Air Historical Branch (RAF) Narrative

THE ROYAL AIR FORCE IN OPERATION GRANBY, THE FIRST GULF WAR, 1990-1991

TORNADO F3

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1. General Introduction

A detachment of Royal Air Force Tornado F3 fighters flew continuous combat air patrols (CAPs) from Dhahran throughout Operation Granby. Twelve F3s were deployed to Dhahran at the beginning of the operation, and this number was increased to eighteen during the first three weeks of September 1990. In total, the Dhahran F3s flew more operational sorties than any other RAF detachment in the Gulf. The sheer intensity of these operations would have tested both aircrew and equipment to the limit under any circumstances, but the challenge confronting the F3 detachment was all the more rigorous for two reasons: first, the operation was completely unexpected; second, it bore little or no resemblance to the military eventuality for which RAF Air Defence (AD) squadrons were prepared in 1990.

In the decades that followed the Second World War, the UK AD effort had focused increasingly on the European theatre, in keeping with the broader shift of British defence policy from the empire to NATO. By the mid-1970s the final phase of decolonisation had been completed; from then on, AD forces were based in Britain and Germany alone (although, after 1982, it unexpectedly became necessary to maintain AD detachments in the Falkland Islands). A new AD system was established in the UK during the 1980s to fulfil the requirements of NATO strategy. This system comprised an enlarged air-to-air refuelling force, a new airborne early warning force, a completely overhauled ground-based radar and command and control network, and a massive programme of airfield improvements; and, of course, it substantially dictated the course of fighter procurement and logistics. The F3 was intended to perform the specialised function of long-range bomber interceptor within the British AD region rather than the Offensive Counter-Air (OCA) or dogfight roles, which were to be undertaken by other western air forces. The aircraft was to operate from well-founded main operating bases with fixed supply, maintenance, command, control and communications facilities, and full accommodation for base personnel, all scrupulously hardened and protected against nuclear, biological and chemical (NBC) contamination.

The F3 entered service in the mid-1980s, while other RAF fighters were progressively phased out. By 1990 the RAF was equipped with eight fighter squadrons: five F3 squadrons and a single Phantom squadron were based in Britain,

two additional Phantom squadrons in Germany. The only regular commitments assigned to the F3 squadrons beyond Western Europe took the form of routine exercises in such locations as Cyprus and Goose Bay in Canada; the Falklands task was assigned to the Phantoms. In August 1990, less than a year had passed since the collapse of the Warsaw Pact, and the Soviet Union was still in existence. The only changes envisaged in British defence policy were force reductions under the so-called 'Options for Change' White Paper first revealed to Parliament only weeks before the Gulf crisis.

It is within this context that the F3 deployment to Dhahran must be considered. The detachment was required to deploy away from main bases to an airfield controlled by a non-NATO government, which offered only limited (and shared) facilities, and which was located far out of area and close to hostile forces. Operations had to be conducted in the same, potentially hazardous, environment, in collaboration with AD elements from the Royal Saudi Air Force (RSAF) and the United States Air Force (USAF). Moreover, the F3 was to receive its baptism of fire not in long-range interception missions over the North Sea against Soviet bombers, but in CAPs over the desert, confronting an adversary equipped with a variety of Soviet-built aircraft, including such modern fighters as the MiG 29 Fulcrum.

This study examines each of these issues in turn. The first section covers the deployment and enlargement of the F3 detachment at Dhahran, and the associated problems of base defence and security; the second surveys the pattern of F3 flying during both the 'Desert Shield' and 'Desert Storm' phases of Operation Granby; the third focuses on the performance of the F3 in the Gulf, and assesses the impact of the extensive F3 enhancement programme at detachment level.

2. Deployment and Basing

A sense of acute urgency surrounded the initial decisions leading to the F3 deployment to Dhahran in August 1990. Immediately after Iraq's invasion of Kuwait, intelligence assessments suggested that Iraqi troops were assuming defensive postures on the Saudi Arabian border, yet Iraq could easily have secured the Saudi oil fields in a matter of days or targeted Saudi Arabia from the air. No military deployments could be initiated until the government had defined British policy towards the crisis, so the Chiefs of Staff meeting on 7 August restricted itself to a

review of military options. Their briefing papers observed that while the greater weakness in the Royal Saudi Air Force was in offensive capability, air defence would be vital in the event of war 'and presentationally could have advantages in comparison to overtly offensive reinforcement'. The initial priority was, however, symbolic: it was essential to make a clear and immediate 'demonstration of [UK] intent' to protect the territorial integrity of Saudi Arabia.

By chance, one of the RAF's Tornado F3 Squadrons, 29 Squadron, was in Cyprus on armament practice camp and was due to rotate with 5 Squadron imminently. Both squadrons were thus already assembled in the form of air-transportable packages, along with their ground-support equipment, and could easily be moved on from Cyprus to the Gulf.

On 8 August, the government decided that forces should be made ready for dispatch to Saudi Arabia, and the Secretary of State for Defence approved the retention of one F3 squadron in Cyprus and, subject to consultation with the Saudi government, for the second squadron to prepare for deployment to the Gulf. There remained only the question of where the F3s would be based. Following a ministerial meeting on the 9th, the Secretary of State approved the dispatch of 12 F3s from Cyprus to Saudi Arabia on the 11th. Meanwhile, the British Air Attaché in Riyadh signalled the MOD:

> Commander RSAF today decided that RAF deployment will be to Dhahran. This is a major RSAF base for Tornado ADV[1] and IDS.[2] No shortage of fuel, oil, or LOX, envisaged but base is very crowded with recent deployments, and refuellers may be in short supply . . . Working accommodation is not yet established; it will probably be of high quality, but space may be limited. However, catering, domestic accommodation and MT for at least 350 has been arranged by BAe [British Aerospace] Dhahran.

A detailed site reconnaissance report prepared by an RAF liaison team subsequently confirmed this positive assessment of the facilities at Dhahran.

[1] ADV – Air Defence Variant.
[2] IDS – Interdictor/Strike.

A Warning Order for the move to Dhahran was issued by the Joint Headquarters (JHQ – located at HQ Strike Command, High Wycombe) on the evening of 9 August. It nominated the Commanding Officer of 5 Squadron, Wing Commander[3] Euan Black, as overall Squadron Commander. The order instructed him to prepare 12 aircraft drawn from the two squadrons, at 12 hours' notice to move. Aircraft were to be fully armed and fitted with 2,250-litre under-wing fuel tanks. The designated armament was four Skyflash Super-TEMP AAMs, four AIM-9L Sidewinder AAMs, and 160 rounds of HE ammunition. In the event, the Skyflash missiles could not be made ready for the initial deployment; they arrived from the UK without sufficient 80/10 racking to allow for missile preparation. TEMP standard missiles were therefore loaded in their place, drawing on pre-positioned Akrotiri stocks. Racking and trolleys for the Super-TEMP missiles arrived at Dhahran 14 days later, permitting armourers to prepare 24 war-loads.

The aircrew to aircraft ratio was to be 2:1, based on a worst-case assumption that 24-hour operations might be necessary in the event of war. Numbers were raised to the required level by the addition of four crews from 11 Squadron, RAF Leeming. The actual crew breakdown was twelve from 5 Squadron, nine from 29 Squadron, plus the four from 11 Squadron. This effectively accounted for all the combat-ready crews of 5 and 29 Squadron, while the groundcrew team absorbed the full complement of both squadrons' Akrotiri detachments. The two principal squadrons each provided their six best aircraft plus two reserves from among those serviceable. Aircraft deploying to Dhahran on 11 August were to land there at 0700 (1100 local time). RAF Lyneham and Brize Norton were to provide C-130 air transports and AAR as required.

At Dhahran, steps were concurrently being taken to establish base facilities for the F3 detachment. The first Dhahran Detachment Commander was Group Captain RS Peacock-Edwards, who at the time was Station Commander, RAF Leeming. He was informed of his posting on the morning of 8 August in a telephone call from the Director of Operations at JHQ, Air Vice-Marshal RE Johns. That afternoon he was flown to Northolt for a briefing at JHQ, which comprised an intelligence appraisal of the situation in the Gulf and a session with the newly appointed Joint Commander,

[3] All commissioned ranks that appear in this narrative are those held by the officers concerned during

Air Chief Marshal Sir Patrick Hine, who revealed that his destination was Dhahran and explained to him the nature of his role. With a team of around 100 specialist staff, which was being assembled to support him, he was to fly out from Lyneham that night, or early the following morning. The team included members of the Tactical Communications Wing, a mobile catering unit, suppliers, administrators and representatives from all the support and operational branches, including Air Transport, Maritime, and RAF Regiment. These personnel were the leading wave of the RAF deployment to the Gulf and were intended not only to prepare the ground for the F3 detachment at Dhahran, but also to form the embryo Air Headquarters. Many of them moved on to Riyadh a few days later to join the staff of Air Vice-Marshal Wilson when he arrived from the UK following his appointment as UK Air Commander.

The briefing that Peacock-Edwards received was far from specific and left much to his own initiative. Preliminary plans were drawn up during the journey to the Gulf. Gathering together the key personnel to discuss their respective briefings and their understanding of their functions and objectives, he formulated a working programme of responsibilities and immediate targets. The C-130s staged through Akrotiri, where Peacock-Edwards took the opportunity to update the Station Commander and the F3 Squadron Commanders. On arrival at Dhahran, he found that the MOD's Saudi Tornado Liaison Team and the local BAe representatives had already made useful progress with the arrangement of accommodation and transportation. Nevertheless, many members of the advance party went straight to work in preparation for the detachment's arrival.

Peacock-Edwards' first action was to seek a meeting with the Base Commander and Saudi AD Commander at Dhahran, Prince (Brigadier General) Turki bin Nasser bin Abdul Aziz Al Saud. At the meeting, Prince Turki explained that he had already allocated a parking line for the F3s, which was under sunshades. For its headquarters, the detachment was offered accommodation within the Saudi headquarters building.

Like other RAF commanders who worked with Prince Turki, Peacock-Edwards conceived a great respect and admiration for him, but he also found that Saudi

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protocol could be trying and drawn-out. Given the rapid pace of events, key decisions often took too long, and it was sometimes necessary to anticipate matters. Of particular note, Peacock-Edwards found himself questioning the plan to locate his headquarters in the Saudi headquarters building. Space there was limited, and it seemed likely that the RAF, as co-tenants and guests, would have to defer constantly to Saudi formalities. Convinced that a separate headquarters would offer a more relaxed and productive environment for his staff, he decided to build one adjacent to the Saudi building. Portacabins, furniture and all the essentials were quickly procured; by 15 August the headquarters was in use.

The RAF Detachment Commander at Dhahran was also the designated RAF AD Force Commander, possessing responsibilities and terms of reference delegated from the Air Commander. His assigned forces, over which he was given Tactical Control (TACON), comprised the Tornado F3 detachment with its crews and support personnel, an RAF Regiment Field Squadron, members of the Tactical Supply Wing and the Tactical Communications Wing, elements of RE Support Troops and 30 Signals Regiment.

The F3s took off from Akrotiri at 0200 on 11 August, flying in two waves of six aircraft, with a twenty-minute interval between them. The first wave was manned by 5 Squadron, the second by 29 Squadron. Their route took them south over Egypt to Luxor, where they parted company with their tankers, and then east to Dhahran. The aircrews had only a superficial knowledge of the situation awaiting them in the Gulf, and it seemed ominous to the lead formation when, on turning eastwards, their radios fell silent; there was no reply on any frequency to any of their calls. After more than an hour, the formation leader was growing deeply apprehensive about the continuing lack of radio contact and was wondering whether Saudi Arabia had already been invaded.

Dhahran finally came on the air, but the contact was hardly reassuring. A controller repeatedly ordered the formation in an agitated voice to ‘turn south immediately’, without offering any explanation. In response, the leader fanned his aircraft out into a wide battle formation and scanned the sky to the north, expecting imminent confrontation with the Iraqi Air Force. He then dutifully turned south. However, when the Dhahran controller failed to elaborate on the reason for his instructions, the F3s

resumed their original course. They reached Dhahran after a transit time of four hours to find that full provision had been made on the ground to receive them. The detachment shared accommodation with 29 Squadron RSAF (equipped with Tornado ADVs) comprising an operations room, offices, briefing rooms, and a flying clothing section. The groundcrew had three portacabin complexes on the flight line, about half a mile from the operations rooms and 300 yards from the parked aircraft. BAe provided air-conditioned domestic accommodation in their own compound after repatriating most of their employees.

In accordance with the Operation Order, the aircraft were turned around immediately and declared on state, with crews at 60 minutes readiness. Flying began on 12 August with training CAPs and theatre familiarisation sorties, but the commencement of operational CAP flying was delayed pending the finalisation of compatible Rules of Engagement (ROE) between the RAF on the one hand, and the USAF and RSAF on the other (see below). The first operational sorties were eventually flown on 17 August, when these ROE differences were narrowed but not fully resolved.

3. Enlarging and Upgrading the Force

By the fourth week of August, the F3 detachment had established a defensive presence in Saudi Arabia, thereby signifying the unequivocal determination of the British government to resist any further advance by the Iraqi armed forces and its solidarity with the allied coalition. In other words, it had achieved its principal objective. Yet this first, hurried, deployment had barely been completed before JHQ began considering proposals for enlarging the detachment.

This was primarily a political measure rather than a military one. The coalition could only benefit from a larger British commitment, which would encourage other nations to participate and discourage any tendency to view the Gulf operation as an all-American affair. At the same time, it was important that further deployments should not appear provocative. ‘The political flavour is still defensive,’ a JHQ brief declared, ‘and the PM favours additional F3 being sent to the Gulf.’ Nevertheless, there were military considerations too. If hostilities broke out, the F3 flying programme was certain to intensify. By early September, a wartime sortie rate of 22 per day was anticipated over a minimum period of 48 hours – an operational output that would be difficult if not impossible to achieve with only 12 aircraft.

The task of enlarging the detachment was not entirely straightforward. It was far from clear that Dhahran could offer additional ramp space, and the urgent need to replace the so-called 'Z-List' standard F3s originally deployed with an upgraded standard of aircraft labelled 'Stage 1 Plus' (see below) raised a variety of problems. It was essential to accomplish a general transition to the Stage 1 Plus F3 via a single roulement because of the many difficulties involved in operating two F3 variants simultaneously. Moreover, the deployment of a larger F3 force with Stage 1 Plus standard aircraft could not be achieved until aircrew and groundcrew had received the necessary training and familiarisation with the updated aircraft.

On 20 August 1990, JHQ contacted Group Captain Peacock-Edwards to ascertain Dhahran's capacity to accommodate more F3s. Peacock-Edwards replied that the base was now suffering from an acute shortage of space but that six additional aircraft could probably be accommodated alongside the existing twelve. The total complement of F3s could thus be increased to 18, with aircrew numbers being raised to 30 – a slight reduction in the aircrew/aircraft ratio. Some 90 more groundcrew would be required.

Considering these recommendations, the staff at JHQ agreed that more F3s would be needed at Dhahran in the event of hostilities, and accepted in principle a reduction of the aircrew/aircraft ratio: the Iraqi Air Force appeared to have little night attack capability, and 24-hour operations therefore seemed unlikely. Yet they did not favour the *immediate* enlargement of the F3 detachment because of the implications for training. 11 Group was working flat out to train an adequate pool of aircrew merely to operate 12 Stage 1 Plus F3s, and there was no desire to increase this burden still further. JHQ therefore proposed retaining the strength of the F3 detachment at 12 aircraft and 24 crews, while a further six aircraft and crews were held at readiness in the UK. These crews could be given priority in training to operate the upgraded fighters. The practicalities of this argument were sound enough, but it did not provide a satisfactory response to the political pressure to send more aircraft to the Gulf.

However, the decisive factor in the debate proved to be the lack of continuation training available for deployed crews at Dhahran when only twelve F3s were in theatre. The very intensity of the flying programme, which required eight sorties per

day, provided little scope for training, but the stereotyped nature of CAP duty made matters worse. There was, for example, no opportunity for general handling or tactical training and no practice in the use of operational systems. Visiting the Gulf at the end of August, the Joint Commander reported back to CDS that more representative and demanding training for the F3 crews was needed. On the assumption that CAP flying would not increase, the Joint Commander recommended augmenting the force at Dhahran by six aircraft, bringing the total to 18. To limit the pressure on UK training capacity, the aircrew to aircraft ratio should be reduced to 1.5:1. The deployed force would then amount to 18 aircraft and 27 crews.

Early in September, these arguments were supplemented by more detailed submissions based on the duration of F3 CAP coverage, the daily sortie rate, the CAP sortie rate per deployed aircraft per day, and the associated requirement to hold two aircraft as spares in case one of the tasked F3s became unserviceable. Averaged out, it was calculated that the pressure of the CAP commitment left just 1.6 sorties per day spare for training. For each of the 24 crews, this margin would barely have permitted one training sortie every two weeks. In short, training was impossible, and the only viable solution was to raise the detachment's strength to 18 aircraft and 27 crews. With the Joint Commander's endorsement, this case was relayed to the MOD on 10 September, and ministerial approval to enlarge the F3 detachment reached JHQ on the 12th. Formal Cabinet agreement followed on the 14th and Saudi approval was received five days later.

Plans for the first F3 roulement, replacing the Z-List F3s with superior Stage 1 Plus aircraft, had been initiated as early as 20 August for execution between 28 August and 7 September. The increased total of 18 aircraft formed a detachment that was labelled 11 (Composite) Squadron, which deployed under the command of Wing Commander David Hamilton. All three Leeming F3 squadrons – 11, 23 and 25 – contributed crews. While the aircraft were being modified, Wing Commander Hamilton supervised an intensive programme of aircrew training. Air combat training was authorised down to 2,000ft, and Phantoms and French Mirages were enrolled as aggressors. The French Air Force provided a team to brief on the Iraqi F-1 Mirage and on the calibre of the Iraqi pilots (whom they had trained), and to give their impressions of the way the Iraqis might operate.

As an invaluable bonus, each of the crews had the opportunity to fly two sorties in an F3 simulator configured to Stage 1 standard – the only Stage 1 simulator then in existence. The simulator had been built for the RSAF by Link/Miles and was still on their premises in Worthing, Sussex, where it was awaiting dismantling before delivery. A cautious approach to the Saudis was ultimately rewarded by their agreement for its use in the UK for a limited three-day period. It proved to be an excellent training aid, permitting full operation of the modified weapon system, fighter vs. fighter engagements against the MiG-29, and practice approaches into Dhahran. Nevertheless, when the detachment deployed, few of the aircrew had flown in the fully modified F3 more than once, their other flights being in only partially modified aircraft. It could hardly be claimed that they were very familiar with the Stage 1 Plus capabilities.

The F3 roulement was organised in three stages. The first eight aircraft departed from the UK on 29 August, staged through Cyprus (where two aircraft were held as spares), and arrived at Dhahran on the following day; AAR support was provided for both legs. The second wave of the roulement, originally scheduled for 5/6 September, was postponed until the 16th. This occurred because of adhesion failures involving Radar-Absorbent Material (RAM) tiles in the engine air intakes of the aircraft at Dhahran. Of the six aircraft that deployed on the 16th, one suffered an engine failure in Saudi airspace and was forced to divert to Medina, causing a diplomatic incident. Medina is one of the three holiest cities in Islam and the location of two mosques constructed by Muhammad himself, and there was considerable sensitivity over the presence of a foreign military aircraft there. Yet the city was on the F3s' approved route, and no other diversion airfield was within range when the failure occurred. The RSAF immediately provided a C-130 to bring a replacement engine and a repair team from Dhahran to Medina, the engine change was completed overnight, and the straggler finished its journey on the morning of the 17th.

The third and final batch of Stage 1 Plus F3s left Leeming on 22 September and flew direct to Dhahran. Four airborne spares accompanied them as far as the French Flight Information Region (FIR) boundary, before returning to the UK. By 22 September, the roulement was complete; the Dhahran F3 detachment now comprised 18 aircraft and 27 crews, as well as the Detachment Commander, 336

groundcrew, and a Warrant Officer. It was formed into three aircrew flights: ‘A’ Flight of 11 Squadron, ‘B’ Flight of 23 Squadron, and ‘C’ Flight of 25 Squadron. The groundcrew were similarly formed into three shifts to provide round-the-clock manning.

The second roulement occurred at the end of November and in early December. Half of the replacements were drawn from 43 Squadron (RAF Leuchars) and half from 29 Squadron (RAF Coningsby). Wing Commander AD Moir, the OC 43 Squadron, became Detachment Commander, while Wing Commander RWD Trotter took charge of personnel from 29 Squadron, most of whom had previously served at Dhahran in August and September. The deployment was again preceded by an extensive work-up, involving affiliation against fighter-escorted and unescorted bomber packages and some fighter sweeps, as well as further simulated combat with FAF Mirage F-1s and a thorough assessment of the F-1’s capabilities. Crews also flew night sorties with Night-Vision Goggles (NVGs), practised donning and doffing the AR-5 NBC suit and eventually flew in AR-5. Stage 1 Plus F3s replaced Z-List aircraft in these exercises as they became available. The first members of the new detachment arrived at Dhahran on 26 November, and the roulement was complete by 21 December.

4. Base Defence and Security

Among the many challenges confronting RAF Detachment Commanders at Dhahran throughout Operation Granby, the security of personnel and equipment was a matter of particular concern. Five principal threats had to be considered: physical invasion by Iraqi ground forces, air, missile and chemical weapons attack, and terrorism.

In the early weeks of the operation, the Dhahran detachment received continuous reports of massive Iraqi troop concentrations and seething military activity just across the border in Kuwait. The coalition ground presence was initially too limited to impede a major Iraqi offensive, and Dhahran, a key airfield situated on the main road south, barely 100 miles from the border, would have been a vital objective for invading forces and could quickly have been overrun. The first Detachment Commander, Group Captain Peacock-Edwards, therefore devised his own evacuation plan, which would have been triggered by a warning from intelligence sources that the Iraqis were crossing the border. Using buses and whatever MT the

detachment could acquire, the groundcrew were to be ferried southwards. Aircraft on the ground would take off and fly south, and those airborne, once relieved from CAP tasking, would also divert to the south. The aim was to preserve the detachment intact, pending further orders on its deployment. The plan was co-ordinated with equivalent emergency measures developed by the USAF.

The proximity of the Iraqi Air Force was another major concern. For protection against the sun, the F3s were concentrated in a single line under shades provided by the Saudi authorities. Even then, a range of unserviceabilities resulted from the exceptionally high ambient temperatures – up to 49ºC – during the early stages of the deployment. Unfortunately, grouped together in this way, the F3s were very vulnerable to air attack. Dispersal from the shaded area would have involved their prolonged exposure to direct sunlight, with corresponding technical penalties, but Group Captain Peacock Edwards decided to draw up contingency plans for dispersal, if only for implementation in the event of hostilities. In mid-September, he wrote to Prince Turki expressing his concern over the vulnerability of the F3s and seeking discretion to formulate an emergency dispersal scheme. For this, he would require temporary access to other parts of the airfield, preferably near revetments or similar features that would provide some protection. In response Prince Turki denied that suitable dispersal sites were available, any vacant areas having been earmarked for additional deployments then under consideration.

Yet the main problem was that the Saudis did not share the RAF's perceptions of the facilities required for dispersal. Dhahran was certainly suffering from a severe shortage of ramp space – space that the base authorities saw as suitable for parking the fighters, and which was designated for that purpose; but there was no general shortage of space at the airfield, which was huge. The RAF, with its considerable experience of operating from dispersed sites during Tactical Evaluation and other exercises, believed that many other areas could be used. They might not have been endowed with communications, shelter, sunshades or other facilities, but these were unnecessary for short-term deployments. Such locations could be employed temporarily with the bare minimum of supporting infrastructure – some tentage, MT and a radio or telephone.

Dispersal plans were therefore prepared, using engine-running pans as dispersal points, but it was desirable to practise their implementation. In October, Peacock-Edwards' successor as Dhahran Detachment Commander, Group Captain John Rooum, wrote to Prince Turki once again, drawing attention to the vulnerability of the F3s, identifying specific locations that would make suitable dispersal sites and suggesting ways in which dispersal could be effected in an emergency. He proposed that a dispersal plan should be practised on a weekly basis during the detachment's normal flying operations, other circumstances on base permitting.

Eventually, by dint of persistence, the detachment persuaded Prince Turki to allow a dispersal exercise to demonstrate the efficacy of their plan, which he attended himself. He was satisfied, and dispersal exercises thereafter became a regular feature of the detachment's activities. They employed such sites as compass-swing pans and engine-running bays, putting a pair of aircraft on each with a small handling team. The sites would not have been suitable for holding alert states because of their lack of communications (aircraft radios apart), but this was not a requirement. They were entirely adequate for the actual task, which was to support the programme of pre-planned flying specified by the Fragmentation Order (see below). The sites were not hardened but they were spread out, and they rendered the aircraft far less vulnerable to a random surprise attack than they had been on their usual apron, where a single strafing pass could have damaged the whole line.

As time went on, the detachment sought to reduce its vulnerability in other ways, including the construction of air-raid trenches and the procurement of 11-ton concrete Splinter Protection Units (SPUs), along with the full range of collective protection ('colpro') facilities. However, much of this equipment was still in boxes in December, when the F3s were compelled to make way for RAF Tornado GR1s and moved to the so-called 'Egyptian Dispersal', a site some 2½ miles south of the original flight line, which had previously been reserved for Egyptian Air Force F-16s. Here the aircraft were parked in two groups across a long open line. Thus, although they were now away from the central area of the Dhahran base, they were not more dispersed. The detachment operations room was in a bunker that could also have served as an air-raid shelter, but it was inconveniently located some 600 yards from the engineering line. With hostilities less than one month away, the air-raid protection issue was now even more pressing.

Nevertheless, over the next few weeks, there were significant security and force protection improvements right across the Dhahran base. Tents, drop-tank storage containers and shed-sized ISO bulk storage containers were all deployed. The SPUs, each standing halfway up to the height of the Tornado fin, were erected between every second aircraft in the line, equipment was dispersed, and sentry positions were created. Porton and Winterbourne liners and other colpro facilities were installed at many locations, and all detachment personnel undertook extensive training in colpro drills. In the Saudi base operations centre, an NBC cell instituted joint NBC training for all personnel at Dhahran and formulated a joint NBC emergency plan. Two biological detection teams were formed to detect any release of biological warfare agents.

In the event, the Iraqi Air Force proved unable to conduct a single attack on any of the coalition air bases, but the Scud missile proved a more formidable threat. Coalition commanders originally believed that the Iraqis would require between three and six hours to prepare a Scud launch, a delay which would have provided sufficient warning of their intentions. But this scenario was based on full procedures for an accurate launch, including the erection of a satellite guidance system. The possibility that they might minimise any chance of forewarning by dispensing with the preliminaries and firing missiles without accurate targeting aids had not been considered. Yet this was a feasible tactic against large targets such as cities or airfields; the Dhahran base was eight miles wide.

The first Scud warning helped to overcome complacency and sharpen readiness. Sandbag walls and revetments were soon added to Dhahran’s defensive preparations. The many launch warnings issued in the second half of December all turned out to be false alarms, but they were sufficient to drive detachment personnel into their shelters dressed in full protective clothing.

Ironically, when at last a genuine Scud attack occurred, on 18 January (after the launch of Desert Storm on the 16th), it caught the detachment by surprise: the first warning was a Patriot missile launch from a battery some 300 yards behind the aircraft line. The attack caused no serious damage but was symbolically of great significance, and there could have been no more tangible demonstration of the reality of live combat. The last Dhahran Detachment Commander, Group Captain

Cliff Spink, recalled that ‘suddenly the whole detachment realised that this wasn’t war by association – you were in it.’ In response, the alert system was progressively improved to a point at which it could provide a four-minute warning of missile attack.

More Scuds were launched against Dhahran on January 19, 20, 21, 22, 23 and 25; in total, eleven missiles hit the airfield. On 25 February, a Scud struck an American army barracks about half a mile from the nearest RAF compounds, killing 28 and wounding 98 others. On another occasion, part of a crippled Scud fell about half a mile from the F3 detachment, and the resulting explosion illustrated all too clearly the value of the air-raid shelters.

Yet the Scud’s psychological impact was far more serious than its material effect; it functioned primarily as a terror weapon. Detachment personnel had to cope with the ever-present sense of threat and with constant alerts, while the shattering noise of Patriot firings robbed them of much-needed sleep. The possibility of Scuds being fitted with chemical warheads could never be entirely discounted, and a grand gesture of defiance involving weapons of mass destruction appeared all the more probable in the later stages of the war, as the Iraqi plight became desperate. Such factors conspired to keep stress levels high, and, in a very small number of instances, personnel suffering from combat stress were transferred from key duties to less important work. Whatever the time or place, whatever the activity, there was always a threat from the Scud. For this reason, in the retrospective view of Group Captain Spink, the missiles ‘severely restricted [our] ability to conduct normal military operations’.

Although the RSAF and the USAF also made sustained efforts to protect their personnel at Dhahran, Group Captain Spink felt that ‘the British were undoubtedly best at it . . . When we had a gas alert, of which we had two or three (gas, chemical and other), the only people working on the airfield were British . . . There was not another national in sight.’ When difficulties occurred, they were generally practical in nature – for example the non-availability of manpower or plant for the erection of protective facilities – or they arose through misunderstandings or insufficient liaison with the host nation. They were usually resolved in the course of time.

But there was no immediate solution to one problem encountered during the early stages of Operation Granby. The F3 detachment’s groundcrew and aircrew had all

been issued with respirators and full protective clothing designed for use in northern Europe rather than the Gulf, where temperatures as high as 50ºC are common in July and August. In these conditions, the Dhahran Detachment Commander (at that time still Group Captain Peacock-Edwards) doubted that flying in the AR-5 aircrew NBC suit would be either feasible or safe. While this judgement proved unwelcome to the staff at JHQ, they were eventually overruled by the Joint Commander. It nevertheless proved necessary to demonstrate the point in theatre by organising a formal trial, in which aircrew undertook their routine tasks clad in the AR-5. This duly occurred on 2 September and proved conclusively that the AR-5 was a threat to both flight safety and aircrew welfare in the Gulf environment. It was, in short, unsuitable for operations in the high ambient temperatures typically experienced there during the summer months.

The Principal Medical Officer (PMO) at JHQ persuaded himself that the problem with the AR-5 was largely caused by the physical act of dressing up in it, and by the body heat generated in the process. This was, he maintained, exacerbated by the aircrews' unfamiliarity with the suit. He therefore recommended that aircrew destined for the Gulf should practise donning drills to achieve proficiency and familiarity before their departure. The AR-5 trial had in fact been conducted by a trained aircrew NBC instructor. Nevertheless, in accordance with the PMO's proposals, JHQ now instituted a strict and graduated programme of training, which applied to both marks of Tornado, and to the VC-10 and the Jaguar. It initially involved multiple donning and doffing cycles; subsequently, crews clad in the AR-5 undertook flight simulator sessions and practice entries to, and exits from, the aircraft. Both aircrew and groundcrew applied themselves assiduously to NBC training to an extent that surprised their RAF Regiment instructors. In theatre, however, AR-5 training at Dhahran was postponed until November, when ambient temperatures of below 25ºC could be expected.

As well as the dangers posed by Iraq's military capability, there was assessed to be a significant threat of terrorist action against coalition forces at Dhahran. Personnel accommodated off-base were particularly vulnerable, both in their housing and in transit. No. 51 Squadron RAF Regiment (augmented by 47 RAF tradesmen guards) was responsible for the security of the detachment sites both on and off base, and collaborated in other tasks with Coalition allies. The ground defence arrangements

were fully integrated with the USAF and RSAF Security Police and US Army MPs, and were based on RAF procedures, which the other coalition forces readily adopted. In all, some 1,000 personnel were committed to these duties by the onset of hostilities in mid-January.

Group Captain Spink later described a particularly striking example of collaborative anti-terrorist action at Dhahran. The base was less vulnerable to terrorism than it might have been because most civilians had been evacuated from the vicinity: personnel who were not engaged in official business were easy to identify. Nevertheless, shortly after his arrival, Group Captain Spink learned that a large enclave of Palestinian immigrants inhabited apartment buildings just south of the airfield, within 400 yards of the Egyptian Dispersal. Elsewhere in the Middle East, Palestinians had expressed strong support for Saddam Hussein and equally vociferous opposition to the coalition. With the Palestinian cause historically linked to a number of terrorist organisations, with hostilities in the Gulf imminent, and with every possible effort being made to conceal preparations for the air campaign, their location so close to the F3 detachment could only be considered a serious security risk. Spink therefore decided to raise the issue of their presence with Prince Turki. The results were truly remarkable. ‘Within three days, 50 buses arrived and bused them out. There was no ‘by your leave’; they just went.’

5. Tornado F3 Operations: Desert Shield

The F3 detachment’s flying programme evolved on an *ad hoc* basis as resources permitted; more than six weeks passed before a routine operating schedule was established. During the first fortnight of Operation Granby, the detachment, with only twelve aircraft and no AAR, flew CAPs as intensively as possible and did not undertake any training. The advent of tanking in early September allowed the sortie rate to be reduced, and training commenced in the final week of September following the enlargement of the F3 detachment from 12 to 18 aircraft. A lower sortie rate then operated throughout October, November and much of December, but CAP tasking increased again in the weeks immediately preceding Desert Storm.

The 12 F3s originally deployed to Dhahran by the RAF shared the AD task with 48 USAF F-15s, 12 RSAF F-15s and 12 RSAF Tornado ADVs. After some early RAF-RSAF attempts to fly mixed formations, the three air forces agreed to operate

separately. Flying operations for the F3 detachment were at first organised on a two-shift system, rotating at noon and midnight, with 12 crews on each. One shift was entirely manned by 5 Squadron, the other divided between 29 and 11 Squadron. A three-shift system was introduced when the detachment was enlarged from 12 to 18 aircraft in September.

CAP sorties were flown in an area 120-170nm north-west of Dhahran. In the early stages of the crisis there were two rows of CAPs – forward CAPs, some of which went up to 40nm from the Kuwait border, and rear CAPs at 70nm. Visitors from the Central Trials and Tactics Organisation (CTTO) noted in November that CAP height was between 5,000ft and 8,000ft, which was assessed to be below enemy SAM coverage at the CAP position. CAP speed was limited to 350kts to conserve fuel. With the USAF F-15s maintaining four aircraft permanently at five minutes ground readiness, there was no need for the F3s to institute formal Quick Reaction Alert (QRA) procedures, but all crews were subject to a nominal 60-minutes readiness state.

The standard aircraft configuration was two 2,250-litre tanks, four Sidewinder and four Skyflash missiles, the cannon, and the AN/ALE-40 flare dispenser (the PHIMAT chaff dispenser eventually replaced one of the Sidewinders). As with aircraft in other roles elsewhere, the flying programme for AD forces was directed by a daily Fragmentation Order (‘FRAG’) issued by the Combined Air Operations Centre (CAOC) in Riyadh. A matrix system was used for positioning the CAPs, and USAF and RSAF Boeing E3A AWACS provided tactical command and control. At least two AWACS would normally be airborne, one of which was always American. Inevitably, the Americans had considerably more experience of airborne C2 than the Saudis.

One of the key operational issues confronting the first Dhahran and F3 detachment commanders was the negotiation of compatible ROE with the RAF’s coalition partners. On 17 August, Wing Commander Black noted the extreme difficulty of agreeing ROE with the USAF and RSAF, whose rules seemingly allowed them to engage any aircraft straying across the border. After a 24-hour hold on F3 flying, their CAPs had resumed, but they had been moved to locations where there was unlikely to be a direct challenge from the Iraqis.

Within the first week of the operation there were three cross-border violations by Iraqi aircraft. In the first instance, an aircraft ventured five nautical miles south of the border before turning away, with a USAF F-15 in contact. In the second, an aircraft south of the border was actually locked up by a USAF F-15; it turned away just in time. On the third occasion, a night-time intruder declared hostile by AWACS and locked up by a Saudi F-15 also retreated at the last moment. Both the USAF and RSAF crews were on the point of firing if the contacts had continued south. However, the UK ROE would not have allowed engagement without more compelling evidence of hostile intent.

Although the ROE had theoretically been harmonised by 20 August, the F3s were still prohibited from engaging contacts beyond visual range purely on the basis that they were declared hostile by US or Saudi AWACS. The F3 crews preferred the American approach to ROE, which seemed more aggressive and rendered them less vulnerable to hostile action. They saw the UK position as 'Don't shoot unless you are shot at.' On the other hand, the senior executives at Dhahran were happier with the UK's more restrictive ROE. They reasoned that an intruder might simply be a defector or a stray. To engage Iraqi aircraft before hostile intent was confirmed could well precipitate the war that the coalition's presence was supposed to deter.

It was therefore decided that potentially hostile contacts passed to the F3s should be allowed to fly further south until their aims became clearer. If engagement proved necessary, it would then occur well inside Saudi airspace. This would reduce the chances of unnecessarily escalating the crisis, prevent escape, and silence any claims from Baghdad that the engagement had occurred over Iraqi territory. If the AWACS reported a contact, the tasked F3s would take an AI lock on the target as soon as possible and, if there was evidence of a hostile reaction (such as Electronic Countermeasures (ECM) or evasion), an offset would be generated to reduce closing velocities. The first pair would then veer off through 180º to allow the second pair to close. This would be repeated as often as possible, giving minimum closure by the F3s and maximum penetration by the enemy. The F3s would ultimately attempt a short-range engagement well inside Saudi airspace. However, this approach was by no means consistent with the F3 detachment's favoured tactics, which emphasised the advantages of longer-range engagements. Furthermore, both

the aircraft and its equipment were better suited to longer range than shorter range combat (see below).

By the end of August, a Tactical Air Control Centre (TACC) had been established at Riyadh to function as the higher tactical air C2 authority in theatre. The RAF then appointed two AD officers of wing commander rank to the TACC to monitor control instructions from the AWACS to the F3s, ready to confirm or override them as circumstances dictated. Yet the TACC lacked direct UHF contact with the E3As, and the new arrangements still did not entirely address UK concerns about residual ROE differences and the application of UK ROE by the AWACS crews. At one stage, the AD staff at JHQ went so far as to suggest that RAF controllers might fly on board the AWACS to safeguard British ROE interests, but the manpower bill for this proposal would have been high, and it was not pursued. The UK Air Commander contended that 'The critical issue is the knowledge and implementation of UK ROE by F3 crews.'

The first F3 sorties mounted in Operation Granby were flown on 12 August. By the end of the month, the F3 detachment had flown 201 sorties for 402.05 hours. During the first four days of CAP flying, the detachment mounted eight sorties per day; the rate increased to reach 12 on 20 August, and 14 on the 26th. In the absence of AAR, the average sortie duration was two hours.

The availability of AAR led to an increase in CAP manning early in September. From the 6th, the sortie duration rose to just over four hours, with F3s refuelling two or three times. To maintain 24-hour CAP manning, each day was initially divided into three: the RAF was responsible for manning the CAP for six hours, while the USAF and RSAF were each on task for nine hours. During the first F3 deployment, CAPs were manned by four overlapping pairs between 0700 and 1310. Thereafter, four-aircraft CAPs were maintained continuously between these times. This was a considerable challenge for a unit still comprising just twelve aircraft, and it was subsequently concluded that the F3 detachment had been over-tasked in this period. Relief came only with the arrival of six more aircraft on 22 September.

The coalition then drew up a new flying plot which divided the F3 detachment's daily schedule between daytime (1000-1310) and night-time (2200-0110) CAPs. By that time, CAP manning was distributed as follows:

USAF F-15	-	12 sorties	-	51 hrs/day
RSAF F-15	-	8 sorties	-	34 hrs/day
RSAF ADV	-	4 sorties	-	17 hrs/day
RAF F3	-	8 sorties	-	34 hrs/day

This remained a substantial burden for the RAF to shoulder, given the resources available. Even after the reinforcement of the detachment, the F3s were flying 25 per cent of the CAP effort, in terms of total flying hours, with only 20 per cent of the AD assets in theatre. The RAF's ability to fly a disproportionately high number of CAP sorties certainly impressed the USAF and the RSAF, but the imbalance was viewed with mounting disquiet in Dhahran, at the UK Air Headquarters, and in the UK. On 23 September, the Air Headquarters was informed that 'MOD have expressed concern at what they perceive to be the very high rate of flying being carried out by our Tornado F3 ac.'

By this time, moves were already afoot in the Gulf to reduce CAP manning from four aircraft to two. RAF proposals for a new CAP plot envisaged reductions in CAP manning for all three air forces but offered the most substantial savings to the F3s, reducing the detachment's proportion of total CAP flying hours from 25 per cent to 16.6 per cent:

USAF F-15	-	10 sorties	-	42.5	hrs/day
RSAF F-15	-	6 sorties	-	25.5	hrs/day
RSAF F3	-	4 sorties	-	17	hrs/day
RAF F3	-	4 sorties	-	17	hrs/day

This plan was initially frustrated by an increase in tension with Iraq during the final week of September and an accompanying requirement to enhance the protection of high-value aircraft such as intelligence, surveillance and reconnaissance (ISR) assets. But efforts to reduce CAP manning were renewed after further representations from the F3 detachment. 'I understand the reasons for the continued CAP plot', the Squadron Leader Operations signalled the UK Air Headquarters on 26

September. ‘However, this means we are doing more than our fair share … Therefore can you go into bat for us at the FRAG meeting.’

On 30 September, the USAF agreed to lighten the F3 detachment’s load by flying one of its CAPs every other week. During that week the detachment would only be required to operate one four-aircraft CAP per day, and all other flying would be training; in the following week, the F3 detachment would revert to two CAPs per day. Over two weeks, the F3 detachment would fly 84 CAP sorties. The revised schedule commenced on 3 October; on 7 October a new plot allocated the F3s to an evening patrol during single CAP weeks and to a morning and evening patrol in double CAP weeks. In leaving the detachment with twenty per cent of CAP flying, this reduction fell short of the 50 per cent cut originally envisaged but was, nonetheless, very welcome.

The next significant revision in the CAP schedule occurred at the end of October as a result of efforts to reduce night CAPs from four to two aircraft, so relieving some of the strain on AAR capacity. The introduction of the new plot was delayed after the Saudis alleged that they had not been properly consulted, and a detailed schedule was only agreed on 7 November after several days of high-level haggling:

Week 1

2 x F3 + 2 x ADV geographically separated

2 x F3

2 x F3

Week 2

4 x F3

2 x F3

2 x ADV

The programme did not provide any reduction in the F3 detachment’s overall CAP sortie rate: over two weeks, this remained 84 sorties. But it did spread the resources of the three air forces more rationally than before over a fortnightly schedule.

Moreover, it was potentially an intermediate step towards a further reduction in the night CAP sortie rate. Finally, it re-introduced the concept of mixed CAPs, thereby reducing the F3s' requirement for AAR. Although four-aircraft CAPs comprising two RAF F3s and two RSAF Tornado ADVs had been scheduled in August on a few occasions, they were only 'mixed' to the extent that they flew at the same time of day at the CAP location. The pairs did not unite into a single formation with a common lead, nor did they begin the CAP at the same datum. On 7 November, RAF and RSAF aircraft flew in overlapping pairs (between 2000 and 2210) to the same CAP datum for the first time. This represented a major step forward.

After flying in excess of 240 CAP sorties in September, the F3 detachment succeeded in establishing a reduced plot of 180-190 sorties per month in October, November and December. The average sortie duration remained slightly more than four hours so that total CAP flying hours numbered approximately 800 per month. However, the monthly total invariably exceeded 1,000 hours. By contrast, the RAF AD squadrons involved in Operation Granby would have been accustomed to flying, on average, approximately 280 hours per month under normal – non-operational – circumstances.

6. Training

The discrepancy between CAP flying hours and total flying hours is accounted for by training, which began in earnest after the expansion of the F3 detachment in September. 'We have to 'up' our in-theatre training as soon as possible', the UK Air Headquarters signalled to Dhahran on 20 September. 'Post 22 September we must look at continuation of your progressive build-up of crew training, to include CAP versus large packages.' The training programme included air-combat training, night intercepts, and multi-target work, with affiliation training against attack formations of both US and RAF aircraft, which offered stiff opposition. Among the opponents were Tornado GR-1s, F-16s, F-15s and F-18s. As well as being essential for the operational efficiency of the crews, this type of flying provided a welcome and refreshing change from the unvarying routine of the CAPs. It also instilled confidence in the Stage 1 Plus standard F3 modifications.

All sorties were flown with live weapons, giving crews the rare experience of handling the aircraft in the operational configuration throughout the flight envelope.

Affiliation exercises with the USAF and RSAF ceased after they both refused to mix their unarmed fighters with armed F3s on flight safety grounds, but the F-18s of the US Marine Corps (USMC) flew their training sorties fully armed, and they proved more amenable. The OC 11 Squadron argued that affiliation training with the F-18s was more valuable than training against larger packages. ‘So-called large packages are unrepresentative of what we believe to be the threat,’ he signalled on 3 November.

During November, there were several large-scale AD exercises designed to test the airborne command and control structure. The F3s were vectored to intercept large formations of ground-attack aircraft which, with their accompanying support, simulated Iraqi raids. According to the F3 detachment record, ‘these exercises gave worthwhile training and engendered confidence in the ability of AWACS to give a good service in war.’ The F3s also participated in exercises to test plans for ‘D-Day’ – the first day of hostilities with Iraq. On the ground, the detachment ran a training programme covering intelligence briefing, threat assessment, Iraqi equipment and tactics, air recognition training and combat survival and rescue, as well as the NBC and dispersal training described earlier in this study.

Training was therefore intensive and wide-ranging. Nevertheless, the F3 detachment believed that it was deficient in certain respects. In mid-November, they noted that no Electronic Warfare (EW) training was being undertaken, and that this was ‘potentially a major problem’. Enquiries into the feasibility of in-theatre EW training had commenced by the end of December, but there was no time to achieve any progress before the general cessation of training in January. The detachment also favoured Sidewinder training with AIM-9L, and air-to-air gunnery training using RSAF Hawks for target towing. Sidewinder training was not approved by JHQ because most crews in theatre had at least some experience of firing missiles, and because all the AIM-9L modifications had been tested and cleared for service. JHQ did approve air-to-air gunnery training, but there is no record to suggest that any occurred.

On 23 December, training was suspended so that an enhanced readiness state could be maintained over the Christmas period, when the risk of a pre-emptive Iraqi attack seemed particularly high. Between 24 December and 2 January, six F3s were

held at 30 minutes readiness. On completion of a tasked sortie, instead of standing down in accordance with normal practice, all aircrew from the duty shift remained with the detachment until relieved by the alternate shift.

At the same time, the impending launch of Desert Storm reversed the trend towards reduced operational flying. From 24 December, the F3 Detachment reverted to eight sorties per day, and training flying ceased entirely on 10 January 1991. This decision was not taken lightly, for an abrupt change in flying activity might well have signalled to the Iraqis that hostilities were imminent. Every effort was made at this time to convey an air of normality at Dhahran. From 12 January, the flying rate increased to 12 sorties (three four-aircraft CAPs) per day on days when three AWACS orbits were flown. On the following day, a two-shift system for both air and groundcrew was reintroduced, with 43 Squadron covering day and 29 Squadron night (the squadrons swapped their day/night commitments around at the end of the month). The early switch to this new shift pattern ensured that engineering operations were well prepared and fully functional by the time the first war sorties were flown.

7. Desert Storm

Two plans had been drawn up in preparation for the eventuality of war with Iraq. The first, plan ‘Reflex’, was designed as a response to a pre-emptive Iraqi attack; the second, named ‘Wolfpack’, was the plan for the liberation of Kuwait on a schedule chosen by the Coalition. The decision to implement Wolfpack was conveyed to the RAF Detachment Commander at Dhahran about 48 hours before the onset of hostilities and then relayed to each individual RAF detachment at the base. The aircrew learnt that they were to go to war just 24 hours before Desert Storm began.

At 2100 on 16 January, the F3 detachment received the order to implement plan Wolfpack, starting at midnight. The first F3 war mission took off at 2310 local time. Within 24 hours, the detachment had flown 48 sorties for 91 hours. The high sortie rate and low duration (approximately two hours) was dictated by the non-availability of AAR: all the tankers were assigned to support offensive missions during the opening stages of the conflict. The rate of tasking did not remain at this level, stabilising at fourteen sorties per day of between three hours and three-and-a-half hours by the end of the first week; AAR was renewed with one or occasionally two refuelling brackets. With the RAF’s VC-10s and Victors still committed elsewhere,

the F3s had to make do with Tristar tankers, which had only a single refuelling point. As the F3s flew in mutually supporting pairs, CAPs were regularly left unmanned for longer than would have been necessary had simultaneous refuelling been available for both fighters.

The F3s formed part of a layered AD system in which their specific role was to provide barrier defence and defence of high-value aircraft, such as AWACS and the larger ISR platforms. Initial operations were flown to the south of Kuwait; the CAPs were then moved west to the vicinity of King Khalid Military City. Aircraft sometimes ventured further north to identify radar contacts, the deepest penetrating 140nm into Iraq, but such probes were undertaken on the initiative of individual F3 crews and were not officially sanctioned or encouraged.

From 26 January, the CAP location shifted to the Saudi/Iraq border, where the absolute prevention of all hostile air activity was vital. Central to CINCCENTCOM's ground plan was the secret redeployment of massed coalition forces to the west in preparation for a surprise 'left hook' against Iraq. A single Iraqi Air Force intruder might well have spotted the immense armoured formations assembling in the desert to the south of the border area, jeopardising General Schwarzkopf's carefully devised deception plan. Continuous patrolling by coalition fighters was thus essential to the strategy of 'blinding' the Iraqis during this critical phase of Desert Storm through both deterrence – as the CAPs would have been visible on Iraqi radar – and the creation of a physical barrier to block any Iraqi aircraft that were not deterred. If, on one solitary occasion, the unscheduled appearance of an F3 under-wing fuel tank from the heavens persuaded some of those on the ground that they were under air attack, this was a small price to pay for the benefits conferred by the strong 24/7 fighter presence in the skies overhead. After the ground offensive was launched, the F3s flew their final CAPs over Kuwait itself.

In the border areas, Iraqi AAA and SAMs were an ever-present danger. The accuracy of the F3's navigation equipment and the clarity of its information display helped to ensure its safety, but the threat nevertheless caused CAP altitudes to be raised to around 20,000 feet. The price for the heavily laden F3 (which was optimised for lower-level operations) was a significant increase in fuel consumption and therefore a greater reliance on tanking. Throughout, the Iraqi Air Force was

conspicuous by its absence. On but one occasion, 18 January, did the F3s come close to live combat. On that date, a pair of aircraft on CAP was vectored to the support of three USAF A-10s being menaced by Iraqi fighters as they were returning from an attack mission in Kuwait. The pair passed the A-10s as they flew south across the border and then identified two hostile radar contacts behind them, but the attackers turned away at a distance of ten miles. Thereafter, while the F3s were frequently vectored to identify AWACS radar contacts, none proved to be hostile except for a helicopter that landed before they reached it.

In many respects, friendly forces presented a more serious threat in Desert Storm than the Iraqis: in the crowded airspace over northern Saudi Arabia, Kuwait and southern Iraq, there was considerable potential for collision or 'blue-on-blue' engagements. The Air Component's Director of Campaign Plans, USAF Brigadier General Buster Glosson, subsequently recorded:

> There is a Navy pilot who is alive today because of an RAF Flight Lieutenant who was in a Tornado F3 orbiting behind another ally. The other ally locked Navy up and was given permission to shoot by the AWACS. The Flight Lieutenant said 'Stop, stop, stop. Do not fire.'

Fortunately, the interceptor heeded his warning.

In almost every respect, the F3 detachment had been thoroughly prepared for its role in Desert Storm during the previous four months. The only serious problems arose not in the conduct of operations, but in the management of operational information: following the onset of hostilities, the detachment was swamped with tasking information and rapidly changing intelligence assessments. Lacking a mission support section, it found this material difficult to process and assimilate. The aircrews were too heavily committed to the flying programme to provide mission support as a supplementary activity, and their diversion to such duties would in any case have involved, in the words of the Detachment Commander, 'the misuse of a valuable asset'.

Although the Detachment Commander had sought to obtain dedicated mission support staff several days before Desert Storm began, he unfortunately made the mistake of addressing his request directly to JHQ, bypassing the AHQ and

Headquarters British Forces Middle East (HQBFME) in the process. He was therefore required to resubmit his proposals through the correct channels. The subsequent course of events is unclear from the documents, but no progress was achieved until, on 20 January, he raised the issue directly with the UK Air Commander. It was then agreed that a five-man cell should be established immediately to provide 24-hour coverage for F3 operations. The cell would be responsible for analysis and presentation of intelligence, sortie planning, and the processing of post-sortie information. The mission support cell was functional by 31 January and proved to be a vital asset throughout the remainder of the operation. Of particular note, intelligence collated by the cell helped to ensure that the more northerly F3 sorties avoided enemy SAM engagement zones and high-calibre AAA.

From the launch of Desert Storm to 30 January, the F3s flew 272 sorties out of a total of 1,000 flown by all RAF fixed-wing aircraft on the operation to that date; sortie number 1,000 was itself flown by an F3. In addition, during this period, two aircraft were held on QRA around the clock, at fifteen minutes readiness by day and twenty minutes by night. By early February, the F3 task was to maintain a two-aircraft CAP for 18 hours per day; by 19 February, the on-task period had been reduced to 11 hours per day; meanwhile, the daytime QRA readiness state was relaxed to 20 minutes. The total combat flying achievement in February was 1,162 hours and 416 sorties, an average of 2.8 hours per sortie, including transit time to the CAP location. In anticipation of the ground offensive on 24 February, AD missions moved from barrier operations to lane operations of a north/south orientation.

At 0500 on 28 February, Desert Storm was terminated, but the F3s continued to fly CAPs over Kuwait and to hold QRA for the remainder of Operation Granby. These final sorties were notable chiefly for the opportunities they provided to witness the destruction wrought by the Iraqi army on Kuwait, and the impact of the coalition air campaign. As the OC 29 Squadron recorded, ‘No one who saw the burning oil fields will ever forget. Neither will the devastation of hardened aircraft shelters create confidence in our current ‘hardened’ posture at home.’ On the Basra road to the west of Kuwait City, where a huge convoy of retreating Iraqi troops was famously caught in the open by coalition ground attack aircraft, ‘vultures remained as the greatest hazard to flying.’

On 6 March two F3s on CAP over Kuwait were advised that Red Cross 1, a Swissair DC-9 escorted by two American F-15s, was *en route* from Baghdad to Riyadh carrying the last of the coalition prisoners of war to freedom; among them were a number of Tornado GR1 aircrew. The CAOC granted permission for the F3s to join the formation. It proved a most moving and poignant sight for the returning POWs to witness their aircraft being escorted by two F-15s off the starboard wing and two F3s off the port.

The last F3 sortie in theatre was flown on 8 March 1991, and the detachment returned to the UK on 12 and 13 March, staging at Decimomannu, Sardinia. In total, RAF Tornado F3s flew 7,785 hours and 2,666 sorties on Operation Granby, including 2,129 operational CAP sorties over Iraq, Kuwait and Saudi Arabia. Some 698 sorties were flown during the period of hostilities. The lack of any significant challenge from the Iraqi Air Force was intensely frustrating for the F3 crews, but they responded to a difficult situation with exemplary professionalism. Moreover, their contribution to the coalition's victory was by no means insignificant. Within days of the Iraqi invasion of Kuwait, they helped (in the words of US President Bush) 'to draw a line in the sand'. They subsequently contributed to the exclusion of the Iraqi Air Force from Saudi airspace, helping to conceal coalition ground manoeuvre so that the 'left hook' caught the Iraqis completely by surprise. Finally, by shouldering the burden of the rear CAP task, they freed up coalition fighters with the escort and sweep capabilities that the F3 lacked, maximising the number that could be employed in more forward roles in support of the OCA campaign.

8. The Tornado F3 at War

Granby was the first live operation to involve the F3 since its entry into service (UK-based QRA operations excepted). As such, it provided an excellent opportunity to assess the strengths and weaknesses of the aircraft objectively. However, by August 1990, the RAF had already recognised that the standard 'Z-List' F3 fell short of requirements in a number of important respects, and a range of enhancements had been introduced to upgrade the aircraft to so-called 'Stage 1' standard. After the Gulf crisis erupted, this enhancement programme was rapidly accelerated and augmented, vastly improving the F3's operational capability and rectifying a number of defects, which had previously caused grave concern. At the same time, frantic

attempts to cram a large number of modifications through the six-month Operation Granby procurement window were never likely to be entirely successful, and, even after the enhancement programme was completed, scope clearly remained for the F3 to be significantly improved.

The RAF's requirement for the air defence version of the Tornado was outlined in Air Staff Target 395 in 1971. Full-scale development began in March 1976, and two prototypes were ordered a year later, the first flying in October 1979. The aircraft entered service with the RAF in 1984 as the interim standard F2. The first Tornado F3s, incorporating a host of improvements, arrived at RAF Coningsby in July 1986, and they equipped five squadrons, all based in Britain, by 1990.

The F3 was a product of the Cold War. When it was ordered, some strategic assessments envisaged combat between RAF and Warsaw Pact fighter aircraft, but an equally dangerous challenge was presented by long-range Soviet bombers equipped with cruise missiles. Such aircraft could have been launched from bases in the North Cape or the Kola Peninsula through the Greenland-Iceland-UK gap. By the mid-1970s, it seemed doubtful that the RAF's ageing Lightnings or newer Phantoms would be able to counter the perceived threat; an entirely new aircraft was needed. The Tornado F3 was therefore procured to meet a very specific operational requirement. It was not designed for combat against fighters or offensive missions over hostile or contested territory; rather, it was to serve as a low/medium altitude Defensive Counter-Air (DCA) bomber interceptor to operate at long ranges within the UK AD Region.

Although arguably well suited for this role, design features dictated by the F3's original specification unfortunately prevented it from assuming a broader range of operational tasks under the OCA mantle (which, in the context of operations in the NATO area, would have been assigned to alliance partners). One MOD assessment prepared in 1990 referred to the F3's 'limited agility' and poor aerodynamic performance relative to the most advanced Iraqi fighters. Another, in the following year, declared that the F3 had 'been chronically short of engine thrust, particularly in cold power, since it entered service'. Although fast and operationally capable at altitudes of up to 10,000 feet, at higher levels, carrying a reasonable fuel load, the F3's performance was poor.

In addition, the standard Z-List F3's equipment urgently needed modernisation. The most significant weakness lay in the performance of its AI-24 Foxhunter radar: 'problems included poor lock acquisition and maintenance, limited Electronic Counter-Countermeasures (ECCM) and cumbersome ergonomics.' The effectiveness of the F3's Skyflash missile was in turn hampered by the AI-24's inability to lock on to targets. Moreover, Skyflash did not boast the range of some Soviet-built missiles in service with the Iraqi Air Force, and the F3's short-range AAM, the AIM-9L Sidewinder, lacked Infra-Red Counter-Countermeasures (IRCCM). The Z-List F3 also lacked a realistic night capability and possessed neither EW self-protection nor ECM-resistant communications. Unsurprisingly, it was only configured to operate in the northern hemisphere.

There were no illusions about the shortcomings of the F3 at the onset of Operation Granby. Indeed, JHQ gave some consideration to the deployment of Phantoms as well, for the Phantom was at least equipped with chaff and flare self-defence equipment. Yet the F3s ultimately flew out to Dhahran on their own. In their favour was the fact that the RSAF operated the Tornado ADV, and an F3 deployment could therefore be expected to enjoy many advantages of commonality with the host nation. The F3's serviceability record was also superior to the Phantom's, it afforded aircrew better positional awareness, and it was a more acceptable choice politically. As the UK had sold the Tornado ADV to Saudi Arabia, the appearance of any other RAF fighters at Dhahran in August 1990 would have been problematic, to say the least.

Nevertheless, the dispatch of Z-List F3s to the Gulf was a massive gamble. The first F3 Detachment Commander recorded that the aircraft was 'quite unsuited to the task':

> Had hostilities broken out then I doubt very much whether the AI-24 radar and associated software would have allowed us to do the job, and whether the aircraft could have survived without any defensive aids … We must never again accept an aircraft into service at a standard which is blatantly below the minimum requirement and so manifestly non-operational.

For much of Granby, the F3 had to be strictly confined to defensive duties well inside Saudi airspace and, in planning for hostilities, the sweep, escort and OCA functions had all to be assigned to other coalition members. There were, however, many short-term enhancements that could be introduced to enable the F3 to perform CAP duties more effectively. Improvements were incorporated in three phases: Phase 1, between the beginning of the crisis and the end of September 1990, and Phase 2, from mid-October to 21 December, brought 40 F3s up to Stage 1 Plus standard, while a third phase was implemented between January and March 1991. In total, no fewer than 78 modifications, including thirteen by Urgent Operational Requirement (UOR), were prepared for the Tornado F3, 60 being embodied in the time available. This was, by any standards, extremely ambitious.

Although the language of ‘phases’ suggests a degree of method behind the F3 enhancement programme, in fact it was implemented with minimal warning or preparation and with remarkable speed. A number of difficulties must inevitably be involved when modifications are introduced in this way. The evaluation and trial of new capabilities tends to be compressed into far shorter time scales than normal, increasing the probability of error. This can in turn allow defective equipment to enter service, or it can result in the procurement of capabilities that do not match requirements. It can also be difficult to replicate operational conditions during trials, and new capabilities that apparently match requirements can then prove hard to employ effectively in the field.

Another problem is that personnel in theatre must accommodate themselves to frequent equipment upgrades. In Operation Granby, a lack of explanatory information about some of the F3 enhancements complicated fault investigation and diagnosis at Dhahran. Groundcrew had to master new maintenance tasks continuously and faced some particularly complex rectification challenges when equipment became unserviceable. Aircrew had likewise to adapt themselves to upgraded technology. In this respect, the assimilation of hardware modifications was not especially taxing, for the physical presence of the equipment served as a reminder of its function; but software modifications were a different matter because they were far less tangible and more subject to further change. Indeed, the rate of change was so rapid that, by November 1990, the F3 detachment was operating Stage 1 Plus aircraft with several different software configurations.

It is thus not surprising that there was a certain friction between those in the UK who were directing the enhancement programme and those in the Gulf who were operating the modified aircraft. The UK authorities sought to exploit the Granby procurement window to obtain as many improvements as possible, while the detachment sought to limit the flow of modifications to a rate that could realistically be accommodated. They were not very successful. Group Captain Spink later described the modifications as ‘an absolute nightmare’ and argued that his detachment had not been structured to accommodate an engineering task of this magnitude. By January 1991, the entire RAF detachment at Dhahran, numbering 37 aircraft (including the Tornado GR1s), employed 1,400 personnel. By contrast, the American fighter wing, although equipped with only eleven more aircraft, employed 5,000.

The enhancements themselves fall into five general categories: environmental, the weapon system, engine modifications, EW, and offensive weapons. Improvements in cockpit ergonomics, such as the positioning of weapon operating switches in the top of the stick, accompanied most of the changes. Of the environmental enhancements, there is least to be said. A series of hot weather modifications was introduced to allow the F3 to operate in temperatures of up to 40ºC, and NVGs were procured to help provide a basic night-fighting capability. NVG-compatible cockpit lighting was installed, and an upgrade during the final months of the conflict helped to rectify several reported problems with the initial capability. Nevertheless, aircrew still regularly taped over the more dazzling lights.

Where the weapon system was concerned, eight software upgrades to the main computer significantly raised the F3’s operational capability, but it is more difficult to assess the performance of the Inertial Navigation System (INS), for there are irreconcilable contradictions in the relevant post-operation reports. Group Captain Rooum, the second Dhahran Detachment Commander, who later (promoted Air Commodore) became the Director of Air Defence at the MOD, recorded that the system was, on average, in error by four nautical miles after a three-hour sortie, which was at least adequate; by contrast, 29 Squadron produced a figure of between five and ten nautical miles after three hours, which was clearly unsatisfactory. Either way, the continuous need for fault diagnosis and rectification exacted a heavy toll in engineering hours and resulted in calls for the procurement of mobile test and

maintenance equipment. It was generally agreed that a more accurate system was desirable, such as GPS, then still a relative novelty.

The F3's radar was greatly improved. Well before Operation Granby, AI-24 radars enhanced to Stage 1 standard were replacing the original Z-List AI-24s. It was a matter of chance that the first aircraft sent to Dhahran had not been modified, and it was their location in Cyprus, rather than any other factor, that ensured their deployment. By the final week of September, all F3s in theatre were of Stage 1 standard, and the Stage 1 radar was itself being improved through the introduction of new software. By November, all the radar modifications were apparently working well. After visiting Dhahran, the CTTO reported: 'Overall performance has been greatly improved and the operators expressed increased confidence in their ability to acquire, track and engage targets far beyond the capability that was experienced before the modifications were incorporated.'

The only lingering criticisms concerned the more detailed specifications of the Stage 1 radar: it did not provide sufficiently accurate height and route information to enable aircrew to discriminate between friendly and hostile aircraft. The F3 was equipped with IFF Mk 12 Mode 4 for Operation Granby, but there was not enough time to procure interrogation equipment compatible with encrypted Mode 4; nor was the F3 fitted with other electronic identification facilities such as Non-Cooperative Target Recognition (NCTR). Such capabilities would have permitted Beyond Visual Range (BVR) engagements under UK ROE. Without them, the ROE could only be satisfied through visual identification, with the inherent and distinctly unwelcome possibility of a close-range manoeuvring engagement.

Negative assessments of the F3's performance were, in certain respects, exacerbated by the experience of the Gulf conflict. Operating at very high ambient temperatures with a full weapon and tank fit, the F3 experienced much faster fuel flow rates than normal, and the problem of high fuel consumption became even more severe when the aircraft was forced up to an altitude of 20,000 feet during Desert Storm. Efforts to improve performance initially focused on the operating parameters of the RB-199 Mk 104 engine. Two changes to the Digital Engine Control Unit schedule were provided to permit the engine to be operated with an increase of either 24ºK or 48ºK Turbine Blade Temperature, which raised the available engine

thrust by up to three per cent and seven per cent respectively. However, the cost was a reduction of projected engine life to 150 and 80 hours respectively, whereas the normal forecast was 500 hours. The 24ºK increase was made available to crews via a switchable facility in the cockpit, but its use was restricted to combat scenarios only and there is no documentary evidence that it was ever employed. The 48ºK increase was not embodied.

Otherwise, hopes were pinned on the RB-199 Mk 106 engine, a development of the Mk 104; F3s equipped with the Mk 106 began arriving in Dhahran in February 1991. In-theatre assessments of the engine seem to have varied. One officer from 29 Squadron recorded that the Mk 106 'had finally produced a reasonably capable ac when compared to the Z-list F3s originally deployed'. On the other hand, the Post Granby Equipment Working Group argued that this improvement had been achieved only by operating aircraft at the very limits of their parameters, with resulting penalties in fuel consumption. Engineering personnel in Dhahran drew attention to the engine's high oil consumption. To the OC of the F3 Detachment, 'the advantages of these new engines appeared to be only marginal.' Nevertheless, in live combat, the very smallest of margins may be decisive.

There were four elements in the F3 EW enhancement programme: an extensive Radar Cross-Section (RCS) reduction scheme, chaff and flare dispensing facilities, Havequick jam-resistant radios, and Radar Homing Warning Receiver (RHWR) improvements. The F3 was already equipped with RHWR at the beginning of Operation Granby, and enhancements were therefore confined to improved software and ergonomics. In theatre, the system proved unsatisfactory on a number of counts. It was vulnerable to interference from the AI-24 radar and to failures in the gore cables that connected the RHWR units throughout the aircraft. Crews complained of spurious SAM warnings, 'ambiguities' and screen 'clutter'.

The principal RCS reduction measures involved the attachment of RAM tiles to the engine intakes and behind the radar scanner, and the application of RAM paint to the leading edges; approximately 1,000 RAM tiles were fitted to each aircraft. Adhesion failures were experienced as soon as the modified aircraft reached Dhahran, and several engines were damaged by tile ingestion. The F3 detachment engineers quickly solved the problem by employing a new grouting technique, but regular

checks on the tiles had to be maintained even after refit, at a heavy cost in engineering man-hours. The RCS reduction scheme lowered the F3's detection range by as much as 20 per cent for head-on aspects, but the aircraft's other profiles were hardly changed.

EW protection was otherwise provided by flare and chaff dispensing systems. AN/ALE-40 flare dispensers acquired from Phantom stocks were initially fitted to the F3s deployed to Dhahran during September 1990, but their flares did not provide the aircraft with all-round protection. In the later stages of Operation Granby, AN/ALE-40 made way for the Vinten Vicon Series 210 system, which did offer all-round protection, but which could not be so easily controlled from the cockpit; nor did it provide a cockpit indication of 'flares remaining'. The problem was partly solved through the installation of cockpit dispense switches as part of the Phase 3 modification programme. Needless to say, equipment with either system represented a vast capability gain for the F3, and the aircrew at Dhahran reportedly 'expressed much greater confidence in their ability to survive hostile AAM attacks'.

Although provision was made at the beginning of Operation Granby for the F3 to carry PHIMAT bulk chaff dispensers on either wing tank station, the standard two-tank fit prevented installation. The Design Authority, MATRA, did not provide formal approval to move the PHIMAT system to one of the Sidewinder stations until November – much to the dissatisfaction of the aircrew at Dhahran. Nevertheless, once fitted, PHIMAT rapidly demonstrated its utility. After the series of training sorties against the USMC F-18s, the detachment recorded 'no doubt as to the effectiveness of PHIMAT, and its value in improving our survivability and hence our capability to carry out our primary task.'

Finally, Havequick jam-resistant radios were installed into 40 F3s as part of the Phase 1 enhancement programme, taking the place of the F3's emergency radio. The modification of cockpit controls in the later stages of Operation Granby helped to overcome shortcomings in the ergonomics of the two-radio installation. The Havequick radio was extensively used within F3 formations but did not provide full interoperability with AWACS aircraft and US AD assets, which used a version of Havequick that was both encrypted and jam-resistant. F3s were therefore unable to receive much of the real-time intelligence information that AWACS made available to

the US fighters, and they could not communicate directly with those fighters for much of the time.

Despite the limitations of these enhancements, they did provide the F3 with a rudimentary EW capability. However, the F3 was not equipped with the active ECM that would have been required to protect it from potential air and ground threats in the Gulf. The most attractive active ECM system could not be developed in time for Operation Granby, and proposals to procure a Towed Radar Decoy were rejected at ministerial level because of the time and expense involved: a UOR submitted in December 1990 envisaged a timescale to deployment of at least six months and a total cost of £16.7 million. The lack of active ECM and/or a Towed Radar Decoy, coupled with the absence of a Mode 4 Interrogator or NCTR system, imposed particularly pronounced limitations on the F3's counter-air contribution.

The problem was perfectly illustrated by the F3's single encounter with the Iraqi Air Force during Operation Desert Storm. As we have noted, on the second day of the war, two F3s were ordered by the on-task AWACS to assist USAF A-10s returning from Kuwait, which were being threatened by hostile fighters. Without the ability to interrogate the friendlies' encrypted IFF Mode 4, and in the absence of NCTR capabilities, the F3s were faced with the need for visual identification and the prospect of close combat rather than their preferred option of BVR engagement. Having detected and locked on to a group of radar contacts, the F3s prepared to attack. Holding fire, they established visually that they were locked on to two of the three A-10s, but two further radar contacts – Iraqi fighters – were now turning back. As the F3s crossed into Kuwaiti airspace, the two contacts continued north and maintained a range of about ten miles, which was well outside F3 weapon parameters. The A-10s were safely on their way home, but the F3s were being dragged into an area of dense SAM concentrations without any active ECM protection.

The F3's two primary weapons were the Skyflash and Sidewinder AAMs. The Skyflash, rapidly upgraded from pre-TEMP to Super-TEMP standard, proved entirely satisfactory. The Sidewinder's record was far more problematic. The F3s were initially equipped with AIM-9L Sidewinder plus a modified version of the LAU-7A launcher to cancel 'chirping' and extend the operational envelope of the basic

weapon. In this form, AIM-9L was very effective. However, the more advanced Sidewinder, AIM-9M, was even better and apparently incorporated an IRCCM capability against Soviet-made slow-rise time flares. To establish whether the missile did indeed possess this capability, the MOD approached the United States Embassy Defense Co-operation Office in London, which confirmed that the US had 'a high degree of confidence that AIM-9M would cope with the threat'. Yet two US Navy Air (NAVAIR) personnel involved in the AIM-9M programme supplied a less optimistic picture to the British Defence Staff in Washington. According to their assessment, the missile only 'had some capability against slow-rise flares'. Despite their reservations, the UK ordered a total of 320 AIM-9Ms for Operation Granby at a cost of £19.3 million.

The first AIM-9Ms were tested in theatre on 27 November, when a serious fault in post-launch guidance was detected. It eventually transpired that the missile was incompatible with the 9L launcher modifications, but not before some 100 missiles had been rendered unserviceable. Rushed procurement or insufficient trials (or both) were probably to blame. At the beginning of Operation Granby, the Aeroplane and Armament Experimental Establishment (A&AEE) had recommended a Controller Aircraft (CA) release covering the carriage of Sidewinder on modified launchers 'which included clearance for AIM-9M'; on 15 August, DA Arm had endorsed 'A&AEE's recommendation … for operational emergency clearance, for the duration of Operation GRANBY, for the carriage, release and jettison of Sidewinder AIM-9L and AIM-9M', stating specifically that 'carriage and release of … AIM 9M can be undertaken' from the modified launcher.

To make matters worse, it emerged in December that the 9M was not effective against slow-rise time flares when the target aircraft was engaged from the front or side sectors – only from the rear in an arc of about 60 degrees. The US authorities themselves only discovered these limitations after the UK had purchased the missile. Some MOD officials accused the US Embassy Defense Co-operation Office and NAVAIR of exaggerating the AIM-9M's capabilities before the transaction, but the MOD does not appear to have obtained *written* assurances from the Americans that AIM-9M had an all-aspect capability against slow-rise time flares. Moreover, in 1989, there had been some UK involvement in an American exercise entitled Dream Rider in which half the AIM-9Ms launched had been decoyed by these flares.

The Americans subsequently offered a modification costing $8,000 per missile to provide an all-aspect capability, but there was no prospect of deliveries before May 1991. The F3 detachment was initially compelled to reload the AIM-9Ls, although 9Ms were later carried on de-modified launchers. This episode was, in Group Captain Spink's view, 'the biggest single problem we had on operational kit':

> Not only does it have a fundamental effect on your fighting ability, but it also conveys a terribly bad message to the groundcrew and the aircrew about your organisational ability. If you're doing this and you're not yet fighting a war, what in the hell's going to happen later? There was a degree of unease in the F3 detachment when this was going on.

Overall, post-operation assessments of the F3, even in its modified form, make depressing reading. While recognising that the aircraft had been greatly improved during Operation Granby, the Post Granby Equipment Working Group stated with regard to the weapon system that the F3 'could not meet its fundamental requirement as an AD Fighter in the DCA role'. On weapons, 'the AIM-9M fell well short of our expectations and the future of AIM-9M in RAF service is being reviewed.' Otherwise, the overall EW system had 'a marginal capability to protect the ac in BVR combat and fell short of the stated requirement' and 'the engine improvements met the UOR requirements but [fell] far below the requirements of an AD fighter.'

The standard defence of the F3 was subsequently presented by Air Commodore Rooum following his appointment as D Air Def. 'I consider,' he wrote, 'that the ac performed very well in the job for which it was designed – that of an interceptor required to stay on combat air patrol for long periods and at long distances from its base.' However, other equally well-informed observers disagreed. A report prepared for the OC 29 Squadron declared in uncompromising terms that Operation Granby exposed 'deficiencies … both in the airframe's capability to operate outside of the benign UK ADR environment and in its systems' ability to fulfil even the basic AD role'.

In most respects, such criticism is difficult to contradict. We must nevertheless bear in mind the historical context in which it was made. War is invariably accompanied by a veritable flood of proposals for the enhancement of weapons, and the Gulf War

was no exception. Throughout Operation Granby, determined efforts were made to exploit the emergency procurement window in the certain knowledge that it would soon close. To obtain approval for enhancements and new purchases, it was first necessary to demonstrate that existing equipment was defective. Some contemporary assessments of the F3 may have been coloured by such considerations, and this bias may have been magnified by the need to maintain political support for the F3's replacement, the European Fighter Aircraft (EFA), which became Eurofighter and then Typhoon.

In a similar vein, a comparative assessment of the F3 and the MiG-29 Fulcrum prepared by the CTTO in December 1990 makes interesting reading. Among the aircraft that equipped the Iraqi Air Force, Fulcrums were generally considered to pose the most significant threat. With this in mind, the USAF arranged flight trials against Fulcrums of the Federal German Air Force, which had previously been in service with the air force of East Germany. It was then agreed that the CTTO should conduct similar trials for the RAF involving, among other aircraft, the F3. The trial, entitled 'YOCKLETON', took place at Manching Air Base from 26 to 30 November 1990. Air combat was neither permitted nor intended, so there were no close-in engagements, and the evaluation concentrated instead on the long-range battle, placing the emphasis on radar and missile performance, and handling. Poor weather limited the extent and conduct of the trial, but the F3 flew three sorties and produced the following results.

The Fulcrum's radar was found to be inferior to that of the Stage 1 Plus F3 in most respects, and although the aircraft was equipped with chaff and flares it lacked active ECM. The cockpit display was small and the presentation basic, attack symbols were so confusing that some of the modes were not put to use, and system integration was poor. A number of cockpit controls and selectors were also badly positioned, though many essential weapon controls were conveniently placed on the stick-top and the throttle. Visibility from the cockpit suffered because the aircrew's sitting position was too low and because the Fulcrum lacked a bubble canopy. The F3 and the Fulcrum could detect one another at similar ranges, but the F3s Skyflash Super-TEMP missile was more capable than the Fulcrum's Alamo-10A.

In summary, Trial YOCKLETON illustrates that the F3 was being judged by particularly exacting operational standards during Operation Granby; employing similar measures, its most formidable adversary was far from perfect. Yet the trial's immediate relevance to the Dhahran F3s was questionable. Even after the outbreak of hostilities, it was always probable that they would have to identify any potential targets visually, and the advantage unquestionably belonged to the Fulcrum in short-range combat. YOCKLETON merely demonstrated that, with more liberal ROE and improved BVR identification, the F3 might have emerged victorious.

If Operation Granby provided a chance to appraise the F3's combat capability, it also allowed assessments to be made of the aircraft's serviceability in an operational environment. The F3 was exposed to a sudden and dramatic increase in flying hours: the average flying rate leapt from 25 hours per aircraft per month to 78 hours per aircraft per month. The only detailed analysis of serviceability rates is confined to the period of Operation Desert Storm, but the general standard throughout the Gulf deployment was good.

Although the extreme heat caused a variety of technical problems in August, temperatures later fell somewhat, and the RAF subsequently concluded that abnormally high serviceability rates had resulted from 'the generally dry/warm weather'. The presence of BAe/RSAF second-line Tornado servicing facilities, which were made available to the RAF, also simplified the engineering task immeasurably. Other advantages included 'the good availability of spares and full wartime manning'. One early situation report suggests that human factors were especially important, describing how groundcrew willingly remained on task for significantly longer than the standard eight-hour shift, if necessary.

> Of particular note was 1 groundcrew shift who having worked for some 38 hrs non-stop had to be recalled for duty 4 hours after being stood down because a replacement shift had been diverted [in transit to the Gulf]. Despite being almost dead on their feet they tackled the task without a word of complaint.

Any period of heavy rain was accompanied by a reduction in the serviceability of the F3's electronic systems. The lowest serviceability rates occurred in the early part of January 1991, when this factor was exacerbated by shortcomings in the supply of

some spares, the disruptive effects of the move to the Egyptian Dispersal, and additional maintenance work generated by the enhancement programme, especially for electrical and radar tradesmen. Fortunately, by mid-January, serviceability had improved again. Throughout Desert Storm, despite the high sortie rate, it was common for the full complement of 18 aircraft to be declared serviceable and available for tasking, even though rectification was meticulous, and there was no recourse to the maintenance concessions that war service conditions now allowed. One helpful factor was the flying programme of rolling pairs: they were easier for the groundcrew to support than larger missions flying at less frequent intervals.

During Operation Desert Storm, an average availability of 84 per cent was maintained. In addition, 59 sorties (8.5 per cent of the total) were aborted after take-off, but the actual number of unserviceable aircraft was lower than this figure because of the adopted policy of maintaining mutual support between pairs. In other words, if one aircraft from a pair became unserviceable, both aircraft generally returned to base together.

9. Conclusion

In assessing the F3 detachment's role in the Gulf, we must remember that it was initially deployed more for symbolic and political purposes than tangible military ones. The key objective was to base a detachment of defensive aircraft on Saudi Arabian soil and commence DCA operations as soon as possible, any longer-term considerations being of secondary importance. Such a deployment would (1) demonstrate solidarity with the United States, the United Nations, and Saudi Arabia and (2) show the Iraqi government that an invasion of Saudi Arabia would involve combat with British forces. Being defensive in nature, these forces could not be said to pose any threat to Iraq's territorial integrity, and any military action against them could therefore only be construed as aggressive in character. It is important to stress here that this task could not have been undertaken successfully within such a short time scale by any force other than a detachment of land-based defensive aircraft.

The unexpected nature of the Gulf crisis and the urgency surrounding the F3 deployment left no time for planning or preparation. All the administrative and operational arrangements described in this study had to be determined by the first Detachment Commanders in theatre, on their arrival, and in consultation with the

Saudi and US authorities. These included the initial flying programme, the creation of operational and support facilities on base, working patterns for aircrew and groundcrew, and evacuation and dispersal plans. It was to their credit that, in general, the procedures established during the early stages of the crisis worked well and remained effective until the F3s were withdrawn. Inevitably, though, adjustments had to be made in response to changing circumstances, particularly the first Scud alerts in November and the F3s' move to the Egyptian Dispersal in December. In the weeks preceding the outbreak of hostilities, elaborate measures were taken to protect installations and personnel from air raids, missile attacks and NBC weapons.

A variety of factors contributed to the success of the deployment. Saudi host-nation support was of inestimable value, as was the presence of Saudi Tornado ADVs and a supporting BAe facility at Dhahran. For the F3s, at any rate, Operation Granby was very far from being a bare-base affair. Equally important in sustaining the deployment were full wartime manning levels, high morale, and the willingness of all detachment personnel to shoulder a significantly higher workload than was normal in peacetime. In the view of at least one Detachment Commander, it was the training, professionalism and expertise of the F3 detachment personnel that really made the difference.

The short-notice and symbolic character of the F3 deployment, together with the absence of AAR, determined its initial flying schedule. That schedule involved an exceptionally high sortie rate, which allowed minimal scope for training or unserviceability, and which could not, therefore, have been sustained on a long-term basis. But AAR, the accompanying reduction of CAP sorties, and the enlargement of the detachment together allowed training to begin during the final week of September. This combination of CAP and training flying continued until the week preceding Desert Storm. During Desert Storm itself, the F3s again maintained an extremely high flying rate until AAR allowed the number of sorties to be stabilised at about 14 per day.

Within constraints determined by its original specification, the F3 performed well in the Gulf. When operated by some of the most dedicated and professional aircrew in the world, it proved capable enough to fulfil the UK's primary strategic and operational objectives. A defensive British presence was very rapidly established in

Saudi Arabia, and, in the longer term, the F3s contributed to the coalition's victory in Desert Storm in two particular ways. First, they liberated fighters better suited to OCA from the DCA role; second, by maintaining air presence, they helped to shield from Iraqi view the westward deployment of coalition ground forces in preparation for the left hook.

At the same time, Operation Granby demonstrated only too clearly the shortcomings of the original F3 concept and the limited scope for upgrading the aircraft, and left the RAF anticipating its replacement with understandable eagerness. The principal air lessons report on Granby accurately summarised the prevailing impression:

> Despite the very significant improvements which were made to the Tornado F3 and its weapons systems, the aircraft's operational effectiveness was limited in the following areas: a lack of active ECM and Beyond Visual Range (BVR) identification capability; inherent engine and airframe limitations (which resulted in poor medium/high level performance and agility); and restricted Airborne Intercept radar ECCM features. As a result, the aircraft could not contribute to the full spectrum of fighter tasks, particularly escort and sweep; these roles were an essential element of Coalition air plans and, of necessity, had to be carried out by other aircraft such as the F-15. The final modification state of the F3 ensured adequate performance for CAP operations over friendly territory. However, the Tornado F3's shortcomings should be overcome by the introduction of EFA in the late 1990s.