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AIR POWER

THE COALITION AND IRAQI AIR FORCES

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Front Cover

Marine machines: a pair of carrier-capable McDonnell Douglas F/A-18C Hornet multi-role fighter and attack aircraft of VFMA-314 'Black Knights' prepare to refuel over the northern Gulf from a Lockheed KC-130T Hercules tanker (one of which is visible in the background), during a combat air patrol (CAP) from their land-base at Thumrayt, Oman. Both Hornets are armed with AIM-7M Sparrow radar-guided AAMs and two wingtip-mounted AIM-9M Sidewinder AAMs. Fitted with three 262 Imp gal (1192 lit) external tanks (which would be 'punched off' prior to combat), the Hornet has a tactical radius of 735 miles (1180 km). (Eves Debay).

THE BACKGROUND

For many years Iraq has claimed the territory of Kuwait, on the basis that at the time of the Ottoman Empire it was an integral part of the province of Basra. However, instead of pursuing its claim through the International Court of Justice in The Hague, Iraq simply waited for an opportunity to overrun Kuwait and thus present the world with a *fait accompli*.

In view of Iraq's massive forces and the minuscule size of Kuwait, such a take-over has clearly been on the cards ever since Britain withdrew from the Persian Gulf. Equally obvious has been the fact that, once installed in Kuwait, Iraq's forces would be difficult to eject.

Britain became responsible for Kuwait's defence under an agreement signed in 1899, one of a series of such deals under which the UK gained trading advantages and potential military bases in exchange for defence and other forms of aid. As the result of the discovery of oil in these Gulf states during the 1930s, they gradually became wealthy enough to take over responsibility for their own defence, while the UK, economically drained by World War 2, was forced to cut back on its overseas commitments. On 19 June 1961 the earlier agreement was accordingly replaced by a formal exchange of notes, in which Britain merely signified willingness to assist in Kuwait's defence when requested.

This reduction in Britain's commitment was apparently misinterpreted by Iraq, whose prime minister (then General Kassim) promptly restated his country's claim to Kuwait, and began moving forces to the south. On this occasion Britain was able to respond quickly and effectively, thanks to an accurate assessment of Iraqi intentions by the Baghdad embassy, and the availability of substantial forces in the region, including RAF Hawker Hunter FGA.9s of No 8 Sqn at Aden and No 208 Sqn at Nairobi, and the commando carrier HMS *Bulwark* at Karachi in Pakistan.

Air assets were redeployed, using Bahrain/Muharraq as the main airhead, in the expectation that the Ruler of Kuwait would call for British assistance. However, Saudi Arabia prohibited overflights by RAF aircraft (including transports) and Turkey restricted them. Kuwait's request for help was made on the evening of 30 June 1961, and at 0900 hr on the following day the helicopters of No 848 Naval Air Sqn began landing *Bulwark*'s Royal Marine Commandos, who secured the airport, allowing Hunters to be flown in from Bahrain.

By 9 July there were 5700 British service personnel ashore at Kuwait, and the carrier *Victorious* had arrived from the Far East. Iraq's forces backed off, and on the 20th the UK began its withdrawal, being replaced by a small Arab League force. It may be noted that this Operation Vantage had included the deployment of Canberras from Germany to Cyprus and Sharjah, from where they were to have mounted counter-air operations against targets in northern and southern Iraq respectively. Two photo-reconnaissance Canberras were detached from Akrotiri to Bahrain in the post-emergency period to provide daily surveillance of the Kuwait-Iraq border.

For some years Britain maintained a strong presence in the Gulf, notably at Bahrain and Sharjah. In 1971 the last of these forces was withdrawn, and with them went the possibility of rapid large-scale intervention in the region, although Britain remained willing to deploy forces to support Kuwait's defence, subject to the necessary overflight rights. That state was meantime encouraged to form its own air force, complete with a modern combat arm. This was initially equipped with BAe Lightnings, then A-4KU Skyhawks, Mirage F.1CKs and BAe Hawk 64s, and at the time of the 1990 invasion Kuwait had ordered F/A-18 Hornets.

However, the very limited service manpower available from the indigenous Kuwait population

made it inevitable that—unless nuclear weapons were obtained—the state would have to rely on external defence assistance. In an ideal world, such help would be provided by a multi-national Arab League force. In the absence of such a force, the defence of Kuwait (and of other militarily weak oil-producers in the Gulf) can rely only on one of the super-powers, acting as the leader of a UN-backed force.

Fortunately for all concerned, the US has long been aware of possible commitments in the south-west Asia region, hence the formation of Central Command and the prepositioning of men and material at Diego Garcia in the Indian Ocean. Without such preparations, the response to Iraq's 1990 invasion of Kuwait would have been much slower, and Saddam Hussein's forces might well have carried on down the southern shore of the Gulf, occupying some important Saudi oilfields before being brought to a halt.

Ironically, at the time of Britain's withdrawal from the Gulf, it was widely anticipated that the world's natural oil supplies would peter out during the 1990s, and that alternative sources of energy would have to be tapped, which would reduce the importance of the Middle East. In the event, discoveries of further oil reserves, coupled with economies in oil consumption, have resulted in oil supplies lasting much longer than expected. On current predictions, although the output from many oil-producers (including the US and UK) will be on the decline by the turn of the century, that from Iraq and Saudi Arabia will not decrease until around the year 2100, and that from Kuwait (the last on the list) not until 75 years later. It follows that, if Iraq were allowed to control Kuwait, it would become immensely powerful. If it went on to conquer Saudi Arabia, Iraq would have a virtual monopoly of world oil production within the foreseeable future.

Iraq's 1990 invasion and annexation of Kuwait may have been primarily concerned with oil, but this was not the whole story. In the preceding months a series of arguments between the two states had come to the boil, and there was no mutually acceptable solution in sight. Iraq claimed that since 1980 Kuwait had been stealing its oil by pumping from the Rumaylah field, which runs under both territories. In addition, Iraq was angered that Kuwait (and other Gulf states) were overproducing, and thus holding down the price of oil, on which Iraq depended for its recovery after the 1980–88 Gulf War with Iran. In the course of that war Iraq had run up overseas debts of around $40 billion, the interest on which amounted to over $3 billion annually. With annual oil revenues running at almost $15 billion (the 1989 figure), Iraq should have been able to pay these interest charges, but was spending $11 billion on civil imports and $5 billion on military equipment. Saudi Arabia had agreed to write off its war loans to Iraq, but Kuwait wanted its money back.

In addition to these oil-related problems, Iraq has a long-felt need to secure access to the Gulf from its port at Umm Qasr, which implies stationing forces on the Kuwaiti islands of Warbah and Bubiyan. Above and beyond economic and security considerations, it may also have been the case that Iraq's president Saddam Hussein, whose reputation had gained little from the indecisive war with Iran, wanted a quick and easy conquest to enhance his personal reputation, and effectively stake his claim for leadership of the Arab world.

For all of these reasons (and possibly others) Iraq invaded Kuwait in the early hours of 2 August 1990. The action took Western and Arab intelligence services by surprise, and organised resistance was quickly quelled, although some elements of the Kuwaiti armed forces (together with some combat aircraft) escaped to Saudi Arabia. Kuwait City was

Test firing of an Aérospatiale AM.39 Exocet from an Iraqi Air Force Mirage F.1EQ-200 in the Bay of Biscay. (CEV-Cazaux).

looted, and resistance was suppressed with systematic brutality.

The United Nations Security Council immediately condemned the Iraqi invasion (Resolution 660), as did the Arab League Council. There followed a series of UN Resolutions, including one instituting economic sanctions (No 661 on 6 August), a maritime embargo (No 665 on 25 August), an air blockade (No 670 on 25 September), and finally one authorising the use of force (No 678 on 25 November). This last Resolution stated that, unless Iraq withdrew its forces from Kuwait by 15 January, member states would be authorised to use '*all necessary means*' to implement Resolution 660 and to restore international peace and security to the area.

THE CHALLENGE

Long before the United Nations sanctioned the use of force to make Iraq withdraw its army from Kuwait, the leaders of the Free World had made their first moves. At the outset the danger was that Iraqi tanks might continue down the southern shore of the Persian Gulf, hence the first priority was to deny them air cover, and thus give Saudi forces a chance to defend their territory. Given breathing space, the nations of the UN Coalition could then put in place a force-mix that would bring to a halt any such further invasion.

Five days after the invasion of Kuwait, President George Bush announced that US fighter aircraft and troops would be sent to protect Saudi Arabia. Tactical Air Command's 1st TFW, based at Langley AFB in Virginia (where it is co-located with TACHQ) has for some years been earmarked to support Central Command, and had been given 36 hours' notice to deploy two of its three squadrons as the first phase of Operation Desert Shield.

On the day following the President's speech, the finest fighters in the world began arriving at Dhahran AB. They landed at 10-minute intervals, bearing the 'FF' tail-code and the yellow fin stripe of the 27th TFS or the red stripe of the 71st TFS. On its second day in Saudi, the 1st TFW began flying CAP missions along the border, in conjunction with F-15Cs and Tornado ADVs of the Royal Saudi Air Force (RSAF), while C-5s, C-141s and C-130s streamed in from the US. In exactly the same way that the arrival of RAF Hunters had changed Iraq's prospects in 1961, the deployment of TAC Eagles transformed the situation in August 1990. Saddam Hussein could still go ahead and attack, but suddenly the stakes had been raised.

The idea of a minor-league nation such as Iraq, weakened after an eight-year struggle with neighbouring Iran, defying the rest of the world may appear absurd at first sight, but the situation was not that simple. Iraq has been described as militarily the fourth most powerful nation on earth, with a colossal proportion of its population under arms, and some of the most modern equipment produced by the Soviet Union and France. Iraq was thus in a position to overpower most of its Arab neighbours, and could have taken on token forces from outside the region with a degree of confidence. It was certainly never seen as a pushover by the forces that were gradually assembled against it. Only a major effort with multilateral backing could succeed in enforcing an Iraqi withdrawal and restoring peace to the region.

To place the threat in perspective, Iraq has a population that is 20 per cent less than that of North Korea, yet in 1990 each of these countries had approximately one million men under arms. Iraq's army was actually somewhat larger than that of North Korea, and its equipment included almost twice as many tanks (5500 MBTs, compared to 3200), a force that was led by around 1500 T-62s and 1000 of the most recent T-72s.

The Iraqi Air Force (*Al Quwwat al Jawwiya al Iraqiya*) was a massive service, with 800–1000 combat aircraft, though it had played an astonishingly small role in the war with Iran. Its only noteworthy success had been in Exocet sea-skimming missile attacks against shipping in the Gulf, aimed at preventing Iran from exporting its oil. However, over a period of seven years (these attacks having begun in 1981) the IAF made only about 500 strikes with guided missiles against Gulf shipping, this figure including attacks by Tu-16 *Badgers* launching Chinese C-601s. Less than two per cent of the ships transiting the Gulf were attacked, and only a few of those attacked actually sank. The largest annual total

The Royal Saudi Air Force has some very modern equipment, exemplified here by a Tornado IDS (foreground) and F-15C Eagle. Between them is sandwiched a Jaguar of the Sultan of Oman's Air Force. (RSAF).

of sinkings occurred in 1987, when six went down, compared with three in 1984, none in 1985, and two in 1986. Shipping insurance claims were relatively low at $1200 million.

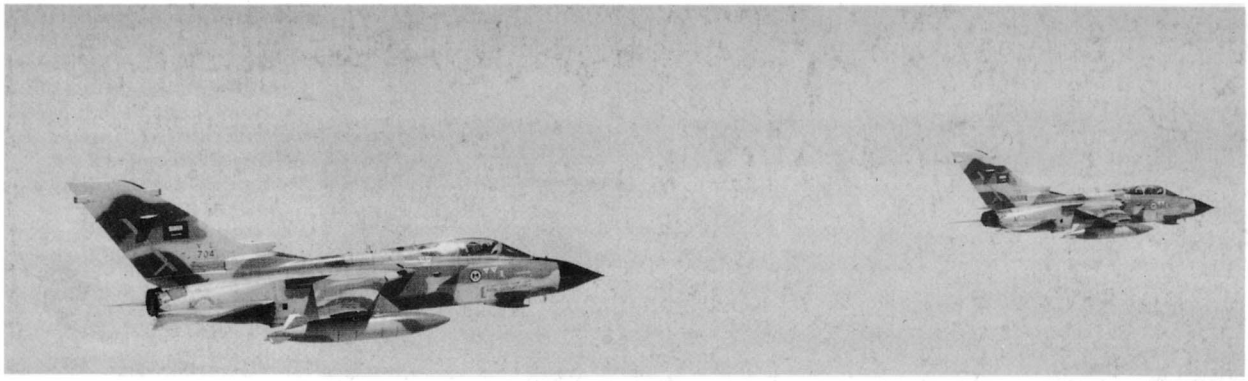
It may also be recalled that on 17 May 1987 two Exocets fired from an IAF Mirage F.1EQ-200 struck the 3585 ton USN frigate *Stark*, which had apparently been mistaken for an Iranian tanker and made no attempt to defend itself. Both Exocets hit, though one failed to explode. Of the 221 officers and men aboard the USS *Stark*, 37 died, but the ship was later repaired and returned to service.

For practical purposes the modern IAF might be said to date from 1955, when Britain's RAF (after 35 years of operations in that country) handed over its bases at Habbaniya, Saibah and Basra to what was then the Royal Iraqi Air Force. Under an agreement signed that year, Britain accepted responsibility for assisting Iraq to establish an efficient system for air defence (against a potential threat from the Soviet Union), with a radar-warning network and a corps of ground-based observers providing a visual watch.

As a protégé of the RAF, the IAF went on to become a major Hunter operator, buying a total of 66 (mainly FGA.59s), which were used in the 1967 and '73 wars with Israel and the 1980–88 Gulf War against Iran. Britain made serious efforts to sell Iraq the V/STOL Harrier and subsequently the BAe Hawk advanced trainer and light attack aircraft, but in 1989 HMG brought an end to such efforts (ostensibly leaving the field clear for the French marketing the Alpha Jet), on the basis that Iraq was still formally at war with Iran.

Notwithstanding its origins, the form of the IAF in 1990 probably owed far more to Soviet Air Force advisers, hence its considerable emphasis on air defence, using interceptors under tight control from the ground. At the time of the invasion of Kuwait, the IAF was estimated to have around 200 MiG-21 *Fishbeds* (including Chinese-built F-7s) for point defence, 50–100 MiG-23MS *Flogger Es* (some with in-flight refuelling capability), and perhaps 20 Mach 2.8 MiG-25 *Foxbats* (and eight more for high altitude reconnaissance). This fighter force had recently been supplemented by 48 or more MiG-29 *Fulcrums*, which in the right hands were capable of taking on F-16s and F/A-18s, though not F-14s or F-15s.

France is believed to have delivered to Iraq at least 328 Mirage F.1 dual-role fighters, which primarily represented a threat in the context of Exocet attacks against naval and amphibious forces,



Two Tornado IDS of the Royal Saudi Air Force. Aside from its national markings, the Saudi Tornado is distinguished from its RAF equivalent by its multi-colour camouflage scheme: sand, brown, green and grey-blue. (RSAF).

although they were also to be encountered in the air defence role. In assessing the F.1 it was, however, noteworthy that it could use the AS-14 *Kedge* and that France had sold Iraq some 600 Matra Armat anti-radar missiles, and that many would have been left over from the conflict with Iran. The reported sales of Aérospatiale AM.39 Exocets between 1977 and 1988 totalled 848, of which perhaps 500 were fired during the first Gulf War by Mirages and Iraq's 10 Super Frelon helicopters. These figures do not include sales of the ship-launched MM.39 Exocet, for which no data are available.

Iraqi strikes against strategic land targets could realistically only be performed by the Su-24 *Fencer*, of which the IAF showed a dozen (reportedly only half its strength) during the fly-past in early 1990. In January 1991, however, the Israeli Air Force chief of staff assured the population that, even if some Su-24s managed to get through that nation's air defences, they would never land back in Iraq. The IAF also had around a dozen obsolete Tu-16 *Badgers* and five Tu-22 *Blinder* supersonic bombers, but it was difficult to imagine either type penetrating modern defence systems.

In the ground attack and close air support categories, the IAF was thought to have around 100 Su-7/20 *Fitters*, 50–100 MiG-23BN *Flogger F*s, 60 Su-25 *Frogfoots* (the only modern CAS aircraft in the inventory), around 50 old MiG-19s (including Chinese-built F-6s), and at least 24 L-39s, though these Czech-built trainers have only a limited strafing capability. Compared to the air defence element, none of these aircraft represented much of a threat to the forces of the allied Coalition, the multi-role Mirage F.1s mentioned earlier probably representing the most useful type available to Iraq.

The Su-25 is a major improvement over the USAF's A-10A in some important respects, especially in having a maximum speed of 526 knots (975 km/hr), compared to the 368 knots (682 km/hr) of the Fairchild product. The Sukhoi aircraft also benefitted considerably from operational experience in Afghanistan in the 1980s, which resulted in the doubling of flare-dispensing capacity from 128 to 256 rounds (an incredible number by Western standards), and the addition of large areas of 5 mm steel plating below the rear fuselage fuel tanks and between the engines. These special measures were introduced to minimize the vulnerability of the Su-25 to shoulder-launched lightweight IR-homing missiles, notably the FIM-92 Stinger, and they would presumably reduce (though by no means eliminate) the effectiveness of the much heavier AIM-9M. By the same token, these modifications would not protect the Su-25 against 20 mm gunfire from an intercepting Coalition aircraft, although the pilot is protected by a welded 24 mm titanium 'bathtub' (providing much better protection against rear quarter attacks than that of the A-10A). The total weight of protective measures is 2415 lb (1095 kg), compared to 2887 lb (1310 kg) for the A-10A.

In addition to these various fixed-wing attack aircraft, the IAF was believed to have around 50 Hot-armed Gazelles (France sold Iraq no less than 5166 Hot anti-tank guided missiles) and a roughly equal number of Mi-24 *Hind* attack helicopters. The Mi-24 is officially described as a combat transport helicopter, and can carry eight fully armed troops in combination with externally-mounted rocket pods

A British Aerospace Hawk Mk 64 of the Kuwait Air Force. Like all other export Hawks, the Mk 64 has a dual-role capability, being equally suited to advanced flying training (and weapons instruction) and the light attack role, having provisions for up to five 1000 lb (454 kg) bombs. (BAe).

and guided missiles, and either a 12.7 mm Gatling-type machine gun or a 30 mm twin-barrel cannon. Iraq also had over 100 Mi-8 *Hip* helicopters, which carry 12–14 fully-armed troops and much heavier weapons. The *Hip E* version is the world's most heavily-armed helicopter, with a flexibly-mounted 12.7 mm machine gun and provisions for six 32-round 57 mm rocket pods in addition to four AT-2 *Swatter* anti-tank guided missiles.

The IAF also had a variety of Antonov transports, including six An-12 *Cubs* that had been modified for tanker duties, and around 18 four-jet Il-76 *Candids*. Some of these Il-76s had been modified for hose-and-drogue flight refuelling for the Mirage F.1s and at least some of the MiG-23s, which appear to have been equipped with suitable probes in-country. Other Il-76s (around three) had been modified for the AEW role, initially with the Thomson-CSF Tiger G air defence radar mounted on the rear fuselage, and later (Adnan-2) with an unspecified radar associated with a traditional *disco-volante* radome over the rear fuselage, resulting in an aircraft very similar in appearance to the Soviet AF's *Mainstay*. However, most observers doubted whether Adnan-2 had anything like the Boeing E-3's ability to track large numbers of targets, control large numbers of friendly aircraft, and continue operating in the face of countermeasures.

Soon after the Iraqi invasion of Kuwait, details of French sales to Iraq were published in the prestigious British aviation weekly *Flight International*, which gave figures from 'official French documents'. Some indication of the vast scale of arms shipments was provided by the statement that between 1979 and 1981 France dispatched to Iraq a total of 3320 guided weapons in the Aérospatiale AS-11, AS-12, AS-20 and AS-30 air-to-ground categories, in addition to 4564 Euromissile (Aérospatiale/MBB) Milan ground-base anti-tank GWs. In the air-to-air category, Matra sold the IAF 2227 Magic short-range and 429 R.530 medium-range GWs during this period, and a further batch of R.530s in 1986. These figures do not appear to have been disputed by the French authorities.

Flight also reported allegations that Thomson-CSF had sold to Iraq electronic warfare (EW) equipment that might be capable of jamming USAF and RSAF (and presumably NATO) E-3 AWACS aircraft, but that the charge had been denied by both the French government and industry. These denials were doubtless perfectly sincere, yet the allied officers planning air operations against the IAF must surely have worked on the assumption that Iraqi combat aircraft of French origin had some type of chaff/flare dispensers and radar-warning receivers (RWRs), and that some proportion had jammers that could reduce the effectiveness of opposing fighter radars to some degree. Whereas EW had been almost totally absent from the Falklands conflict of 1982 (SIGINT being one obvious exception), planners in 1990 had to assume that the IAF had a useful EW capability, though it would be far less than that of NATO or Soviet air forces.

In attempting to assess the potential threat posed by Iraqi forces to allied ground forces, air bases, surface vessels and strategic targets (such as Riyadh and Ankara), it is natural to think in conventional terms, emphasising the roles of dedicated attack aircraft such as the Su-24 (which is broadly comparable to the F-111) and Su-25, and dual-role aircraft such as the Mirage F.1 and MiG-23BN. However, in

attacks on Coalition surface targets the efforts of the IAF had to be viewed in conjuction with those of the Iraqi Army, using the tactical Frog-7 and longer-range *Scud* ballistic missile series.

Both of these weapons may be regarded as postwar derivatives of the German Army A-4 (or V-2), which entered operational service in September 1944. The liquid-fuelled A-4 took six hours to prepare for launch, weighed about 13 tons at lift-off, and delivered a one-ton HE warhead over a range of 190 nm (350 km). London received around 2000 A-4s and Antwerp around 1600, but casualties were relatively small in number.

The Soviet-built Frog-7 is a comparatively small solid-fuel unguided, spin-stabilized rocket, which weighs about two tons at launch and delivers a small warhead over a maximum range of 38 nm (70 km). The Soviet Army version made its public début in 1967, and Frog-7 was used against the Israelis during the 1973 Yom Kippur War. However, in Soviet service it has been replaced by the SS-21 Tochka ('Dot'), known to NATO as *Scarab*. The Frog-7 is transported on the ZIL-135 eight-wheel vehicle, and can be fired within 15–30 minutes of arriving at a previously-surveyed site. Standard references give an accuracy of 500 metres CEP, which is probably satisfactory only for the nuclear-tipped version.

The SS-1C *Scud-B* (Soviet Army designation R-17) appeared in the early 1960s and achieved operational capability around 1965. It is a single-stage liquid-fuel inertially-guided rocket, normally associated with an MAZ-45 eight-wheel transporter/erector launcher (TEL). It is claimed that firings can take place within one hour of arriving on site, although accuracy (a figure of 900 metres CEP is quoted at 100 nm/185 km range) depends on releasing and tracking a radio-sonde balloon to establish upper-air winds and temperatures. Launch weight is around 6.3 tons, and maximum firing range is approximately 160 nm (300 km), reportedly in association with a one-ton warload.

However, Iraq is known to have two longer range variants, the results of East German assistance. The first (*Al Hussayn*) delivers a 1100 lb (500 kg) warload over a 320 nm (600 km) distance, and the second (*Al Abbas*) carries a 500 lb (250 kg) warhead over 480 nm (900 km). However, development of the latter had not been completed. Accuracy at these longer ranges is naturally far worse than for the basic *Scud*, but this is not a serious problem when the missile is employed as a terror weapon against major centres of population, such as Riyadh or Tel Aviv.

Iraq's limited strike capability was to some extent offset by the evident willingness to employ 'weapons of mass destruction', which normally refers to NBC systems. The general assessment was that (thanks partly to Israel's air strike against the Tammuz reactor near Baghdad on 7 June 1981, in which F-16s were escorted by F-15s) Iraq had not yet achieved a nuclear strike capability in 1990. In addition, it is widely held that biological agents (eg, anthrax) are too difficult to use to be an attractive option, although they remained a threat.

This left chemical weapons, in which field Iraq was known to have a serious capability both in regard to mustard gas and the highly lethal nerve gas (*Tabun*) series. Both types, though forbidden by the Geneva Protocol of 1925, are believed to have been employed by Iraq in aircraft bombs and artillery shells during the 1980s against the Iranian army and Iraq's own Kurdish population. Historically, since World War 1 chemical weapons have generally been used only against people who were in no position to retaliate, as in Abyssinia in 1936 and Laos in the early 1980s. Whether Iraq would dare to use such weapons against the Coalition forces, knowing that America has a much more advanced CW capability, and that not only the US but the UK and France could hit back with nuclear weapons, was clearly difficult to predict. One source estimated that several hundred nuclear weapons were actually deployed with the allied forces in the Middle East, including 400 with the US Navy and 300 in Turkey.

Just as important as assessing Iraq's offensive capability was the task of predicting the effort required and the losses likely to be incurred in destroying the IAF on the ground, and in attacking Iraqi army, naval forces and nuclear and chemical warfare facilities. Aside from the effectiveness of the allies own weapons, such estimates clearly depended on Iraq's AAA and SAM systems, and on the availability and invulnerability of hardened aircraft shelters (HAS).

Estimates prepared by the International Institute for Strategic Studies in London credited the Iraqi Army with approximately 4000 air defence guns,

including relatively heavy 85 mm, 100 mm, and 130 mm weapons, presumably of Soviet Bloc and Chinese origin. Cannon in the smaller calibre range included the 37 mm M-1939 and the self-propelled ZSU-23-4 (ie, four-barrelled 23 mm) and ZSU-57-2 (twin-barrel 57 mm).

The ZSU-23-4 Shilka is an air defence derivative of the PT-76 amphibious light tank, and it made its public début in Moscow in 1965. Its fire is believed to be effective to a slant range of around 2000 metres. Its four guns can be fired at up to a combined rate of 4000 rd/min, but it is normally restricted to 800 rd/min, since it carries only 2000 rounds, a figure that is felt to limit its usefulness. Its *Gun Dish* radar has a maximum detection range of about 11 nm (20 km), but it also has an optical reversionary mode.

The ZSU-57-2 is heavier (28 tons) and even older, having made its first appearance in 1957. It makes use of a modified T-54 tank chassis, and mounts two S-68 cannon, which can give a combined rate of up to 240 rd/min, though a more practical figure is 140 rd/min. It carries 264 rounds ready for immediate use, and a further 52 rounds in reserve. Effective firing range is around 4000 metres. It appears to be generally used with only an optical fire control system, but a radar-equipped version has been reported.

In the field of man-portable SAMs, Iraq was totally dependent on Soviet systems, namely the SA-7, SA-14 and the SA-16, which is the latest of the series to be exported. The very basic SA-7 *Grail* (Soviet name Strela 2) is popularly supposed to have originated in the late 1950s, in response to press reports concerning the US Army's development of the Redeye MANPADS. It entered service in 1966, and was first used operationally in Vietnam in April 1972, since when it has cropped up regularly around the world. Thanks to its lightness and accuracy, it became popular with terrorist groups. In Rhodesia it was used by a ZIPRA unit in September 1978 and February 1979 to shoot down civil Viscount transports. However, the SA-7 is easily decoyed by flares, and has a maximum target speed of 420 knots (780 km/hr), although it is effective up to 15,000 ft (4600 m).

The SA-7 Strela ('Arrow') was largely superseded by the SA-14 *Gremlin* in the early 1980s, and by the SA-16 Igla ('Needle') in the late 1980s. Iraq reportedly received both of these improved systems. According to information provided at the Soviet exhibit at a defence exhibition in Kuala Lumpur in early 1990, the SA-16 (which presumably has a reduced susceptibility to decoys) has a maximum slant range of 5000 metres, and can intercept targets at speeds up to 700 knots (1300 km/hr) at any altitude from 35 to 11,500 ft (10 to 3500 m).

Such missiles provide front-line troops with a portable, cost-effective means to protect themselves against fixed-wing aircraft and helicopters, but their warheads are small and they currently cannot be used at night (unless the target's afterburner is visible), since the operator has to acquire the aircraft visually and point the missile at it if the IR seeker is to achieve lock-on. Several companies are now working on the means to take target coordinates from a radar and present them to the MANPADS operator in such a way that he knows where to point the missile, but no such system was available to Iraq in 1990.

In the larger SAM category, the Iraqi arsenal included the old SA-2 *Guideline*, which was introduced in Vietnam in 1965, the SA-3 *Goa*, and the SA-6 *Gainful*. All of these systems have slant ranges in excess of 16 nm (30 km) and can reach any height likely to be used by operational aircraft. It was an SA-2 that shot down Gary Powers' U-2 over Sverdlovsk in 1960. The SA-6 has the Soviet name Kub ('Cube'), was first paraded in Moscow in 1967, and was in large-scale service within three years, being first used operationally by the Egyptian Army in Sinai in 1973.

The SA-8 *Gecko* is believed to have been the world's first mobile SAM system incorporating its own radars on a single vehicle. It is thought to have a slant range of around 6.5 nm (12 km), and saw limited use in Syrian hands during the Israeli invasion of Lebanon in 1982. The Soviet name is Romb ('Square').

The European equivalent of the SA-18 is the Euromissile Roland, for which France is reported to have sold Iraq some 1050 rounds, presumably for use on vehicles using the AMX-30 tank chassis. Roland can engage targets over a height band from 65 ft (20 m) up to 16,500 ft (5000 m) and at ranges up to 3.4 nm (6.3 km). Although originally intended to provide air defence for tanks in the battle area, it was used during the Falklands conflict (in trailer-

mounted form) to provide cover for Port Stanley airfield. It had the effect of keeping British aircraft out of a hemisphere of 15,000 ft (4600 m) radius. Only one aircraft was shot down by Roland, a Sea Harrier loitering at the top of the missile's envelope (waiting for an Argentine aircraft to take off) and unable to manoeuvre out of its path.

However, Euromissile marketing material refers to two occasions on which Roland was used successfully, presumably by Iraqi operators against Iranian aircraft. The first relates to an attack by two F-4Es on 21 July 1982, against an oil refinery on the outskirts of a city that had several Roland firing units around its perimeter. The AMX-30s, emplaced on mounds of earth to give a clear field of view, destroyed one F-4E and the other turned back without releasing its weapons. In the second case, on 26 February 1982, three F-5Es attacked an oil well in the countryside. One was shot down by Roland, a second aborted, and the third dropped a bomb that missed. This aircraft was subsequently shot down by a Mirage F.1.

Iraq also employed the Thomson-CSF Crotale SAM system, for which 100 rounds were reportedly exported in the period 1979–81. Crotale was originally developed to meet a South African requirement for an air-portable area defence system to protect important sites such as airfields, ports and industrial complexes. Whereas Roland has both the search and tracking radars on the missile launch vehicle, the Crotale system has the search radar on a separate vehicle (likewise a 4×4 by Hotchkiss-Brandt), an arrangement which presumably gives a better detection range, since antenna size is less restricted. However, this concept is somewhat similar to that of the SA-6, in which one *Straight Flush* radar vehicle provides target data for four launch vehicles. The SA-6 took the Israelis by surprise in 1973, but they subsequently realised that by attacking the *Straight Flush* vehicle they could put all four firing vehicles out of action. In the fighting in the Bekaa Valley in 1982, the SA-6 failed to make a single kill against Israeli aircraft. The Crotale system may not be as vulnerable, since the firing units probably have some autonomous capability. The acquisition vehicle has a radar range of 10 nm (18.5 km) and the firing units have a range of up to 5.5 nm (10 km) against a typical fighter.

In addition to the SAMs listed above, Iraqi forces had captured four batteries of Improved Hawk missiles during the invasion of Kuwait, although there was some doubt whether they could learn to operate such a system effectively in the course of a few months. The Hawk appears to be similar in range and altitude capability to the SA-6. The US system is probably superior in terms of its ability to operate in the presence of countermeasures, but its mobility depends on trucks and trailers, hence it is less suited to a battlefront environment.

Turning to the question of the vulnerability of Iraqi aircraft on the ground, it appears that (despite the low level of Iranian air activity during the 1980–88 Gulf War) the IAF had funded at least 594 HAS, many of which were built to an extremely high standard, following examination of both Soviet and NATO shelters. Belgian, British, French, German, Italian, Swiss and Yugoslav companies were reportedly involved in the programme, which did not contravene the arms embargo that applied during the war with Iran. In the period 1984–85 one Belgian company was responsible for the construction of 12

Reports indicate that Israel's experience with the A-4 Skyhawk in the 1973 Yom Kipper War inspired Kuwait to buy the A-4KU, which is based on the USMC's A-4M (hence its hump-back appearance). The KAF ordered 30 A-4KUs and 6 TA-4KUs in late 1974, and the first flight of an A-4KU took place on 20 July 1976, the TA-4KU following on 14 December. Deliveries began in 1977. (Ian Black).

shelters at each of eight main bases, together with hardened control towers, administration buildings, accommodation blocks, generating plant, etc. The roof of this type of HAS is 47 inches (120 cm) thick, compared to 27.5 inches (70 cm) for a standard NATO shelter, and the whole shelter is covered in sand to provide further protection and make detection more difficult. The 40-ton steel doors are filled with concrete, and the paving underneath has a water-trap to defeat attacks with napalm. To reduce the likelihood of blast damage to the doors (or the aircraft while the doors are open), there is a concrete blast wall 125 ft (38 m) in front of the shelter, with a ramp of sand against the outer face.

To summarise, in 1990 the Iraqi Air Force was a large service, which had spent a great deal of its funding to develop an effective air defence system and reduce its vulnerability to air attacks. Nonetheless, in the war with Iran this defensive posture had dominated operations, and the IAF had shown itself to be badly equipped for tactical reconnaissance, incapable of coordinating ground attack missions with Iraqi Army activities, and unable to make effective strikes on second echelon forces. However, the fact that Baghdad was much closer to enemy airfields than was the case for Tehran may have encouraged Iraq to make minimum use of air power.

Host Nations

In assessing the external assistance required to restore peace to the Gulf region, the first consideration was clearly the ability of Saudi Arabia and the Gulf states to protect themselves from Iraqi aggression.

The Royal Saudi Air Force (*Al Quwwat al Jawwiya as Sa'udiya*) was by far the most powerful service in the Arabian peninsula, with relatively large numbers of F-15s and obsolescent F-5Es, and smaller numbers of Tornados and Hawks, supported by a remarkable force of AWACS aircraft and tankers. The most important combat aircraft in the RSAF fleet was the F-15C/D, of which 60 had originally been ordered, with two replacement aircraft to cover attrition. In the immediate aftermath of the invasion of Kuwait, President Bush waived export restrictions on the transfer of 12 F-15s, and Saudi Arabia requested a further 48. It is known that in the course of September 1990 some 12 Eagles were transferred to the RSAF from the USAF's 32nd TFS at Soesterberg AB in the Netherlands, and an equal number from the 36th TFW at Bitburg in Germany. By late 1990 the RSAF was operating four Eagle squadrons: Nos 13 and 42 Sqn at Dhahran, No 5 Sqn at Taif, and No 6 Sqn at Khamis Mushayt.

The aircrew for the additional F-15s were presumably found by converting pilots from F-5E units, since these lightweight fighters (though excellent for air combat training) were probably viewed as too short-legged to play a major role in a war with Iraq. It may none the less be noted that in 1990 the RSAF had around 110 F-5E/Fs and RF-5Es, forming four squadrons: Nos 3 and 10 Sqn at Taif, No 17 Sqn at Tabuk, and No 15 Sqn at Khamis Mushayt. In the event, some F-5Es were used in ground attacks.

After the F-15, the second most important combat aircraft in the RSAF was the Panavia Tornado, supplied from the British Aerospace assembly line at Warton under the Al Yamamah Phase 1 programme. The RSAF had ordered 48 Tornado IDS interdiction/strike aircraft and 24 Tornado ADV interceptors, and in late 1990 a report in a BAe publication indicated that over 50 of these aircraft had been delivered. These had been used to form No 7 Sqn with strike aircraft, and No 29 Sqn with the air defence variant, also reportedly at Dhahran. In addition, all 30 Hawk Mk 65s had been delivered by BAe under Phase 1, and at least some of these were assigned to the close support role.

Most importantly, by late 1987 Boeing had completed deliveries of the RSAF's five E-3 AWACS aircraft and KE-3A tankers under the Peace Sentinel programme, all equipped with CFM56 turbofans, giving significantly increased take-off weights and better fuel economy. Both types were initially based at Riyadh, although it was planned to transfer the AWACS aircraft later to Al Kharj.

It may also be noted that the Royal Saudi Navy had acquired 24 SA.365F Dauphin 2 helicopters, of which 20 were assigned to the anti-ship role, using the AS.15TT sea-skimming missile. The service was also taking delivery of six SA.332 Super Pumas, which were to be used in a similar role, with the much larger AS.39 Exocet.

Ironically, during the 1980s Gulf War Saudi Arabia has sided with Iraq, and many IAF aircraft had landed at Saudi bases to be refuelled or even

repaired, spare parts being flown in by IAF An-12 *Cubs*. The RSAF was clearly less experienced than the IAF, but on two occasions F-15s from the former service had intercepted and destroyed Iranian F-4s that entered Saudi airspace, reportedly using AIM-7 medium-range missiles in head-on engagements.

Saudi Arabia's fear of being drawn into the Gulf War led the kingdom to buy intermediate-range ballistic missiles (IRBMs) from China to provide a strike capability against Iran, a transaction that caught Western intelligence agencies by surprise. However, the movement of these CSS-2 East Wind missiles by ship was followed by US satellites, and the road convoys were tracked to two launch sites. These were located at Al Sulaiyil and Al Joffer, respectively 310 and 60 miles (500 and 100 km) south of Riyadh. The 120 missiles were evidently divided equally between these complexes, each of which had around five launch pads.

At the time of their delivery in 1988 the West was concerned about the type of warhead fitted, and the potential threat posed to Israel. However, Chinese officials provided assurances that no nuclear weapons were involved, and that the fitment of heavy conventional warheads had reduced firing range from 1350 to 1025 nm (2500 to 1900 km). There was none the less some concern that Saudi Arabia might have purchased the CSS-2 with the intention of passing some of these missiles to Iraq, to counter the threat of Israel's nuclear-tipped Jericho IRBM. Fears that some Saudi CSS-2s might have chemical or nuclear warheads persisted, and in January 1991 there were press reports that the Saudi defence ministry was resisting US requests to inspect them.

As a result of the Iraqi invasion of Kuwait, the RSAF had effectively been strengthened by more than 30 combat aircraft of the Kuwait Air Force (*Al Quwwat al Jawwiya al Kuwaitiya*). Prior to the invasion, the principal combat elements of the KAF were two squadrons (Nos 18 and 61) of around 29 Mirage F.1CK2/BK2s at Ali al Salin, close to the Iraqi border, and two squadrons (Nos 9 and 25) of around 36 A-4KU/TA-4KUs at Ahmad al Jabir in the south.

At the start of the invasion at 0100 hr on 2 August 1990 the northerly airfield came under artillery fire, but around half the Mirages managed to take off and escape to Bahrain and Saudi Arabia. The southerly

Close-up of an A-4KU with its post-invasion Free Kuwait *markings. The A-4 is broadly comparable to Britain's Hawker Hunter, the latter having an inferior warload-radius performance, but a better self-defence capability. (Ian Black).*

airfield was bombed, but the A-4 squadron continued operations from a road site until 4 August, when these aircraft were flown to Saudi Arabia. Initial reports indicated that none of the KAF's 12 BAe Hawk Mk 64s had escaped, but it was later said that six were in Saudi Arabia, as were various KAF helicopters.

The Kuwait defence minister stated in September 1990 that around 80 per cent of KAF aircraft and 95 per cent of KAF pilots were operating in Saudi Arabia, and that losses had been limited to eight Mirage F.1s, three A-4s and two helicopters. British journalist Paul Jackson visited Dhahran later in the year, and reported that 19 KAF A-4s were operating from that base as an integral part of the RSAF, and that 15 Mirage F.1s were operating from another (unknown) Saudi airfield. In February 1991 a unit of 16 F.1s began ground attack operations. The A-4s carried the legend *Free Kuwait* on the centre fuselage, and the Kuwaiti flag on the fin.

Of the various Gulf states able to provide basing facilities and military assistance in operations to free Kuwait, Bahrain is the most westerly, followed closely by Qatar, and then by the United Arab Emirates (UAE) and finally Oman.

The Bahrain Amiri Air Force received the last of its 12 F-16C/Ds (with General Electric F110 engines) in the month following the Kuwait invasion, hence full operational capability was still some time away. The service also had 12 F-5E/Fs, which could

provide some daylight air defence capability. There are two principal bases, at Manama and Muharraq island.

The Qatar Emiri Air Force had 14 Mirage F.1E/B dual-role fighters forming No 7 Sqn and six Alpha Jets, with a ground attack capability, forming No 11 Sqn.

The UAE Air Force had 35 Mirage 2000E/R/Ds, 29 Mirage 5AD/RAD/DADs, and 16 Hawk Mk 63s at Abu Dhabi, and 8 Hawk Mk 61s at Dubai.

Finally, the Sultan of Oman's Air Force (SOAF) had 22 Sepecat Jaguars (probably the best ground attack aircraft in the Gulf) forming Nos 8 and 20 Sqn on the island of Masirah, and 18 Hunter FGA.73/T.67s forming No 6 Sqn at Thumrayt in the south of the country.

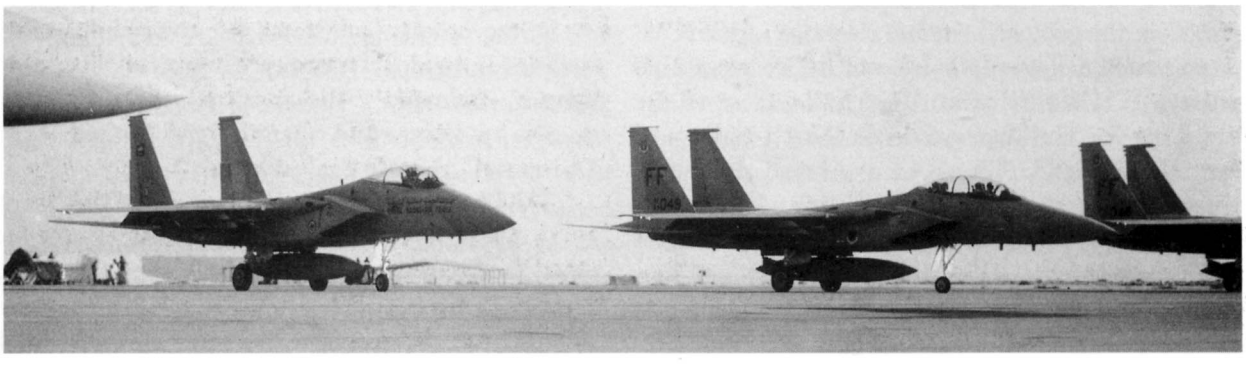
Reviewing the situation, Saudi Arabia's F-15s and Tornados, Bahrain's F-16s, Qatar's Mirage F.1s, Abu Dhabi's Mirage 2000s, and Oman's Jaguars made up a useful force of technically advanced aircraft. However, their small numbers and the very limited operational experience of their aircrews (in comparison with those of Iraq) necessitated very powerful reinforcements, and a sophisticated command and control system that could integrate the operations of aircraft from many nations.

THE PREPARATIONS

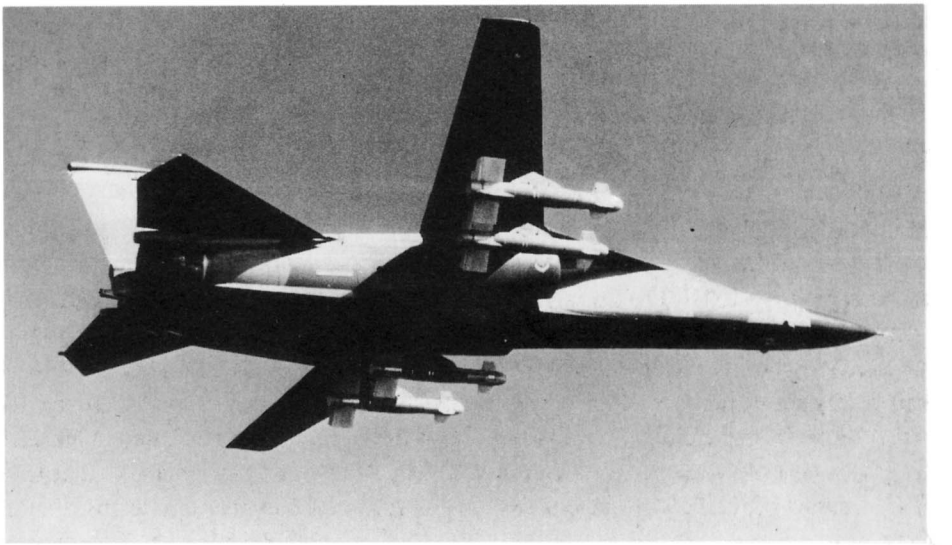
The buildup of Coalition forces prior to the initiation of hostilities on 17 January 1991 was an operation of unprecedented scale and complexity, and it was only natural that America took the lead in providing most of the assets deployed (including perhaps three-quarters of the aircraft) and the command and control system for the offensive that was to liberate Kuwait and provide a stable peace throughout the region. America's deployments were known as Operation Desert Shield.

As described earlier, the USAF's first action was the deployment of two squadrons of F-15C/Ds to Dhahran, these Eagles arriving on 8 August 1990, only six days after the Iraqi invasion of Kuwait. Five E-3A Sentries (AWACS aircraft) and some electronic intelligence RC-135s were shortly afterwards stationed at Riyadh, and KC-135 and KC-10A tankers were based at three airfields in Saudi Arabia. Several squadrons of F-16Cs were deployed to Abu Dhabi, and B-52s were flown to Diego Garcia in the Indian Ocean. A stream of C-5s and C-141s brought in supporting equipment, and the helicopters essential to US Army operations, including AH-64 Apaches, UH-60A Blackhawks, AH-1F Cobras and OH-58D Kiowas. The CV-62 *Independence* with CVW-14 (tail-code 'NK') arrived in the Gulf, quickly followed by the nuclear-powered CVN-69 *Dwight D Eisenhower* with CVW-7 ('AG'). By the end of August 1990 and within a month of the invasion, the US had in place the core of a force that could halt any further adventures by Saddam Hussein, and eventually drive his army out of Kuwait.

At time of writing, a comprehensive list of the units involved is not available, though most of the information can be obtained in fragmented form in press releases, and from aviation enthusiasts' publication and TV news reports. What is more difficult to obtain is a breakdown of where US units were



A Royal Saudi Air Force F-15C, parked alongside two USAF F-15Ds (serials, 82-0047 and -0046) from the 1st TFW, based at Langley AFB, Virginia. (Ian Black).



An F-111 carrying late-model GBU-15 glide bombs, with the wings and canards of the powered AGM-130A. The GBU-15 Cruciform Wing Weapon has the warhead from a Mk 84 bomb, weighs 2450 lb (1140 kg), and employs either TV or IIR guidance. (Rockwell).

deployed, since many of their 30 bases were described for security reasons simply as 'somewhere in Saudi Arabia'.

Beginning with USAF units in the attack category, it is understood that six units of A-10As were flown to Saudi Arabia, including the 23rd TFW ('EL') 'Flying Tigers' from England AFB, Louisiana. This wing was frequently shown on TV, surprisingly retaining its predominantly green European One camouflage (perhaps for its reduced IR signature), and sporting tigers' mouths in the Chennault tradition. Other A-10A units included the 10th TFW ('AR') from RAF Alconbury in Cambridgeshire, the 354th TFW ('MB') from Myrtle Beach AFB, South Carolina, and the 706th TFS ('NO') of the 926th TFG of the AFRES 10th Air Force, based at New Orleans NAS (Alvin Callender Field), Louisiana. Since the F-117A is designated as a fighter, the only other dedicated attack aircraft deployed was the AC-130H Spectre, of which 12 examples were flown in from the 16th Special Operations Sqn, part of the 1st SOW at Hurlburt Field, Florida. Presumably for equipment commonality reasons, Special Operations is part of Military Airlift Command (MAC), discussed later in this chapter.

Although it might have been instructive to deploy the Rockwell B-1B, which could have attacked targets anywhere in Iraq, the decision was taken to use the B-52G, although this aircraft lacks the ability to penetrate modern air defence systems, and was therefore restricted (at least initially) to targets in occupied Kuwait and in southern Iraq. The Vietnam War had demonstrated the usefulness of the B-52 in making accurate attacks (in some cases with MSQ-77 Sky Spot ground-based aids), generally from such high altitudes that their approach was unheard. The CEP with MSQ-77 was claimed to be less than 330 ft (100 m). A cell of three aircraft would typically lay waste an area approximately 3300 ft (1000 m) wide and 10,000 ft (3000 m) long. The B-52G can carry 27 M117 or Mk 82 bombs internally, and a further 24 Mk 82 externally (using four triple-mountings in tandem on each of two pylons). The M117 weighs 830 lb (375 kg) and a free-fall Mk 82 about 530 lb (240 kg), hence maximum bomb load is 35,130 lb (15,885 kg), but restricting ordnance to Mk 82s reduces this figure to 27,030 lb (12,240 kg).

The initial deployment consisted of B-52Gs from two Bomb Wings: the 42nd BW at Loring AFB, Maine, and the 93rd BW at Castle AFB, California. It may be noted that the 93rd is part of SAC's 15th Air Force, whereas the 42nd and those units deployed later are elements of the 8th Air Force. At the time there was speculation that some of the B-52s might be equipped with the Israeli-developed Rafael AGM-142A Have Nap standoff missile, which had just completed USAF tests, but this was not confirmed. Have Nap (formerly Popeye) is a 3300 lb (1500 kg) weapon with a 750 lb (340 kg) warhead, a range of 50 nm (27 km), and inertial guidance with TV/IIR terminal homing.

Lockheed F-117A stealth fighters of the 37th TFW, based at Tonopah, Nevada played a key role in Desert Storm, striking at individual buildings in Baghdad undetected and unscathed. (Randy Jolly).

Immediately before the outbreak of hostilities in January 1991, some of these B-52Gs were moved up from Diego Garcia to the Middle East, evidently Egypt and Saudi Arabia. On the 15th day of the war it was announced that further B-52s would be introduced into the air offensive, based at RAF Fairford in Gloucestershire and at 'another European base', which eventuated as Morón de la Frontera near Seville in Spain. On 5 February 1991 the first five (of eight) B-52Gs arrived at RAF Fairford. These aircraft seem to have been a mixture from the 2nd BW at Barksdale, Louisiana, the 379th BW at Wurtsmith AFB, Michigan, and the 416th BW at Griffiss AFB, New York. Morón took 26 B-52Gs.

Turning to the fighter category, the old F-4G Wild Weasel (air defence suppression) version of the Phantom II was to play a vital role in the conflict. The F-4G was represented in Saudi Arabia by aircraft from the 35th TFW ('WW') from George AFB, California, and the 52nd TFW ('SP') at Spangdahlem AB in Germany.

As mentioned earlier, the F-15C/D was originally represented by the 27th and 71st TFS of the 1st TFW from Langley AFB, Virginia, but the 94th TFS was added at a later stage, giving three squadrons of 24 to 28 aircraft. There was initially some speculation that the AIM-120 AMRAAM might be rushed into service to replace the AIM-7M, but this missile appears to have been fitted to only a few aircraft (probably 33rd TFW F-15s), and it was not fired operationally. In the event, the limited availability of this advanced missile was not to prove a problem, since the IAF never threatened Coalition air supremacy. If needed, the active-guidance AIM-120 would have provided the ability to engage up to four targets simultaneously at medium/long ranges, and for the F-15 to disengage immediately after firing, thus minimising the likelihood of return fire. The USAF F-15C/D units deployed included the 33rd TFW ('EG') from Eglin AFB, Florida, and the 53rd TFS of the 36th TFW ('BT') from Bitburg AB in Germany.

The conflict provided a good opportunity for the 'swing-force' F-16 to demonstrate the case for a lightweight fighter that can deliver bombs accurately, yet can hold its own against most enemy aircraft. Large numbers of F-16s were consequently deployed to the area, including examples from the 10th TFS of the 50th TFW ('HR') at Hahn AB in Germany, the 347th TFW ('MY') at Moody AFB, Georgia, the 363rd TFW ('SW') at Shaw AFB, South Carolina, the 388th TFW ('HL') at Hill AFB, Utah, and the 401st TFW ('TJ') at Torrejon AB in Spain. Some F-16s (401st TFW) were based in Turkey, and others (eg, 363rd RFW) at Al Dhafra AB, Sharjah.

The Air National Guard was represented by the

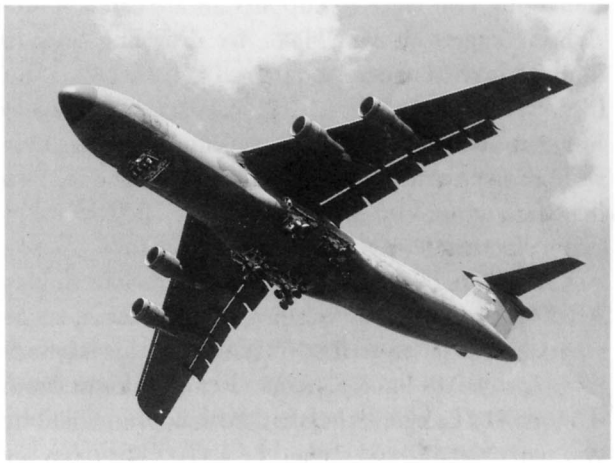
138th TFS/174th TFW of the New York ANG, based at Hanock Field, Syracuse, and the 157th TFS of the 169th TFG of the South Carolina ANG at McEntire ANGB, both units equipped with F-16A/Bs. The New York squadron had pioneered the ground attack use of the General Electric GPU-5 30 mm gunpod, which carries the four-barrel GAU-13/A derivative of the well-known seven-barrel GAU-8/A Avenger tank-killing gun used in the A-10A. The pod fires at 2400 rd/min.

The other USAF dual-role fighter is the F-15E, which was deployed primarily for its all-weather interdiction capability, but also achieved air-to-air kills. The type was initially represented at Thumrayt by the 336th TFS of the 4th TFW ('SJ') of Seymour-Johnson AFB, North Carolina. This was the first operational squadron to convert to the F-15E (from the F-4E), and it seems likely that additional units were later deployed to the region.

Although their operations received little publicity, USAFE assets deployed to Adana-Incirlik AB in southern Turkey included at least two squadrons of F-111Fs from the 48th TFW ('LN'), based at RAF Lakenheath in Suffolk and two squadrons of F-111Es from the 20th TFW at Upper Heyford in Oxfordshire.

The F-111Fs had previously been used operationally during the El Dorado Canyon strikes against Libyan targets in April 1986. For that single night strike, 24 F-111Fs had taken off from Lakenheath, but four were spares and five aborted, leaving 13 to bomb. The targets were first identified at long range by means of the aircraft's Texas Instruments APQ-119 radar, then transferred to Ford Aerospace AVQ-26 Pave Tack FLIR, with associated laser ranging. This system makes possible the precise delivery of unguided bombs, and five Il-76s were destroyed at Tripoli airport, and four MiG-23s, two F.27s and two Mi-8s at Benina. Since France and Spain refused overflight rights, the mission radius was 2500 nm (4650 km), giving a flight time of 12 hours, requiring four refuellings on the way to the target and two during the return.

The need to be able to make surgical strikes against key military buildings in the centre of Baghdad with minimum collateral damage and hopefully with zero attrition provided a clear case for the Lockheed F-117A 'stealth fighter'. Some 59 of these night attack aircraft had been built, the type making its first flight on 18 June 1981 and achieving IOC with the 4450th Tactical Air Group at Tonopah test range airfield, Nevada, in October 1983. The group was



(Above) The C-5 was to demonstrate its merits throughout the campaign, including the emergency deployment of Patriot missile systems to defend Israel against Iraqi Scud-series missiles. (Tony Holmes).

Lockheed products also proved invaluable at the other end of the size spectrum, the C-5 Galaxy carrying some 45 per cent of the cargo that was taken from the US to the Gulf during Operation Desert Shield. This C-5A was photographed at Mildenhall. (Tim Ripley).

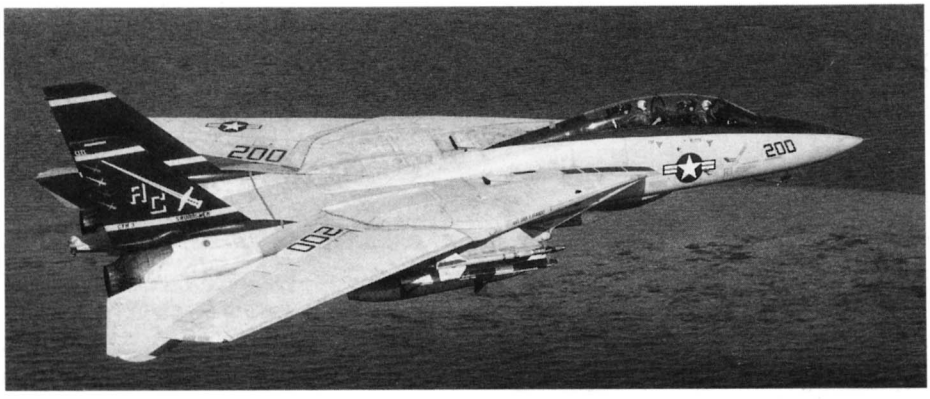
redesignated as the 37th TFW ('TR') in October 1989, and organised as three squadrons: the 415th TFS 'Nightstalkers', the 416th TFS 'Ghostriders', and the 417th TFS 'Bandits'. The wing (which may well be strengthened by the purchase of a further batch from Lockheed) is expected to transfer from Tonopah to Holloman AFB, New Mexico, in 1992.

To help perform its mission stealthily, the F-117A carries all its fuel internally, and has a ventral weapons bay to house two 2000 lb (900 kg) LGBs. Weapon delivery accuracy depends on an FLIR/laser system, which is presumably a modern equivalent of Pave Tack, developed for single-seat aircraft. The only previous operational use of the F-117A occurred during the US invasion of Panama on the night of 19/20 December 1989. Six aircraft were tasked, but two of these were reserves, and two were allocated to targets that were cancelled (because Panama's dictator Manuel Noriega was not at any of them). The remaining two were to support an air drop by US Army Rangers at Rio Hato, by dropping 2000 lb (900 kg) bombs within 500 ft (150 m) of the barracks of the defending soldiers. In the event, surprise was lost because Panamanian forces learned of the invasion three hours in advance. None the less, two bombs were delivered accurately, and did not improve the morale of the defenders.

Some 20 F-117As were ferried from Langley AFB to an airfield in western Saudi Arabia on 20 August 1990, with tanker facilities for this 15-hour flight provided by KC-10As. For the flight from Tonopah to Langley, they had been accompanied by two spare aircraft and tanked by KC-135Qs from the 9th SRW at Beale AFB, California. It is understood that the F-117As were subsequently joined by a further squadron.

An alternative means to attack heavily-defended targets precisely was the US Navy's Tomahawk land attack missile, fitted with a conventional warhead, and designated TLAM-C or BGM-109C. Launched from a surface vessel or submarine, the BGM-109C carries a 1000 lb (455 kg) warhead over a range of 700 nm (1300 km), using a Teledyne CAE turbofan engine. It employs inertial navigation, with updates provided by terrain contour-matching (TERCOM), a system that automatically compares the output from a downward-looking radar with a memorised three-dimensional map of the country. The radar can also be used for automatic terrain-following. For even more precise navigation in the target area, TLAM-C can use digital scene-matching area correlation (DSMAC), in which the scene below is compared with a detailed map. The Tomahawk series is manufactured by McDonnell Douglas and General Dynamics, and one of the recent developments from GD had been the introduction of a vertical dive attack option. What had yet to be determined was whether Tomahawk attacks could be coordinated with aircraft strikes, and whether DSMAC would function consistently at night.

In close support operations by aircraft such as the A-10A and F-16, weapons delivery accuracy (and the safety of friendly troops) would once again depend on the forward air controller (FAC), whom the USAF prefers to have airborne, rather than immobilized on the ground. The service used the OV-10 Bronco in Vietnam, flying it as a single-seater, armed with four 7.62 mm M60C machine guns and pods of 2.75 inch (70 mm) FFARs for target-marking and attacks in which quick response was essential. In a recent nose-count the USAF still had 78 OV-10s, and at least one unit was deployed to Saudi Arabia, the 507th Tactical



The F-14A Tomcats of VF-32 'Swordsmen' were attached to CVW-3, based on board the CV-67 USS John F Kennedy, which throughout Desert Storm operated in the Red Sea, flying strikes across Saudi Arabia against targets in southern Iraq and occupied Kuwait. (Lt Cdr Parsons, USN).

Air Control Wing ('SR') from Shaw AFB, South Carolina. The FAC role of the OV-10 (and OA-37B) has now largely been taken over by the OA-10A, which retains a serious attack capability by virtue of its 30 mm GAU-8/A Gatling gun. In early 1990 the USAF announced plans to convert around half its A-10A fleet of 440 aircraft to the FAC role. One OA-10A unit identified in Saudi Arabia was the 23rd Tactical Air Support Sqn ('NF') from Davis-Monthan AFB, Arizona, which operates a mixture of OA-10As and OV-10As.

One need that was destined to emerge very clearly from the conflict was that for speedy and compre-

This US Navy A-6E Intruder is pictured carrying a total of 10 Mk 82 bombs and two AGM-88A HARMs (High-speed Anti-Radiation Missiles). (Texas Instruments).

This EA-6B Prowler of VAQ-131 'Lancers' is about to be catapulted from the deck of the CV-61 Ranger. *Note the ALQ-99F jammer pods and the fin-tip radome through which enemy transmissions are received and analysed. (Tony Holmes).*

hensive reconnaissance, regardless of weather and lighting conditions. This demand applied equally to detecting transient targets such as *Scud* TELs and to bomb damage assessment (BDA). The basic USAF tactical reconnaissance aircraft is still the RF-4C, deployment of which included aircraft from the 67th TRW ('BA') from Bergstrom AFB, Texas, and the 106th TRS, 117th TRW ('BH') of the Alabama ANG, based at Birmingham Municipal Airport (Smith ANGB), and the 192nd TRS, 152nd TRG of the Nevada ANG, based at May ANGB.

High-altitude reconnaissance was provided by a number of Lockheed TR-1s and U-2Rs from the 99th TRS of the 9th SRW at Beale AFB, California. A single U-2R normally operates as Detachment Three from the unit, at RAF Akrotiri in Cyprus. Other TR-1s came from the 17th RW at RAF Alconbury.

Other reconnaissance assets included the Boeing RC-135 Rivet Joint from the 55th SRW, Offutt AFB, Nebraska, presumably chosen for its standoff surveillance and electronic reconnaissance capability, combining protracted endurance with long antennas for side-looking radars and large oblique cameras. The USAF's willingness to field the latest technology was illustrated by the deployment of two prototypes (strictly speaking, EC-18C testbeds) for the Boeing/Grumman USAF/US Army E-8A J-STARS (Joint Surveillance and Target Attack Radar System), flown by the 4411th J-STARS Sqn. The E-8A is a modified 707 with a Norden synthetic aperture side-looking airborne radar (SLAR), capable of detecting tank movements at slant ranges of the order of 100 nm (185 km). These two aircraft had been carrying out full-scale development work, based at Melbourne in Florida, and on 11 January 1991 departed for Saudi Arabia. Each had a crew of 14 USAF personnel from TAC and the Electronics Systems Division of Air Force Systems Command,

supplemented by four volunteers from Grumman.

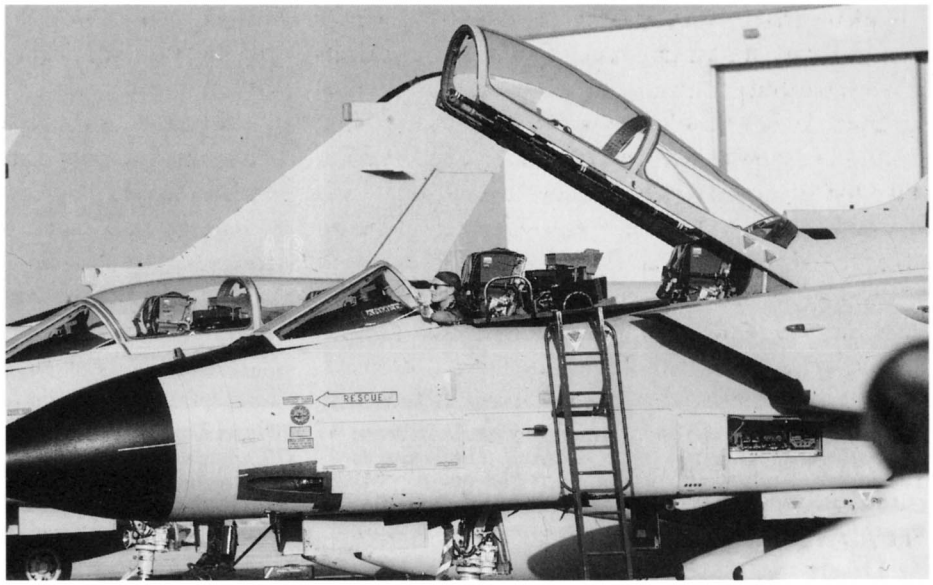
In terms of keeping track of aircraft movements in the area and controlling the large number of allied aircraft flying simultaneous missons, the USAF naturally depended on the E-3B Sentry (AWACS), at least five of these aircraft being deployed from TAC's 552nd Airborne Warning and Control Wing at Tinker AFB, Oklahoma. Details of the performance of the E-3 have never been released, but it is thought to have an unrefuelled endurance of around 10 hours, and up to 22 hours with flight refuelling. It normally cruises at Mach 0.72 at around 30,000 ft (9000 m), and is said to be capable of detecting small, low-flying aircraft at a range of 150 nm (280 km) and large co-altitude aircraft at 360 nm (670 km). The Westinghouse APY-2 radar has a total weight of 8250 lb (3740 kg), of which the rotating antenna mass is 3400 lb (1540 kg). Interestingly, the power transmitted is so great that the radar is switched off whenever the aircraft is within 2 nm (3.7 km) of its tanker, to eliminate the risk of a fire during refuelling.

Minimising losses of friendly aircraft would depend not only on knowledge of enemy movements from AWACs, but also on the ability to jam enemy radars. For this role the USAF has what is probably the world's best long-range electronic warfare aircraft in the form of the Grumman EF-111A Raven. This retains the supersonic performance of the basic F-111A from which it was derived, and can thus provide penetration of direct support jamming regardless of the speed used by the strike aircraft it is escorting. The EF-111A carries 8182 lb (3710 kg) of avionics, much of which is associated with the Eaton-AIL ALQ-99F jamming subsystem. The receiver antennas that detect any enemy radars are mounted in a fin-tip pod, and the jamming transmitter antennas are in a 16 ft (4.9 m) canoe-shaped radome under the fuselage. Some 42 aircraft were converted to EF-111A standard, and the first unit to be equipped (from late 1981) was the 390th Electronic Combat Sqn of the 366th TFW ('MO') at Mountain Home AFB, Idaho. Aircraft from this squadron participated in the Just Cause Operation in Panama in late 1989, and were the first aircraft to penetrate Iraqi airspace at the start of hostilities in

The 'QB' tail-code indicates that these are KC-130R tankers (serials 160014 and '017) from VMGR-352 at El Toro MCAS in California, the unit abbreviation indicating that 352 is a Marine Aerial Refueller and Transport Squadron. (DPR(N), Crown Copyright).

This RAF Tornado GR.1 of No 14 Sqn was photographed leaving its HAS on 27 August 1990 to depart from its base at Bruggen in Germany for Bahrain/Muharraq, where it was to join No 15 (Composite) Sqn. It carries a Marconi Sky Shadow jammer pod (port wing), and a BOZ-107 chaff/flare dispenser. (PRM).

Tornado GR.1s in the Middle East., illustrating the fact that, although the new 'Pink Panther' desert sand camouflage was lavishly applied, the radome remained unpainted to avoid any deterioration in radar performance. (DPR(N), Crown Copyright).



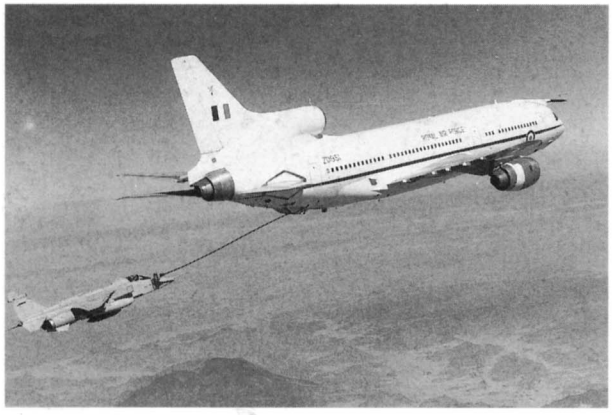
A rare picture of a Tornado without external fuel, flying relatively low over the desert. Note the application of radar-absorbent material on the leading edges. This F.3, coded 'DL' was formerly 'HD' with No 111 Sqn at Leuchars. (Ian Black).

January 1991, operating from a base in eastern Saudi Arabia. The second unit to receive the EF-111A was the 42nd ECS of the 66th ECW, which is attached to the 20th TFW ('UH') at Upper Heyford. It seems likely that the EF-111As deployed to Anada-Incirlik in Turkey came from this second unit.

Other USAF jamming aircraft deployed to the theatre included the RC-135 Rivet Joint mentioned earlier, and the EC-130H Compass Call communications jammer. The latter aircraft were taken from the 41st ECS at Davis-Monthan AFB, Arizona.

The deployment of USAF combat and support aircraft to the Middle East involved the use of KC-10 and KC-135 tankers from virtually every SAC Air Refuelling Sqn and many ANG and AFRES units. Most tankers temporarily based in the Middle East reportedly used three Saudi airfields and Al Dhafra, but from mid-February 12 KC-135s used to refuel B-52Gs attacking from RAF Fairford were deployed to Mont de Marsan AB in south-west France and Avord AB in the centre of the country.

The logistics involved in moving US men and equipment to Saudi Arabia were on an unprecedented scale, but the USAF has in its inventory (or had, on 30 September 1989) some 83 C-5s, 254 C-141s, and 336 C-130s of various models. Desert Shield involved the use of almost 90 per cent of the MAC fleet on the 7000 nm (13,000 km) run from the US East Coast, with C-5s initially averaging up to 10.5 hr/day and C-141s up to 12 hr/day. Flights generally staged through Torrejón de Ardoz or Zaragoza-Valenzuela in Spain, or Frankfurt/Rhein-Main or Ramstein in Germany. The Republic of Ireland later provided refuelling facilities, arguing that supporting UN actions did not conflict with the nations's traditional neutrality. India initially allowed MAC transports to refuel at Bombay Airport on their way to Saudi Arabia from the Philippines, but from 20 February this practice was stopped.



Photographed in early November 1990, this TriStar (formerly G-BFCD) of No 216 Sqn was refuelling a Jaguar en route to Thumrayt from Coltishall. The Jaguar is already fitted with overwing pylons. (Mike Rondot via PRM).

This section of Jaguar GR.1As was photographed while returning to Bahrain/Muharraq after a successful sortie over occupied Kuwait on 28 January 1991. Note the overwing AIM-9Ms. (Mike Rondot via PRM).

Desert Shield was the first major test of America's Civil Reserve Air Fleet (CRAF) programme. Stage I provides for the US Government to call up 45 commercial transports from the airlines, though in fact only 18 were required. Stage II can activate up to 180 aircraft (including the initial 45), and was implemented on 18 January 1991, though only 40 long-range cargo aircraft were taken from 32 operators. Stage III could take the total to around 500 aircraft, the plan being that in a full-scale war the civil sector would provide 90 per cent of US passenger airlift and 40 per cent of US cargo airlift. To provide additional capacity, 14 Reserve and ANG squadrons were activated on 23 August 1990, primarily to overcome a shortage of MAC pilots associated with restrictions on their flying time. Aside from the CRAF aircraft operated full-time as part of Desert Shield, other civil aircraft were chartered, mainly to move personnel to the Middle East. In all, civil aircraft moved 60–65 per cent of the passengers and 20–25 per cent of the cargo. The C-5 and C-141 each moved around 18 per cent of the passengers, but the figures for cargo were around 45 and 30 per cent respectively, illustrating the enhanced usefulness of the larger aircraft.

By early December 1990, MAC had transported over 200,000 people and 200,000 US tons (181,500 tonnes) of cargo, though it must be admitted that this tonnage was only a tenth of that taken by sea. By the start of hostilities, the totals had risen to approximately 429,000 personnel and 550,000 US tons (500,000 tonnes).

Various reports have claimed that this is several times the tonnage carried in the Berlin Airlift of 1948–49, but that well-known author Bill Gunston (writing in *The Rolls-Royce Magazine*) quotes for the latter a figure of 2,325,808.7 tons (approx 2,363,021.6 tonnes). The Berlin supply operation was carried out over very short distances in comparison with those of Desert Shield, US aircraft in the earlier operation flying only 240 nm (450 km) from Wiesbaden or Rhein-Main, while the other nationalities flew only 140 nm (260 km) from Hamburg. In terms of ton-miles, Desert Shield was thus probably around seven times as large as the Berlin Airlift, and in mid-January 1991 the former simply became Desert Storm and went on running.

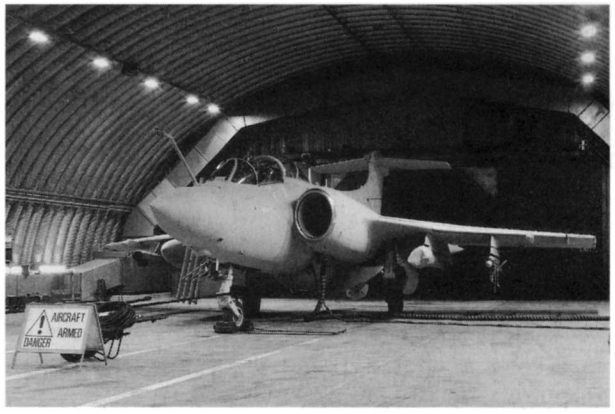
Since strategic transports such as the C-5 and C-141 can land only at large airfields, the intratheatre positioning of personnel and materiel demanded large numbers of C-130s capable of using much smaller strips. In Saudi Arabia it was also necessary to operate C-130s from straight stretches of road around 3000 ft (900 m) long and 40–60 ft (12–18 m) wide. In preparation for the forthcoming offensive, similar road strips were identified in Kuwait and Iraq, and crews practised LAPES (Low Altitude Parachute Extraction System) and CDS (Containerized Delivery System) air drops.

So far this discussion had been concerned only with manned aircraft, but it may be noted that unmanned vehicles of various types had important roles to play. Aside from UAVs (the Pioneer used by the USMC and USN, and the Pointer used by the

US Army and USMC), satellites provided reconnaissance, weather forecasts, navigation, communications and other facilities. At least 12 different series of military satellites were involved, including the KH-11 (photographic) and Lacrosse (radar) reconnaissance systems, DMSP meteorological and DSP missile-warning satellites, the Navstar GPS navigation series, and various communications systems, including the DSCS series, the US Navy's FltSatCom and Syncom IV, and the British Skynet 4. Among many other roles, satellites provided the essential links between the commanders in the field and Central Command's Templar (Tactical Expert Mission Planner), a supercomputer at MacDill AFB in Florida. Templar generated detailed planning for a coordinated air offensive that was to involve up to 3000 allied sorties daily.

By mid-August 1990 the US Navy had positioned two carriers in the Persian Gulf: CV-62 USS *Independence* and CVN-69 USS *Dwight D Eisenhower*, equipped respectively with carrier air wings CVW-14 ('NK') and CVW-7 ('AG'). Five months later, when the UN deadline ran out, both of these ships had been withdrawn, to be replaced by the CV-41 USS *Midway* and CV-61 USS *Ranger*, with CVW-5 ('NF') and CVW-2 ('NE'). At that stage the CVN-71 USS *Theodore Roosevelt* with CVW-8 ('AJ') was in the Red Sea, but was repositioned to the Gulf. Remaining in the Red Sea for strikes across Saudi Arabia against targets in southern Iraq, there remained the CV-60 USS *Saratoga* with CVW-17 ('AA'), CV-66 USS *America* with CVW-1 ('AB'), and CV-67 USS *John F Kennedy* with CVW-3 ('AC'), giving a total of six carriers with over 450 aircraft in range of Iraq. There was some irony in the fact that, just as these ships were going to war, the Secretary of Defense was announcing FY92 budget proposals including the retirement of the *Midway*, *Saratoga* and *Ranger* (and also the CV-59 USS *Forrestal*). All the vessels of the US Navy's Middle East Group came under the control of the command ship AGF-3 USS *La Salle*.

At time of writing full details of the squadrons involved in Desert Storm operations have not been released, but it is believed that most of the carriers had two squadrons of F-14 Tomcats, two of F/A-18 Hornets, one of A-6E/KA-6D Intruders, one of S-3A/B Vikings, and small squadrons consisting of 4



When RAF Tornado GR.1s were switched to LGB delivery, a dozen Buccaneers were flown to Bahrain/Muharraq. This S.2B has a laser designator on the port inboard pylon, used to 'paint' targets. (DPR(RAF), Crown Copyright).

E-2C Hawkeyes, 4 EA-6B Prowlers, and 6 SH-3H Sea Kings. The *Midway* was the principal exception to this rule, with no F-14s (the CV-41 cannot take the Tomcat) or S-3s, but three squadrons of F/A-18s and two of A-6E/KA-6Ds. In addition, *Kennedy* had two A-7E squadrons (on what was probably the Corsair II's final deployment) in place of F/A-18s, and the 93,000-ton nuclear-powered *Roosevelt* had a second squadron of A-6E/KA-6Ds.

Provisional information indicates that the F-14A Tomcat was represented by VF-1 and -2 on *Ranger*, VF-33 and -102 on *America*, VF-14 and -32 on *Kennedy*, and VF-41 and -84 on *Roosevelt*. In addition, the F-14A+ with uprated (F110) engines was flown by VF-74 and -103 on *Saratoga*, and VF-142 and -143 on *Eisenhower*. The F/A-18A Hornet was likewise operated by VFA-151, -192 and -195 on *Midway*, VFA-81 and -83 on *Saratoga*, VFA-82 and -86 on *America*, and VFA-15 and -87 on *Roosevelt*. The old A-7E was flown by VA-42 and -76 on *Kennedy*.

The A-6E/KA-6D Intruder and EA-6B units were reportedly VA-115, VA-185 and VAQ-136 on *Midway*, VA-35 and VAQ-132 on *Saratoga*, VA-145 and VAQ-131 on *Ranger*, VA-85 and VAQ-137 on *America*, VA-75 and VAQ-130 on *Kennedy*, and VA-36, VA-65 and VAQ-141 on *Roosevelt*.

The E-2C Hawkeye early warning squadrons were VAW-115 on *Midway*, -125 on *Saratoga*, -116 on *Ranger*, -123 on *America*, -126 on *Kennedy*, and -124 on *Roosevelt*. The S-3 Viking ASW squadrons were VS-30 on *Saratoga*, -38 on *Ranger*, -32 on

America, -22 on *Kennedy*, and -24 on *Roosevelt*, and it may be noted that VS-30 and -22 had the S-3B with an improved weapons system.

In view of the importance of strikes against land targets in Desert Storm, it is noteworthy that the A-6E has an excellent night attack capability, as demonstrated in the 1986 missions against Libya. Targets are first detected on a Norden APQ-148 radar, then transferred to a Hughes AAS-33 FLIR/laser for precise weapon delivery computation. By 1990 some A-6E crews had night vision goggles. Equally important was the EA-6B Prowler, which lacks the supersonic performance of the USAF's EF-111A, but employs the same ALQ-99F jamming system, in this case using up to 10 smart amplifiers in five external pods.

In addition to these carrier-based aircraft, many of the larger fighting ships had an SH-60B Seahawk or an SH-2F Seasprite helicopter. Carrier onboard delivery (COD) duties were performed by C-2A Greyhounds from VR-24 of NAS Catania-Sigonella in Sicily, and from VRC-50 of NAS Cubi Point on Bataan in the Philippines. Other US Navy aircraft and units known to have been involved include P-3C Orion patrol aircraft from VP-1 of Barbers Point on Hawaii, EP-3C electronic intelligence and jamming aircraft from VQ-2 of NAS Rota in Spain, C-130F Hercules from VR-22 (also at Rota), and C-9B Skytrains from VR-55 of NAS Alameda in California.

The US Marine Corps deployed over 300 aircraft to the Gulf, mainly from MAW-1 on Okinawa and MAW-2 at MCAS Cherry Point. Some Marine F/A-18A Hornets, OV-10A/D Broncos, AV-8B Harrier IIs and large numbers of helicopters operated from shore bases, including Dhahran, Al Jubayl, and a number of small airstrips and pads that were upgraded or built from scratch by laying AM-2 aluminium planking.

A Fleet Air Arm Sea King HC.4 leaves the deck of the helicopter support ship RFA* Argus. *Note the sand filters on the roof-mounted intakes. (DPR(N), Crown Copyright).

This Royal Navy Sea King HC.4 (ZE428, 'WC') was assigned to the newly-formed No 848 Sqn, and photographed in the hold of the* Atlantic Conveyor *in the early hours of 23 December 1990. (PRM).

For self-defence while supporting the 1st Armoured Division, the HC.4s were fitted with pintle-mounted 7.62 mm GPMGs (General Purpose Machine Guns). (DPR(N), Crown Copyright).

Full details of all the units involved were not available at time of writing, but participating Marine squadrons are believed to have included the following. Hornets came from VMFA-235 ('DB') and -232 ('WT') at Kaneohe Bay, Hawaii, VMFA-314 ('VW') of MCAS El Toro, California, and VMFA-333 ('DN') -312 ('DR') and -451 ('VM') of MCAS Beaufort, South Carolina. Intruders formed two squadrons, of which one was VMA(AW)-224 ('WK') from Cherry Point, which also provided the Prowlers of VMAQ-2 ('CY').

Harrier IIs came from VMA-223 ('WP'), -231 ('CG'), -331 ('VL') and -542 ('CR'), all from Cherry Point, and from VMA-311 ('WL') of MCAS Yuma, Arizona. Some of this last unit's AV-8Bs may have been the night attack version, with GEC Sensors FLIR, night vision goggles (NVGs) and modified cockpit lighting. Target identification and marking was performed by OV-10A/Ds from VMO-1 of MCAS New River, North Carolina, and VMO-2 of MCAS Camp Pendleton, California.

Camp Pendleton also provided four AH-1W SuperCobra units: HMLA-267 ('UV'), -269 ('HF'), -369 ('SM') and HMLA-367 ('VT'). The AH-1W has a three-barrel M197 20 mm cannon, and provisions for TOW and Hellfire ATGWs and AIM-9s.

Turning to medium transport helicopters, New River deployed three squadrons of CH-46E Sea Knights: HMM-261 ('EM'), -263 ('EG'), and -265 ('EP'), while MCAS Tustin, California, sent HMM-161 ('YR'), and Kaneohe Bay sent HMM-165 ('YW'). In the heavy category, Tustin provided the CH-53D Stallions of HMH-462 ('YF'), and the CH-53E Super Stallions of HMH-465 ('YH') and -466 ('YK'), which served with those of HMH-461 ('CJ') from New River.

The Marine's own air refuelling facilities were provided by KC-130s from VMGR-152 ('QD') at MCAS Futenma, Okinawa, VMGR-252 ('BH') at Cherry Point, and VMGR-352 ('QB') at El Toro. Reserve units included VMGR-234 from NAS Glenview, Illinois, and VMGR-452 from Stewart ANGB, New York, both using the KC-135T.

Aside from small numbers of OV-1 Mohawk FAC aircraft and RU-21 Super King Airs, the US Army's contribution to air operations took the form of helicopters, that service naturally providing most of the 1700-plus rotary-wing aircraft deployed by America's four services to the Middle East. Around 400 USAREUR helicopters were redeployed from Germany, mostly being flown to the Netherlands NAS base at Leiden-Valkenburg, and then direct to the dockside at Rotterdam to be shipped to the Gulf. The principal types involved were the AH-64A

All RN Sea Kings deployed to the Gulf were fitted with sand filters, IR jammers, flare dispensers, and IFF Mk 12 Mode 4 to suit operations in conjuction with US forces. (DPR(N), Crown Copyright).

Apache, AH-1F Cobra (the fully upgraded TOW version), OH-58C/D Kiowa (which also acted as a scout for the Marines' AH-1W), the old UH-1H Huey of Vietnam fame, its successor the UH-60A Blackhawk (including the medevac version) and its EH-60C battlefield communications jammer derivative, and the medium-lift CH-47D Chinook.

The four US services had thus created by the time of the UN deadline an aerial armada, the like of which the world had never seen. However, it was essential for the political credibility of the action to liberate Kuwait that other services (aside from those of the Arab host nations) should be seen to be taking part on a significant scale. In all, some 28 countries provided military contributions to the force assembled against Saddam Hussein, but only a handful of these nations provided aircraft.

While Saudi Arabia was overall second in scale to the US in numbers of aircraft deployed, the second largest contributions of those nations deploying forces to the region from outside came from Britain. Perhaps in view of the UK's traditional responsibility for the defence of Kuwait, and the former's perpetual claims to a special relationship with the US, it was only right that the British Forces should be present on a major scale.

The principal RAF combat aircraft to be deployed in Operation Granby was the Panavia Tornado, which was making its operational début. It was initially stated that 'up to 72' Tornados would be sent to the Gulf, but the number was later increased to 78 in view of the relatively high attrition experienced with GR.1s. These numbers suggest four large composite squadrons of 18 aircraft each, with three GR.1/1A units for strike, interdiction and reconnaissance, and one F.3 unit for combat air patrols (CAPs).

It is currently not possible to give the complete history of Tornado deployments, because crews were continually rotated back to the UK and Germany. The point is well illustrated by the Tornado F.3 unit, which was formed at Dhahran on 11 August 1990 as No 5 (Composite) Sqn, with six aircraft from each of Nos 5 and 29 Sqn, both based at Coningsby in Lincolnshire. All these Tornados had been prepositioned at Akrotiri in Cyprus. At the end of September six more F.3s arrived from the UK, and the crews were rotated, producing No 11 (Composite) Sqn, with men from Nos 11, 23 and 25 Sqn, ie, the Leeming Tornado Fighter Wing from North Yorkshire. Around the end of the year another rotation took place, and the unit became No 43 (Composite) Sqn, with crews from No 43 Sqn at Leuchars in Fife and No 29 Sqn at Coningsby. It was in this form that the F.3s went to war in January 1991.

At the time of the conflict, there was one Tornado

GR.1 unit, No 15(C) Sqn, at Bahrain/Muharraq formed from No 15 Sqn at Laarbruch and Nos 14 and 17 Sqn of Bruggen (likewise from RAF Germany), replacing Nos 27 and 617 Sqn from Marham, and one GR.1 unit at Tabuk formed from Nos 16 and 20 Sqn of Laarbruch, No 20(C) Sqn. There was also a Tornado unit at Dhahran, No 31(C) Sqn, with GR.1s from Nos 31 and 9 Sqn of Bruggen, later supplemented by GR.1A reconnaissance aircraft from No 2 Sqn at Laarbruch and No 13 Sqn at Honington in Suffolk.

All the RAF Tornados involved were equipped with Have Quick 2 secure radios and IFF to Mk 12 Mode 4 cryptographic standard. The low-flying GR.1/1As were fitted with GPS Navstar receivers and were painted in the new desert sand ('Pink Panther') camouflage, developed for short-term deployments to the Middle East by Philip Barley of RAE Farnborough. In addition, all Tornados were given coatings of radar-absorbent material (RAM) on the intake ducts and the leading edges of the wing, vertical tail and pylons, in addition to the front end of their Phimat chaff-dispenser pods.

In the case of the F.3s (the only RAF aircraft not to be painted desert sand), the latest Block 13 aircraft were selected, with Marconi Foxhunter radars to Type AA standard, HOTAS controls, Marconi Hermes RWR, and a 5 per cent combat boost for their RB199s. Two Tracor ALE-40(V) flare scabs were added on the engine access panels. The cabin conditioning systems were also uprated, improved tyres were fitted, and the cockpit canopies were modified to overcome problems resulting from thermal distortion. The GR.1/1A's RB199 Mk103 engines initially suffered turbine blade problems, due to sand dust forming a glass deposit that clogged the cooling holes, but this was solved by the use of single-crystal blades from the Mk104 of the Tornado F.3. The only principal armament change appears to have been the use of Skyflash 90 AAMs by the F.3, giving longer firing ranges. In addition, AIM-9Ms were hurriedly supplied, with improved rocket motors and seeker heads.

For attacks on tactical ground targets and the relatively small vessels operated by the Iraqi Navy, the RAF deployed 30 Jaguar GR.1As from Nos 6, 41 and 54 Sqn at Coltishall in Norfolk. The Jaguars were painted in desert sand and equipped with ALE-40 flare dispensers below the jetpipes, complementing the Phimat chaff pod under the right wing and the Westinghouse ALQ(V)-101 jammer under the left. To offset the use of outboard pylons for countermeasures, overwing Sidewinder pylons were fitted, and this may well explain the initial deployment to Thumrayt in Oman (to borrow export-standard overwing pylons) prior to relocating to Bahrain/Muharraq. Specifically for this operation, 70 mm Bristol Aerospace CRV7 rocket projectiles were purchased from Canada, though reportedly without warheads, possibly indicating the use of more advanced *flèchette* warheads from another source. The 41 Sqn Jaguars had provisions for centre-line reconnaissance pods, each housing five Vinten F95 cameras and a BAe Type 401 IR-linescan equipment.

Infrared jammers (ALQ-156s) were fitted to

Two Sea King HC.4 pilots wearing NBC protective equipment and carrying their electrically-powered air filtration units. (DPR (N), Crown Copyright).

A French Air Force Jaguar of EC1/11 'Roussillon', deployed from its base at Toul to Al Ahsa AB, south of Dhahran. (Ian Black).

RAF and RN helicopters and RAF C-130s. Chinook HC.1s of the RAF were also equipped with intake filters, flare dispensers, GPS receivers, and two pintle-mounted 7.62 mm Miniguns. The Chinooks came from No 7 Sqn at Odiham in Hampshire, and No 18 Sqn at Gutersloh in Germany. Around 25 Puma HC.1s from No 33 Sqn at Odiham and No 230 Sqn at Gutersloh were based ar Ras al Ghar in northern Saudi Arabia. The first 15 Pumas were flown out in C-5s, but the remainder (together with the Chinooks and some RN and British Army helicopters) were shipped out on the *Atlantic Conveyor*, the replacement for the container ship that was sunk by Exocet missiles during the Falklands conflict. The Chinooks and Pumas formed a Joint Helicopter Support Unit (JHSU).

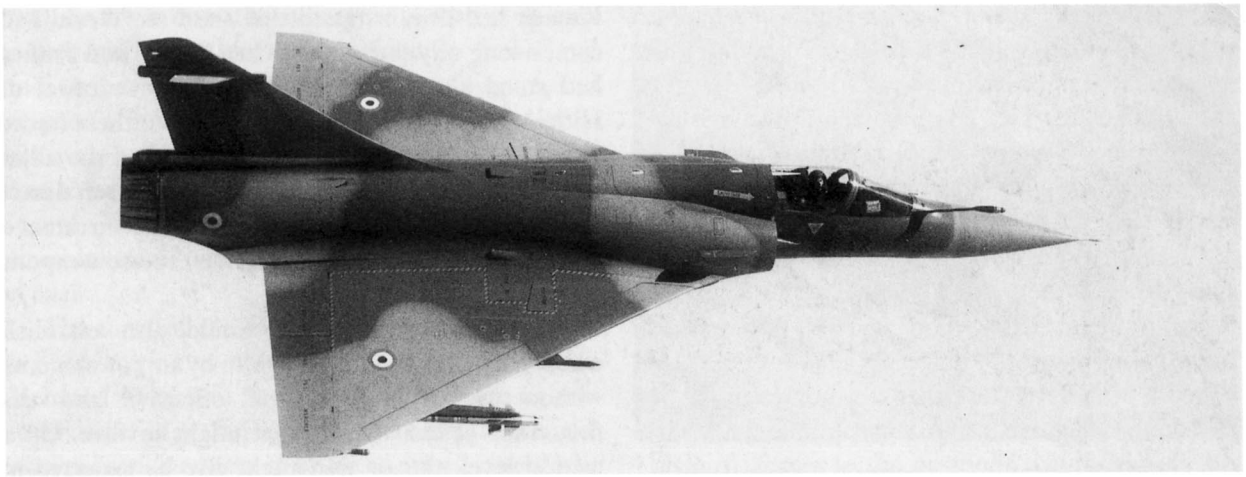
During February 1991 two batches of six Buccaneer S.2s were flown to Bahrain from Nos 12 and 208 Sqn at Lossiemouth in Morayshire, to act as laser target designators for Tornado GR.1s. Reports indicate that the first batch had Westinghouse ASQ-153 Pave Spike designators suitable for daylight use only, and that the second batch had the day/night GEC Ferranti TIALD (Thermal Imaging Airborne Laser Designator). All the Buccaneers had Marconi Sky Guardian 200 RWRs and US chaff/flare dispensers. Other aircraft from Scotland included Nimrod MR.2s of Nos 120, 201 and 206 Sqn, deployed from Kinloss in Morayshire to Seeb in Oman. They were later joined by Nimrods of No 42 Sqn from St Mawgan in Cornwall.

The fixed-wing logistics element took the form of C-130 Hercules from Nos 24, 30, 47 and 70 Sqn, from Lyneham in Wiltshire. Aerial refuelling was provided by Victor K.2s of No 55 Sqn, based at Marham in Norfolk, and VC10 K.2/3s of No 101 Sqn and TriStar K.1/KC.1s of No 216 Sqn, both based at Brize Norton in Oxfordshire. The Victors were located at Bahrain, and the VC10s and TriStars tankers at Riyadh.

Turning to the Royal Navy's helicopters, missile attacks on Iraqi vessels were the responsibility of five Lynx HAS.3s from Nos 815 and 829 Sqn, each fitted with IR jammers over the side doors and three chaff/flare dispensers at the forward end of the tail-boom. At the outbreak of hostilities, two Lynxes were carried by the Type 22 frigate *Brazen*, one by its sister-ship *London*, and one on each of the Type 42 destroyers *Cardiff* and *Gloucester*.

The troop-carrying Sea King HC.4 was fitted with sand filters and IR jammers, and was represented by three six-aircraft squadrons: Nos 845, 846 and 848. This last unit was re-formed in December 1990 at RNAS Yeovilton, having previously been formed (with Wessex 5s) at the time of the Falklands conflict. Though normally associated with the Royal Marines of No 3 Commando Brigade, the role of the HC.4s was to support the 1st Armoured Division. The first 12 were shipped out on the *Atlantic Conveyor*, and the remainder on the helicopter support ship RFA *Argus*. In addition, two Sea King HAS.5s of No 826 Sqn, stripped of their sonar equipment, were sent out for use in the surface-search role.

The principal Army Air Corps helicopters to be



A Mirage 2000C of EC5, pictured over the desert, armed with Matra Magic short-range air-to-air missiles. (via Ian Black).

deployed to the theatre were Lynx AH.7s and Gazelle AH.1s from Nos 654, 659 and 661 Sqn; all were equipped with sand filters.

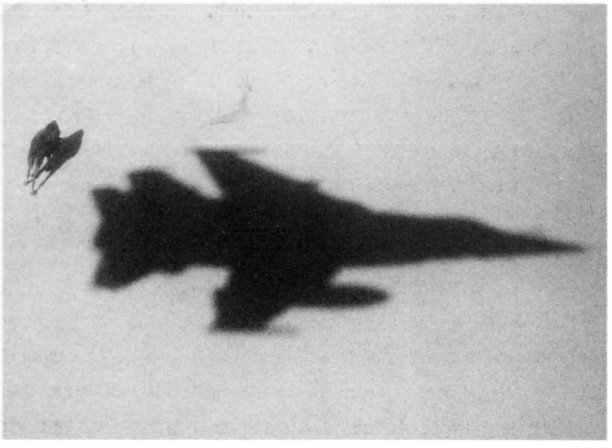
Despite France's large-scale arms sales to Iraq, major deployments were made by the French Air Force (*Armée de l'Air Française*) and Army, and these forces were strengthened in the light of Iraq's ill-treatment of French diplomats in Occupied Kuwait. The principal combat elements contained in *Opération Salamandre* were 24 Jaguars from EC11, based at BA136 Toul-Rosières, 12 Mirage 2000Cs from EC5 of BA115 Orange-Caritat, 8 Mirage F.1Cs from EC12 of BA103 Cambrai-Epinoy, and 4 F.1CRs from ER33 to BA124 Strasbourg-Entzheim. The Jaguars and Mirage 2000s were based at Al Ahsa, near Hofuf, some 70 nm (130 km) south of Dhahran, but the Mirage F.1s were initially set back at Qatar (which also has this type) to minimise recognition problems. These aircraft were supported by C-135F tankers at Riyadh from ERV93, four C.160F/NG Transalls, and one C.160NG Gabriel electronic intelligence aircraft.

French Army Aviation (*Aviation Légère de l'Armée de Terre*) was reported to have contributed up to 120 helicopters, which were mainly delivered by the carrier *Clemenceau* to the Red Sea port of Yambu. The principal type was the SA.342M Gazelle, armed with HOT missiles or a 20 mm cannon. Smaller numbers of AS.332 Super Puma transports were operated from Hafar Al Bateen and King Khalid army camp.

The Italian Air Force (*Aeronautica Militare Italiana*) contributed under Operation Locust 10 Tornado strike aircraft from the 154th Gruppo of No 6 Stormo at Ghedi, the 156th Gruppo of No 36 Stormo at Gioia del Colle, and the 155th Gruppo of No 51 Stormo at Treviso-Istrana. These aircraft were ferried out via Luxor in Egypt to Al Dhafra in the UAE, with logistical support provided by C-130s and the shorter-range G.222. In addition, Italy is reported to have sent six F-104S and ten G.91Rs to Diyarbakir in Turkey, to provide air support against any possible Iraqi attacks.

The Canadian Air Force positioned a composite squadron of 26 CF-18 Hornets at Qatar, primarily to give air cover to the three Canadian warships in the Gulf, although they were later to escort strike aircraft *en route* for Iraq, and attack Iraqi surface vessels and ground targets. This squadron operated CF-18s from Nos 409 ('Nighthawk') and 439 ('Tiger') Sqn of Baden-Söellingen in Germany, and from No 416 ('Lynx') Sqn of Cold Lake in Alberta. The Hornets were supported by CC-130 transports, and reportedly refuelled from KC-130s.

The Canadian Forces also operated six CH-124A Sea Kings from the destroyer HMCS *Athabaskar* and the fleet replenishment vessel HMCS *Protecteur*, in the surface surveillance role. These helicopters were modified with FLIR, GPS receivers, Tracor laser-warning receivers, APR-39 RWRs, Loral AAR-47 missile approach warning equipment, ALE-37 and M130 flare dispensers, a Sanders ALQ-144 IR jammer, and a door-mounted heavy machine gun.



One of the few tactical reconnaissance aircraft available in the Gulf was the Mirage F.1CR. This portrait of a camel was taken by an F.1CR from ER33 as its shadow passed the animal. (via Ian Black).

The Belgian Air Force (*Force Aérienne Belge*) combat aircraft contribution took the form of 18 Mirage 5BAs from the 8th *Escadrille* of No 3 Wing at Bierset, which were deployed to Diyarbakir as part of NATO's ACE Mobile Force. They were supported by C-130s from No 15 Wing at Melsbroek, which also carried Patriot spares to Turkey. In addition, FAB converted one C-130 and one 727-100QC to air ambulance configuration, and made these aircraft available to carry British wounded back to a hospital in Cyprus. Aside from the Italian Starfighters mentioned earlier, the ACE Mobile Force included 18 German Air Force (*Luftwaffe*) Alpha Jets from JBG43 at Oldenburg, supported by C.160 Transalls.

Other aircraft in the theatre of operations included Royal Australian Navy S-70B-2 Seahawks on board the frigates HMAS *Brisbane* and *Sydney*, which at the start of hostilities had replaced the *Adelaide* and *Darwin* deployed earlier. New Zealand provided two C-130Hs from No 40 Sqn at Whenuapai, to be based at Riyadh and assist British forces. Spain and the Netherlands each provided two transport aircraft, though no details are available currently. Japan's ASDF sent five C-130s for casualty evacuation duties. At least three NATO E-3A AWACS aircraft were deployed from Geilenkirchen in Germany to Konya in Turkey. By mid-January 1991 a remarkable multi-national fleet of aircraft was in place, and time was fast running out for Saddam Hussein.

This buildup of Coalition forces to liberate Kuwait had demonstrated that the Free World had come a long way since 1939, when Britain and France had stood alone in demanding the withdrawal of Hitler's legions from Poland. Having put these forces in place, it remained to be seen whether the allies really had the stomach for a fight in a barren desert against an unspeakable enemy who had threatened (and already proved his willingness) to use weapons of mass destruction.

The coming hostilities would also establish whether a major war could be won by air power alone, without recourse to a land offensive and the thousands of casualties that it might involve. On a tactical level, the air war might also be expected to prove:

— whether low-performance aircraft such as the OV-1 Mohawk, OV-10 Bronco, and A-10A Thunderbolt II could survive over a modern battlefield

— whether the aged B-52 could penetrate a post-Vietnam air defence system

— whether dual-role fighters such as the F-15E and F-16 (and their dual-role crews) could really provide a useful operational flexibility

— whether the European concept of low-level unescorted penetrations was superior to the US concept of medium-level strikes with patrolling fighters and jamming aircraft.

Nobody had wanted this war, but it promised to send a message to other dictators obsessed with self-aggrandisement, and to teach some practical lessons concerning air warfare.

THE ACTION

In the Korean War (which was also a UN-approved action), US bombers had been forbidden to attack enemy bases beyond the Yalu River, ie, in China. In Vietnam some of the most worthwhile targets, including Soviet vessels bringing arms to the Communists, had been off-limits, and the whole conflict was micro-managed from Washington, with bombing pauses that allowed the enemy to repair damage and strengthen defences. However, in the battle to eject Iraqi forces from Kuwait, the commanders on the spot were going to run things their own way. The green light would come from Washington,

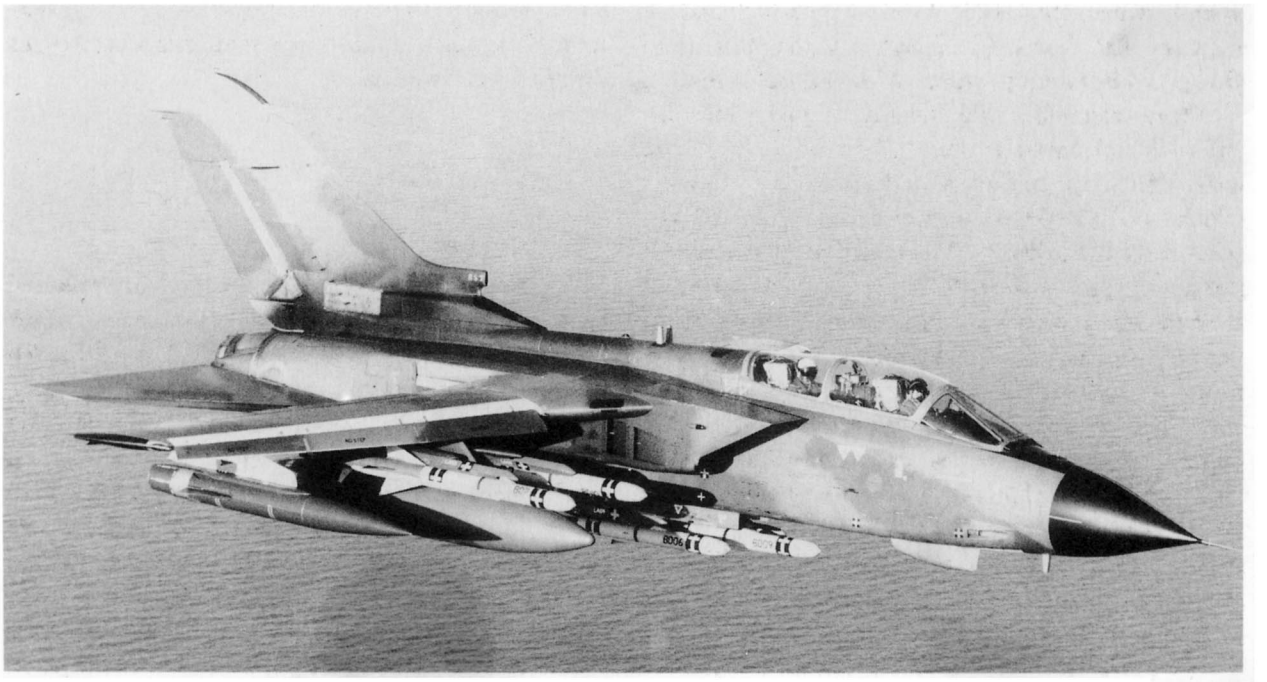
and then it was up to the military to prevail as quickly as possible. Casualties among friendly forces and Iraqi civilians were to be reduced to a minimum, and weapons of mass destruction would require political approval, but in other respects the men in uniform were to have a free hand. Probably for the first time since USAAF B-29s dropped atomic bombs on Hiroshima and Nagasaki in 1945, air power was really on trial.

The form of the forthcoming air war had been outlined during a press interview given by Gen Michael J Dugan in September 1990, when he was USAF chief of staff. According to Gen Dugan, the principal strike targets in order of priority would be air defence systems, airfields and aircraft, command and control centres, armament production facilities, and lastly Iraq's armoured divisions. Aside from these military targets, the Coalition aircraft would attack petroleum production and storage facilities, in order to restrict the fuel supplies available to enemy forces. In addition to making all possible efforts to avoid civilian casualties, US planners had specifically embargoed three religious centres in Iraq.

Gen Dugan went on to say that allied strikes would also be aimed at achieving 'decapitation' by focusing (on Israeli advice) on Saddam Hussein, his mistress, his family, and key members of the armed forces who provided the basis for his support. This reference to targeting individuals angered US defence secretary Richard B Cheney, who felt that the interview showed a lack of discretion in discussing sensitive operational matters, and that it implied a willingness to violate the presidential executive order forbidding assassinations of foreign leaders. The USAF chief of staff was dismissed for showing lack of judgement.

The United Nation's Resolution 678 had set a deadline of 15 January 1991 for Iraq to withdraw from Kuwait, after which the Coalition forces could use 'all necessary means' to implement the original Resolution 660, demanding an immediate return of Hussein's forces to the positions they held before 1 August 1990. As the deadline drew near without any sign of a withdrawal, the time became more precisely defined as 2400 hr Eastern Standard Time (EST), ie, the end of Tuesday 15 January as measured at the UN headquarters in New York.

The deadline came and went without any sign of hostilities, and some of the news media began suggesting that the Coalition was waiting for a high tide for an amphibious landing or ideal lighting conditions for the allies to exploit their perceived



The BAe ALARM defence suppression missile made its operational début in Desert Storm. This photograph shows preproduction rounds on an RAF Tornado GR.1. (BAe).

THE PLATES

A
USAF F-4G Phantom II SAM-suppression aircraft played a (literally) leading role in the massive aerial onslaught against Iraqi targets on 17 January 1991. Equipped with the McDonnell Douglas AN/APR-38 radar and missile detection and launch homing system, F-4G Wild Weasels cleared a path through ground-based air defences as wave after wave of Allied warplanes penetrated deep into Iraq. Active threat radars were mostly 'taken out' using the AGM-88 HARM (High-speed Anti-Radiation Missile), four of which are slung under each of these Weasels from the 35th TFW based at George AFB, California. (DoD via David F. Brown).

B
Flight refuelling from USAF Strategic Air Command KC-135 and KC-10 tankers was instrumental in sustaining the unprecedented number of sorties flown by Coalition aircraft which, laden with full warloads, would have otherwise been unable to reach their targets and return to base. Maintaining strict radio silence, four F-4G Wild Weasels (hence 'WW' tailcode) rendezvous with a Boeing KC-135R Stratotanker. (DoD via David F. Brown).

C
The performance of the Lockheed F-117A night attack fighter during the Gulf War vindicated the USAF's huge investment in stealth technology. Designed to destroy critical high-value targets, the 'Black Jets' of the 37th TFW crippled Iraq's nuclear and biological weapons production facilities as well as helping to severely damage the command, control and communications (C^3) capability of the Iraqi armed forces. As the stealth tanker has yet to be invented, F-117As were refuelled in Saudi airspace beyond Iraqi radar cover. (DoD via Robert F. Dorr).

D1
The crew of this USN Grumman F-14A Tomcat carrier-borne multi-role fighter could not resist taking a closer look at what to them must have been a distinctly unfamiliar type—an RAF Jaguar GR.1A tactical strike fighter—during an operational sortie on 23 January 1991. Two days earlier, an F-14A TARPS of VF-103 'Sluggers' was shot down by Triple-A during a reconnaissance mission over Iraq. The pilot, Lt Devon Jones, was later rescued by a 'special ops helicopter' (possibly an MH-60G of the 1st SOW), having been protected by two orbiting A-10 'Warthogs' for some five hours; his RIO, Lt Lawrence Ratslade, became a POW. In the fighter's only confirmed kill at the time of writing, two Tomcats pounced on a luckless Iraqi Mi-8 *Hip* battlefield helicopter, almost certainly hosing it down with M61 cannon fire. (Mike Rondot via PRM).

D2
This close-up of a USN Sikorsky SH-60B Seahawk LAMPS (Light Airborne Multi-Purpose System) helicopter of HSL-45 from the guided-missile frigate USS *Kurts* (FFG-38), reveals the name *Freddy's Back* (inspired by the 'Nightmare on Elm Street' motion pictures) to the right of the horizontally stacked sonobuoy ejection chutes. The SH-60B is capable of both anti-submarine warfare (ASW) and anti-ship surveillance and targeting (ASST) missions. (PRM).

E
Even the portly Vought A-7E Corsair II is stealthy when terrain-masking techniques are employed. This SLUF (Short Little Ugly Fellow—polite version) of attack squadron VA-72 'Blue Hawks' from the USS *Ranger* (CV-61) hugs the desert floor to avoid detection by radar, infrared and optically-guided air defence systems. (DoD via Robert F. Dorr).

F
A Marine helicopter pilot gets the low down on the next mission for his trusty Huey. This Bell UH-1N from HMLA (Helicopter Marine Light Attack) -367 'Scarface', based at Camp Pendleton, California operated in support of USMC AH-1W SuperCobra attack helicopter units. (DoD via Robert F. Dorr).

G1
A pair of USMC AH-1W SuperCobras and a single UH-1N Huey make use of a disused runway in Saudi Arabia. During the course of Desert Shield, the US deployed no less than 1700 rotary-wing aircraft to the Gulf. (DoD via Robert F. Dorr).

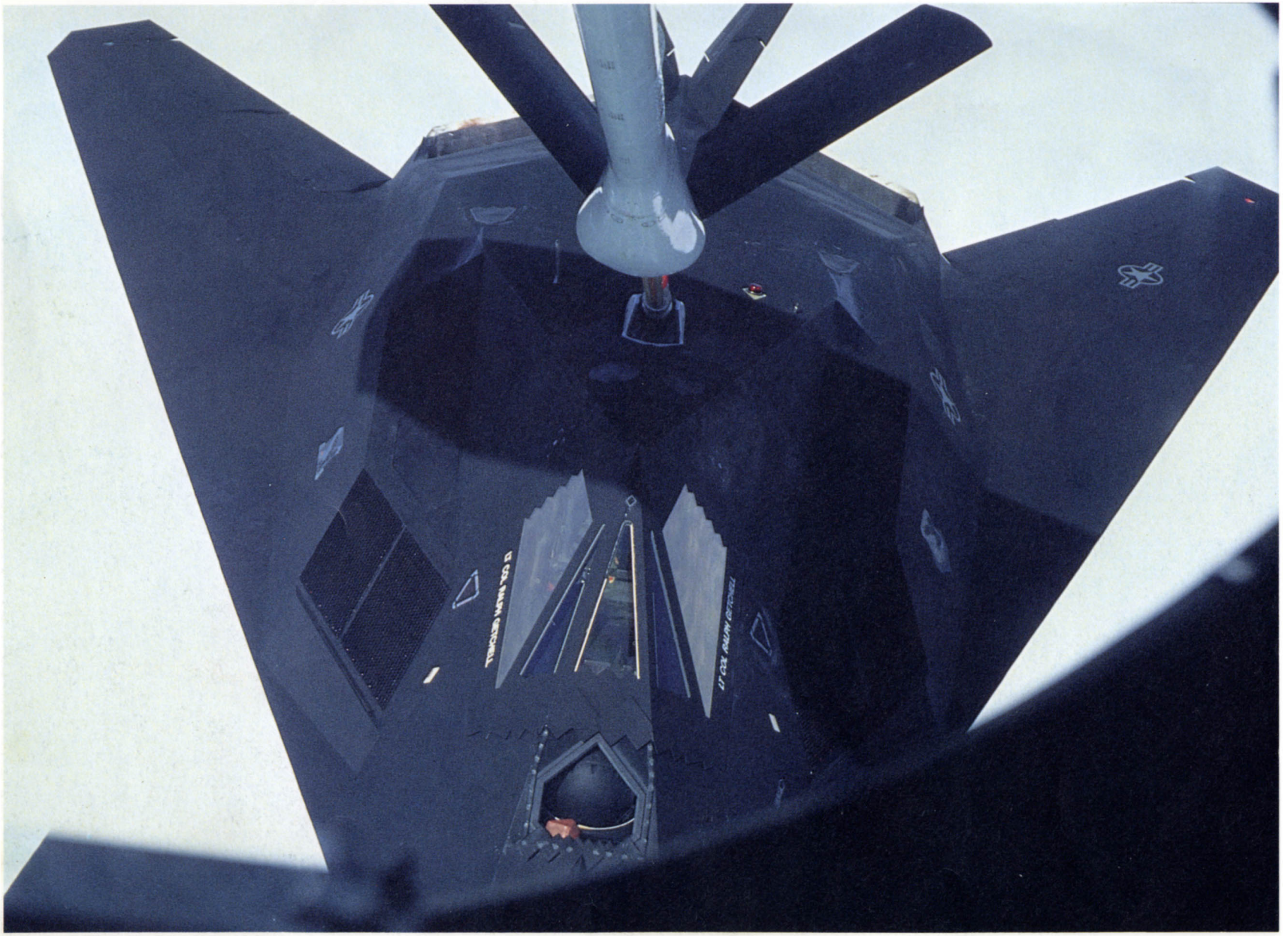
G2
A TOW (Tube-launched, Optically-tracked, Wire-guided) anti-tank missile team from the Marine Expeditionary Brigade sprint to their firing positions as an AH-1W prepares to play its part in exercising a coordinated attack against Iraqi armoured units. (DoD via Robert F. Dorr).

H1
US Army Sikorsky UH-60A Blackhawk tactical transport helicopters provided much of the air mobility required to establish and secure the vast Cobra Base deep inside Iraq when the ground phase of Desert Storm began on 24 February 1991. (DoD via Tim Ripley).

H2
Nearly nine years after the Falklands conflict, the Westland Lynx/Sea Skua missile once again proved to be a

USAF F-4G Phantom II Wild Weasels

USAF Wild Weasels refuelling



USAF F-117A night attack fighter

1

USN F-14 Tomcat and RAF Jaguar GR.1A

2

D USN SH-60B Seahawk LAMPS helicopter

USN A-7E Corsair II cockpit view

F USMC UH-1N Huey helicopter

1

USMC AH-1W SuperCobras at desert base

2

USMC TOW-missile team and AH-1W SuperCobra

1

US Army UH-60A Blackhawk helicopter

2

H RN (Fleet Air Arm) Lynx HAS.3 (GM)

RAF Jaguar GR.1A armed with Sidewinder

1

RAF Tornado F.3 refuelling from VC10 tanker

2

J RAF Tornado F.3 of No 11 (Composite) Sqn

RAF Tornado GR.1A reconnaissance aircraft

RAF Tornado GR.1 strike aircraft at Bahrain

RAF Jaguar GR.1A being armed at Bahrain

N RAF Victor K.2 tanker *Lusty Lindy*

RAF Jaguar GR.1A *Mary Rose*

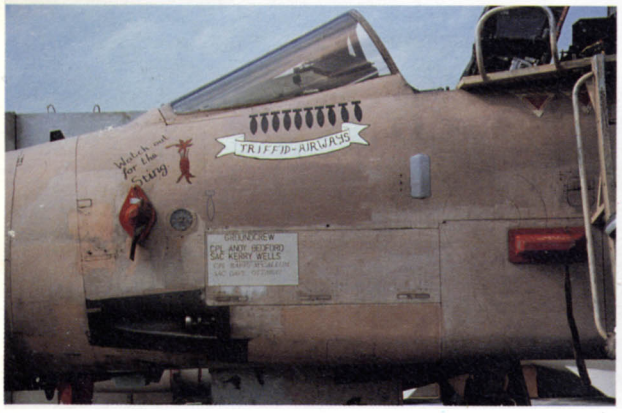
1

2

3

4

5



6

P1 RAF Buccaneer S.2B *Miss Jolly Roger/Fiona*
P2 RAF Jaguar GR.1 *Katrina Jane*
P3 RAF Tornado GR.1 *Snoopy Airways*
P4 RAF Tornado GR.1 *Helen*
P5 RAF Tornado GR.1 *Triffid Airways*
P6 RAF Tornado GR.1 *Hello Kuwait G'Bye Iraq*

deadly combination. Lifting off from HMS *London*, this Lynx HAS.3(GM) is fitted with Orange Harvest ESM antenna on the nose; roof-mounted 'Hot Brick' infrared jammers; chaff/flare dispensers on the rear of the cabin; a Sandpiper FLIR pod under the belly; and a Yellow Veil radar jamming pod (AN/ALQ-176(V)). (DPR(N), Crown Copyright).

I1
Until the Gulf Crisis, no RAF Jaguar had been seen with overwing Sidewinder launchers, CRV7 rocket pods (one of which is visible under the port wing of the formating Jaguar), ALE-40 flare scabs or a desert sand paint scheme (even the pilots' flying helmets were sand-coloured to complete the camouflage effect). Although their initial deployment was marred by the unfortunate death of one pilot in a training accident, no RAF Jaguars were lost during Desert Storm. (Mike Rondot via PRM).

J1
An RAF Panavia Tornada F.3 interceptor refuels from a VC10 tanker en route to Dhahran in Saudi Arabia, from where three successive composite squadrons each mounted long-range fighter CAPs for a total of five months from 11 August 1990. (Andrew March via PRM).

J2
A Tornado F.3 from No 11 (Composite) Sqn bears its teeth in the form of four Sky Flash 90 radar-guided AAMs and four AIM-9M Sidewinder AAMs, the latter almost completely hidden by the two 500 Imp gal (2250 lit) underwing tanks. Two Tracor ALE-40(V) flare scabs are fitted under the engine access panels. Ironically, after the incorporation of an impressive number of modifications which substantially improved the aircraft's combat performance, F.3 crews never had an opportunity to fire a shot in anger due to the lack of any serious opposition from the Iraqi Air Force. (Ian Black).

K
Tornado GR.1A reconnaissance aircraft from Nos 2 and 13 Sqns, deployed from Laarbruch and Honington, Suffolk respectively, formed part of the *Scud*-busting team which searched for Saddam's elusive terror weapons in southern and western Iraq. The recce version of the GR.1 is fitted with an horizon-to-horizon infrared camera in place of the twin-Mauser 27 mm cannon carried by the strike-dedicated Tornados. The store on the nearest outboard pylon is a Marconi Sky Shadow ECM pod, balanced on the opposite station by a Swedish-designed BOZ 107 chaff/flare dispenser. With its wings swept fully aft at a rakish 67 degrees, this 'Pink Panther' prepares to go 'feet wet' during No 2 Sqn's Gulf workup. Interestingly, 'Panther' was one of the names originally suggested for Panavia's Multi-Role Combat Aircraft (MRCA). (DPR(RAF), Crown Copyright).

L
A Tornado GR.1 taxies in at Bahrain during the formative stage of the RAF's Gulf deployment. Compared to other Coalition air assets, Tornado attrition appeared disproportionately high, six GR.1s being lost in action. As this book went to press, five RAF Tornado aircrew KIA were returned to the UK. Happily, Sqn Ldr Robert Ankerson, Flt Lt John Peters, Flt Lt Adrian Nichol, Flt Lt David Waddington, Flt Lt Robert Stewart, Flt Lt Rupert Clark and F/O Simon Burgess were released under the terms of the ceasefire agreement after being held as POWs. Flt Lt John Peters walked free on 4 February 1991, followed the next day by the remaining RAF prisoners. (PRM).

M
Bahrain, 29 January 1991; RAF groundcrew perform the delicate task of loading a Westinghouse ALQ(V)-101 radar jamming pod under the port outboard pylon of *Katrina Jane*, a Jaguar GR.1A. By this time, American CBU-87 cluster bombs (adjacent pylon) were being used in place of Hunting BL755 units to permit weapon release from higher altitudes. (Mike Rondot via PRM).

N
Nose art flourished during the Gulf War, especially on RAF aircraft. Already a veteran of the Falklands conflict, *Lusty Lindy* is one of 20 Victor K.2 tankers converted from SR.2 strategic reconnaissance photographic aircraft between 1973–75. After giving outstanding service, these Victors are now tired airframes and will probably be scrapped upon their return from the Gulf. (PRM).

O
Photographed at Bahrain, Jaguar GR.1A *Mary Rose* bears the pennant of Wg Cdr G.W. Pixton, AFC, 'Boss' of No 41 Sqn based at RAF Coltishall in Norfolk. (Mike Rondot via PRM).

P1
Miss Jolly Roger/Fiona was one of the Buccaneer S.2Bs equipped with Westinghouse ASQ-153 Pave Spike laser designator pods used to mark targets such as bridges and aircraft shelters for Tornado GR.1s—hence the LGB symbols under the cockpit. (Mike Rondot via PRM).

P2
Katrina Jane, a Jaguar GR.1A flown by F/O R.M. MacCormac, F/O M.D. Rainier and F/O N.D. Collins. (Mike Rondot via PRM).

P3
The nose art of this Tornado GR.1 depicts Charles M. Schultz's Snoopy character riding on a JP233 airfield-denial weapon, which was used exclusively by RAF Tornado strike aircraft. Note the extended flight refuelling probe and plugged-in ground power cable. (Mike Rondot via PRM).

P4
Helen appears to be carrying spare 27 mm ammunition for the Tornados Mauser cannons, the muzzle of the starboard gun being clearly visible. ZD892 is decorated with 20 bomb symbols, the four with laser seekers denoting LGB strikes. (Mike Rondot via PRM).

P5
Tornado GR.1 *Triffid Airways* (*Watch out for the Sting*) lists the groundcrew who toiled to make her ready for the next mission: Cpl Andy Bedford, SAC Kerry Wells, Cpl Barry McCallum and SAC Dave Ottaway. The ultimate in low-visibility roundels is just discernible under the cockpit. (Mike Rondot via PRM).

P6
Hello Kuwait, G'Bye Iraq is painted with Gulf Air livery, an acknowledgement of the ramp space and general assistance provided by the carrier at Bahrain. The two 'L' plates may indicate missions aborted due to bad weather over the target or technical problems. (Mike Rondot via PRM).

Laser-guided bombs, waiting to be loaded on RAF Tornados at Bahrain/ Muharraq. The RAF employed LGBs primarily to destroy Iraqi bridges with the minimum of sorties and aircraft losses. (PRM).

superiority in night vision devices. However, the point that made a delay inevitable was that 2400 hr EST corresponded to 0800 hr on the next day in the theatre of operations. The initial phase of operations would be conducted by Coalition air forces, and they were to strike on the first night after the expiry of the UN deadline.

January 16th thus passed quietly, but there was a report that some B-52s were being repositioned from Diego Garcia to bases in the Middle East. Though it went unreported at the time, the first RAF Tornado GR.1s were airborne from Bahrain/Muharraq at around 2315 hr local time, and the first EF-111As and F-111s probably left the ground on a similar timescale.

At a secret base somewhere in Saudi Arabia, the F-117A stealth fighters had taken off much earlier to offset their slower speed. Meanwhile, somewhere in the Persian Gulf the old 57,500-ton BB-63 USS *Missouri* and BB-64 *Wisconsin* were about to create maritime history.

Thousands of miles away at a USAF base in Florida the supercomputer had punched out all the numbers for the 180-page daily task order, and now a strange multiplicity of flying objects were winging their way to Iraq to rattle Saddam Hussein's cage.

Day One of the battle for Kuwait began with the air raid sirens sounding in Baghdad at around 0200 hr local time on Thursday 17 January 1991. The multinational operation named Desert Storm was just beginning.

Reports of the initial strikes against Iraq emphasised those on Baghdad, for the simple reason that the Western press were concentrated there, sending out words and pictures via satellite links. The first explosions occurred around 0240 hr, and there were evidently at least four waves of attacks. These are believed to have begun with Tomahawk missile strikes from the two battleships in the Gulf, aimed at heavily defended large targets such as barracks and airfields. Single buildings in built-up areas of Baghdad, such as the Presidential Palace, the national telecommunications station and the headquarters of the Iraqi Air Force and various ministries, and that of the ruling Ba'ath Party, were attacked by the F-117A using its stabilised FLIR, laser designator, and 2000 lb (910 kg) LGBs.

Outside the capital, the targeting followed the lines of the briefing given the previous September by Gen Dugan. Airfields and air defence radars and SAM/AAA sites were hit, as were NBC and conventional armament plants, oil refineries, and *Scud* launching sites around the H-2 and H-3 airfields in the west of Iraq, opposite Israel. Individual targets were reported to include the SAAD-16 R&D facility at Mosul, the Project 124 *Scud* upgrade and DO-2 *Scud* production plant at Fallouja (a town that was to experience heavy civilian casualties later in the conflict), the DO-1 rocket and explosives facility at Al Hillah, a missile components plant at Karbala, and the uranium 235 production plant at Al Qain.

Initial statements from the Pentagon indicated that the night attacks involving manned aircraft had been performed by the air forces of the US, UK, Saudi Arabia and Kuwait. However, with the dawn of the 17th the French Jaguars of EC11 joined in, attacking the Al Jabir airfield in the south of Kuwait, the former A-4KU base. Four of the Jaguars were damaged by return fire, and one pilot was injured.

Disregarding highly imaginative reports of 100 Iraqi airfields were put out of action in the first night, it was soon established that around 750 sorties had been flown in the first 7 hr, over 1000 sorties in the first 14 hr, and approximately 1300 in the first 24 hr (compared to only 80 by Iraq). As was often the case in this war, bomb damage assessment (BDA) was

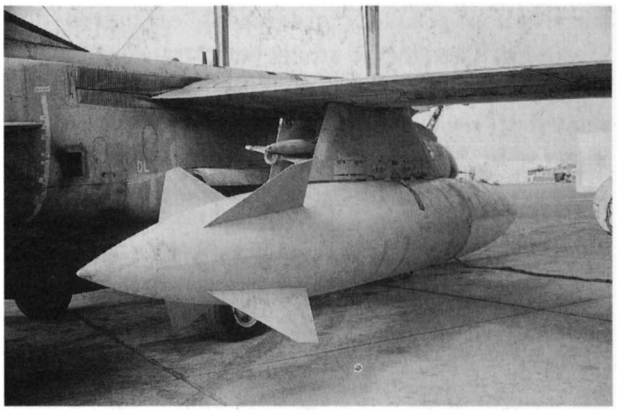
difficult, but at least the Western journalists in Baghdad were able to report that Iraqi TV was off the air, and that electricity and water supplies had been completely cut.

These initial operations involved virtually every aircraft type deployed to the Gulf theatre. For the USAF the attacks were performed by the F-15E, F-16A/C, F-111F, F-117A, A-10A, B-52G, and F-4G, with the F-15C flying escort missions, the EF-111A jamming Iraqi radars, the E-3A AWACS directing operations, and the KC-10A and KC-135 providing *en route* refuelling. The USN and USMC flew attack missions from carriers in both the Persian Gulf and Red Sea, with the A-6E, A-7E, AV-8B and F/A-18A carrying the ordnance, escorted by the Navy F-14 and Marine F/A-18A, with jamming provided by the EA-6B, tanking facilities by the KA-6D, and airborne early warning by the E-2C. The US Army was meanwhile represented by eight AH-64 Apaches, which used Hellfire missiles RPs and 30 mm gunfire to destroy two early warning radar installations deep in western Iraq.

In a Pentagon briefing on that first day, Gen Colin L Powell, chairman of the joint chiefs of staff, rated the air sorties 80 per cent effective, in the sense that the aircraft had reached their targets, delivered their ordnance, and returned to base. Most of the other 20 per cent had encountered mechanical or weather problems, or had aborted because they could not identify the target positively.

In those first strikes Saudi Arabia provided a total of 150 F-15s, Tornados, KE-3A tankers and E-3A Sentries. The Free Kuwaiti element was represented by A-4KUs. Britain's RAF flew Tornado GR.1s and F.3s, Victor tankers and Nimrod maritime patrol aircraft. In the daylight missions, both Britain and France attacked with Jaguars.

For the Tornado this had been the first-ever combat mission, although the type had entered service in 1982. The GR.1 was used in low-level attacks against airfields, using the Hunting Engineering JP233 submunition dispenser, and one report indicated that the Tornado had been escorted by the F-15C, although the concept of fighter cover would appear to be against normal RAF practice. Flight time was given as 3 hr 25 min, and a TV report showed the returned aircraft being fitted with new external tanks, which suggested the RAF would



The 500 Imp gal (2250 litre) 'Hindenburger' metal tank was developed for the Tornado F.3. It is shown here on Tornado GR.1 (serial ZE969), in place of the standard 330 Imp gal (1500 litre) plastic tank. (PRM).

quickly run out of these expendables. Another equipment making its operational début was the BAe ALARM defence-suppression missile, which had been rushed into service on the GR.1. Compared to earlier anti-radar missiles, ALARM has the advantage of an operating mode that allows a slow descent on a parachute, thus providing a long search time.

Unfortunately, one Tornado GR.1 from 15 Sqn at Bahrain/Muharraq was lost that first night, while returning from its target. The crew announced over the radio an engine fire and baled out. Also lost during the first day of war were an F/A-18A from the USS *Saratoga* (which was shot down by a SAM and its pilot killed), and a Kuwaiti A-4KU.

These initial losses were surprisingly small, considering that Iraq was supposed to have the sixth largest air force in the world and an impressive array of Soviet and French air defence systems. Whatever the effects of the bombing on individual buildings in Baghdad, it was clear that the Coalition air forces had been very successful in jamming radars and disrupting activities at key Iraqi airfields. Most IAF aircraft that succeeded in getting airborne appear to have simply withdrawn to safer airfields in the north. Iraq's only real response to the strikes was an artillery bombardment on the Saudi oil refinery at Ras al Khafji, just south of Kuwait. One storage tank was ignited, but the guns were silenced by A-10As and AH-1F Cobras.

Coalition losses had indeed been small, but it soon transpired that only around half of the daily

sortie totals referred to missions over Iraq and Occupied Kuwait (the others being transport, training, liaison sorties, etc), and that only half of these related to aircraft delivering ordnance. The initial impression was thus that something in the nature of one per cent of 'bombing' sorties was resulting in an aircraft loss. This figure confirms the old rule-of-thumb that you lose one per cent of aircraft on each pass over the target, hence the '*One Pass, Haul Ass*' rule. What was to concern Coalition planners was not the overall attrition rate, but the fact that a disproportionate number of losses was experienced by the RAF Tornado GR.1. The overall loss rate was to be far less than one per cent.

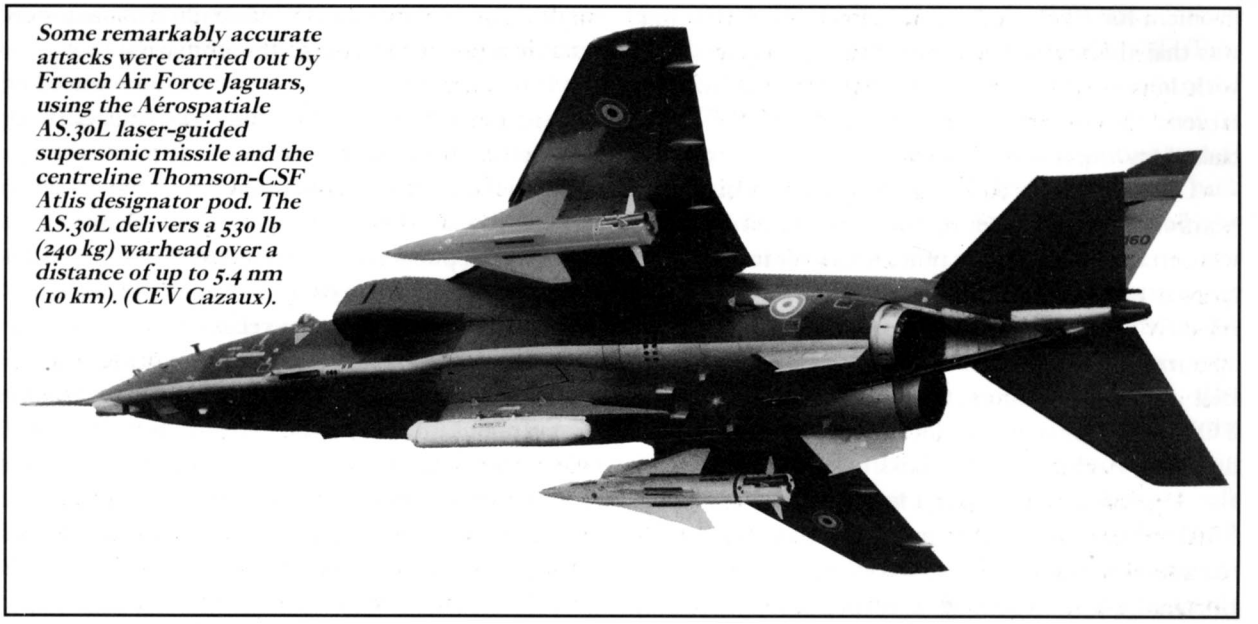
During this first phase of the air offensive six GR.1s were lost in little more than six days, in the course of which the type had flown an estimated 300 sorties, giving a loss rate of around 2 per cent. The initial explanation was that the Tornados were performing low-level attacks on well-defended airfields, and that the Iraqis could put up a wall of flak (and suspend cables to damage low-flying aircraft), even when their radars were silenced. However, only one loss was associated with a JP233 attack, another was caused by a mechanical problem immediately after take-off, and the last (on 24 January) was not on a low-level mission.

The significant fact appears to be that on 25 January MoD announced a suspension of low-level strikes (since the IAF had virtually ceased operations), and there was then a pause in GR.1 losses until 14 February. This may suggest that attrition was mainly associated with low-level penetrations at night, but the true cause may take a long time to establish (as in the case of the initial F-111 deployment to Vietnam).

To digress, for the first three days (at least) the GR.1s had been mainly armed with pairs of JP233 dispensers, each pod containing 30 Hunting SG357 tandem-warhead runway penetrators (the first warhead blowing a hole in the concrete and the second exploding under the paving) and 215 Ferranti HB876 minelets to delay runway repairs. A Pentagon illustration suggests that, rather than being used to create a line of craters along the runway centreline, JP233 was employed to cut off aircraft in HAS from their runways. Press reports indicated that this weapon system was closing airfields for over 24 hours at a time, but the Iraqis were finally detonating the HB876s with machine gun fire from armoured vehicles, then surveying the craters from a helicopter and applying repairs schemes with fast-setting concrete and aluminium mats.

The USAF had participated in the early stages of JP233 development, but withdrew in favour of a later standoff dispenser, which was preceded in the inventory by the Matra Durandal rocket-accelerated 485 lb (220 kg) bomb as an interim system. Durandal was reportedly used by F-111s, but Turkish-based operations received little publicity. The French Air Force uses the Thomson-Brandt 72 lb (32.5 kg) BAP100, but there are currently no reports of its use against Kuwait airfields. The potential risks associated with all these overflight weapons is expected to lead to the development of dispensers that can be launched from a distance, or from altitude.

An RAF Jaguar dispensing flares. The overwing Sidewinder launchers proved to be unnecessary—no AIM-9s were fired operationally by the RAF during Desert Storm. (Mike Rondot via PRM).



Some remarkably accurate attacks were carried out by French Air Force Jaguars, using the Aérospatiale AS.30L laser-guided supersonic missile and the centreline Thomson-CSF Atlis designator pod. The AS.30L delivers a 530 lb (240 kg) warhead over a distance of up to 5.4 nm (10 km). (CEV Cazaux).

In the second night of the conflict an Italian Air Force Tornado was lost during that service's disastrous operational début. Reports state that all eight aircraft took off from the UAE, but that one had an undercarriage problem and aborted. Of the remaining seven, all but one failed to refuel from their USAF KC-135 tankers, due to severe turbulence and perhaps to the pilots' limited experience (three 707s were being converted to tankers in Italy, but had not then been delivered). The remaining Tornado was shot down near Baghdad.

That second night (17/18 January) also witnessed the first *Scud* or *Al Hussayn* ballistic missile attacks on area targets in Israel and Saudi Arabia, the former action being clearly aimed at dragging Israel into the conflict and breaking up the Coalition. Some missiles directed at Dhahran were successfully intercepted by Raytheon Patriot ABMs, and similar air defence systems were deployed on 20 January to Israel in C-5s. *Scud*-series weapons continued to be fired, though without the much-feared chemical warheads.

One practical effect of the *Scud* bombardment was that an increased Coalition air effort had to be directed toward finding mobile launchers (designated *Al Waleed*). One of the most useful assets in this struggle was the F-15E of the 4th TFW, equipped with the high-resolution Hughes APG-70 radar and Martin Marietta LANTIRN (Low-Altitude Navigation and Targeting IR for Night) system, and armed with Mk 82 'dumb' bombs or various cluster weapons (CBU-52, -58, and -87, and the Mk 20 Rockeye). The Tornado GR.1A began *Scud* searches on 19 January.

One of the advantages of modern attack systems is that they can produce a video record of a strike, which in this context was useful both for sortie assessment and to convince TV-viewers of the surgical accuracy (and hence minimal collateral damage) achieved. One particularly impressive sequence taken from an F-117A showed a dead-centre impact by an LGB on a multi-storey headquarters, and all four sides of the building being blown out.

French Jaguars produced some interesting strike records of Aérospatiale AS.30L supersonic laser-guided missiles arriving at targets designated by Thomson-CSF ATLIS pods. Not to be outdone, the US Navy showed a video recording produced in an A-7E by the IIR seeker in the nose of an Intruder-launched McDonnell Douglas SLAM (Standoff Land Attack Missile) as it slammed into a hydro-electric facility. Derived from the AGM-84D Harpoon, SLAM weighs 1385 lb (628 kg) and combines GPS navigation with the IIR system from the Maverick AGM-65D/F, and the data-link from Walleye.

Damage assessment may be straightforward in such cases, but simpler weapons still require the target to be photographed from low level. One special

problem for BDA in the early phases of the air war was that the region suffered unusually bad weather, with low cloud, mist and fog frequently obscuring targets. This problem applied equally to the on-going task of finding *Scud* launchers.

On the third day (19 January) Iraqi troop positions in Occupied Kuwait and southern Iraq were attacked for the first time, with OV-10s marking targets with white phosphorus (WP) rockets for AV-8Bs and A-10As. In subsequent close-support operations, Saudi forces used an airborne FAC in a Bell 406CS helicopter with a high magnification TOW missile sight to locate targets for bomb-dropping F-5Es and BAe Hawk 65s. The helicopters also provided suppressive fire against AAA and SAMs. The various Arab armies of the Coalition (ie, from Saudi Arabia, Egypt, Syria and Kuwait) were allocated USAF tactical air control parties (TACPs), each with two men and a rough-terrain vehicle, to ensure the accurate delivery of bombs and the immunity of CAS aircraft from friendly fire. Another CAS element was the USAF EC-130E Airborne Battlefield Command & Control Center, operated by the 7th ACCS from Keesler AFB, Mississippi.

After the emphasis had switched to destroying Iraqi Republican Guard tanks, which were generally dispersed in revetments around 100 metres apart in northern Kuwait, large numbers of F-16s were used with 2000 lb (910 kg) Mk 84 bombs, of which each Fighting Falcon can carry up to four. One interesting development was that, instead of using a 'slow FAC' such as the OV-10, the F-16s evidently employed a HIFAC in the form of one of their own aircraft, reportedly from the 401st TFW and carrying extra fuel tanks in place of ordnance. The 'bombers' flew from a forward airstrip to minimise transit times (though they overnighted at a rear base), while the two FACs per 'killing box' had their own tanker to allow them to stay over the attack area. The HIFAC technique reduces losses and is better suited to a long radius of action. It was pioneered in Vietnam, using the F-100 Super Sabre and F-4 Phantom II.

One of the least-reported aspects of the war was the operation established to rescue downed Coalition aircrews, since the success of each combat-SAR mission depended heavily on the Iraqis not knowing that it was taking place. For the same security reasons, the losses of individual aircraft were not necessarily announced at the time, though they were acknowledged later in attrition summaries.

The first combat-SAR success was announced on 22 January, when an A-6E pilot was rescued from Iraqi territory by a USAF helicopter (presumably the MH-53H Pave Low III or MH-60G Pave Hawk) escorted by A-10As. This was quickly followed by the rescue of pilots from an F-14A and an F-16 on the 23rd and 24th. One of the deepest penetrations reported for aircrew rescues related to an F-16 pilot who was picked up on 18 February in Kuwait, some 40 miles (64 km) behind Iraqi lines. One French Jaguar pilot came very close to being shot down (and killed) in late January when he was carrying out a ground attack mission over Kuwait, and two small arms rounds passed through the aircraft canopy. One round also passed through his helmet, grazing his scalp, but he returned safely to base.

For those aircrew who were shot down and not rescued by the helicopter service, the prospects were generally bleak. A number of Coalition aircrew were forced to appear on Iraqi TV, and looked distinctly the worse for wear, although they may have been roughed up by civilians who captured them, rather than their military guards. Allied POWs were held at potential air-strike targets (in contravention of the Geneva Convention), and on 29 January it was announced that the first such prisoner had been killed in an air raid. None the less, a ray of hope came from an Iraqi radio announcement on 3 February, that during the last two days some 11 US airmen who had been shot down over Iraq has been handed over to the US Embassy in Damascus by the Syrian authorities.

Like the IAF, the Iraqi Navy played little part in the conflict, yet suffered substantial losses. By the end of the first month approximately 85 Iraqi patrol boats, minelayers and landing craft had been destroyed by US Navy A-6Es and A-7Es, RAF Jaguars, and by Royal Navy Lynx helicopters using the BAe Sea Skua sea-skimming missile, which had its début in the Falklands nine years earlier. In the same way that the USAF lacked a submunition dispenser for airfield attack, the USN had been very slow to put anti-ship missiles on helicopters, and the Norwegian Penguin Mk 2 Mod 7 developed for the SH-60B Seahawk was not yet in service.

The first anti-surface vessel operation took place on 24 January, after *Cardiff*'s Lynx detected three

vessels and called up A-6E support. An Iraqi inshore minesweeper was evidently scuttled to avoid capture, but the accompanying patrol boat and landing craft were both sunk by A-6Es. On the evening of the 29th a further joint action took place, when 17 small Iraqi craft were detected (by an SH-60B) heading south off the island of Maradin, close to the Saudi-Kuwait border. Sea Skuas were fired by Lynxes from *Gloucester*, *Brazen* and *Cardiff*, and further attacks were carried out by AH-1 Cobras and A-6Es, while fire was returned using heavy machine guns. Four of the boats were sunk and the remainder badly damaged. It was later concluded that these vessels had been tasked with landing troops to support the ground attack on the Saudi border town of Ras al Khafji, which began later that day.

A further large-scale engagement occurred on the following day, when four of a group of eight Iraqi FPBs (including *Osa*-class missile boats) were sunk outside Kuwait harbour by A-6Es and F/A-18s, and further north *Gloucester*'s Lynx destroyed a Type 43 minelayer and an ex-Kuwaiti Navy TNC-45 armed with four MM.39 Exocets. The Lynx also damaged another Type 43. East of the estuary leading to the Iraqi port of Umm Qasr, RAF Jaguars and USN A-6Es attacked the three *Polochny*-class vessels *Atika*, *Jawada* and *Nouh*, and sank all three. This type of vessel can carry six tanks and 180 troops.

In a smaller-scale action on the 31st, a Lynx engaged an *Osa*-class FPB near Bubiyan island, again using Sea Skuas. The boat returned fire before exploding and sinking. On the following day Lynxes from *Gloucester* and *London* attacked a further TNC-45. It was shortly afterwards concluded by the Coalition joint command that the Iraqi Navy had lost all its Exocet-capable vessels, and had effectively been destroyed. None the less, in the early hours of 11 February *Cardiff's* Lynx sank a Soviet-built *Zhuk*-class FPB in the RN's first night-time engagement using the Sandpiper FLIR system. A Lynx from *Manchester* (a Type 42 destroyer) is also believed to have sunk an FPB on the same day. A further FPB was disabled by a Lynx on the 16th.

Iraq's only reported attempt to use a sea-skimming missile took place on 24 January, when a formation of three Iraqi Mirage F.1EQs was detected by the radar pickets *Gloucester* and *Cardiff*. Two Saudi F-15Cs flying CAP over the area were directed by AWACS to intercept, and one Eagle, piloted by Capt Aueidh Saleh Chamrani, shot down two escorting F.1s, using AIM-9Ms. The third F.1 turned back to Iraq, and was reported to have jettisoned the Exocet over land.

Air combats were small in scale compared to Korea, but took place from the first night of the conflict. The first kill is believed to have been achieved by an F-15C pilot, Capt 'Steve' Tate, who was leading a section of four Eagles over Iraq in the early hours of 17 January, flying a four-hour CAP for a mixed strike group of F-15Es and F-111Fs, which were supported by F-4G Wild Weasels and EF-111A Ravens. At around 0330 Tate was informed by AWACS that his No 3 was being followed by a hostile aircraft, which was identified (it is not clear how) as an Iraqi F.1EQ. Tate fired an AIM-7M at a

This RN Lynx HAS.3 is about to take off with a warload of four BAe Sea Skua anti-ship missiles. (DPR(N), Crown Copyright).

separation of around 12 nm (22 km) and saw the F.1 fireball. In the first 24 hours a total of six MiG-29s were shot down, including three by F-15s, and on 19 January two MiG-25s were shot down by F-15s.

Benefiting from their own excellent radars and much-improved AIM-7s, and the support of AWACS aircraft, both the F-15E and F/A-18A proved capable of air combat kills while carrying ground-attack ordnance. One Hornet pilot was warned of an approaching MiG-23 immediately before making his dive attack, and shot down the Iraqi with an AIM-7M before rolling in on the target.

With Iraqi sortie rates dropping as low as 31 per day (20 January), the largest air battle was small, even in comparison with Vietnam, where seven MiGs were destroyed in a single action (Operation Bolo on 2 January 1967). In one early dogfight (possibly on 26 January) six F-15Cs shot down three MiG-29s, with a fourth listed as a probable. On 27 January two F-15Cs from the 53rd TFS, 36th TFW destroyed three MiG-23s and one Mirage F.1, using a total of four AIM-7Ms and two AIM-9Ms in the course of a 10-minute dogfight just south of Baghdad. This engagement was technically interesting, as it was a look-down, shoot-down combat (on the part of the F-15s) with firing initiated beyond visual range (implying that—unlike Vietnam rules of engagement—visual target identification was not required), and with radar tracking stopped as the F-15s closed on their prey in order to minimise warning. In essence, the lead F-15 engaged two MiG-23s flying in trail, and fired an AIM-7 at the rear aircraft, but missed, and therefore killed it with an AIM-9. His No 2 meanwhile engaged the third MiG-23, which was flying in tight formation with a Mirage F.1. His first AIM-7 fell short, but closing rapidly he fired two more in quick succession, destroying both aircraft. The lead F-15 then destroyed the remaining MiG-23 with an AIM-9.

A number of IAF aircraft were shot down while their crews were trying to defect to Iran. These defections entered the news on 26 January, when seven military aircraft were flown to Iran, whose air force intercepted them. One IAF aircraft exploded on landing, and two more were damaged. Within a month 137 Iraqi aircraft were sitting out the war at the Iranian airfields of Tabriz, Hamadan-Shahrokhi, and Dezful-Vahdati, and on 19 February the public was shown covertly-taken Fuji-TV film of three IAF Su-22s on the ground at Hamadan. On 6 February USAF F-15Es intercepted four IAF aircraft fleeing to Iran, and shot down two Su-25 *Frogfoots*, the two accompanying MiG-21s being listed as possibles.

A mid-February breakdown of confirmed IAF combat losses gave nine Mirage F.1s, two MiG-21s, nine MiG-23s, eight MiG-29s, three Su-22s, four Su-25s, one Bo 105, one Mi-8, two unidentified helicopters and one unidentified transport aircraft. Interestingly, on 15 February an F-15E was directed by an AWACS aircraft toward an IAF helicopter. On arrival, the pilot of the Eagle Echo found that it was hovering, so, rather than strafing it or wasting an AIM-9, he put the laser designator on it and dropped an LGB, which produced a direct hit. Air actions included an IAF helicopter shot down by gunfire from an A-10A of the 706th TFS, 926th TFG on 6 February over Kuwait.

There were no Coalition aircraft shot down by IAF aircraft, but there was attrition due to AAA, SAMs, mechanical problems, accidents, etc. In the first six days the US services lost one F/A-18A, two A-6Es, two F-15Es, one Marine OV-10, two F-16s and one F-14A due to enemy action, and one F-4G, one UH-60 and one AH-64 in accidents. Subsequent losses included an AC-130H gunship, which went down off the Kuwait coastline on 31 January, a B-52G that went down in the Indian Ocean on the way back to Diego Garcia on 3 February (though three of the crew were saved), and an F-111F that was lost over Saudi Arabia on 14 February.

Aircraft losses, though statistically small, would form a major element in the daily cost of the conflict, assuming that they were subsequently made good. However, old aircraft such as the A-10A, B-52G and F-4 Phantom II clearly cannot be replaced.

In assessing the cost of the air operations, the use of smart weapons on an unprecedented scale seems more likely to cause some hair-tearing on the part of the accountants. Full details may take a long time to emerge, but it has been reported that in the case of the Hughes/Raytheon Maverick air-to-surface missile the USAF was using around 100 rounds per day, representing an expenditure of $10 million on that weapon alone. The Maverick generally used was the AGM-65D with IIR guidance and a 125 lb (57 kg) shaped-charge warhead. The imaging seeker gives a

better acquisition range in haze, fog, smoke, etc, than the earlier TV guidance, and it was found to be very helpful to pilots in detecting camouflaged targets at long range, as a result of the temperature contrast. There was later concern that the $60,000 Hellfire round was being used against targets justifying only unguided weapons.

Although expensive, smart weapons are cost-effective if used against suitable high-value targets. For instance, Maverick was reportedly giving an 80 per cent single-shot kill probability during Desert Storm, a far higher figure than for a 'dumb' bomb. Several types of laser-guided bomb (LGB) were used. The F-15Es of the 4th TFW employed relatively old GBU-10s and -12s. Other types in use included the 2000 lb (910 kg) GBU-24A/B with the BLU-109 I-2000 improved blast warhead, and the GBU-27 with a steel-encased penetration warhead in the same weight category. The one-ton TV/IR-guided GBU-15 cruciform wing weapon was also used. The RAF use of LGBs against key bridges began on 2 February, with Buccaneers designating for Tornado GR.1s. Standard procedure appeared to be to attack each end of the bridge with a salvo of three Mk 84-class LGBs from one Tornado. Where it was felt that this was too dangerous for civilians, the centre of the bridge would be attacked instead.

An unusual smart weapons attack took place on the night of 27 January, when an F-111 used an IIR version of the GBU-15 to destroy two pumping stations at the Mina Al Ahmadi facility in Kuwait, where the Iraqis had been pumping millions of gallons of crude oil into the Gulf. Once again, the video records from the sensors in the noses of the weapons testified to the accuracy of the strikes, and this was confirmed by the Kuwaiti Resistance.

However, even the smartest of weapons depends on a correct intelligence assessment of the target and on the pilot identifying the target correctly. In addition, if the weapon does not have the energy to reach the target (eg, if designation takes place too early in an LGB toss attack), then it will fall short, and even the simplest and most reliable of guided weapons occasionally suffer total guidance failures. Thus, the availability of modern weapons does not necessarily mean that attacks can safely be carried out any closer to friendly troops than was the case in earlier conflicts.

Trials firing of a Sea Skua from an RN Lynx. The missile employs semi-active radar guidance, homing on to reflected energy from the target, which is illuminated by the Ferranti Sea Spray radar of the helicopter. (BAe).

At the time of the Iraqi attack on Khafji (beginning late on 29 January), a number of other incursions took place further west along the Saudi-Kuwait border. In the course of one of these fire-fights it is believed that seven US Marines died when their APC was struck by an air-delivered (and thus 'friendly') missile. As the result, Coalition vehicles were to carry coloured discs on their rear ends, the colour being changed each day to minimise the chance of the Iraqis copying it. Despite the discs, on 17 February it was announced in Riyadh that in the course of border clashes Hellfires from an AH-64 Apache had destroyed two US Bradley IFVs, killing two and wounding six more. This was reported in the press as bringing the number killed by friendly fire to 10 out of the 14 US troops who had died in action.

It was not only members of the Coalition forces who were killed by various targeting mistakes. With 2000–3000 sorties flown per day, it was inevitable that some Iraqi civilians would die as the result of

An F-15C of the Royal Saudi Air Force at Dhahran. One such aircraft is believed to have made the first double kill of the war, when on 24 January 1991 two Mirage F.1EQs, which were thought to be about to make an Exocet attack on Coalition shipping, were shot down using AIM-9s. (Ian Black).

collateral damage, and some buildings would be wrongly targeted.

On 22 January Peter Arnett, CNN's resident reporter in Baghdad, was taken to see the bombed ruins of what was claimed to be a baby-milk factory. This claim was supported by the presence of large numbers of cans of British powdered milk, although the UK manufacturer pointed out that the product was not suitable for babies. In Riyadh a USAF spokesman stated that numerous sources had indicated the facility was associated with biological warfare production, and that it was camouflaged, surrounded with barbed wire, and was garrisoned.

The Iraqi authorities had initially played down the results of the bombing campaign, but soon decided that there was more mileage in publicising the suffering of the civilian population. On 16 February it was claimed that RAF Tornados had bombed Fallouja at 1600 hr on the 13th, that 130 civilians had died and 78 had been wounded in the bombing, and that one Tornado had been brought down by defensive fire. The RAF subsequently admitted that one of the bombs aimed at the centre of a bridge in Fallouja had suffered a guidance failure and landed around 2400 ft (730 m) off target in a built-up area. However, the attack had taken place on the 14th, and there were no aircraft losses.

Fallouja, some 16 miles (30 km) north-west of Baghdad, was in any event a dangerous place to spend the war. Aside from important bridges over the Tigris, it also housed the Project 124 *Scud* development facility and the DO-2 SSM production plant. It was from Fallouja that on 14 February two long-range missiles (probably the *Al Abbas*) were launched against Saudi Arabia. Both disintegrated over the north-east of the country. On the 17th Baghdad Radio stated that three examples of a new missile named *Hijarah Al Sijjil* (Shale Stone) had been fired against Israel, with one targeted on the Dimona nuclear reactor in the Negev desert. Israel acknowledged that two had landed, but there were no reports of casualties or damage. Since the missile's name refers to a story in the Koran, in which God sent giant birds to drop shale stones on the heads of those who invaded Islam's holiest shrines, it may be suspected that this was simply the *Al Abbas* renamed in the light of the infidel presence in Saudi Arabia.

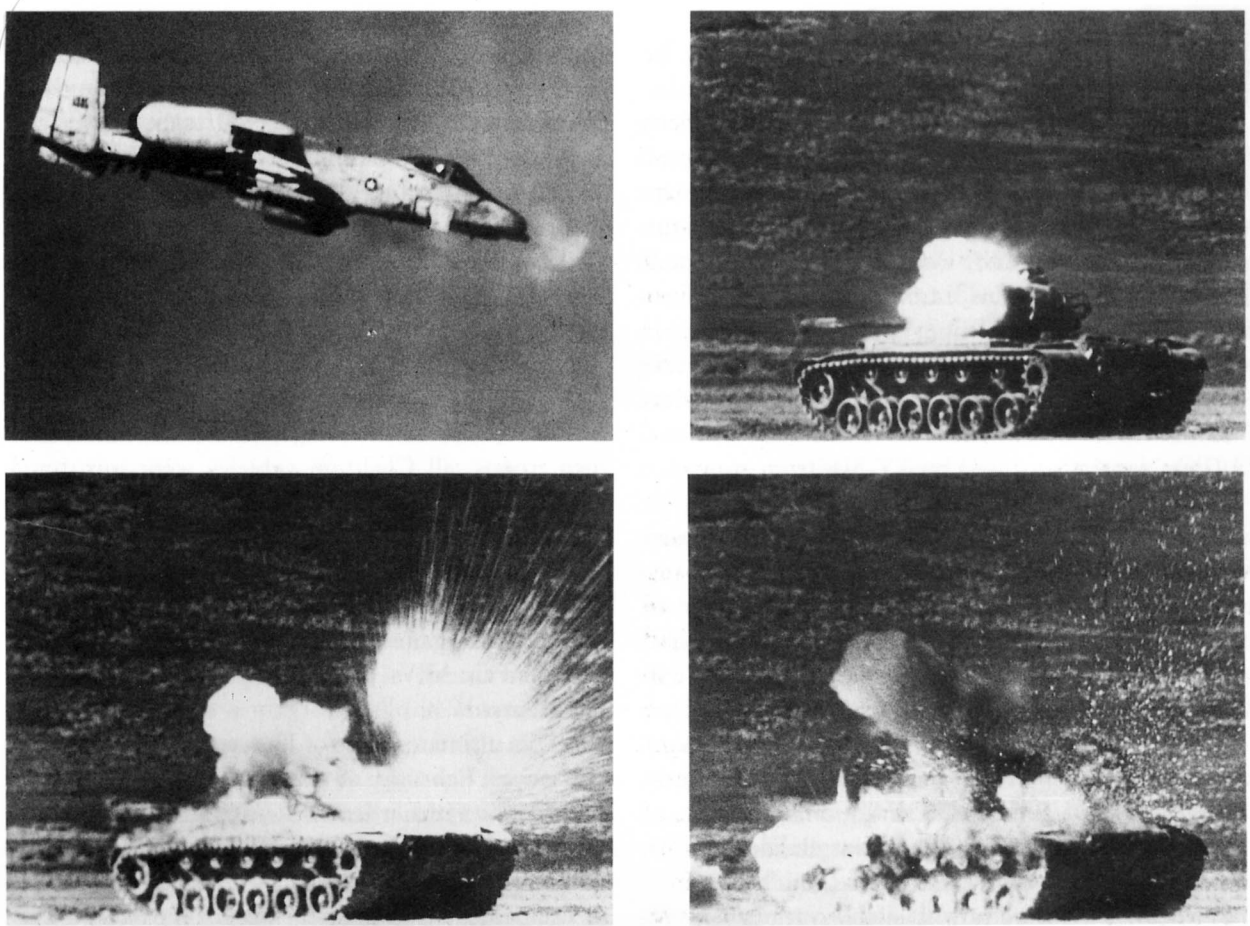
Ironically, Iraq's indiscriminate SSM attacks on Israeli and Saudi centres of population (39 and 43 launches respectively) caused few casualties, but precision Coalition bombing of military targets on occasion had disastrous consequences. At 0400 hr on 13 February two LGBs delivered by an F-117A against a bunker in Amiriya in western Baghdad produced a civilian body-count of 314 and many horrific injuries. The concrete bunker had been built during the 1980–88 Gulf War, and was being used as an air-raid shelter. The Coalition intelligence percep-

tion was that it was a command and control centre, and that its military use had been confirmed by electronic monitoring. The bunker had been built by a Swedish company, and it was subsequently stated by a Swedish engineer that each of the bunkers had a civilian shelter on the top floor, with a communications centre underneath. Similar bunkers had been built by German and Finnish companies. Later rumours suggested that the strike may have been made because it was believed that key Iraqi military personnel were sheltering inside. Whatever the truth, it seems inevitable that the harrowing TV reports of the rescue attempts and of the recovery of the human remains from the shelter will ensure that the name of Amiriya goes down in the history of air warfare alongside that of the old Basque city of Guernica, where around 1000 civilians were killed in a Nationalist bombing raid on 26 April 1937, during the Spanish Civil War.

Although all types of land targets were attacked throughout the air offensive, the targeting emphasis changed, and in this sense the air war may be characterised as a series of distinct phases. In the first phase the priority was to ensure absolute air superiority, so that the strike aircraft could destroy Iraq's war potential with minimal losses. Airfields and aircraft on the ground were therefore attacked, a considerable effort going into damaging runways so that defending fighters could not take off.

It might almost be said that this effort was too successful, in the sense that the Coalition fighter sweeps and CAP missions were largely wasted. By mid-February, French Mirage 2000 pilots were complaining that they had never even seen an enemy aircraft. During one early CAP mission, RAF Tornado F.3s were directed by AWACS to defend some

Firepower demonstration by an A-10A against an M48 tank. The GAU-8/A Avenger cannon of the A-10 is a 30 mm seven-barrel gun that fires an API round with a depleted uranium (DU) penetrator.



A-10As that were being approached by Iraqi fighters. However, as the F.3s got closer the IAF aircraft turned tail, and not a shot was fired. In essence, runway damage resulted in very few Iraqi aircraft being shot down. Instead, they were 'put on ice' to fight another day.

Attention then turned to the interdiction of supplies and reinforcements heading for the Kuwait theatre of operations (KTO), although some effort continued against other airfield facilities, such as HAS, fuel dumps, radars and communication centres. In the interdiction phase, Iraq's two major rivers (the Tigris and Euphrates) provided natural choke-points in the form of bridges, although the Iraqi Army proved adept at substituting pontoon bridges, which could easily be repaired. It was found throughout the air offensive that the Iraqis made maximum use of passive defences. They painted simulated bomb craters on runways, made dummy *Scud* launchers, camouflaged all potential targets, and created smoke screens (and the impression of prior damage) by burning oil and old tyres.

In the third major phase of the air offensive, the emphasis turned to direct attacks on Iraqi front-line units and the Republican Guard in order to achieve an acceptable force-level ratio, using special weapons to collapse dugouts and detonate minefields. One such weapon was the BLU-82B high-capacity light-case (HCLC) bomb, which weighs 15,000 lb (6800 kg) and contains 12,600 lb (5715 kg) of ammonium nitrate/aluminium powder explosive. In Vietnam it was dropped by parachute from the C-130, primarily to clear helicopter landing zones, and it may have been delivered in the same way over KTO. Napalm was used by AV-8Bs from around 22 February to ignite oil-filled trenches.

Another special weapon is fuel-air explosive (FAE), usually delivered in the form of a bomb or a submunition that creates a cloud of fuel droplets. When detonated, this aerosol generates a highly destructive pressure wave over a large area. First-generation FAE weapons were used in Vietnam from 1969, but proved sensitive to atmospheric conditions. Improved FAE bombs appeared in the early 1970s, including the USMC MADFAE, which contained 12 propene oxide bomblets and was claimed capable of clearing one million square feet (nine hectares) of minefield. There are now available various second-generation FAE warheads, notably the 500 lb (227 kg) BLU-95 and the 2000 lb (910 kg) BLU-96.

Another aspect of air power was demonstrated during the final buildup for the ground offensive, when on 20 February two AH-64 Apaches, supported by two OH-58 Kiowas, struck deep behind enemy lines. Aside from destroying 13 bunkers in a 15-unit complex, using RPs and 30 mm gunfire, these helicopters brought about the surrender of 421 Iraqi troops, who were ferried in Chinooks to EPW camps in the rear.

The ground war began in the early hours of 24 February, and from this point air power took a largely supportive role, aside from the large-scale helicopter operation to establish the Cobra Base 50 miles (80 km) behind enemy lines. Covering some 60 square miles (155 sq km), Cobra involved the use of around 300 helicopters to inject 2000 men, 50 vehicles and artillery pieces, and tons of fuel and ammunition, in what has been described as the largest assault since the Normandy landings.

Direct support for forces on the ground probably reached its peak in the sustained attacks against Iraqi forces retreating from Kuwait City to Basra, in which US Navy and USMC aircraft were reportedly restricted only by the rate at which the carrier lifts could bring ordnance to the flight deck. At that stage RAF Jaguars had switched from Hunting BL755 CBUs to Rockeyes, to permit release from higher levels. In one day British Army Lynxes from No 4 Regiment AAC destroyed four tanks and numerous other tracked vehicles, using TOW missiles.

Following earlier operational accidents, in which US fixed- and rotary-wing aircraft had killed their own troops, all Coalition vehicles went into battle bearing dayglo markers and IR-reflective inverted chevrons, and many carried national flags on their antennas. In spite of these identification measures, on 26 February nine British soldiers from the 4th Armoured Brigade died when an A-10A strafed their two Warrior AFVs, in positions recently vacated by the enemy.

This ultimate phase of Desert Storm came to an end on 27 February at 0800 hr local time (2400 hr EST on the 27th), when a ceasefire was announced by President Bush, based on Iraq's acceptance of all the UN Resolutions and the Coalition's conditions, and on the perception that 'there was no one left to fight'.

The formal ceasefire document was signed on 3 March 1991 at Asfan AB in southern Iraq.

Reviewing the operation, air power was clearly of crucial importance in winning a quick victory (once the land battle had started) and in minimising casualties, though on its own it was not able to force Saddam Hussein—secure in his subterranean bunker—to accept the idea of unconditional withdrawal from Kuwait. Only when his army had been decimated by Coalition ground forces was he to allow terms to be dictated to him.

What air power had achieved was to destroy Iraq's ability to produce NBC weapons, and to keep its ground forces supplied with food, fuel and munitions. In addition, by winning absolute air superiority it deprived Iraqi forces of essential intelligence, and thus made possible the Coalition's flanking movement to the west of the defences constructed in southern Kuwait. Total air supremacy also made possible concentrations of allied armour, and tightly-packed logistic convoys to keep the front-line forces supplied.

Above all, Iraqi forces in the KTO had been so weakened by air attacks (and to some extent by artillery fire and rocket bombardments) that the ground fighting was over in a mere 100 hours, with less than 150 Coalition troops killed in action. America suffered the heaviest losses, with 79 killed and 213 wounded, in addition to which 9 were known to be POWs and 35 were (at the time of the ceasefire) listed as missing in action. It is believed that 26 Saudi, 17 British, 9 Egyptian, 6 UAE and 2 French troops were killed. These initial figures give a total of 139 killed, compared to something in the region of 40,000 Iraqis.

It was also claimed that in the course of Desert Storm some 3008 Iraqi tanks, 1856 APCs and 2140 artillery pieces were destroyed or captured, and it is clear that a significant proportion of each of these totals was the result of air attacks. At least 141 Iraqi aircraft were destroyed (either in the air or on the ground), without a single Coalition aircraft being shot down in air combat.

Only a detailed postwar analysis will decide such matters as whether slow-speed aircraft (eg, OV-10, AC-130, and A-10A) survived reasonably well over the battlefront, and whether the Coalition persisted too long with its bombing campaign against Iraq.

Armament options for the AV-8B Harrier II include (from front to rear): four AIM-9s, four LAU-10 and six LAU-68 rocket launchers, six LAU-61s and four LAU-68s, six LAU-10s and four LAU-61s, ten Mk 77 napalm bombs, ten Mk 20 bombs, sixteen Mk 82. and six Mk 83s. (MDC).

Desert Storm certainly showed up some critical gaps in allied equipment. Nine years after the need for standoff weapons had been demonstrated forcibly in the Falklands, Britain's RAF was still overflying airfields to attack them. The RAF's only standoff weapon was still the LGB, which required the hurried deployment of Buccaneers for target designation. The French meanwhile attacked with supersonic AS.30L, and the Americans had a whole range of smart weapons. There was a need for a standoff dispenser with smart submunitions to attack dispersed tanks, but such a weapon is still in the future.

Bomb damage assessment would have benefited from the availability of a long-range, high-speed stealthy reconnaissance drone to supplement the RF-4C. 'Overhead data-collection assets' such as satellites and U-2s are of limited value in bad weather.

Perhaps partly because of the large-scale day/night close air support effort, the action showed up the need for ground-attack aircraft to be able to identify vehicles as friends or foes. Dayglo panels and IR-reflective inverted chevrons (the Arabic '8') were

Some armament options for the AH-64A Apache, including 1200 rounds of 30 mm ammunition, 76 unguided 2.75-inch (70 mm) rockets, and 16 Hellfire laser-guided anti-tank missiles. The Apache is equipped with an M230 Chain Gun, derated from 900 to 625 rd/min for area fire suppression. It can also carry air-to-air missiles such as the AIM-9 and special versions of Stinger and Mistral, though these were not used in the Gulf War. (MDC).

added as a stopgap measure, but in the longer term ground vehicles will clearly need to be fitted with IFF transponders in wartime, and ground-attack aircraft will need equipment to interrogate them.

To the surprise of many European observers, American operational concepts came out of Desert Storm with honours. It really was possible to coordinate highly complex missions involving hundreds of aircraft. Likewise, total air superiority was achieved from the outset, and air defence systems were suppressed so successfully that penetrations could take place at medium levels, above the threat of most AAA. Postwar analysis may change even the RAF's adherence to low-level flying.

The star of the show was the Boeing E-3 AWACS, which played just as vital a role in controlling air operations as ground-based radars had done in the Battle of Britain. Aircraft of the 552nd AWACW alone flew almost 5000 hours in 375 sorties. This second Gulf War also provided the first major test of the Lockheed F-117A stealth (strike) fighter, which appears to have performed very creditably, going in undetected and bombing individual buildings with surgical precision.

Despite its age, the Boeing B-52G once again proved its usefulness. If there is any truth in the '20,000 tons of bombs per day' claim, most of the credit must belong to the USAF's Big, Ugly Fat Fellow. Another giant to prove invaluable once again was the Lockheed C-5 Galaxy.

One lesson that emerged very strongly was the value of 'swing-force' aircraft that could quickly be switched between air-to-air and air-to-ground operations. Iraqi fighters largely disappeared after the first few days, and had virtually ceased operations by 10 February, hence dual-role fighters such as the F-16 and F-15E were far more useful than dedicated interceptors such as the Tornado F.3 and Mirage 2000C. In mid-February the Canadian defence minister announced that the CF-18 Hornets, sent to the Gulf to provide air cover for surface vessels, would be switched to the ground-attack role. No such announcements came from Britain and France regarding their in-theatre air defence assets.

Air power was not able to obtain an Iraqi surrender single-handed, but seldom before has it played such a major role, and never has it been able to demonstrate so dramatically how it can shorten the land war and save thousands of lives. Despite the tragic loss of lives due to friendly fire, there will be many soldiers who in future will demand overwhelming air support before they go into battle.

The battle for Kuwait will be analysed not only for many months, but in many different lands. Interestingly, the Soviet Union is reported to be taking a critical look at its own air defence system in the light of the complete failure of that in Iraq, which was based on the Soviet model. Apparently the only air defence weapon to emerge with any honour from the conflict was the old ZSU-23-4 Shilka. The war opened many eyes to the value of modern air power, and nobody's eyes were opened wider than those of Saddam Hussein.

ABBREVIATIONS

AAA	anti-aircraft artillery
AB	airbase
ABM	anti-ballistic missile
ACE	Allied Command Europe
AFB	Air Force Base
AFRES	Air Force Reserve
ALARM	Air-Launched Anti-Radar Missile
AMRAAM	Advanced Medium-Range Air-Air Missile
ANG	Air National Guard
APC	armoured personnel carrier
ASDF	Air Self-Defense Force
ATLIS	Automatic Tracking Laser Illumination System
AWACS	Airborne Warning And Control System
BDA	bomb damage assessment
BW	biological warfare
CAP	combat air patrol
CAS	close air support
CBU	cluster bomb unit
CDS	containerised delivery system
CNN	Cable News Network
CRAF	Civil Reserve Air Fleet
CVW	carrier air wing
CW	chemical warfare
DMSP	Defense Meteorological Satellite Program
DSCS	Defense Satellite Communications System
DSMAC	Digital Scene-Matching Area Correlation
DSP	Defense Support Program
ECS	Electronic Combat Squadron
EST	Eastern Standard Time
EW	electronic warfare
FAB	Belgian Air Force
FAC	forward air control
FAE	fuel-air explosives
FFAR	folding-fin aircraft rocket
FLIR	forward-looking infra-red
GBU	glide-bomb unit
GD	General Dynamics
GE	General Electric
GPS	Global Positioning System
HAS	hardened aircraft shelter
HCLC	high-capacity, light case
HOTAS	hands on throttle and stick
IAF	Iraqi Air Force
IIR	imaging infra-red
IRBM	intermediate-range ballistic missile
JSTARS	Joint Surveillance and Target Attack Radar System
KAF	Kuwait Air Force
KTO	Kuwait Theatre of Operations
LANTIRN	Low-Altitude Navigation and Targeting IR for Night
LAPES	Low-Altitude Parachute Extraction System
LGB	laser-guided bomb
MAC	Military Airlift Command
MANPADS	man-portable air defence system
MBB	Messerschmitt-Bölkow-Blohm
MBT	main battle tank
MCAS	Marine Corps Air Station
NAS	Naval Air Station
NBC	nuclear, chemical and biological
RSAF	Royal Saudi Air Force
RWR	radar-warning receiver
SAC	Strategic Air Command
SAM	surface-air missile
SIGINT	signals intelligence
SLAM	Standoff Land-Attack Missile
SLAR	sideways-looking airborne radar
SOAF	Sultan of Oman's Air Force
SRW	Strategic Reconnaissance Wing
SSM	surface-surface missile
TAC	Tactical Air Command
TACP	tactical air control party
TEL	transporter/erector launcher
TERCOM	terrain contour-matching
TFS	Tactical Fighter Squadron
TFW	Tactical Fighter Wing
TIALD	Thermal Imaging Airborne Laser Designator
TLAM-C	Tomahawk Land-Attack Missile—Conventional
TOW	Tube-launched, Optically-tracked, Wire-guided
UAE	United Arab Emirates
UAV	unmanned air vehicle
USAREUR	US Army (Europe)
V/STOL	vertical or short take-off and landing

APPENDIX

AIRCRAFT LOSSES

Reports indicate that in the course of approximately 110,000 sorties the Coalition air forces lost a total of 68 aircraft in combat (a miraculously low attrition rate of 0.062 per cent), in addition to which 22 were lost in accidents. The latter figure probably includes those lost in-theatre between the Iraqi invasion of Kuwait and the start of Desert Storm.

The combat losses are reported as follows:

US services:

1	F-14
7	F-16
6	AV-8B
5 (each)	UH-60; A-10/OA-10
4 (each)	A-6E; AH-64; AH-1J
3 (each)	F/A-18; UH-1
2 (each)	F-15E; OV-10D; OH-58
1 (each)	AC-130H; B-52G; EF-111A; F-4G; OV-1D; CH-46E; H-46; SH-60B

US total: 56 aircraft

Other Coalition air forces:

7	UK Tornado GR.1
2	Saudi F-5Es
1	Saudi Tornado IDS
1	Italian Tornado IDS
1	Kuwaiti A-4KU

Non-US total: 12 aircraft

It has also been reported that 42 Iraqi aircraft are believed to have been destroyed in air combat, including 9 MiG-23s, 9 Mirage F.1EQs, 8 MiG-29s, 3 Su-22s, 2 MiG-25s, 2 MiG-21s and 2 Su-25s. The total estimated to have been destroyed in action varies from 103 to 141, presumably depending on the assumption made regarding shelter-occupancy rate.

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