everything that a flight lieutenant captain had to do. He had to do his target study, the flight simulator, all those nasty tests from the weapons trainers and so on, and it all had to be done to at least the same standard as a flight lieutenant – he couldn't possibly fail. So he had to be a *de facto* flight lieutenant captain and then be a Squadron Commander as well; some of them clearly could not cope. Does anyone else have any views on this?

Sir John Willis. Yes. One of my Station Commanders certainly suffered the same fate. I wouldn't say that it was a common occurrence, but it did happen, and it clearly reflected the pressures on management, on leadership, at that level.

AVM Mike Robinson. Could I just add a point on stress. I think that these incidents may have been confined to a certain period because there weren't any in 3 Gp in the early 1960s and I don't recall any failures when I was SASO. A slightly oblique, but I think not irrelevant point; in my squadron of about forty officers, all but five or six were married and I had only one dodgy marriage. That was, I think, a great stabilising factor. It helped enormously and should not be forgotten.

I imagine Sir John, that your crew were pretty steady…….

Sir John Willis. Oh yes. They used to say add five knots for each child – it's a wonder that we ever got down! (*Laughter*)

Sir Freddie Sowrey. I have a question for Stephen Rickett. How did we handle nuclear fallout before the ROC took on the task? Did it inherit an existing organisation or did it have to be set up from scratch?

Stephen Rickett. My understanding, and I acknowledge a debt to Derek Wood here, is that the system was set up from scratch. Personnel were trained both to monitor fallout and to report aircraft movements until the latter role was deleted after about ten years. So, in short, so far as I am aware, there was no nuclear monitoring prior to the ROC's becoming involved.

AVM John Price. It was not until I became involved in running a

TACEVAL at St. Mawgan that I became aware of nuclear weapons in the context of Nimrods. They had to be generated and handled in much the same way as for bombers and I wonder whether anyone could enlighten us on the maritime role. For instance, were the weapons British or American?

Sqn Ldr Alastair McCord. For my sins, I wrote the weapon loading schedules for Nimrod Special Weapons. They were a 550 lb bomb and they were controlled by the US Navy at St. Mawgan. They were also stored at Machrihanish. The Kinloss aircraft used to collect their weapons from there, although we kept training rounds at Kinloss to train the loading teams.

Sir John Willis. That's right. The British WE177 did have a depth bomb option, of course, although the RAF never exploited this. We tend to overlook the employment of nuclear weapons in the maritime role, to treat it almost as a sideshow. That was not the case, of course, the Nimrod was as much a nuclear system as any other, albeit without the strategic overtones that we associate with the V-Force.

AVM Willie McRae. Could I ask, what was the rationale for the removal of our aircraft from the nuclear role in 1998? To what extent was there a debate about it? Was there any linkage to our independent deterrent? To what extent were our allies consulted? And, because we shall soon have to start thinking about replacing Trident, perhaps I could add a question for Professor Freedman - where does he see Britain's nuclear role in the future?

Sir John Willis. Thank you; that's about three days' worth! Perhaps I could offer a little, since I was still around when we did the 'Options for Change' defence review in 1990-91 which began the process. We began by planning to reduce the number of warheads substantially but we were looking to replace the WE177, itself very long in the tooth by that time, with an air-to-surface missile. Both Lockheed and Boeing were offering a suitable system, not just for us but for the whole of NATO. It is my perception that the whole thing was overtaken by the end of the Cold War which meant that the 'good times' were gone and money was extremely tight. The decision hinged on whether the Trident could be used in, what was by now being described as, a sub-strategic role. That is to say to send a 'nuclear signal'; could Trident be used to restore

deterrence in the initial stages of a confrontation? After much study it was decided that it could be used in that role, whereas we had always previously argued that it could not. Once that decision had been made, given the reduced requirement, it followed that we no longer needed a second system and in due course therefore the WE177 faded away without a replacement.

I have to say that, from a personal standpoint, I am of the opinion that a serious nuclear power needs to have two strings to its bow because, if you lose any significant element of one system - a weapon, the launch vehicle or indeed the submarine - you have lost the lot.

Dr Eric Grove. I would like to ask the extent to which such factors as Last Minute Loading and, with YELLOW SUN Mk 1, I gather, the need to take half a ton of ball bearings out of it as part of the arming process, affected QRA? So far as the weapons were concerned, QRA was quite straightforward with something like YELLOW SUN Mk 2. On the other hand, earlier weapons, and I have seen, for instance, documents saying that, once the core was in it, RED BEARD might possibly go off with a yield of 0.1KT, even if set to 'Safe'. To what extent did those kinds of technical weapons factors affect the whole QRA process?

Air Cdre Owen Truelove. YS1 had 6500 ball bearings in it. I know that because I dropped them all over the hangar floor and had to personally count every one back in! (*Laughter*) It was not an easy process to do Last Minute Loading on YS1 but we never actually used YS1 as a QRA weapon. We actually went straight from BLUE DANUBE to YS2.

Cdre Toby Elliott. I am the 'dark blue' member of the Society and was, at one stage of my career, the Commanding Officer of a Polaris submarine. In fact I went on the second Polaris patrol and finished up meeting *Vanguard* back from her first deterrent patrol in the Trident era. What I have found fascinating about today is that virtually everything we have talked about, the Royal Navy could talk about. It would do it in a slightly different way but we would all understand each other. I have thought very hard about the differences, as opposed to the commonality, between the operational crews of submarines and aeroplanes and it comes down to one thing.

I love flying, especially low flying; it has given me a buzz whenever I have been allowed to do it. On the other hand, I have to say that I would

have much preferred to have been in a Polaris submarine, launching fourteen minutes after the order came to fire, than taking off on that long flight. That was the difference and I am full of admiration for the crews of the V-Force era who knew what they were going to have to do and what they would have to face up to. Like the RAF's crews, incidentally, we would have had no diversion afterwards either, if it had ever happened.

I also firmly believe, however, as I am sure you all did, that it never was going to happen because we were so determined that it should not, and we put so much effort into ensuring that everyone knew how effective we would be.

Sir John Willis. Thank you, Toby. I think one of the reasons for the affinity between submariners and flyers is that neither can understand why the other does it!

Wg Cdr Mike Mockford. There was, at one stage, a fleeting reference to people not wanting to recognise or to be posted to a certain place. I wouldn't really like today to pass without just a brief mention of JARIC. I suspect that much of what was done, and I was involved in the 1950s and '60s, could not have been done without a great deal of intelligence support.

Sir John Willis. Thank you for that Mike. I am sure that we would all acknowledge how much we depended upon what JARIC did for us, both in targeting and, when we went low level, of course, in producing route strip maps for us.

That is, I think, a fitting note on which to end this panel discussion. Those of us who attended the Society's previous seminar on nuclear weapons, back in 1990, will recall that the proceedings were brought to a close by Professor Lawrence Freedman and I am delighted to say that he is here with us again to give a final overview to today's event. Lawrie, we are most grateful to you.

FINAL SURVEY

Professor Lawrence Freedman

After graduating from Oxford, Prof Freedman held research positions at Nuffield College and at the International Institute for Strategic Studies before becoming Head of Policy Studies at Royal Institute of International Affairs. He was appointed to the Chair of War Studies at King's College, London in April 1982, an appointment which he still holds. In 1990 he became Honorary Director of the University of London's Centre for Defence Studies. He was elected a Fellow of the British Academy in 1995 and was awarded a CBE in the Queen's Birthday Honours in June 1996. He has written many books on modern history, his most recent, Kennedy's Wars: Berlin, Cuba, Laos and Vietnam*, having been published in 2000.*

I fear that, at some point, I shall, like the V-Force, be judged to have reached the end of my usefulness on occasions such as these. Nonetheless, I shall try to round up, and even to look forward a little, as I was asked to do by one of the questioners. I think what came across to me, particularly during the afternoon, was the extent to which the deterrent, if it was going to be credible, had to be credible to those who were responsible for it. The professionalism, the rigour, the care, the hours, perhaps the *certainty* of those involved was what made the deterrent work. It would not have taken very much, in terms of evident sloppiness, a lack of care, a lack of professionalism, for this to have undermined the credibility of the whole exercise.

I was struck by Michael Hely's legal formulation (if I jotted it down correctly) that the greater the consequences of a mishap, the greater the precautions that one needs to take to demonstrate that you have shown reasonable care. That seems to me to be a fair description of what you need to do with nuclear weapons under any circumstances. The routines that were established in the interests of safety reflected this philosophy but they are quite difficult for an historian to deal with. By their very nature, 'routines' are not very exciting; they are conducted relentlessly, day by day, precisely because they are *routine*. As a result, people soon take such activities for granted and simply assume that they are being done, while those directly involved in these routines can often become frustrated by the greater attention given to those who have more exciting

things to do. That having been said, of course, we also heard about one of the *most* exciting things that anyone might ever have had to do, had the V-Force ever been used. But it never was, and for the historian of the Cold War, this again produces certain problems as to how to convey the tensions associated with what was actually a non-event.

In this context, I was struck, during a visit to the Imperial War Museum where I noted that the exhibits on World War II were very crowded, with schoolchildren crawling all over them, whereas the exhibit on the Cold War was virtually empty. I think our kids do know quite a lot about WW II, and I am very pleased that they do. But I am not sure that they know very much about the war of their parents or, increasingly, that of their grandparents. The Cold War was so diffuse, with so many different actors involved and so many disparate events. Yet, apart from the occasional crisis, like Cuba, it lacked the high drama that you can so easily invoke when talking about the Second World War. It is simply very difficult to talk about something that *didn't* happen. At the time, one was required to rely on one's imagination. Those of us who grew up during the Cold War did use our imaginations, quite often. We were prompted to do so (not to the government's liking), by Peter Watkins' *The War Game*, for instance. The BBC was encouraged to keep this off our screens for many years. When we were eventually permitted to see it, it certainly made us think. Although, strictly speaking, we are still in the nuclear age, today's younger generation is not called upon to confront the problems that this involves, and thus to exercise their imaginations to the same extent that we were. It is, therefore, a real problem for those of us who want not only to keep alive the memories of that era, but to remind ourselves of just how important it had been. The Cold War was actually a war that was fought for basic values and was won! It was a war that was fought against an opponent whose views represented a way of life that we rejected and it *could* have all turned out very differently.

Another recent observation concerns Cuba, or at least the new film about the crisis, *Thirteen Days*; a film which I would strongly recommend that you should see. It is very evocative. It is not accurate, but it *is* very evocative! (*Laughter*) It doesn't reach Oliver Stone-levels of travesty; although some of you may be surprised to see a civilian member of the President's staff portrayed as being able to talk directly to pilots about to fly a reconnaissance mission over Cuba, circumventing

the entire military chain of command, and telling them, in effect, to lie to their superior officers if they were shot at. I was told by the film's producers that the Pentagon did query that when they were providing facilities to shoot the film, but the sequence evidently survived.

This was quite an interesting anomaly as the makers of these sorts of quasi-documentaries go to considerable lengths in an effort to make things *look* right, to have the right kinds of aeroplanes, the right kinds of ships and the right kinds of procedures. Yet they play fast and loose with the detail of what people actually said to each other and the actions that they took. Nonetheless, *Thirteen Days* is one of the few recent attempts to explain that the Cold War was something which really was dangerous - for all of us. These things did matter at the time and the Cold War did have its moments of high drama – there was Berlin at around the same time, of course, and this had some influence on the situation in Cuba. In fact, many people still think, and with some justification, that Cuba was really all about Berlin – or, at least, as much about Berlin as it was about Cuba itself.

Nevertheless, once the Cuba crisis had been resolved, it was often hard to believe that what was going on thereafter was anything more than a sort of institutionalised activity; a Great Power contest that had lost a lot of its meaning. Perhaps it was only when the Wall finally came down that we were once again able to see the whole period in perspective. It was the sheer relief of those who no longer had to live under Communism that made it apparent that the Cold War era really had been about something that had mattered.

There is a third observation that I would offer, arising from a project in which I am currently engaged, writing the official history of the Falklands campaign. This raises an interesting question for the V-Force because we have today been talking about its nuclear role, which didn't happen, rather than its conventional role, which did, and under quite extraordinary circumstances. When the RAF proposed the use of the Vulcan, the other Service Chiefs were not wholly convinced that it was the best way of attacking Port Stanley airfield. Interestingly, however, the main concern of the Secretary of State for Defence was that, whatever happened, the use of the Vulcan should not be cited as an excuse for keeping the V-Force in existence!

I do not want to examine this episode in any depth. Suffice to say that there were several BLACK BUCK raids, involving extraordinary

numbers of Victor tankers, to deliver a few 1000 lbs bombs, only one of which actually hit the runway. But that was enough to make the point that it would also have been possible to reach mainland bases and there is quite a lot of evidence that their vulnerability caused considerable concern in Buenos Aires. Quite properly, there were a number of people in London, and elsewhere, who had serious reservations over the international legal implications of such an attack, and there were clear danger signals in terms of our relations with the rest of Latin America. Besides which, there were the practical difficulties involved in actually knocking out a runway using 1950s technology. Nonetheless BLACK BUCK did have an impact on Argentina's calculations. It is, however, ironic that the V-Force, having been employed as a nuclear deterrent for so many years, and successfully so, since what it was supposed to deter did not happen, should end its operational career with a *conventional* attack. As a result, it is this in connection with this event that many people now remember the V-Force. This brings me back to my point about the difficulty of representing the routine nature of the activities involved in maintaining the deterrent in such a way as to engage the imagination.

I think, therefore, that it is important to remind ourselves *why* the UK was committed to deterrence. It was not simply a case of dissuading the Soviet Union from embarking on the ultimate aggression. A whole series of other political points was made through the possession of a national nuclear strike force. Some reference was made earlier in the day to impressing the Americans. Certainly one of the rationales, right from the start of the UK's nuclear programme, was to be able to influence the American decision making process. Unless we were actually contributing to the, otherwise largely American, NATO deterrent, we could hardly expect to have much say in its use.

Reference, which provoked some surprise, was also made to Shastri's India of 1964-65, but Andy Brookes was quite right about this. Indeed, for the newly elected Labour government of the day this had been quite a useful development, because those who wanted a rationale for retaining a nuclear capability could use this context to circumvent doctrinal arguments with the Left as to whether the Soviet Union actually represented a threat. It was certainly easier to be seen to be protecting a member of the Commonwealth against China and I suspect that that was one of the reasons why we considered extending the deterrent to cover

India. As was suggested, however, this initiative was never a very realistic prospect and it was not pursued for long. Later on, of course, our possession of a nuclear capability was very relevant in terms of our relations with our European allies in general, and a constant factor in our discussions with the French in particular. Indeed, it is some indication of how much things have changed that, throughout the 1960s, '70s and '80s, any discussion of European co-operation, especially involving Britain and France, always invoked questions of joint nuclear activities. Today, the topic is never even raised in the context of current discussions to do with Intervention Forces and that leads me to Willie McRae's question about the future of the national nuclear force.

In this post-Cold War era, one suspects that many people would probably be surprised to learn that the UK still is a nuclear power. It very rarely makes the news and Labour administrations have never been noted for their encouragement of debates on nuclear issues. It has to be said, however, that in the recent Strategic Defence Review more detail was provided on the national nuclear force than has *ever* been provided before. This was the sort of stuff that would have driven the *New Statesman* wild with excitement had it been leaked to them in the early 1980s and it would have been widely reported elsewhere under banner headlines. As it was, I am not aware of a *single* newspaper paragraph that made any reference to the newly revealed details on the national nuclear force. It seems that there has been a total loss of interest in such matters. Will it revive? It could be that President Bush may have some influence in this regard, since his National Missile Defence programme may provoke some interesting questions, although, thus far, these have been more concerned with Fylingdales than with Trident. Nevertheless, there is an interesting context here when the time comes to consider whether or not we should replace Trident.

I first became involved in questions of this nature around 1976, which was about eight years after Polaris had entered service, when it was decided that Chatham House should conduct a study to consider a successor to Polaris. We found difficulty as the Callaghan Government was busily looking at these things in secret and did not want anybody else to be doing it with them, and so provoking public interest. We got no formal co-operation. Despite this, Ian Smart, whom many of you will know, produced a good study, which helped set the subsequent public debate and I am pretty sure that his informal contacts with the Civil

Service were not too bad when he wrote it.

If we were considering Trident replacement at the same point in its life cycle as we discussed replacing Polaris, it would be about 2002. On that basis, therefore, we might be expected to start thinking about this issue next year. I just do not believe that we will, however; I suspect that Trident will be kept going for as long as possible and that any consideration of a replacement will be postponed by refits. I can foresee that, like the USAF which plans to keep its B-52s operational until the middle of the century, we may well try to do the same with our Trident submarines.

To conclude, I would point out that, although the Cold War may have ended, the nuclear age has not. The great debates on nuclear weapons of the late 1950s and early '60s, to which we returned in the late 1970s and early '80s, may also be moribund but the weapons still exist. Nevertheless, public interest has declined quite dramatically. In one sense, I am disappointed that the public takes so little notice of such an important matter. On the other hand, I am also relieved because their interest is only likely to be rekindled by a major international crisis, and I would prefer that we did not have one of those.

CHAIRMAN'S CLOSING REMARKS

Thank you, Lawrie, for bringing the day's proceedings to a close in such a thoughtful and well expressed fashion. I hesitate even to attempt to summarise all the ground that we have covered today, but we have clearly examined in some detail what was, I believe, one of the most important activities in which the Royal Air Force has ever participated.

The First World War was billed as the war to end all wars, which it manifestly was not. Nevertheless, by ushering in the nuclear age, the Second World War really did have the potential to be the war that ended, at least, all *major* wars. But that would only be true if we clearly understood what we were doing and if we then developed and deployed the necessary means to achieve the desired end and then conducted ourselves with dedication and professionalism. What we have been hearing is an account of just how well that was actually done. It was not exclusively air force business, certainly not in later years, but the RAF was directly involved from the very beginning until 1998, first as the primary strategic force and thereafter as, what became known as, the sub-strategic force. In reality, by its very nature, a nuclear force can hardly be anything other than 'strategic' in its tone, so we have, in a sense, been a part of something which has carried on the tradition established by Bomber Command in the Second World War, but perhaps ultimately in an even more meaningful way.

The fact that the RAF can no longer participate, because it has neither the weapons nor aeroplanes with an adequate range with which to deliver them, does not mean that we have lost everything. The RAF still has an important role to play and much of its activity still supports a deterrent posture. In due course some future government will have to come to terms with the need to replace Trident. Who knows? The RAF may yet venture back into the field of nuclear operations.

AFTERTHOUGHTS and SUPPLEMENTARY PAPERS

In the course of preparing, and in the aftermath of, the nuclear seminar, some additional information became available which was not presented on the day. This took the form of formal papers which, for a variety of reasons, were not actually read and contributions from members of the audience who were unable, through the pressure of time, to offer their thoughts from the floor but who subsequently responded to our Chairman's invitation to write them down. What follows is a selection of this material. **Ed**

AFTERTHOUGHTS

AVM Jack Furner wished to offer some comments, mostly inspired by Sir Michael Beetham's contribution to the morning discussion.

I was working on war plans at High Wycombe in the early 1960s and one of the oddities I recall from those days is that there were two distinct plans - at least there were two before assignment to SACEUR. The main one, of course, was the Single Integrated Operational Plan, the SIOP, which was co-ordinated with SAC. The other was the National, ie a quite independent, Plan, which we *could* have implemented all on our own, with, in many cases, different target assignments and routes. One did not dwell on the circumstances that might have brought this Plan into action. But it still created extra work, both for the planners and for the crews.

It was not surprising to hear that CINCSAC and Sir 'Bing' were not talking much during Cuba; everybody was too damned busy and looking after their own back yard. Nevertheless in quieter times, the close co-operation between SAC and ourselves (and SHAPE and ourselves) was remarkable; we were frequently darting between High Wycombe, Omaha, Versailles and 7th Air Div HQ (also in High Wycombe) to make absolutely sure that plans dovetailed together and did not conflict. Although SAC was obviously a much larger partner, there was a mutual respect for the professionalism of both participants.

Turning to the Cuba fortnight in October 1962: it was undoubtedly a very tense period indeed for all of us working down in the 'hole' at HQ Bomber Command. There has been comment that nothing much was being said in the media about the situation. I note, nearly forty years later, that there is still nothing much being said. I have not seen the recent BBC series *Cold War* but I have browsed through the book (by

Jeremy Isaacs) that accompanies the series. In the context of Cuba, there is not a single mention of Bomber Command, or the Royal Air Force, or of any British military aircraft or of any British airman. There is a brief reference to the RAF in respect of the earlier Berlin blockade. In that particular history book, we did not exist.

I must confess that I do not recall the command's intending to rid the front line of Thor *before* Cuba. After all, they had been on-station for only a couple of years. My impression was that the post-Cuba Kennedy/Khrushchev deal called for the withdrawal of Jupiter *and* Thor from Europe. It is, incidentally, interesting to reflect that one of the factors contributing to the eventual success of Thor was that Bomber Command had missed Werner von Braun at Peenemunde in August 1943.

Finally, having retired from the Service some twenty-five years ago, I must confess that, to me, the biggest shock conveyed by the seminar was the '1960-1998' specified in its title. I had no idea that there were no longer any nuclear weapons in service with the Royal Air Force.

Further to the above, and prompted by some of Sir Michael Quinlan's observations, **Wg Cdr Jeff Jefford** offers some personal thoughts on the 'independence' of British nuclear forces and amplifies a point raised by Andrew Brookes.

As a long-term resident of the HQSTC/UKAIR 'Strike Shop' in the mid-1980s, I can confirm that there were still two plans extant at that time, both of which were revised annually. AVM Furner hints at some early uncertainty over the philosophy underpinning the national option and this too was still present in the 1980s. For the British to have executed its independent plan, either as a whole or in part, implies some kind of private UK-USSR confrontation. This just *might* have been a possibility in the 1950s but it was a highly unlikely scenario once NATO had become a viable and integrated international organisation to whose control the UK had actually assigned its nuclear delivery forces. Nevertheless, we took the seamanlike precaution of doggedly maintaining a national plan throughout the life of the V-Force, even if it was only on a contingency basis, and a remote one at that.

Sir Michael recalled an occasion when the UK had elected to respond positively to an exercise request for a nuclear release that had been

declined by the USA. The point that I would make, however, is that this request had been initiated by SACEUR, ie the weapon was to have been delivered within a NATO context and released via the NATO command and control chain on a target nominated by SHAPE. This process required national sanction throughout, of course, but it had plainly *not* been a national initiative. Having 'played' many of these games (Exercises WINTEX and ABLE ARCHER), incidentally, my reading of the 'nuclear politics' involved is such that I cannot conceive that, despite his having been granted authority to do so, any SACEUR would ever have actually released a British (or a US) weapon in isolation.

None of this is to say that British weapons were irrelevant. Quite the contrary, although this does need to be seen in perspective. Subtlety was hardly a feature of the early tripwire posture but, with the adoption of MC14/3, this was superseded by one of flexible response. From 1968 onwards, therefore, a 'selective release' of nuclear weapons would have been far more to do with sending signals than with unleashing devastation. Thus, while most of the airmen who were required to deliver them were conditioned to treat a 'nuke' as being simply a bigger, better bomb, it was actually a political symbol. The primary aim in using nuclear weapons was, to invoke oft-used exercise buzz-words, to let the opposition know that the 'resolve', the 'integrity' and the 'cohesion' of the alliance were intact. To demonstrate this, it was considered necessary for participation in a strike to be fairly broad-based. While many (but not all) NATO governments maintained nuclear-capable forces assigned to SACEUR, they were, with the sole exception of the UK, all armed with US weapons. If a planned strike had envisaged the use of *only* American weapons, the prevailing logic was that Washington would probably have refused to authorise their release for fear of provoking a direct response against the USA. By 'sharing the blame' the involvement of British weapons underlined the unity of the alliance. Furthermore, the fact that there were two nuclear powers complicated Moscow's problem, because the Kremlin had to try to guess what *two* sets of decision makers *might* do.

Because no nation ever developed the ability to be able to launch a 100% successful 'first strike' during the Cold War, there could never have been a winner in a nuclear exchange – which is precisely why deterrence worked (and why many see the latest American proposals for a defensive shield to be dangerously destabilising). The mere possession

of nuclear weapons was not sufficient, however, and for the politicians and diplomats to be able to do their work it was essential for them to be backed by a committed and credible military organisation, hence QRA and the frequent exercises, all such activities undoubtedly being monitored by the opposition. While nuclear forces had, therefore, always to be seen to be held at a high state of readiness and to be able to function at the peak of operational efficiency, for them ever to have been used would have been their ultimate failure.

All of that having been said, however, it is interesting to reflect that, in addition to NATO, with its flexible plans, its formalised procedures, its political processes and the close co-operation between its nuclear sponsors in London and Washington, there was a *third* western player at the Cold War game – France. The French developed substantial and very capable air-, land- and sea-based nuclear forces and had their own, declared, definition as to when they would consider that 'the line' had been crossed. As Sir Michael Beetham suggested, once one had released even a handful of nuclear weapons, it would have been all too easy to lose control of the whole affair and that it would have been difficult to prevent the situation rapidly degenerating into a General Nuclear Release. In the event, while the North Atlantic Council would have been deliberating whether or not to authorise 'First Use' in an effort to stem the Soviet tide and while each of its delegates would have been busily referring back to his national capital for endorsement of his recommendation, there was a better than even chance that Brussels' decision would have been pre-empted and that it would have been Paris, that actually brought the nuclear ball into play.

The Russians would have been only too well aware of this possibility, of course, and I would argue that the existence of American, British *and* French nuclear weapons, all of which *could* have been used independently, made the West a very complex and unpredictable institution, as viewed from Red Square. This unpredictability would, of course, have been a cause for considerable concern in Moscow but, from a western standpoint, it was a factor that served to enhance the deterrent value of retaining, even a notional, *national* strike capability.

Finally, I would like to add to Andy Brookes's mention of the introduction of the 'Simstart' trolleys for V-bombers. While Sqn Ldr Dixon (Eng 8(a)) conceived the scheme, responsibility for design and development, and, in the first instance at least, production, was delegated

to the Bomber Command Modification Centre (BCMC) at Hemswell in March 1960. Four prototypes were 95% complete by the end of April. Sqn Ldr Dixon visited on several occasions, most significantly on 23rd June when the design was 'sealed'. The aim at that stage was to produce five Vulcan-trolleys by mid-July and five Victor-trolleys by mid-August. Using the resources available to BCMC, however, it was not at all certain that these targets could be met.

By July, it had been decided that the RAF would take advantage of the 1960 SBAC Show to provide a public demonstration of its ability to scramble four V-bombers within four minutes. This commitment meant that there could no longer be any question about completing the task, which now ran to fifteen trolley sets because the Valiant was to be included in the demonstrations. Production was given maximum priority; additional manpower (mostly metal workers and electricians) was drafted in from other units and a 12-hour day was introduced, plus Saturday mornings and selective working on Sundays. The job was completed during August in time for some practice scrambles to be carried out and the procedure was duly demonstrated at Farnborough. The aircraft types were changed on a daily basis, first up being four Vulcans of No 617 Sqn which were all off the ground in 1 minute 45 seconds, the drama of the demonstration being heightened by clouds of steam and spray from a very wet runway.

While the Mk 2 V-bombers were provided with an integral 'rapid air' simultaneous start capability, I believe that the Mk 1s continued to rely on trolley-mounted batteries. In order to sustain dispersed operations, however, many more trolley sets must have been manufactured. Since Hemswell had required external assistance to handle the initial project and had been able to complete it only at the expense of building up a significant backlog of routine work, it seems unlikely that the unit could have coped with a major production run and the additional trolleys were presumably built on a commercial contract. Incidentally, OC BCMC in 1960 was a Sqn Ldr Jefford; not me, you understand – Jefford the Elder.

Gp Capt Terry Holloway, was unable to attend the seminar but, had he been able to, he would have endeavoured to have ensured that, in the wider context of the RAF's nuclear capabilities, the efforts of his current employers, Marshalls of Cambridge, were acknowledged. Further to the above, for instance, he points out that Marshalls carried out a Trial

Installation on a Valiant with the aim of perfecting the rapid start procedure, the trial involving the use of 'heavy duty ground starter units', presumably trolley-mounted batteries of batteries, based on Sqn Ldr Dixon's design.[1]

Gp Capt Holloway also points out that Marshalls were involved in realising the RAF's nuclear potential from as early as the 1950s when the company began fitting an eventual total of seventy-three Canberras with a LABS system, permitting them to deliver an American 1650 lb weapon. The company accepted its first Valiant in 1956 and maintained a close association with Vickers thereafter. Particularly significant engineering tasks carried out on the Valiant involved modifying an aircraft to carry an early BLUE STEEL missile and extensive work on the latter's inertial navigation system. All of this led to Marshalls eventually being appointed as Delegated Design Authority for all electrical and electronic work on the Valiant until the type was withdrawn from service in 1965 owing to a fleet-wide problem with the main spar.

Another contribution making an oblique reference to plans was offered by **Wg Cdr Bryn Lewis** who recalled taking part in a three-Vulcan round-the-world flight in 1959, led by AOC 1 Gp, AVM John Davis. On the second day they flew from Cyprus to Karachi and during the eastbound leg over Turkey the AOC was constantly asking about the state of the compasses, the navigation equipment and generally seeking reassurance that all was well. As the Nav Plotter, Bryn feared that if the AOC was going to carry on like this for the entire trip, his life was going to be a misery but, once they had turned south towards Teheran, the questions stopped and life returned to normal. He later concluded that the AOC's concern would have been due to that fact that he was probably privy to NATO, National and possibly even US nuclear plans and that he was nervous over the possibility of his aircraft being seduced into Soviet airspace by meaconing, a technique that the Russians were known to have employed in this region. Interestingly, at this early stage of the exercise there were actually five Vulcans involved, flying in a stream at

[1] Readers wishing to know more about this project, and other work conducted on behalf of the RAF, are referred to the history of the company, *The Marshall Story* by Sir Arthur Marshall, which was published by Patrick Stephens in 1994.

20 minute intervals; the last two both reported observing MiGs which had been sent up to investigate them.

While noting that BMEWS would have given the UK a marginal four-minute warning, Peter Hudson suggested in his presentation that the primary role of the site had actually been to provide the USA with up to half an hour's notice of an attack. While not disputing the times on offer, **Sqn Ldr Michael Hely** takes issue with the priorities involved. Having spent three years as the engineering staff officer responsible for Fylingdales, he writes:

The site's function was governed by a Joint Operations Plan, which set out the operational priorities. While Fylingdales did supplement Thule and Clear, in that it could detect ICBMs bound for the USA, its *primary* role was to provide a warning of an IRBM attack on the UK. I would stress, specifically, the UK, not continental Europe, not even other NATO states. This might be seen as political fallout from the GRAPPLE tests which had demonstrated our ability to make a serious contribution to the Western deterrent.

As I recall, two scenarios were discussed at Hendon, a simultaneous launch and a simultaneous impact. There was actually a third possibility for which we also rehearsed, a simultaneous entry into the radar 'fans'. It would probably have been the most difficult case from our point of view, as the sudden appearance of multiple targets would have complicated track analysis; it could still have been done but it would have taken longer and time was in very short supply. Because they would have involved complex phased launch sequences, we doubted that the Soviets had the capability to mount a simultaneous impact or penetration, our assessment being that they were far more likely simply to press all the buttons at once for a simultaneous launch.

The radars at Fylingdales were FPS-49s. We had three of them covering an arc between about 350^{o} and 140^{o}. The engineering aim was always to have at least two radars serviceable and operating in scan mode with the third, if on line, available for tracking. Scan returns were used only to create a track queue, not to generate an alarm. The third radar would be assigned the first target detected; one of the scanners would be allocated the second and a third target would go to the third radar. This process took only seconds. Prediction was carried out by

reference to range, azimuth and frequency shift (Doppler effect). Our very clear priority was to identify UK-bound IRBMs; only when that aspect had been resolved did we divert effort into tracking ICBMs heading for America.

The point that I am trying to make is that we were the dominant co-habitee in the relationship, not merely the landlord. Indeed, the Americans recognised our national operational priorities to the extent that we were able to have specific modifications made to our FPS-49s to optimise them for the defence of the UK. The USAF Logistics Command was responsible for configuration control via its Sacramento Air Materiel Area (SMAMA) where the operational necessity for a requested modification was evaluated. Sacramento could veto any proposals but we were often able to drive through changes that we needed; NORAD quite envied us.

Maintenance on-site was handled by a contractor, RCA. One interesting feature of being exposed to the SMAMA engineering regime was the 'Zero Defects' (ZeeDee) culture. Before passing *anything* up the chain, a stores requisition, a memo, the draft of a letter or an engineering assessment/design, the originator had to sign a declaration stating that it contained no errors. Needless to say there always *were* errors, in style, in authorities, whatever, but the culture was pervasive. It had very positive effects on morale (a ZeeDee Trophy made the rounds between the sections with the best records), productivity and professionalism. Gp Capt Taylor's account of the attention to detail involved in engineering on a strike squadron is the nearest approach that I ever came across in the RAF.

SUPPLEMENTARY PAPERS

THE RAF NUCLEAR DECADES[1]

Humphrey Wynn

For over four decades the RAF was equipped to carry, and to deliver, nuclear weapons. With the withdrawal from service of the WE177 laydown bomb in 1998, that era ended. It began so long ago that the current generation of Service personnel may have no idea as to its origins, no knowledge of the Operational Requirements which led to BLUE DANUBE and the V-bombers, or of the post-1945 climate of opinion which resulted in Britain becoming the world's third nuclear power.

The attacks of 6th and 9th August l945 which resulted in two Japanese cities being destroyed by single bombs changed the character of warfare. Only some five weeks previously, fifty nations had signed the United Nations Charter. But such was the imbalance of power at the end of the Second World War, with the military giants, the USA and USSR, bestriding the world stage, that atomic weapons offered Britain the chance to continue to play an influential role. 'Until the United Nations Organisation is proved', the Chiefs of Staff declared in January 1946, 'we require the greatest capacity to make atomic bombs that economic factors and the supply of raw materials will allow.'

The post-war Labour Government took a long time to reach a decision - taken on 8th January 1947 by a committee of senior Ministers - that Britain should produce atomic bombs. But once that decision had been made, all of the other consequences followed: a policy of strategic nuclear deterrence (with kiloton- and then megaton-range weapons); high-flying four-jet bombers and all the logistic apparatus of aircrew and groundcrew training; main bases with lengthened runways and special fuel and storage areas; and a network of dispersal airfields. This was the beginning the V-Force era.

The RAF had been prepared for the decision to authorise the production of atomic bombs. On 23rd January 1946 the Government had decided that work should proceed on the building of the first atomic pile and the setting-up of a research establishment at Harwell. This meant

[1] Originally published in *The Officer* magazine and reproduced here by kind permission of the Editorial Board.

that the foundations had been laid for a nuclear weapons programme, although their production had not yet been authorised.

In early 1946, therefore, the Air Staff drafted an Operational Requirement for a bomb 'employing the principle of nuclear fission'. Since at that time only one man in the UK, Dr William Penney, who had been a member of the US team which built the bombs dropped on Japan and was now Chief Superintendent of Armament Research in the Ministry of Supply, had had first-hand experience of nuclear weapons, it is reasonable to assume that the Air Staff drew on his experience; the 'channel of communication' was, no doubt, AVM E D Davis, a distinguished armament specialist who had just retired from the RAF and been given a special MoS appointment.

Behind this arrangement was Lord Portal, who at the end of 1945 had retired as the wartime Chief of the Air Staff and taken on the appointment of Controller of Production of Atomic Energy. It was he who, in a Note to Prime Minister Clement Attlee in November 1946, asked whether research and development work on atomic weapons was to be undertaken; this led to the momentous Government decision of 8th January 1947.

The Air Staff's Operational Requirement for an atomic bomb (OR100l), suitable for carriage by the four-jet bombers for which an Operational Requirement (OR229) was circulated in November 1946, together with the idea of strategic nuclear deterrence, propounded by two influential post-war Chiefs of the Air Staff, Lord Tedder and Sir John Slessor, set the pattern for RAF bomber operations over the next forty years, from the mid-1950s, when it became a reality with the Valiant/BLUE DANUBE force, to 1998 when the last British nuclear bomb was phased out of service.

BLUE DANUBE was a kiloton-range weapon which was carried by all three V-bombers, Vickers Valiant, Avro Vulcan and Handley Page Victor. Its warhead had been meticulously constructed by a ten-strong hand-picked team of RAF engineers led by Sqn Ldr J S (later Air Mshl Sir John) Rowlands, under the supervision of Dr William Penney. It had been 'blown off' in the Operation HURRICANE test in the Monte Bello Islands in the Pacific on 3rd October 1952. But only a few weeks later the Americans had exploded their first thermonuclear device and in August l953 the Russians followed suit. As a result of this emergence of the hydrogen bomb, which, as Sir Winston Churchil1 said,

'fundamentally altered the entire problem of defence', the UK Government decided on 16th June 1954 to authorise hydrogen bomb production.

At the beginning of the next year the first of the swept-wing V-bombers resulting from OR229, the Vickers Valiant, entered service. It was followed in 1956 by the Avro Vulcan and in 1957 by the Handley Page Victor. The Valiants carried BLUE DANUBE and, in their low-level tactical role, RED BEARD; but they were withdrawn from service in 1965 after main spar failures due to metal fatigue. The Mk 1/1A Vulcans and Victors carried BLUE DANUBE and the YELLOW SUN Mks 1 and 2 megaton weapons; five B.2 squadrons were equipped to launch BLUE STEEL and the Vulcan B.2s carried WE177B, the laydown bomb which will be described subsequent1y.

Megaton weapon warheads were tested. in Operation GRAPPLE, a major series of trials based on Christmas Island in the Pacific in 1957-58, involving drops from a Valiant of No 49 Sqn. Britain's first thermonuclear bomb, a GREEN GRANITE warhead in a BLUE DANUBE casing, was dropped by the CO, Wg Cdr K G Hubbard, on 17th May 1957.

These GRAPPLE trials, which lasted from early that year until September 1958, provided the warheads for the YELLOW SUN bombs carried by the Vulcan B.lAs and B.2s and Victor B.lAs from 1960. YELLOW SUN Mk 1 had a 0.5MT yield warhead (GREEN GRASS) and the Mk 2 a 1MT warhead. Both of these bombs were lighter in weight (at approximately 7000 lbs) than the 10 000 lbs BLUE DANUBE.

The GRAPPLE trials also provided the warhead (RED SNOW) for the Avro BLUE STEEL stand-off bomb and for the tactical bomb, RED BEARD, which was carried by Canberra B.l5/l6s as well as by Valiants of the Tactical Bomber Force (TBF).

YELLOW SUN Mk 2 and BLUE STEEL were modified for low-level release from 1963, as one of a series of changes in Bomber Command's operational policy designed to counter the increased thickening of USSR point defences.

The last British nuclear bomb to come into service, WE177, also had a 'pop up' low-level delivery capability. The product of a Joint Naval/Air Staff Requirement (NASR1177), it was a versatile weapon which could be carried by a wide variety of RAF and RN aircraft. It

replaced YELLOW SUN, BLUE STEEL and RED BEARD from 1966 onwards. Produced. in three versions (A of 600 lbs nominal weight with a low yield, and B and C of 950 lbs nominal weight, with the B having the most powerful yield) it could. be dropped ballistically or by parachute and was capable of air-, ground- or under-water burst.

WE177 bombs with their under-water burst capability were not however carried by Nimrod maritime patrol aircraft in their anti-submarine role: their multifarious armament included US nuclear depth bombs for this aspect of the Cold War, when submarine-launched ballistic missiles posed as great a threat to the West as ground-launched or air-dropped nuclear weapons.

The carriage of US nuclear bombs by RAF aircraft had begun in the late l950s with Valiants and Canberras in the tactical role, so was nothing new or exceptional. As with the megaton warheads for the UK-based Thor IRBMs of 1958-63, American nuclear bombs were held in US custody at RAF bases, under ‘dual key’ arrangements.

WE177s were in service for over thirty years, the Type Bs being withdrawn by 1995 and the last As and Cs by the end of March 1998, coinciding with the withdrawal of Tornados from the nuclear role on 31st March of that year.

Like the weapons they were designed to deliver, bomber aircraft had got smaller over the years, from the four-engined, five-crew Valiants, Vulcans and Victors to the twin-engined, two-crew Tornados. The original V-bombers were bold in concept and brilliant in execution, their success in operation being intensified by the twin policies of dispersal and QRA (Quick Reaction Alert). The vast apparatus of building-up and exercising the V-Force to meet these commitments was unprecedented in peacetime; but this was the era of the Cold War.

Dispersal had been part of the plans for Bomber Command’s V-Force from its inception, involving not only the ten major bases but also twenty-seven airfields throughout the UK, to which the V-bombers dispersed in regular exercises. These involved not only V-Force air and ground crews but also major support by Transport Command in getting personnel to and from the dispersed airfields.

QRA, which meant that one aircraft of each squadron was maintained at 15 minutes’ readiness by day and by night, all the year round, had been raised to this intensity from the beginning of 1962 and was maintained by Bomber Command until the Royal Navy took over

responsibility for UK strategic nuclear deterrence with its Polaris missile-armed submarine force at the end of June 1969.

With the V-bombers succeeded by nuclear-armed Tornados, it can be said that from the 1950s to the 1990s RAF Bomber and Strike Commands successfully fulfilled awesome deterrent responsibilities - an achievement redounding to the credit of generations of highly skilled and dedicated air and ground personnel.

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RECOLLECTIONS OF NUCLEAR WEAPONS AND No 94 MU, RAF BARNHAM

Air Cdre M J Allisstone

As a Flying Officer of the Equipment (now Supply) Branch, I did the Explosives Specialist Course at RAF Calshot in 1959 and was posted from it to one of the two nuclear weapons depots within Maintenance Command, No 94 MU at RAF Barnham, near Thetford in Norfolk. This was then a very recently-completed unit built on the site of a WW II ammunition depot, part of which was permanently sealed off, having apparently stored some form of war gas; I never did discover quite what. Apart from the off-base married quarters in Barnham village, virtually everything was brand new, but on a much smaller scale than a full-sized RAF station. There was a domestic site, by the main Thetford-Bury St Edmunds road, and a separate technical area (known colloquially as 'Top Site') crowning a slight rise about half-a-mile behind the tiny Officers Mess. This area was surrounded, not only by heathland and scrub, but also by several high, barbed wire security fences with an electric inner gate, floodlighting, 'goon' towers, RAF Police dogs and armed guards with (we always understood) live ammunition. Locally rumoured to be breeding chimpanzees for a non-existent but convenient UK Space Programme, very few knew that here were stored and serviced many of the RAF's nuclear weapons.

The unit was commanded by a wing commander of the Equipment Branch, with a squadron leader equipper as his second-in-command, engineering being in the hands of a squadron leader armaments specialist with a flight lieutenant Elect Eng as his deputy and a Mechanical Transport Officer; security was handled by a flight lieutenant provost officer, whose staff included several flying officers and warrant officers

and we had a Secretarial Branch pilot officer as Adjutant, most of the unit's administrative support actually being provided by nearby RAF Honington. In addition there were a number of junior equipment officers filling such appointments as Stock Control Officer, Officer i/c Storage Site, Area Fuels Officer and Unit Equipment Officer, while two or three others acted as convoy commanders when nuclear weapons were being moved by road. There must also have been about a hundred NCOs and airmen on strength; it was a wholly-uniformed unit.

Within 'Top Site', and leading off a circular internal road inside the wire, there were: three very large semi-buried storage sheds for weapons; a number of individual brick huts within each of which one nuclear core could be kept securely underground; electrical and armament workshops; a small Seco hut office for records, stock control etc; and another which served as an RAF Police crew-room. Entry and exit to/from 'Top Site' was very tightly controlled by the RAF Police and an unusually high level of security clearance was required to work therein. We all understood that, but we were not exactly prepared for the over-enthusiasm of certain members of the RAF Police, who seemed to believe that their duties included covert observation of our extra-mural activities when bird-watching with our girlfriends on Thetford Chase!

My initial employment at Barnham was as a convoy commander, which involved sitting for hours at a time in a specially-modified Morris J2 van, in charge of several Leyland Hippo load-carriers and a posse of RAF Police motor-cyclists, plus a fire/technical safety vehicle with an armaments specialist aboard. We plied our trade between, on the 'wholesale' side, No 94 MU and various Royal Ordnance Factories, especially Burghfield near Reading, the Atomic Weapons Research Establishment at Aldermaston, and sundry other suppliers/manufacturers of tail units etc, some of which went to quite unusual lengths to disguise what they actually did, including operating out of semi-derelict premises, Nissen huts, etc. Our 'retail' operations took us out from the depot to the various V-Force stations' Supplementary Storage Areas, principally, for us, the southern ones, a sister depot, No 92 MU, which had been established on the site of the WW II airfield at Faldingworth, near Lincoln, tending to deal with Bomber Command's more northerly units. Most stocks of RAF nuclear weapons were held forward in the SSAs and were rotated through the depots for periodic servicing; depot stocks were, we understood, intended mainly for 'second strike' sorties. I

remember hoping that we would be able to get these weapons forward to the front-line airfields and depart again *before* they became the subject of further attention by Soviet forces, although how long I expected to survive thereafter scarcely entered my head.

In the early l960s, Barnham held stocks of (nominally) 10 000 lb BLUE DANUBE free-fall fission bombs; these were gradually superseded by physically much smaller 2000 lb RED BEARD fission weapons. Both of these bombs had spherical implosion main charges in the centre section of the weapon, made up of shaped explosive 'lenses'. These were detonated from the periphery and designed to focus their shock-wave inwards, hence compressing the central cores of uranium into a critical mass which resulted in the requisite nuclear chain reaction and explosion. The cores were removable and stored separately in individual below-ground, double-combination safes to which no one person had sole access. Each core was kept inside a heavy metal-lined drum, just about man-portable (with an escort) but special precautions were taken not to allow one core to come within a certain distance of another. They were normally transported by road, separately from the weapons, in 'shock-proof' containers which were fixed to the floor of the load-carrying vehicle. BLUE DANUBE was a relatively crude device by modern standards: a large, pointed tear-drop in shape, it had a maximum diameter of perhaps ten feet and was moved by road in one piece (minus its core) inside a long trailer looking rather like a glider-transporter. RED BEARD was much more compact, with separate nose and tail sections - removable for servicing or transportation on wheeled frames called 'stillages'. The mighty YELLOW SUN fusion bomb was mainly dealt with by No 92 MU so I had very little knowledge of that weapon.

If convoys had explosive components or cores aboard and thunderstorms threatened, we were required to find the nearest parking area and pull in until the squall had passed. This was not always easy, as we often had three Hippos, two J2s and the safety van plus four police motor-cycles to accommodate, and most lay-bys were too small. On one occasion a storm beat us to it; there was increasing lightning and a lot of noise, and then one exceptionally vivid flash hit a lamp-post right alongside one of the still-mobile Hippos just ahead of me, followed immediately by the loudest thunderclap I have ever encountered. The Hippo swerved into the middle of the road and stopped almost dead in its tracks - and so did the rest of the convoy. As the RAF Police closed the

carriageways in both directions, I leapt out of my J2 and went round to the Hippo where the driver was sitting transfixed and completely dumb-struck. We lifted him out of the cab, stiff as a board and, still in the sitting position, laid him as gently as we could on the floor of my van. We then put a relief driver in his place and got the convoy moving again as quickly as possible. It transpired that our victim, having seen the flash and heard the enormous explosion just to his rear, was convinced that the load he was carrying had blown up and that he was dead! It took him several days to recover.

There were scarcely any motorways in those days and I remember taking convoys through many towns, and especially through the middle of Maidenhead. The Hippos' exhaust pipes were fitted with spark-arresters which gave out a loud banshee wail, such that everyone knew we were coming from that alone, notwithstanding the police escorts, etc. These pipes were positioned so that they exhausted to the front right-hand side of the vehicle, about two feet off the ground. In Maidenhead's one-way High Street the Hippo drivers discovered that, by blipping their throttles at the right moment, they could lift the mini-skirts of the girls on the pavement alongside them - so our progress through such places was both noisy and hilarious, besides doubtless being known to every Soviet agent within half-a-mile of our route!

In 1960, I was reassigned to become No 94 MU's flight lieutenant i/c Stock Control. Thereafter I remained on base most of the time, supervising the manually-kept records on Kalamazoo cards, scheduling the convoy work and being the direct channel for 'Broken Arrow' incident reporting between our convoys out on the road and No 10 Downing Street. I had to activate this link only once, when one of our load-carriers experienced a runaway engine at the top of a hill on the outskirts of Reading. The crew had used the standard procedure (for this was not an uncommon occurrence) of ratchetting up the hand-brake and attempting to stall the, otherwise unstoppable, engine by putting it into gear and letting in the clutch. On this occasion, however, it kept running until the clutch eventually burned out amid clouds of white smoke. With the engine screaming, and apparently about to explode, the occupants evacuated the cab and the driver then bravely attempted to turn off the external fuel cock. Unfortunately, before he could complete his task the vibration released the hand-brake. The driverless Hippo set off down the hill and, at the first bend it encountered, embedded itself in the front

room of a terraced house. Fortunately the sole elderly occupant was in the back kitchen at the time, from which she emerged, dusty but unhurt, to offer everyone a cup of tea! The RAF Police did a good job of keeping the local press, etc at a safe distance and the only national publicity was a small headline in one tabloid the following day entitled 'The Secret Something in Widow's Parlour'.

A couple of years ago I returned to Barnham, the domestic site having been handed over to the Army some years ago. 'Top Site' had been sold off long since and was wide open to casual visitors. I wandered into a couple of the hitherto Top Secret storage sheds and noticed that, in one, old motor cars were being patched up. And the other? Well that was being used to grow mushrooms, and if that isn't beating swords into ploughshares, I don't know what is.

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NUCLEAR WEAPONS IN CYPRUS IN 1962

Group Captain Hugh Verity

In December 1961 I took command of RAF Akrotiri in Cyprus vice the late Andrew Humphrey. One of my first memories of my time there is of inspecting the Supplementary Storage Area. This fine installation had been taken over as recently as 28th November. I remember watching the RED BEARD weapons being flown in at night and transported to their splendid storage facility. The triggering mechanisms were, obviously, stored separately. We had two RAF Regiment squadrons to defend these weapons as part of the protection of the base.

The Near East Air Force (NEAF) Strike Wing at Akrotiri had thirty-two Canberras (plus the PR 9s of No 13 Sqn). Nos 32 and 73 Sqns had recently re-equipped with B.15s and Nos 6 and 249 Sqns with B.16s. Both versions could operate in either the tactical nuclear or conventional bombing role. Thirty-two RED BEARDs had been provided. These 15KT weapons weighed 1750 lbs apiece. Individual target details were kept in the Operations Block and were carefully studied by the crews.

In war a RED BEARD would have been delivered by a LABS manoeuvre. This involved a high speed run at low level towards the target before pulling up into a 3G loop. On the way up, at just the right moment, the weapon would be released and so 'tossed' towards its target. At the top of the loop one would half-roll out and dive back to

low level, thus getting as far away from the ensuing explosion as possible. When practising this I was not alone in hoping that the nuclear deterrent, of which we were proud to be a part, would continue to work.

A factor supporting our morale was the knowledge that Geoffrey Dhenin, who, during Operation TOTEM in 1953, had flown a modified Canberra B.2 through a radioactive cloud near Woomera, was not only alive but obviously very fit and happy. At the time he had been a wing commander flying doctor. In 1962 he was commanding the great RAF Hospital at Akrotiri; he is now Air Mshl Sir Geoffrey Dhenin KBE AFC* GM.

Back in 1962 all of this was TOP SECRET, of course, but it does serve to demonstrate the UK's commitment to its obligation to support the Central Treaty Organisation (CENTO) should the Soviet Union have ever attacked Turkey, Iran or Pakistan.

Note: I am most grateful to Sebastian Cox, Head of the Air Historical Branch, who reinforced and enlarged my memory with quotations from Air Chf Mshl Sir David Lee's *Wings in the Sun* and Humphrey Wynn's *RAF Nuclear Deterrent Forces*. My warm thanks too to Sir Geoffrey Dhenin and to Air Cdre Colin Foale, an erstwhile OC No 73 Sqn, who kindly checked and improved the above.

BOMBER COMMAND AIRCRAFT STRUCTURAL DEFECTS AND THE USE OF NDT IN THE EARLY 1960s

Squadron Leader Michael Murden

Michael Murden's experience as an engineering officer between 1956 and 1974 included tours at Bassingbourn, Khormaksar, Swanton Morley, Seletar and Kinloss. He subsequently worked for the Air Registration Board (later part of the CAA) until his retirement in 1992. Although this paper has nothing to do with the atom bomb, it is included in this Journal to show that, even within the military, we can find constructive applications for nuclear radiation.

In the late 1940s aircraft designers began to use two new lightweight, high-strength aluminium alloys DTD683 and DTD687 for the manufacture of forgings. The long-term properties of these alloys were not fully understood at the time and they were to lead to many unforeseen structural problems in aircraft which entered RAF service during the 1950s. These problems began to manifest themselves during the 1960s, the types most seriously affected including the Beverley, Britannia, Comet, Canberra, Lightning, Vulcan and Valiant. This led to the development of Non-Destructive Testing (NDT) of aircraft structures, a field in which the RAF was to play a leading role.

Comet and Britannia

Following the Comet accidents, the Air Registration Board insisted on extensive modifications being carried out before aircraft were returned to service. From that time on mandatory structural sampling was also introduced on all civil Comets and on Transport Command's fleet. When BOAC subsequently introduced sampling on all civil-operated Britannias the Air Ministry decided that the RAF should also participate in that programme.

Where inspections could not be carried out visually, because parts were hidden from view, or because the defects would be too small to be seen with the naked eye, radiography was required. As a result the RAF had an urgent requirement to train staff in the new inspection methods.

Central Servicing Development Establishment (CSDE), RAF Swanton Morley

Established at CSDE in the late 1950s, the Non-Destructive Testing

Squadron was responsible for the development of inspection procedures and the training of staff in the, then new, techniques. The squadron consisted of two flights:

Development Flight. As OC Development Flight I was responsible for the evaluation of all test equipment for use on aircraft and aircraft-associated equipment, including the use of radioactive isotopes, X-ray machines and ultrasonic, eddy current and electromagnetic devices. The precise method of inspection was devised following on-site trials and then published as an annex to the aircraft or equipment servicing manual. This involved close co-operation with the aircraft industry. The results of Comet and Britannia structural samplings were reviewed monthly at joint meetings between CSDE, the airlines and the manufacturers.

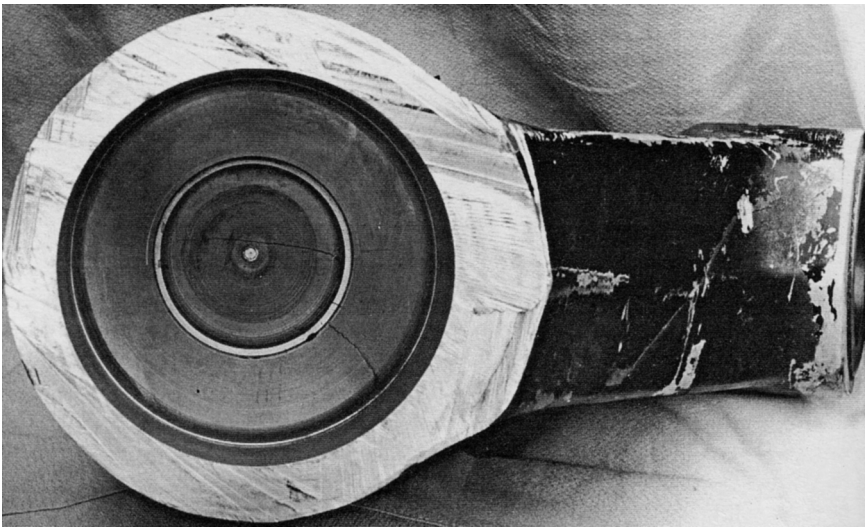
Training Flight. Carefully selected volunteers, with the rank of chief technician and above-average assessments, were given three months' training followed by a demanding theoretical and practical examination. Successful candidates were then screened for five years and posted to one of the NDT teams established in each of the home commands. A mobile team was also established at Swanton Morley to carry out all overseas inspections.

Engineers sent to Swanton Morley for training soon included personnel from the Royal Navy, Commonwealth air forces, the USAF, BOAC, BEA and most British aircraft and engine manufacturers. In the early 1960s the development of radiography, ultrasonic and eddy current inspections was led by the RAF. The Service's small team of NDT technicians worked on all sorts of new structural problems on many aircraft types. Consequently, CSDE gained more experience than any other air force or civil airline in the world.

Canberra

The Canberra was the first post-war RAF bomber aircraft to have major failures because of the use of new alloys. The main undercarriage forgings were manufactured from DTD683. Many failed in service, and even some new and unused undercarriages failed whilst still in storage at overseas Maintenance Units because of the local climate. The failures were eventually found to be caused by a previously unknown phenomenon called stress corrosion. By the late 1950s teams

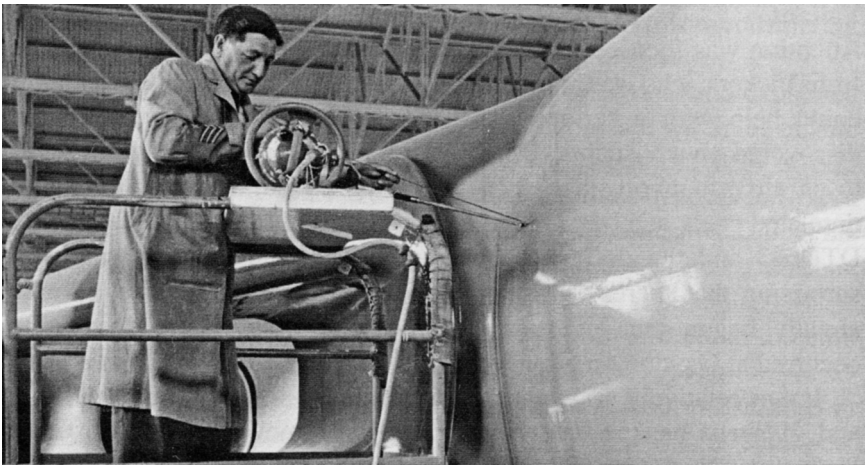
Carrying out an ultrasonic inspection on the undercarriage of a Canberra.



Section through a Canberra oleo showing a crack revealed by NDT.

from CSDE were using radioactive isotopes to inspect the oleo legs at first line. But that method of inspection was very hazardous for the RAF technicians concerned and it still failed to detect a number of cracks, so in-service failures continued.

To use radiography one needs access to both sides of the component so that film can be placed on one side and the isotope or X-ray machine on the other. The difficulties in inspecting the Canberra were overcome in 1964 when CSDE developed the earliest uses of ultrasonics as an aircraft inspection method. This enabled, for the first time, inspection of a component with access to only one side. Staffs at HQ RAF Germany were particularly worried about the possibility of undercarriage failures on aircraft carrying nuclear weapons. As soon as the new ultrasonic technique was ready I went to Germany with a mobile team. There was so much interest in the new method that the CinC came to Wildenrath to see a demonstration. In just 48 hours the team of four CSDE technicians inspected eighty aircraft, finding several defects. By comparison, a strip examination would have taken 96 man hours *per aircraft*; the ultrasonic inspection reduced this to just 10 minutes. The ultrasonic technique was far more reliable than using an isotope and the aircraft ‘down time’ was obviously considerably reduced.



X-ray inspection of the rear pressure bulkhead on a Vulcan.

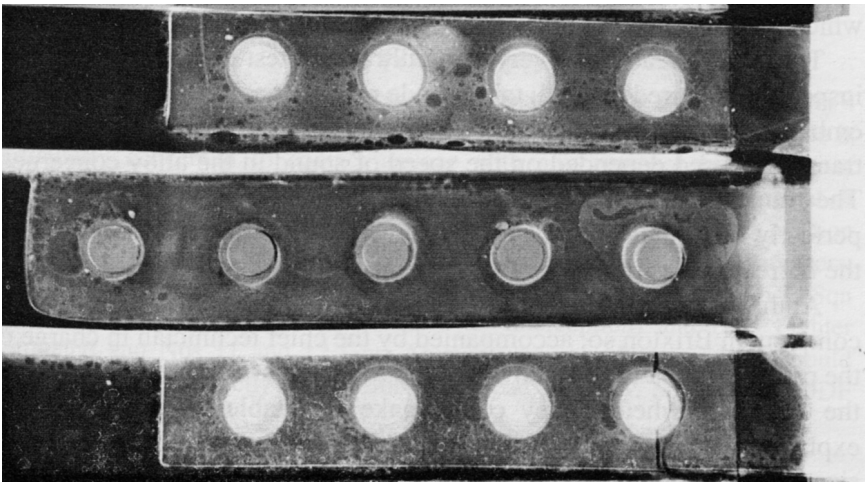
Vulcan

Structural problems began to emerge on the Vulcan in the early 1960s. Working with Avro, CSDE developed X-ray techniques to examine the intakes, fin and rudder. But the area of greatest concern was the risk of a failure of one or more of the fifty-two 'finger brackets' attaching the rear pressure bulkhead to the surrounding structure.

Valiant

Attention was focused on the Valiant in early 1964 when a metallurgist from Vickers, who was attending the CSDE course, asked me whether we could help with a serious structural problem that had recently been discovered on a Viscount. He explained that, whilst carrying out repairs to an aircraft involved in an accident, the manufacturer had found an unrelated crack at a bolt hole in the spar. Both Viscount and Valiant used DTD683 and the design of both spars was similar so it was hardly surprising that there was much anxiety at the manufacturers. We had already begun our investigation when the first Valiant spar failure occurred at Gaydon on 6th August 1964.

It was relatively easy to reach and examine the spar on the Viscount and, if needs be, the outer wing could be removed without difficulty. Unfortunately this was not the case on the Valiant where the spar was completely encased within the wing. Vickers agreed to send a section of



X-ray of one of the fifty-two three-fingered retaining brackets which secured the Vulcan's rear pressure bulkhead; the right hand bolthole of the lower bracket has failed.

Viscount spar to Swanton Morley so that we could try to devise an inspection method for a defect much too small to be seen with the naked eye. I went to Marham to assess the task. It was extremely difficult to gain access to the spar. Radiography was out of the question and even ultrasonics might not be possible. I could only just get my hand through a very small access panel under the wing and touch the bolts with my fingertip but there was insufficient space remaining to permit me to see which part of the spar I was touching.

The RAF already had very good ultrasonic test equipment, but each inspection required a small, tailor made probe, consisting of a transducer embedded in a specially manufactured plastic 'shoe'. The type of transducer used depended on the speed of sound in the alloy concerned. The transducer was then encased in a specially designed probe which perfectly fitted the contour of the item under test and which thus ensured the correct angle for the ultrasonic beam.

At that time all RAF probes were being manufactured by a very small company in Brixton so, accompanied by the chief technician in charge of the project, I went to see them, taking the section of Viscount spar. I asked the designers whether they could make a suitable probe for our use

explaining the need for a smaller diameter, ideally about half the one-inch size then currently in RAF use. I could not mention our worries about the Valiant for security reasons, so I told them that the RAF was considering buying a Viscount for Boscombe Down.

A few days later, the chief technician came to see me and explained that he had trapped his middle right finger in a door and would be unable to hold a probe until it had healed. The MO had given him a finger stall to protect the injury. It consisted of a leather middle finger taken from a glove and held in place by elastic around the wrist. As we joked about his injury we suddenly realised that if the ultrasonic probe could be attached to the finger stall it might make the difficult inspection possible.

When the special probe was ready, we returned to Marham to begin the inspections. We soon found the first cracked spar and in the weeks that followed many others. Unfortunately, repair was not possible so in January 1965 MOD announced that the Valiant fleet was to be scrapped.

The introduction of NDT into the RAF had been shown to be of great value. On the Valiant, without the use of ultrasonics, the Air Staff would have faced the near impossible task of having to decide whether or not to continue to fly the aircraft not knowing when a catastrophic in-flight failure might occur. As it was, aircraft with defects were grounded whilst the remainder continued to fly safely for a further five months whilst the situation was reviewed by MOD.

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CAN YOU HELP?

Dr David Clarke is engaged on a research project involving the Air Ministry's investigation of 'aerial phenomena', ie UFOs, during the period 1947-60. He is particularly concerned to contact anyone with any personal knowledge of incidents which occurred between 2130hrs and 0330hrs (GMT) on the night of 13/14 August 1956 and which became the subject of a Parliamentary Question in May 1957. Units known to have been involved included Bentwaters, Lakenheath, Neatishead, Bawburgh, Waterbeach (whence Venoms of No 23 Sqn were despatched in an attempt to make an interception) and HQs Fighter Command and Nos 11 and 12 Gps. Anyone who can shed any light should contact Dr Clarke directly at 292 Bole Hill Road, Walkley, Sheffield, S6 5DF (Tel 0114 2345856).

BOOK REVIEWS

Bomber Harris – His Life and Times by Air Commodore Henry Probert. Greenhill; 2001. £25.

This is the second biography of one of the best known of the wartime commanders, but the first written without his supervision. Drawing on new material, with the full support of the family with their unrivalled letters and scrapbooks, Henry Probert has rightly chosen to concentrate on Harris as the whole man. The dustjacket shows, in stark contrast, the difficulties which any author faces with this complex subject. On the front is a good portrait of Harris, chin in hand, looking benignly over half glasses - a generous host, raconteur, and family man. The rear shows his bronze statue standing four-square outside St Clement Danes at the unveiling by the Queen Mother, when ex-Bomber Command aircrew were spattered with red paint amid shouts of 'murderers'.

The author has chosen to devote almost one third of the pages to Harris's life from childhood and the period after the Second World War, but it is the wartime Commander-in-Chief which inevitably provides the core of this excellent work. The long childhood separation from his parents in India gives substance to Harris's deve1opment as a resourceful and independent personality who took easily to aviation in the Royal Flying Corps of 1915. Serious-minded and a natural leader, he appreciated the relatively ineffective Zeppelin raids as being the first strategic air campaign as he progressed to Squadron Commander in the newly formed Royal Air Force. Between the wars, a period on air control in Iraq, followed by command of a night bomber and then a f1ying boat squadron, with the emphasis on training and the introduction of long-distance night flights, were a good grounding for the Deputy Director of Plans in the run-up to war, and in 1939 the narrative shows Harris convinced that bombing could be a war winner and the a1ternative to the heavy casualties of a ground campaign.

From his own experience Probert reminds the reader of the fact that after the Battle of Britain and the Blitz the public expected Bomber Command to take the war to the Germans themselves and would not have accepted anything less from the only force which could strike back. There is an extra dimension to this; many of those who fought in the First Wor1d War regarded Germany's lack of acceptance of defeat in the field as 'unfinished business', and both Churchill and Harris were no

exception. The accusation that the latter was waging a private war against the German people by city bombing is not proven. The directives reproduced from first to last all included to varying degrees the destruction of the morale of the civilian population and industrial workers in particular. It was a lack of honesty on the part of the wartime Government over the tasks which Harris had been set, by stating that only military and industrial targets were being attacked, which sowed the seeds of doubt for the future. Also, a lack of precision in some directives gave both Harris and his detractors the opportunity to decide what they considered to be priority targets.

The well-known controversies are met head on. Harris's pungent turn of phrase starts from the pages, but his exaggeration of facts to emphasise a point did provide a number of hostages to fortune and obviously irritated the logical mind of Portal as Chief of the Air Staff with his worldwide responsibilities. However, Harris could well contend that he was writing to sustain his command in winning a war, and not for posterity, and Portal did not relieve him or accept his offer to stand down early in 1945. No one who has suggested otherwise has come up with a possible successor who would have had the same determination or experience of bomber operations, nor assessed the effect that Harris's disappearance might have had on Bomber Command's morale. When convinced of their necessity or ordered to do so, Harris carried out attacks, for example, on the continental transportation system before D-Day, and subsequent close support of ground forces, with skill and effect. Probert provides: an ingenious explanation for the absence of any mention of Bomber Command (and the US 8th Air Force) from Churchill's Victory speech; sound reasons for the bombing of Dresden (where the 8th Air Force would have attacked first if it had not been for the weather); and good coverage of both the lack of a peerage for Harris and the absence of an award of a Bomber Command campaign medal. In the end the latter evolved into an effort by Harris to gain recognition for UK ground crews of all commands whose units had flown operational sorties - a typical gesture which will strike a chord with all wartime aircrew.

Probert's view that Harris was a great wartime leader is substantiated. Today's strong links between the Royal Air Force and the United States Air Force owe much to the advice and practical help which Harris gave to get the US 8th Air Force into action at the earliest possible moment to

stretch the defences of Germany, both by night and by day. That he was not without his faults is made clear, and some of the remaining uncertainties are never likely to be resolved. For example, Probert reveals that, surprisingly, Harris was never made privy to the decrypts of the German ENIGMA cyphers and was therefore unaware of the effect on their armed forces of the shortage of oil. Whether this would have been enough to convince him late in 1944 of the fact that oil was no longer a 'panacea', and that concentration on this target by his now extremely powerful and accurate bomber force really would have shortened the war, will always be in doubt. What is certain, however, is that for three-and-a-half years, virtually without leave (and with an untreated duodenal ulcer), Harris daily carried the heavy personal weight of an offensive air campaign; the decision as to when and whether to launch practically the whole of the front line, and occasionally almost all of his reserve, was entirely his. The fact that he took the full responsibility on his own shoulders was, in Probert's words, the way which he had learnt, and the way in which he would run Bomber Command. On Harris's judgement alone depended the success of the attacks, the losses of aircraft and the casualties which his crews sustained. It was his courage and conviction, and his concern for his men, both aircrews and groundcrews, which provided the strength of his wartime leadership and which, post-war, formed the basis for the deep understanding and mutual support which existed between him and the survivors.

The extensive references are conveniently placed at the end of each chapter; many of the photographs are from family albums and have not been seen before; there are helpful diagrams (where needed) of Air Ministry organisation, and a family tree. The bibliography runs to over one hundred titles and includes our Society, and the selections which the author makes are extensive, fair and balanced. The description of being 'definitive' is much overused and has become debased. However, no one is ever likely to surpass Henry Probert in his very readable, searchingly accurate and all-embracing coverage of Sir Arthur Harris. The book will be read by all those who seek a greater understanding of the man who came to epitomise the bomber offensive and, together, their place in the final victory.

Air Mshl Sir Frederick Sowrey

Electronic Airborne Goldfish by Air Cdre John Clements. Patercurch Publications (6 Laws St, Pembroke Dock, SA72 6DL); 2001. £10.95 (inc P&P).

Aiming to become a sergeant pilot, John Clements began his RAF career as an apprentice wireless operator mechanic at Cranwell's Electrical and Wireless School in 1937. He finished up some forty years later as an air commodore electrical engineer. Some might consider that the author had exceeded his original, relatively modest, ambition by a handsome margin, but it is clear that he still harbours some regrets that 'the Ministry' steadfastly refused his repeated applications for pilot training. Nor, despite his substantial airborne experience, would they permit him to wear one of the single-winged flying badges. His arm wrestling with authority went on until as late as 1975 but his arguments invariably foundered on the twin rocks of a degree of high-tone deafness (probably caused by his flying in the line of duty) and his not having passed a 'prescribed course of flying training'.

The author satisfied his urge to fly by qualifying for a PPL in 1955 and, despite his frustration with the RAF's refusal to endorse his abilities as a *de facto* aviator, he did have a full and interesting career. He racked up some 800 (non-passenger) hours in the course of testing twenty-two types of equipment during which he flew in twenty-nine different aircraft types ranging from Stranraers, through Lancasters, Beaufighters and Fireflies, to Shackletons and Canberras. The devices he worked on included AN/APS-4, various marks of ASV, AI and H2S, YELLOW ASTER and BLUE STUDY. His accounts of installing and testing these equipments, especially the earlier wartime devices, provide some interesting vignettes. Although the air force would not give him a flying badge, Clements actually flew on a number of operational wartime anti-submarine patrols and survived a ditching in a Botha in the course of which the pilot lost his life. This incident entitled the author to be a member of the Goldfish Club, an option which he did not actually take up until 1993 but which explains the rather odd title of his book.

One can spot the odd error; for instance, I am sure that, on page 47, the author meant narrower beam width in azimuth, rather than elevation, and Parry-Davis was OC No 42 Sqn, not 242 (page 61). That having been said, I confess that, being an ex-GD type, my heart sank when I read the following on page 17: 'We had been trained to operate and service the two valve, master oscillator-power amplifier, T1083

continuous wave transmitter but now we had to become knowledgeable on the 200MHz squegging transmitter; two VT90s (micro-pups) in parallel, operating in a tuned anode-tuned grid with tuneable lecher bar transmission lines.' This sort of electro-speak crops up only infrequently, however, and readers, like myself, who have only a vague grasp of the science of wiggly amps will be able to skip easily over the odd techno-prose passage without losing the plot.

Electronic Airborne Goldfish is a well-produced, 124-page softback printed on coated A5 paper. As such, it is good value for money. Since it deals with a non-flying branch, rather than being yet another aircrew memoir, and thus provides an unusual perspective on some aspects of Service life, it also represents a very worthwhile contribution to the corporate record. Recommended.

CGJ

Luck and a Lancaster - Chance and Survival in World War II by Harry Yates DFC. Airlife (2001). £9.99.

It is not unusual these days to find authors getting their first book into print in the 'wrong half of their seventies', but far less common to find an individual wartime experiences book justifying a second edition barely two years after its original publication.

Overcoming two sticky incidents during training, Harry Yates gained his 'wings' in Canada. Back in England, an above average assessment at the end of his (P)AFU course at Little Rissington in mid-1942 resulted in a posting to a FIS at Montrose. Suitably qualified he then spent his next 1600 flying hours instructing, mainly at No 3 (P)AFU, South Cerney. After pestering for an operational posting he and his crew arrived at Mepal in early August 1944 to start operating with No 75 (New Zealand) Sqn.

It was to be an eventful tour and Yates and his crew were to be grateful for the extra flying experience he had acquired. An early raid to Bremen established their reputation; coned and peppered by *Flak* as they came off the bombing run, an encounter with a fighter on the return journey cost them their starboard outer engine yet the aircraft was nursed back on three engines and successfully landed at base. Later, on a raid to Kamen, they lost a major part of the nose section from *Flak*; wounded about the eyes, but not blinded, Yates, with full support from his crew and the unseen presence of Lady Luck, got the aircraft back to Mepal.

Thoughtfully and attractively written, this well-produced softback is a very good read at an inexpensive price.
Roy Walker

Hambuhren, Lower Saxony: A Military History 1939-1999 by Peter Jackson. Privately published; 2001. £6.50 via the author at 110 Church Rd, Wheatley, Oxford, OX33 1LU (Tel 01865 873246).

The character of the quiet rural community of Hambuhren, about five miles from Celle, was transformed during the *Nazi* era when a munitions factory was built there in 1938. The wartime labour force comprised 'foreign workers' and POWs (possibly including some British and Canadian airmen) drawn from nearby camps subordinated to the notorious Bergen-Belsen.

After the war the factory buildings began to be converted into accommodation for displaced persons and in 1946 a small complex within the site, which had previously been occupied by the *Luftwaffe*, became a REME workshops. The RAF displaced the Army in 1952 and at various times over the next five years Hambuhren was home to HQ 5 Signals Wing and Nos 291 and 755 SUs. This meant the erection of an aerial farm with D/F facilities to permit the opposition's radio transmissions to be monitored. The unit's establishment ran to about 300 men, the bulk of them being telegraphists and linguists specialising in East European languages. When the RAF moved out in 1957, the *Luftwaffe* moved back in and the unit apparently continued to operate in its eavesdropping role under its new management until the facility was finally demilitarised in 1994. The buildings were left largely unoccupied until 1999 when they were demolished to permit the site to be redeveloped.

Peter Jackson spent 1956-57 at Hambuhren as a clerk/typist National Service man. Many years later he set out to satisfy a lingering curiosity about this rather obscure facility and this monograph is the result. It certainly sheds some light on an era that is rapidly fading from memory and lifts a corner on a poorly documented aspect of RAF activity. What surprised and puzzled this reviewer was the extent of the RAF's signals network in Germany in the 1950s and the strange way in which it appears to have been organised. In June 1954, for instance, HQ 2nd TAF 'owned' the remarkable total of 104 individually numbered SUs of which no fewer than forty-four were noted as being located at Sundern

and another thirty-four at Wahn. Curious; they were, presumably, mobile units, merely parented by those stations.

Jackson's book is essentially a collection of photocopies of contemporary documents, photographs and site plans linked together by some sixty pages of narrative plus a number of interesting annexes, including one listing all RAF personnel known to have served at Hambuhren, a number of whom contributed to the telling of this story. All of this material is presented as a 'perfect bound' (like this *Journal*) A4 softback. The subject matter is a little esoteric, but it is none the worse for that. One for the specialist perhaps, but if you are one this would be a very good way to spend a mere £6.50.
CGJ

The Vulcan B.Mk2 from a Different Angle by Craig Bulman. Pentland; 2001. £19.99.

Since Craig Bulman was first attracted to the Vulcan in the 1970s he has clearly devoted a great deal of effort to gathering and collating details of the careers of each of the eighty-eight B.2 airframes. He offers us this information between the covers of a nicely produced, 200-page hardback, along with 185 photographs, ten of them in colour. There appear to be very few typos *per se* although the names of some RAF stations are sometimes rendered incorrectly, eg Cottersmore, Kia Tak, Honnington and Mackrihanish/Macrihanish, and a Russian airliner is identified as an Illusion Il-62. Furthermore, despite the author's evident familiarity with the Vulcan (he has flown in one and is/has been in contact with many ex-Vulcan personnel) one may be a little surprised at some (sometimes acknowledged) vagueness over certain technical matters. For instance, engine nacelles are described as 'nestles' and the 'constant drive speed unit' is actually a constant speed drive unit. Then again, a photograph which is said to illustrate a camera mounted at the visual bomb-aiming station actually shows a T.4 bomb sight. Similarly, the 'towel rail' on the port nosewheel door is identified as having been the aerial for LORAN C. The problem here is that this aerial had been a fleet-wide standard fit since the 1960s whereas LORAN was confined to the handful of aeroplanes which were modified for the maritime reconnaissance role in the mid '70s. This array was actually the sense aerial (displaced from its original location in the fin cap) for the Marconi radio compass, although it is possible that it may subsequently have been

adapted for LORAN for No 27 Sqn's benefit.

As an ex-member of No 50 Sqn, I have to declare an interest in taking issue with an observation on the emblem used to adorn the fins of our Vulcans. The author points out, correctly, that among the squadron's memorabilia there is a plaque dating from WW I which shows two greyhounds in pursuit of a much smaller dog, possibly the 'dingo' which was the unit's callsign in 1918. He reasons, therefore, that it would have been more appropriate for the squadron to have adopted the image of the dingo rather than that of the greyhounds. Not so. The aim of the exercise was to reinstate a tradition and it was the greyhounds, not the dingo, that were actually applied to at least one of the squadron's Camels.

These cavils aside, does the book work? Sadly, not very well. In essence, the content is a mass of, essentially, chronological, data. There are two ways of presenting such information. It could be tabulated to summarise the movements, modifications and fate of each aeroplane or an attempt could be made to stitch it all together into a piece of narrative prose. In my opinion, in pursuing the second option, the author made the wrong choice. To take just one airframe, references to XL388, for instance, crop up on no fewer than forty-eight pages. In practically every case, however, XL388 will be just one of the score or more serial numbers appearing on that page. In passing, many (but not all) of the major overseas detachments, bombing competitions, various crashes and so on are noted, these passages providing some relief from the otherwise relentless lists of alphanumerics. This form of presentation makes the book very difficult to read and, although a great deal of information is embedded within the text, it is very difficult to assimilate. I would guess that many purchasers will spend a lot of time 'reverse engineering' the content to construct chronological tables

Did you know that the high time B.2 was XH559 and that it had logged 7313 hrs15 min by the time that it landed for the last time at St Athan on 27th May 1981? If this is the sort of Vulcan gen that interests you, there is a lot of it in this book. The only snag is that you have to winkle it out.

CGJ

Fire by Night by Jennie Gray. Grub Street; 2000. £17.99

On the night of 16th/17th December 1943 forty Bomber Command aircraft crashed in appalling weather conditions as they tried to land back

at their airfields in eastern England. One Lancaster crew of No 97 Sqn was returning from its first operation when it crashed endeavouring to land at Bourn. There were two survivors but the rear gunner was lost on operations soon after. In later years the other survivor related the story of his astonishing survival and miraculous recovery to his young daughter, the author of this book.

Initially, I expected this book to be typical of the many written by families wanting to understand and record the experiences of loved ones. However, as the story unfolded it soon became clear that this book was different and worthy of much deeper consideration. In addition to relating the amazing escape of her father and his battle to regain his fitness, the author also explores the circumstances that led to the tragic events of 'Black Thursday' and the fate of other crews. Her research into the events leading up to the crash and its immediate aftermath is excellent. She also displays a very clear understanding of bomber operations discussing many aspects that have received limited attention in the past such as: the training, or lack of it, for blind approaches; the decision making process leading to the use of FIDO; and casualty and hospital procedures. These all provide valuable insights into little known aspects of the bomber war but it is the author's frank account of the aftermath of this tragedy that gives this book an added and valuable dimension.

The author's father struggled to understand why he should have been spared when all his colleagues had perished and a feeling of inadequacy at having completed just one operation compounded this. These factors created an increasing sense of survivor's guilt and trauma that progressed with time until eventually his anguish and distress created a need to feel more worthy and so he claimed to have been decorated for gallantry and his family were to believe this for many years before discovering the truth. The manner in which they dealt with this disturbing and upsetting news is worthy of the highest praise and the author's readiness to disclose this aspect of her father's experiences is most laudable. It is also important because it highlights the realities and torment that some bomber crews had to face long after the war was over but during an age when there was no such thing as counselling for combat stress.

This is a very poignant and touching story highlighting a less familiar aspect of courage, one far removed from the more familiar, thrilling stories of gallant deeds. Although the experiences outlined are almost

certainly not unique, never has this sad, human side of war been so graphically recounted. This book adds much to our understanding of the stresses of flying operations and the author is to be congratulated for her readiness and courage to publish the details of a tragic wartime episode and its distressing aftermath.

Air Cdre Graham Pitchfork

Blenheim Over the Balkans by James Dunnet. Pentland; 2001. £17.50.

On 13th April 1941 James Dunnet should have been flying as observer in one of the six Blenheims of No 211 Sqn which attacked a road junction near Florina. As luck would have it, however, his place had been usurped by the Wing Commander. The Blenheims were intercepted by Bf 109s and all six were shot down. Only four men survived; three of them died shortly afterwards and the fourth just after the war. The author's memory was jogged by an appeal for information relating to this incident which was published in *Air Mail* in 1982. He responded and this book was the eventual result.

Running to 296 pages in all, it is a rather patchy account of No 211 Sqn's activities in 1940-42, a period during which the unit had the ill-fortune to be virtually wiped out twice within less than twelve months, once in Greece and again in the Dutch East Indies. About a third of the content consists of personal accounts from a handful of veterans. These include: extracts from *Epitaph for a Squadron* by J R Gordon-Finlayson (OC 211 Sqn for much of the Greek campaign); extracts from some of the letters home written by Tommy Wisdom (the local RAF Press Officer and author of *Wings Over Olympus*); verbatim reproductions of diaries kept by three young airmen and the recollections of four equally young aircrew, including summaries of their log books. Some of these contemporary accounts are particularly poignant as they reflect the fact that the RAF had had its tail well up in early 1941 and, with the Italians being roughly handled in Libya and Abyssinia, no one had had any doubts that the same would happen in Albania – and then the Germans became involved and everything soon began to look very different. Of particular interest is a 39-page contribution by Henry Sharp who, as ADC to the AOC, AVM D'Albiac, had a very privileged view of the whole Greek episode.

The author contributes about 100 pages himself from a manuscript that he wrote in Palestine in 1941. This may appeal to some readers but I

found the prose to be excessively florid and the extensive use of direct speech makes it read more like a novel than a factual account. A typical exchange reads:

> 'Metaxas is the boy for them all right,' smiled James.
>
> Waring broke in, 'He was educated in Germany, wasn't he, went to a military school there, I think.'
>
> 'The Kriegsacademie in Germany, yes,' I replied, 'so he must have a pretty good idea of warfare. He's the very man for the country, I should say.'

Did airmen aircrew really talk like that? There are one or two other oddities. At 10 000 feet over the Mediterranean in September I would have expected the temperature of the metal framework of the cockpit to be not far off freezing, even in direct sunlight; I find it hard to accept that it could have been 'blistering hot to the touch'. Then again, in describing nights out in Athens, Dunnet makes three references to the Greek national colours being green and white – blue and white, surely.

The final section of the book recreates the circumstances of the loss of the six Blenheims, locates their crash sites and identifies the German pilots responsible. The story is brought to a close with some photographs of the remains of one of these aeroplanes being recovered from a lake in 1993.

The author has elected not to adapt or to edit the available material which results in some duplication, some tales being told two or three times. This, and the fact that it contains such a wide variety of styles of writing, meant that I found this book to be a rather uncomfortable read and it certainly falls a long way short of providing a definitive history of No 211 Sqn. Nevertheless, it does contain some useful information and there is a lot of contemporary 'atmosphere' written between the lines. It is no masterpiece but it is a worthwhile contribution to the record.

CGJ

The 'FOB'S KID' Syndrome by Barry Goodwin. Airlife; 2001. £19.99

This is a fascinating book, of particular interest to those, both air and ground crew, who gave much of their youth, and some of their middle age, to manning the Vulcan nuclear deterrent in the 1960s and '70s. Spoilt only by a silly title ('FOB'S KID' stands for Fed On Bull Shit and Kept In the Dark - a cheap laugh I suppose), the book is illustrated with some twenty-seven of the best colour photographs of Vulcans (mostly

XH558) I have ever seen.

The author, the late Barry Goodwin, was an aircraft servicing chief (ASC) on Vulcan B.2s at RAF Waddington from 1969 until 1977, and was thus one of that élite band who not only oversaw the servicing and day-to-day operations of 'their' Vulcans but also, from time to time, accompanied, in those claustrophobic 6th seats, the squadron aircrew on overseas Ranger flights and sometimes much longer detachments (a test of professional skill and initiative for the ASC in itself).

Barry Goodwin covers the gamut of Vulcan operations in the low level nuclear strike role at Waddington: the constant pressure on air and ground crews; the unremitting servicing challenge set by those large aircraft left out on the airfield in all weathers; the unrelenting, largely no-notice, exercises; and the occasional flight to the sun in the Mediterranean or to the ice and snow of Goose Bay. As I read this book, I felt again the wind and rain blowing across 'Echo' dispersal, mellowed only slightly by the camaraderie of my squadron. Not always sweetness and light, the author, with a ring of truth and without exaggeration, describes some of the tension both in the crewroom and on the flight line.

If you were there at the time, you will enjoy the author's anecdotes and the accuracy of his descriptions. You may even recognise yourself! If you are just interested in this era - covered largely by the Society in a seminar in April earlier this year and recorded in this edition of its Journal - the book is an excellent read. If it lacks anything, it lacks only BS.

AVM Nigel Baldwin

Winged Life. A Biography of David Beaty MBE DFC* by Betty Campbell Beaty. Airlife; 2001. £19.99.

David Beaty was a multi-talented man. Following service in Coastal Command, during which he was awarded the DFC and Bar, he became a BOAC Captain. He was a regular on the Atlantic route at a time when that involved flying through the weather, rather than above it, initially in old aircraft like the Liberator until Constellations joined the BOAC fleet. Such crossings, illustrated here by extracts from Beaty's writings, were very different from the sort of computer assisted, jet-powered transits of today. Beaty was a gifted writer and his flying career ended in 1952 when he left BOAC to devote himself to writing novels and books which

incorporated either his own or others' experiences in the air and the lessons which could be learned from them. He disliked findings of pilot error in accident cases and thought that such verdicts were often unfair and based on ignorance of the human factors involved. Following studies in psychology as a mature student at University College, London, which he undertook in the 1970s he placed his ideas on an academic footing. You may want to read this book because you are interested in an account of flying with Coastal Command, or with BOAC, or because you have read Beaty's books and want to know about the man who wrote them. On the other hand, you may want to know more about his work on the causes of aircraft accidents but it is in this department that the book may not entirely satisfy you.

The author says that Beaty's ideas about the importance of human factors in such events, have percolated the aviation establishment – and in 1992 he was awarded the MBE for his services to aviation. She also implies that a huge worldwide industry in cockpit resource management, communication skills, assertiveness courses and safety has been built on the 'once-frowned-upon ideas' which he espoused. All this may be so but, in the absence of a bibliography, one looks in vain for sources of opinion which might put his influence into perspective. In his book *Naked Pilot. The Human Factor in Aircraft Accidents.* (1990), Beaty frequently refers to the work of others. For example, he cites and describes as comprehensive, a collection of state-of-the-art papers written by American and British experts, *Human Factors in Aviation*, E L Wiener and D C Nagel (eds), which was published in 1988. However, although the papers in that book refer to work carried out over several decades, going back to Bartlett's study of pilot fatigue at Cambridge in 1939, there is no reference to him in any of them. Beaty's writings in the 1960s and 70s certainly helped to 'popularise' the human factors concept (I am not using the word in a pejorative sense) and to raise consciousness about the issues involved – but that is not the sort of thing which normally gets mentioned in scientific or technical papers. Hence, there may be scope for a study focused on his influence, set in the contexts of work in such fields as psychology, ergonomics applied to aircraft design, management theory and accident investigation between 1950 and 1990. Someone may have done that already – a bibliography might have revealed it.

To raise such points is to place this biography in a category where it

does not belong – that of an academic kind to which the author has not aspired. Her lucid narrative, covering the whole of his life, is written from the perspective of one who shared it after their marriage in 1948 and who, through her own writing talents and WAAF background, was able to participate in his world as an active co-operator. Their family life was a happy and fulfilled one and this well-illustrated book contains much relating to that. As I have indicated, it is difficult to say exactly what members of the Society would gain from reading it. Certainly they, like the general public who have read Beaty's novels and seen the films which were made from them, would be able to enjoy a pleasant read. I think that the book will be popular when it appears on the shelves of public libraries. Try your local branch first.

Dr Tony Mansell

Gunner by Donald Nijboer with photographs by Dan Patterson. Airlife; 2001. £24.99.

Subtitled, *An Illustrated History of World War II Aircraft Turrets and Gun Positions*, this lavishly produced book succeeds in the 'illustrated' department but is a few rads off target with its 'history'. Originally published in Canada, Airlife have not anglicised the text for the UK market. Nevertheless, while one has to put up with armor, caliber, defense and the like, the text does convey some impression of what it was like to fly and fight in a very confined space while having to endure fatigue, sub-zero temperatures, a sense of isolation - and fear. This 'atmosphere' has been recreated through the use of first-hand accounts by ex-air gunners.

Despite this positive aspect, the book's weakness is in its written content which simply contains too many errors, of which the following are but examples. The overwing Lewis gun shown in a picture of a Bristol Fighter on page 14 is a Mk II, not a Mk III. The author does not seem to appreciate that the RFC differentiated between observers and gunners, and the requirements for qualification as the former (but *not* as a gunner) were first laid down in July 1915 (not August) - page 15. The British Air Ministry never endorsed the acronym 'WAG' for its WOp/AGs, as is implied on page 22, although the Canadians did, even going so far as to sanction a 'WAG' flying badge for the RCAF, all of which probably betrays the book's transatlantic origins. Apart from being fitted to some Lancaster I/IIIs, provision for the FN64 ventral

turret was standard on the Mk II so it will have served with more than four squadrons (as stated on page 72) and, although there were difficulties with the periscopic sighting system, the turret's withdrawal was more to do with its incompatibility with the installation of H2S, than with a restricted field of view. On page 127, the Me 410's FDL 131 barbette is credited, in the same sentence, with a mutually exclusive 40° freedom of movement in azimuth *and* an ability to fire at 90° on the beam; it could not do the latter. On page 132, the Italian SM 79 is credited with having sunk six named naval vessels, a carrier and five destroyers. Of these: HMSs *Eagle* and *Jaguar* were torpedoed by the U73 and U652 respectively; *Kujawiak* struck a mine; *Legion* succumbed to Ju 87s and/or 88s in Malta's Grand Harbour and I can find no reference whatsoever to a *Southwall* or a *Husky* (there was a *Southwold,* but she was another mine victim, and a merchantman called *Husky* which survived the war).

While it is not actually incorrect, there is a very misleading statistic on page 24 which credits the Americans with having trained nearly 215 000 gunners during WW II, compared to the BCATP's 34 196. The latter figure is tolerably accurate, but, because it represents a strictly Canada-centric perspective, it seriously understates the contribution made by the rest of the Commonwealth; the overall total corresponding to the author's chosen categories was some 106 889.

All of that having been said, while I would clearly have to counsel caution over accepting some of its text as gospel, this book is not really about words. It is a 'coffee table' book and, as such, it is about pictures and in this respect it scores very highly. This large, 30.5cm × 22.5cms, book is printed on glossy paper and filled with almost 200 magnificent images, many of them reproduced full-page size, more than half of them in colour. The illustrations are a blend of wartime posters, sectional diagrams of turrets and action photographs, even some of this material being in colour, and recent photographs of the interiors of restored aeroplanes, Lancaster, Blenheim, B-29, He 111 and so on, twenty-two types in all.

As AVM Ron Dick points out, by quoting one of them in his Foreword, air gunners have become 'as dated as the archers of Crécy'. Aerial gunnery, for defensive purposes, is a military discipline that came and went in a half-a-century which ended almost half-a-century ago. As such it lends itself to study as an historical capsule. If you want technical

details of turrets there are better references, but if you are interested in understanding something of the 'feel' of being a gunner, or if you simply enjoy looking at intimate pictures of bits of an aeroplane's anatomy, you will appreciate this book.
CGJ

To Live Among Heroes by George Armour Bell. Grub Street; 2001. £17.99.

This book has been written by a Medical Officer who served with No 609 Sqn when it was equipped with rocket-firing Typhoons as a component of 123 Wg of the 2nd TAF in North West Europe in 1944-45. Purely for the sake of historical accuracy, a bit of nit-picking is in order here concerning the author's description of his service in, quote, 609 (West Riding) Squadron of the Royal Auxiliary Air Force. The AAF did not become Royal until 1947 and its flying squadrons were disbanded in 1957. A squadron's ethos is a remarkably enduring thing but the composition of a pre-war AAF unit had become indistinguishable from that of any RAF squadron well before 1944. Reviewers have to be pedantic at times!

The perspective on operations given here is novel and reveals the feelings of those on the ground and their relationships with the men who flew. I know of only one similar book, *Surgeon at Arms*, by Lipmann Kessel which recounts his experiences as i/c the Surgical Team with 1 Para at Arnhem and his subsequent escape through occupied Holland. Bell captures the excitements and the tragedies experienced by both the pilots and the French, Belgian and Dutch civilians around whose heads the battle for Europe raged. He did not attend only to the needs of the RAF but became involved with the local populations, for example at Caen where he dealt with the harrowing consequences of Allied bombing on a five year old child and her family, and at Gilze following the destruction of the village school, full of children assembled for a Christmas party, by a V weapon.

Unlike soldiers, airmen do not often experience the human consequences of their fire at first hand. It was not so in 609's theatre of operations. As he fired on a German tank one pilot was certain he had killed a little French girl who was running for cover. He sat disconsolate in the bar that night before confiding his misery to the MO. After Falaise, Bell and some of the pilots visited the scene of the victory.

Eisenhower has written that it was literally impossible to walk for hundreds of yards there without stepping on dead or decaying bodies. There was vomiting at the stench of death and charred flesh; all were grim-faced and there were no signs of rejoicing. In such episodes a picture of aerial warfare emerges which is very different from that in the combat accounts which have come to characterise so many books about it. Those accounts are also concerned with life and death affairs and it is a cause for regret that, because of their frequent and often unselective repetition, they stand in danger of becoming boring. Here we have writing which conveys the experiences of decent men confronted with the horrors of modern war in a restrained and dignified way.

We are also told a lot about the author's personal life and about the men he served with in an entertaining manner - there is plenty of humour in the text - and his narrative provides a framework for understanding the flow of events as the Germans were defeated and he finally came to set foot on German soil. He tried hard to be a good 'Doc' to the men of No 609 Sqn and occasionally to some from other squadrons in the wing, dealing with their physical needs and trying to empathise with them in what they were going through in their sorties. He was acutely aware of the possibility of a case of LMF arising – it never did – and he knew that he had to be on the look-out for flying stress in a pilot so that he could step in and rest him, as he had to do at one point in the case of the squadron's Belgian CO. To do that he had to know the men well and this was easy for him in the case of the officer pilots with whom he shared a Mess but more difficult with the sergeants - and he confesses that he never got to know the latter as well as he would have liked. I suppose this is an example of how Service hierarchies could get in the way of the complete fulfilment of some roles. Both Padres and Doctors belong to professions in which all men are to be regarded as equal - but both reside in the Officers Mess.

I think that this is a very good book. It shows what it was like to share one's life with men who faced death, or dealt it out, daily. The author has no hesitation in describing them as heroes and demonstrates how good men can triumph over the most evil of circumstances. Go out and buy a copy now.

Dr Tony Mansell

Mosquito Thunder by Stuart R Scott. Sutton, 2001. £12.99.

Nineteen-year old Sgt Stuart Bastin was killed flying as a WOp/AG in 1941. In trying to learn more about his uncle, Stuart Scott was drawn into studying the history of his unit and his work was published in 1996. *Battle-Axe Blenheims* is an excellent history of No 105 Sqn so far as it goes, the problem being that it covers only 1940-41. The author was subsequently persuaded to take the story on to cover the rest of the war, the result being *Mosquito Thunder*, which first appeared in 1999 and is now available in paperback.

As this reviewer has pointed out before, there is a fundamental problem with operational histories in that they can be very repetitive, the details of each mission being very much like the previous one, and the next one and the one after that. Thus, although their subject matter deals with dramatic events and life and death situations, many squadron histories are surprisingly difficult to read because they soon become boring. Nevertheless, a gifted writer can sustain the interest by injecting some variety into the way in which he presents the available information. Stuart Scott has this talent.

Reading between the lines of his book one can detect that, probably being more inclined to use a sledgehammer than a rapier, Bomber Command was none too sure what to do with its new Mosquitos in 1942. As the tale progresses it is evident that all sorts of tactics were being tried out at both high- and low-levels, the Mk IV's lack of cannon often being lamented in the latter case. Since the Mossie was something of a novelty, No 105 Sqn was allocated rather more than its fair share of VIP visitors in the early days, provoking some caustic comments at the coal face. Deployment was also slow and it was early 1943 before, operating in concert with No 139 Sqn, it became possible to mount twenty-aircraft strikes.

The author pulls no punches and the squadron's failures are reported in as much detail as its successes. He disposes of the idea that the Mosquito's speed made it invulnerable. Indeed, it is surprising to learn that, operating its Mosquitos in daylight in 1942, the squadron's loss rate was actually worse than it had been with Blenheims in 1941. Then again there is no attempt to disguise the difficulties involved in navigating solely by DR, occasionally resulting in missions being abandoned or, perhaps worse, the wrong targets being attacked. Similarly, the operational realities of working with OBOE are made plain (the proportion of crews who 'coped' often being as low as 50% and rarely

better than 70%) and one is left with a clear impression of the tension and sense of exposure involved in having to fly ahead of the Main Force, alone, and straight and level over the centre of Berlin.

No 105 Sqn had many spectacular successes, of course, and there are detailed descriptions of precision strikes against, for instance, the *Gestapo* HQ in Oslo, specific industrial targets, like the diesel engine factory in Copenhagen, the Philips plant at Eindhoven and locomotive works at Namur, Nantes and elsewhere, and of the attacks on Berlin timed to interrupt major public events being presided over by Goering and Goebbels. These accounts are amplified by colourful descriptions contributed by many of those who took part. One of the more remarkable of these (true) tales concerns a Mosquito which developed an uncontrollable swing while taking off on a low level mission. The end result was that the undercarriage was wiped off at about 100 mph, the port engine coming adrift and catching fire. The crew promptly fired up the spare aeroplane and they were only one minute behind the rest of the formation as it crossed the French coast! Whether this had been wise is a moot point but, as the pilot concerned explains, his primary motivation had been less to do with 'press on spirit' than with putting 'as much distance as possible between myself and the CO.'

The book's authenticity is manifest throughout, the only area in which the author's touch seems a little uncertain is in his handling of *Luftwaffe* terminology. *Würzburg* and *Lichtenstein* are both mis-spelled, for instance, and a *Staffel* is more akin to a squadron than a flight (which would be a *Schwarm*).

Illustrated with more than seventy-five photographs and supported by an index and the customary annexes providing a roll of honour and details of individual aeroplanes used by the squadron, *Mosquito Thunder* is both readable and comprehensive. My only regret is that having had its two-part operational history written so well, it is unlikely that anyone will ever get around to topping and tailing No 105 Sqn's story with accounts of its time in Ireland during WW I and around the Gulf with Argosies in the 1960s.

CGJ

Britain's Shield – Radar and the Defeat of the Luftwaffe by David Zimmerman. Sutton; 2001. £25.00.

The central theme of this book is the development of radar in Great

Britain, from the scientific novelty it was in 1935 to the capable system that played a vital role in the direction of RAF day and night fighters in 1941. The bones of the story of the technical development of radar in this country have been described in several previous books. David Zimmerman's well-researched account puts several layers of flesh on those bones. He describes the principle characters involved in the story, men like Henry Tizard, Robert Watson-Watt, Sir Hugh Dowding and Frederick Lindemann. Without being over-dramatic or overly personal, he describes their strengths and weaknesses and the influence these and others exerted on the programme. The notorious personality clash between Tizard and Lindemann, and its effects on the air defence programme, are well covered.

It is the first account this reviewer has seen that gives due weight to the myriad problems that had to be overcome before the radar chain worked sufficiently well to play a key role in the nation's defence. As the author tells us, during the spring of 1939 the radar early warning system was 'simultaneously undergoing construction, upgrading, expansion, experimentation, training and operational testing and operations'. At that time no two stations possessed the same inventories of equipment or had reached the same modification states. It was a time of unrelenting hard work, and not a little muddling through.

The need to maintain secrecy caused a spread of problems. Initially contracts to the radio industry were issued in piecemeal fashion, so that each company knew about only one part of the system. There were long running difficulties in recruiting high calibre personnel. The rapidly expanding research teams had an uphill struggle to draw suitably qualified people - who could not be told the nature of the work - away from well-paid civilian jobs. Until the war began few such people were willing to accept the poor pay and prospects offered by the scientific civil service. The RAF required some 600 radar operators and a similar number of maintenance personnel to keep the equipment in round-the-clock operation. As readers of this Journal are fully aware, effective training takes a lot of time and effort. Moreover, with everyone on a precipitous learning curve, it was no easy task to provide adequate instruction for the instructors.

In the case of the early warning radar chain it proved possible, just, to assemble a system that functioned well enough against the large-scale daylight attacks on England when they began in August 1940. Against

the night raiders, it was a different matter. The initial batch of Airborne Interception (AI) radars delivered to the RAF was virtually useless in terms of performance and reliability. The equipment had been placed in production prematurely. Even if the early AI radars had worked perfectly, however, the mediocre performance and light armament of the Blenheims carrying this equipment meant they could achieve little against the night bombers. To defeat the night raider three elements were necessary: an effective Ground Controlled Interception (GCI) radar, an effective AI radar and a fighter aircraft large enough to carry it with the performance to catch enemy bombers and the fire power to knock them down. And, of course, each of those elements needed trained and experienced people to operate and maintain them. The first GCI radars did not become operational until early in 1941. After overcoming some teething troubles the Beaufighter, fast, rugged, and armed with four 20mm cannon, became available in reasonable numbers soon afterwards. Also at that time the effective AI Mk IV radar started to become available in quantity. By the late spring of 1941 Great Britain possessed an effective night air defence system, too.

When reading this detailed account it is easy to become a little impatient with those involved in the development of radar. Why did they have to take so long to bring the various types into service, in the required quantities and with the required capabilities? The answer is that, starting from scratch, the various agencies took just six years to provide Great Britain with a radar directed air defence system that was effective both by day and by night. Given a programme of similar magnitude, even today we might find it difficult to beat that timetable!

It is a good story and David Zimmerman tells it well. Strongly recommended.

Dr Alfred Price

The Devil at 6 O'clock. An Australian Ace in the Battle of Britain by Gordon Olive and Dennis Newton. Australian Military History Publications (13 Veronica Place, Loftus 2232, Australia); 2001. Approx £12 (inc p&p) via the publisher.

Gordon Olive joined the RAAF in 1936, transferring to an RAF short service commission in 1937. He flew Spitfires with No 65 Sqn over the French coast, at Dunkirk and during the Battle of Britain, destroying at least five enemy aircraft and picking up a DFC in the process. Then

came a spell as a fighter controller before he took over the newly formed No 456 Sqn, an RAAF Beaufighter night fighter unit based at Valley. In 1942 his health broke down and after convalescence he rejoined the RAAF and returned to Australia where he served as a Staff Officer on the AOC's staff until the end of the war. He died in 1987. This book has been compiled by Dennis Newton from Olive's own notes, diaries, etc and the writing appears in the first person throughout. When I was asked to review it I thought I was going to be in for yet another series of well-worn combat accounts but I'm glad to say that, although there are some, they do throw new light on such things.

The early chapters give insights into squadron life in the pre-war RAF, particular reference being made to: the sense of unease experienced by fighter pilots, flying aircraft too slow to catch Blenheims, on hearing reports of the Bf 109; the arrival on squadrons of the first RAFVR men; the futility of air exercises conducted with France and the sense of relief when the Hurricane and Spitfire began to appear on the scene. Olive recounts (in much the same terms as Peter Townsend in *Time and Chance*) his feelings as a professional when the amateurs of the VR arrived although, on reflection, he realised that these weekend flyers could be putting in as much flying time as some of the regulars. That was due to the shortage of aircraft in the Service and the manifold other duties that he and his fellows had to perform. Like Townsend, he had no criticism of the VR when the chips were down. His combat accounts are more interesting than usual because of his discussions of the qualities and handling characteristics of the Spitfire and its adversaries - in fact his technical comments on all of the aircraft he flew are informative - and because he takes time out to reflect on tactics. For example, he describes how German fighter escorts which had formed into a defensive circle could be held there by a couple of Spitfires circling above it whilst the bombers flew on undefended. Having discovered this by accident on one occasion he used it deliberately on another, resulting in major losses in the bomber stream. This episode is illustrated in the book by one of Olive's paintings. He was a talented artist who produced many scenes of aerial warfare and his pictures are to be found in the Queen Mother's collections, in the RAF Museum and elsewhere. Unfortunately all the illustrations in this book are in monochrome, and not very good monochrome at that, so much of the beauty and atmospheric quality of the originals has been lost.

After the Battle he and his fellow 11 Group pilots were treated to a talk by Leigh-Mallory who told them that they had fought the wrong way and that he was going to show them how it should have been done, with Big Wing sweeps over France. Olive had his misgivings, which were amply confirmed when he flew such missions. To save the day Bader and No 242 Sqn were brought in to sort things out, by which time Olive was a controller and well placed to observe the results; they were no better we are told. He in fact implies that the losses of RAF aircraft which resulted from successful German fighter tactics, analogous to those which Park and Dowding had employed against them, robbed other theatres of war of men and machines which could have been used more effectively. Australians are often outspoken types and Olive was no exception!

There are lots of interesting things in this book, ranging from the personal experience of being strafed and bombed at Manston to problems of sabotage encountered with Spitfires at the Supermarine factory (which incensed Jeffrey Quill who flew with No 65 Sqn) and with Beaufighters at Valley. We are told about the causes of high accident rates in night flying and in training, due both to difficulties in handling Beaufighters and to human factors. In the closing sections Olive is unsparing in his criticism of the cumbersome organisation of the RAAF which he found on his return to Australia and which, according to him, caused the Americans to relegate Australians to the second line in the Pacific war.

The technical quality of the book leaves a bit to be desired. A piece of text seems to be missing between pages 196 and 197, fortunately without loss of narrative flow, and the photographs would have benefited from enhancement. Some effort may be required to get hold of a copy because of its publication in Australia but that effort would be repaid. For those with the necessary technology, the publisher can be contacted at *www.warbooks.com.au.* I can certainly recommend this book and I am glad to have a copy on my shelves.

Dr Tony Mansell

ROYAL AIR FORCE HISTORICAL SOCIETY

The Royal Air Force has been in existence for over 80 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 inter-war period, and in the era of Cold War tension. Material dealing with post-war history is now becoming available under the 30-year rule. 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 three 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 free of charge 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 £15 per annum and further details may be obtained from the Membership Secretary, Dr Jack Dunham, Silverhill House, Coombe, Wotton-under-Edge, Gloucestershire. GLI2 7ND. (Tel 01453-843362)

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