XIII. THE AIR AND MISSILE WARS AND WEAPONS OF MASS DESTRUCTION

13.0 The Air and Missile Wars

The Iran-Iraq War involved the use of a wide range of air defense, air, helicopter, and missile systems. It also was the first war in modern times to involve the extensive use of chemical weapons. Unlike the Arab-Israeli conflicts of 1973 and 1982, however, Iran and Iraq often lacked the strategic and tactical sophistication to make effective use of the technology they obtain, to integrate it into an effective combat force, and to exercise effective command and control.

The key lessons and issues raised by the war may be summarized as follows:

- Air power had an important impact upon the war, but it never had the major strategic or tactical impact that the number and quality of the weapons on each side should have permitted.

- Neither Iran or Iraq were able to make effective use of their air control and warning and C^3I assets, and medium or heavy surface-to-air missiles. Both were forced to relay on shorter range systems, in part because of design problems and a lack of low altitude coverage, but large because of problems in technology transfer.

- Both Iran and Iraq made heavy use of anti-aircraft guns for point defense, area coverage, and as anti-infantry weapons. This follows a broad pattern in the Third World forces and deserves careful study in the West.

- Both Iran and Iran made heavy use of manportable and light surface-to-air weapons. Iraq, in particular, came to rely more on light surface-to-air missiles than medium or heavy systems -- in large part because the lighter systems were easier to operate and did not require integration into a complex air control and warning and battle management system.

- Air-to-Air combat was heavily influenced by technology, but the primary factor again was technology transfer and particularly each side's access to outside support and resupply.

- A variety of factors sharply limited the ability of fixed wing aircraft to provide effective close air support, although helicopters were somewhat more successful. The main limiting factors were the target mix, widespread proliferation of area and point defense anti-aircraft weapons, problems in technology transfer, and problems in command and control and battle management.

- Efforts at interdiction of land forces and strategic bombing had mixed success. The interdiction mission presented many of the same problems as flying close air support. The strategic mission presented problems in range-payload capability, but the key

problems were political and the result of a failure to commit sufficient resources to specific targets with the mass and consistency necessary to be effective.

- The use of surface-to-surface missiles was largely ineffective until the last year of the war, when Iraq successfully used mass missile attacks to seriously undermine Iranian morale and popular support for the war. The success of these missile attacks was, however, highly dependent on their interaction with other political and military factors.

- Iraq's use of chemical warfare became a critical instrument of war in the final year of the war in both military and political terms. This sets important precedents for the future.

- Neither side used nuclear weapons, but both sides made active efforts to obtain them.

In broad terms, the Iran-Iraq War did lead to the use of military technology in air and air-to-ground combat in ways that may set important precedents for the future. By and large, however, the main lessons of the air war are lessons in the limits of technology transfer and in the critical importance of assessing the degree to which friendly and threat forces in the Third World can actually use the weapons they obtain.

13.1 Command, Control, and Communications (C^3I); Battle Management (BM), and Air Control and Warning (AC&W)

The broad problems in Iran and Iraq's C^3I/BM and AC&W systems have already been discussed in Chapter XI. The Iranian systems were never effectively integrated before the fall of the Shah. The operation of individual elements of Iran's capability were then badly disrupted by the Revolution, and Iran lost access to the kind of Western equipment and software that might have allowed it to make major improvements in its systems. Iran had to rely on point defense and occasional use of its F-14s as a "mini-AWACs." There is no question that Iran would have been better able to deal with the Iraqi air threat with an effective C^3I/BM/AC&W system.

Iraqi air C^3 was characterized by over-centralization and rigid planning from the beginning of the war to the ceasefire. This often led to serious Iraqi mistakes or problems in Iraqi capability. Iraqi aircraft often flew rigidly preplanned missions that originated at high levels of command and too long periods to plan. Iraq tended to ignore both the immediate needs of the tactical situation and to respond to targets of opportunity. A prime example occurred at the beginning of the war when unsheltered Iranian aircraft and helicopters on the ground were ignored by Iraqi fighter bombers that were unsuccessfully attempting to crater runways in Iran. If more Iranian combat aircraft had been eliminated at the outset of the war, this might have provided Iraq with a significant psychological edge over the Iranians in the combat that followed. [1]

[1] "Iranian/Iraqi Air Strikes Appear at 'Limited' Level," Aviation Week and Space Technology, (October 6, 1980), p. 20.

The exact reasons that the Iraqi air control and warning and C^3I system performed so badly are unclear. Iraq does not seem to have had a high degree of readiness and technical proficiency when the war began, however, and seems to have had a system that was heavily overoptimized around medium to high altitude defense and had poor integration and data transfer rates. This system could not deal with low flying aircraft, and seems to have been copied from a Soviet model with little operational value in dealing with threats like the modern fighter bombers of Iran and Israel. While Iraq attempted to improve its system throughout the war, Iran was still able to penetrate it with low flying F-4 sorties in 1988.

Iraq did better in structuring its offensive operations, and in gradually improving the quality of its reconnaissance efforts, mission planning, damage assessment, and ability to response to the tactical needs of land commanders on a timely basis. Iraq was often remarkably slow to learn from experience, however, and even at the ceasefire, it seemed unable to use its strategic and interdiction bombing capabilities with anything like the effectiveness its assets should have allowed..

Like the Arab-Israeli and Falklands conflicts, this experience indicates that superior C^3I and AC&W technology and organization can be a key asset for Western and friendly local forces in future low level wars, and that the West should seek to exploit its technical lead as much as possible. This exploitation will be particularly important because of the West's matching lead in IFF, ESSM, and EW.

There is no question, however, that part of the problem both nations faced was a lack of modern command and control and battle management systems. Iran or Iraq's capabilities would have been radically different if either side had had the E-3A AWACs and the E-2C in U.S. forces. Similarly, Iran and Iraq would also have benefited from a forward area C^3I/BM system to control their helicopters, and from a targeting platform using ESSM, SAR, SLAR, FLIR, or electro-optics to locate targets beyond visual range, to provide warning of ground based air defenses, and to ensure against surprise on the ground.

The lack of these assets--with the limited exception of Iran's ability to use the F-14A as a "mini" AWACs, and its P-3C maritime patrol aircraft to locate naval targets--was a critical factor in depriving both sides of the ability to make proper use of their vast investment in air power. Given Israel's success with the E-2C, and Britain's crucial problems with the lack of such assets in the Falklands, there can be little doubt about the value of such airborne systems in low level wars--provided that the sensors, software, and training are suitable to the region and type of conflict. The history of the "tanker war" and Iran's attempts to put pressure on the Southern Gulf states also demonstrated the value of the U.S. sale of the E-3A and Peace Shield package to Saudi Arabia, a lesson that has broader implications for the West. The West not only can exploit the lack of such assets in threat forces, it can benefit from equipping friendly forces with such assets.

13.2 Surface-to-Air Missiles

The most effective ground based air defenses during Iran-Iraq War were anti-aircraft (AA) guns, and short range air defense systems (SHORADS). Although both sides deployed large numbers of medium and heavy surface-to-air missiles (SAM), neither achieved great effectiveness in their use.

Iraq relied largely on SA-2 and SA-3 heavy and SA-6 medium surface-to-air missiles at the start of the war and kept these systems active throughout the conflict. It had roughly 120 SA-2 launchers, 150 SA-3 launchers, 25-60 SA-6 launchers at the time of the 1988 cease-fire. In practice, however, Iran soon came to rely on a mix of AA guns with SA-7, SA-8, and SA-9 missiles, and eventually the SA-14. Iraq also acquired 30 Crotale missile fire units from France in 1981, and built this force up to 60 Roland fire units by the end of the war.[2]

Few details are available on Iraq's problems in using its SA-2 and SA-3 surface-to-air missile systems during the war, but it is clear that Iraq found it difficult to integrate warning into its missile command and control system, and to use its SA-2 or SA-3 missiles effectively. Iraq seems to have begun the war without clear operational doctrine and realistic technical understanding of the SA-2, SA-3, and SA-6. Even senior Iraqis privately admit that the top command levels of Iraq's ground-based air defenses was a political sinecure at the start of the war.

The Iraqi medium and heavy SAM units were also deployed for a medium-to high-altitude threat that proved largely non-existent. Iraq adopted Soviet deployment and fire techniques and relied on the Soviet "book" without adaptation of the overall SAM system to Iraqi needs. Iraq maintained low, if not appalling, training and readiness standards, in comparison with similar powers like Egypt and Syria. It also failed to test the weaknesses in Iran's C^3I/BM system and deployment pattern.

It is hard to tell how much Iraq improved its medium and heavy SAM capabilities between the start of the war and the 1988 ceasefire. Iranian air attacks were so infrequent after the early 1980s that it is difficult to make precise judgments. Even in 1988, however, it was clear that Iraq was unable to keep its SA-2 and SA-3 missile defenses on continuous alert without burning out some of its electronics and seriously degrading the operational capabilities of its missiles. Iraq was still experiencing systems integration problems. Iraq only seemed to be able to use its Crotales, Rolands, and SA-6 on a target of opportunity, or individual fire unit basis. The Iraqi SAM "system" never operated as an integrated or netted entity. As a result, some Israeli experts came to regard Iraqi ability to manage the command and control and electronic warfare aspects of their Soviet supplied surface-to-air missile systems as far inferior to those of Syria.

Iran began the war with comparatively good Hawk surface-to-air missile defenses, although these were organized largely for the defense of fixed military facilities, and its force structure emphasized fighter air defense and the use of aircraft like the F-14A. Iran was unable to use its Hawk's effectively during any period of the war, however, and could not even mount an effective point defense of its key oil facilities. This Iranian failure to use its Hawk defenses effectively may have been heavily affected by the turmoil and disruption following the Shah's fall. Iran seems to have suffered severely from the disorganization and purges that followed the revolution, from a lack of spare parts, and from a lack of foreign technical support. Iran did make its Hawk defenses more effective during the period when it had covert access to U.S. parts and arms, and this indicates that Iran was heavily affected by maintenance and supply problems.

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[2] Estimate based on the data in the IISS, Military Balance, 1988-1989, pp. 102-103.

Like Iraq, Iran had continuing problems in integrating its surface-to-air missile defenses into any kind of net. After the first months of the conflict, Iraq generally used its SAMs large in a point defense mode and placed primary reliance on the SA-6 and shorter range systems. Although there are only a few confirmed instances of Iranian Hawk kills of Iraqi aircraft, the Iraqis still regarded the Hawk as far more effective than their Soviet missiles. They also excused some of the problems problems in the performance of their air force during parts of 1986 and 1987 on the ground that Iran was getting extensive resupply of its Hawk missiles. There are reports that Iraq began in 1986 to actively attack or suppress Iranian Hawk with Mirage F-1s, using Matra Armat anti-radiation missiles, but the truth of such reports is unclear.[3]

Iran also used Short Tigercat SAMs and Oerlikon cannons controlled by Super Fledermaus radars to defend its air bases, but their performance is unclear. Iran did make good use of some 300 RBS-70 missiles it obtained from Sweden, but it could only obtain limited re-supply. Iran's primary surface-to-air missile was the SA-7, and Iran used it for both the area defense of its forces and key point targets like oil facilities. The Iranians began to rely on the SA-7 for area defense during their Winter 1982 offensives. Form this point on, Iranian forces used large numbers of SA-7s, in conjunction with curtain fire from automatic weapons and anti-aircraft guns, to limit Iraq's ability to exploit its air superiority. While most such missiles were fired to degrade Iraqi sorties, and to force aircraft to fly high or break off their attacks, Iran did find that Soviet bloc-supplied SA-7s, or SA-7s it could assemble with Soviet parts, outperformed Asian and other copies of the SA-7 and had a much lower misfire rate.

All in all, the Iranian and Iraqi experience medium and heavy with surface-to-air missiles highlights the problems and opportunities raised by the transfer of high technology systems to Third World states. It is a further indication that most Third World states will be far less effective in operating modern SAMs than Egypt was during its "Canal War" of 1970, and that suppression of heavy SAMs may pose less of a problem in dealing with Third World forces than the suppression of SHORADs. Since many weaknesses in SAM operations can be monitored passively with ESSM and ELINT platforms, or probed with RPVs and decoys, the West is in an excellent position to characterize and exploit them. At the same time, it highlights the need to support SAM transfers to friendly states with proper planning and training.

It is important to note, however, that manportable surface-to-air missiles proved to be effective on both sides. Even though the vast majority of the missiles fired did not hit a target (it is unlikely that one kill was obtained per 20-30 missiles fired), the widespread proliferation of such missiles had a major impact in degrading the effectiveness of fighters and helicopters by forcing them to fly high, limited their ability fly over target areas long enough to spot and kill targets effectively, and curtailing the conditions under which they could operate with a high degree of survivability.

It is interesting to note, however, that the Iraqis were surprisingly ineffective in their efforts to use flares or balloons to help their fighters and helicopters counter the SA-7. These countermeasures were readily available to Iraq and Iraq was well aware that the Israeli use of such countermeasures meant that the SA-7 gave the Israelis little trouble during their Peace for

[3] Iraq now has AN/TPS 43/59/63 and AN/TS9-73 radars and Fan Songs, Flat Face P-15, Spoon Rest P-12s, Low Blows, Straight Flush Missile/gun radars, and Squint Eye and Long Track early warning radars.

Galilee operation in Lebanon. It seems likely that if the Iraqis had made the same kind of extensive use of flares and thermal balloons as the Israelis, the SA-7 would have been much less effective.[4]

The Iraqis did make an interesting attempt to adapt the SA-7 for use with helicopters. In order to do this, they mounted the SA-7 on the HOT missile pylons of the Gazelle attack helicopter. They did this because the Gazelle helicopters had little defense against Iran's Cobra helicopters during the first part of the war. The extent to which the Iraqis pressed forward with this experiment is not known, although there do not seem to be any Iranian reports of losses to such missiles.

13.3 Anti-Aircraft Artillery

Both sides found that the widespread proliferation of AA guns severely inhibited the other side's ability to use aircraft and helicopters effectively in interdiction and close air support missions. As was the case with manportable surface-to-air missiles, both sides found that the key to effective air defense was the ability to degrade the effectiveness of its opponent's air-to-ground operations, and not the number of aircraft that ground based air defenses killed.

Both sides also found that anti-aircraft weapons made effective anti-personnel weapons and deployed significant numbers in the forward edge of the battle area. Anti-aircraft machine guns proved to be a particularly effective means of provided fixed defenses with very high rates of fire and effective killing power at long ranges. The weapons could also be dug in or employed outside the effective range of enemy rocket launchers and machine guns. This made suppression very difficult, and further enhanced the effectiveness of barrier defenses.

Iraq's anti-aircraft guns included a mix of Soviet AA machine guns, 23 mm AA guns, ZSU-23-4 radar guided AA guns, M-1939 and twin 37 mm AA guns, ZSU-52-2 and other 57 mm AA guns, and 85 mm, 100 mm, and 130 mm AA guns.[5] The Iraqis made extensive use of unguided AA guns and heavy AA machine guns against both air targets and Iranian infantry. They claimed to have used Soviet-built radar-guided ZSU-23-4 anti-aircraft guns effectively against Iranian aircraft and helicopters, but they seem to have had serious problems in maintaining and operating the complex ZSU-23-4 guidance system at least at the start of the war.

The overall importance of anti-aircraft guns is shown by the fact that Iraq increased its inventory of anti-aircraft weapons from roughly 1,200 weapons in 1980, to 4,000 weapons in 1985. Iraq seems to have kept its numbers of anti-aircraft weapons relatively constant after 1985, although it steadily increased the number of AA guns it used against Iranian infantry, and bought more short range surface-to-air missiles.

Iraq's ability to deploy large numbers of AA weapons over a wide area was of considerable value to Iraq's air defense early in the war because Iraq could not utilize its air defense warning system and surface-to-air missiles effectively, and had to turn to point defense. AA guns and machine guns were deployed to cover virtually every important target and to

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[4] See IISS, Military Balance, 1985-1986, pp. 74-77; Bussert, "Iran-Iraq War Turns Strategic," pp. 133-148; and Cook, "Iran-Iraq: The Air War," op. cit., pp. 1606.

[5] IISS, Military Balance, 1980-81 and 1985-86, op. cit.

provide area defense in some urban and industrial areas. The radar-guided ZSU-23-4, and other 23mm AA guns, were widely used to protect various stationary targets, such as bridge, from low level attack.[6]

The ZSU-23-4 was also used to defend combat forces, and was reported to have been especially effective in combat with Iran's armed helicopters, including Iran's Cobra gun-ships armed with TOW missiles.[7] At least some Iraqi officers feel that a mix of ZSU-23-4s, and tanks using their machine guns in anti-helicopter fire, provided enough protection against helicopter attack to force Iran to sharply curtail its attack helicopter operations. This Iraqi experience, however, may be more of a reflection of the steady decline in Iran's number of operational fighters and helicopters, and in Iranian C^3 capability and training levels, rather than the effectiveness of such defenses. The survivability problems that Iranian helicopters experienced after 1982 were compounded by serious shortages in spare parts and maintenance skills, poor command and control and mission planning, having to fly over relatively open terrain, and against extensive Iraqi barrier positions with dug-in AA guns and other automatic weapons with certain fire capability. Further, the Iraqis deployed large numbers of unguided AA guns and machine guns in the same areas where they used the ZSU-23-4 and missiles. A limited number of interviews indicate that unguided weapons may have produced a substantial number of the total kills. There is no way to be sure how much of the impact of AA weapons came from guided, aimed, and/or "curtain fire."

The Iranians had about 1,800 23mm, 35mm, 40mm, 57mm and 85mm towed AA guns and machine guns when the war began, and roughly 100 ZSU-23-4 and ZSU-57-2 self-propelled AA guns. They had about 2,200 air defense guns in 1985, and raised this total to around 2,800 in 1988. As was the case in Iraq, the Iranian ZSU-23-4 had radar guidance. All other weapons had to be aimed be hand.[8]

Like the Iraqis, the Iranians claim that AA guns were often been effective against attack helicopters. This claim is important because the Iraqis were consistently able to deploy large numbers of armed helicopters from the beginning of the war to the 1988 ceasefire. Once again, however, it is not possible to get any precise estimates of kills or of the relative impact of guided, aimed, and curtain fire. Furthermore, Iraqi helicopter losses did decline steadily as Iraqi pilots learned to use nap-of-the-earth and "pop- up" helicopter tactics, and to avoid dense concentrations of well positioned Iranian troops.

No data are available on either side's losses of fixed wing aircraft to anti-aircraft guns, or on losses per sortie flown by type of sortie. It also is difficult to draw any conclusions about the overall vulnerability of helicopters to AA guns from the war. There again are no reliable data on the losses on either side. Iraqi helicopter pilots did avoid defended Iranian areas where possible, but this was part of a broad caution in committing air resources. Further, the Iraqis faced that

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6 Clarence A. Robinson, Jr., "Iraq, Iran Acquiring Chinese-Built Fighters," Aviation Week and Space Technology (April 11, 1983), p. 18.

7 Iran had 150 Cobras and 300 other assault helicopters in 1980, and Iraq had about 120 assault helicopters.

8 These estimates are based on various editions of the IISS, Military Balance; Aharon Levran and Zeev Eytan, The Middle East Military Balance, 1986, Boulder, Westview, 1987, pp. 236-258; and Anthony R. Tucker, "Armies of the Gulf War," Armed Forces, July, 1987, pp. 319-323.

same problem as Iran in trying to operate helicopters in areas where the target held the high ground and helicopter approaches could often be seen several kilometers away.

The problem of helicopter survivability in desert warfare in relatively open terrain and/or when the target forces occupy well established defensive positions is one which needs more attention from U.S. and other Western planners as dependence on the helicopter and helicopter-mounted ATGM systems increases. Much of the data on the estimated survivability and effectiveness of attack helicopters has been based on attacks on mobile or exposed armored forces exercises and simulations conducted rough or wooded terrain, or where the enemy is assumed to be "buttoned down" in armor, rather than dispersed in well-dug in defensives positions. While both Iran and Iraq did helicopters to be relatively survivable against AA guns in rough or mountainous terrain, more study is needed of their vulnerability in open deserts or flat open marshes.

13.4 Air Strength and Capabilities

The history of the air war involved several phases which did not always coincided with those in the ground war. These phases included: (1) an initial surprise attack by Iraq in September 1980, followed by a short period of intense air combat and ground attack operations, with Iran then winning air superiority in late March 1981; (2) a stalemate from April 1981 to September 1983 with the ground forces settling into static defenses, Iran's failure to obtain spare parts for its aircraft, and the gradual loss of Iranian air defense capability; (3) the period from September 1983 to mid-1985 when Iraq acquired air superiority, and steadily increased its effectiveness in attack missions; (4) Iraq's shift after mid-1985 to strategic bombing in an effort to cut off Iranian oil exports; (5) Iraq's shift to aggressive and more effective close air support and interdiction missions after Iraq's defeat at Faw in early 1986; and (6) the resumption of the war of the cities in August 1987, followed by the missile war of 1988.

The general course of the air war between Iraq and Iran was shaped by several factors:

- An initial Iraqi misconception of Iranian weaknesses, coupled to incompetent initial attack planning and delusions about Iraqi offensive and defensive capabilities which helped inspire an attack by technically inferior Iraqi Air Forces;

- An Iranian Air Force which showed surprising determination and ability, especially in the ground-attack role, and a high level of technical competence resulting from the American training effort in that country;

- A high rate of attrition in Iranian Air Forces due to parts shortages and service problems, especially after the major Iranian offensives of 1982, which eventually gave Iraq air superiority;

- An Iraqi shift to reliance on Western-supplied aircraft and munitions for both air defense and critical attack missions;

- Iranian efforts, so far unsuccessful, to substitute North Korean versions of Chinese and Soviet fighters for U.S. aircraft.

When the war began, Iraq's combat air strength was inferior to that of Iran. Iran had 445 fighter aircraft to Iraq's 372, and Iran generally had far superior aircraft. Only about 200 of the Iranian aircraft are believed to have been operational when the war started, however, and Iran's operational air strength soon dropped to about 80 serviceable aircraft while Iraq kept up a strength of over 500.

The force strengths, technologies, and trends on each side have been discussed earlier, and the trends by type during the period in which Iran still had sufficient strength to to engage in air-to-air combat are shown in **Figure 13.1 (Old Figure 4.19)**. Earlier data, made available in October 1985, indicated Iran had only about 23 to 35 operational R-4s, 5 to 14 F-14s, and 40 to 45 F-5s. Iraq had over 500 combat aircraft with 44 to 50 Mirage F-1EQ/EBs, 150-200 MiG-21s, 48 MiG 23BMs, 75 Su-7s, 50 Su-20s, 25 to 30 MiG-25s, and 40 MiG-19s.[9] The mission range capabilities of the fighters used in the Iran-Iraq War and other fighting in the Middle East are shown in **Figure 13.2 (Old Figure 4.20)**.[10]

13.4.1 Iraqi Aircraft

The Iraqi Air Force had 38,000 men when the war began, including some 10,000 air defense personnel. Its main combat aircraft consisted of a bomber squadron with 12 Tu-22s, and a light bomber squadron with 10 IL-28s. It had 12 fighter ground attack (FGA) squadrons with 4/80 MiG-23B, 3/40 Su-7B, 4/60 Su-20/22, and 1/15 Hunter FB-59/FR-10. Its fighter strength included five squadrons with 115 MiG-21s, plus a training squadron with 40 MiG-19s. It also had a number of armed helicopters, including 41 MiG-24s.

During the period from 1980 to 1988, Iraq stressed quality over quantity, although its combat air strength increased from 332 aircraft in 1980 to around 500 in 1988. At the time the ceasefire was agreed to in 1988, Iraq had 40,000 men, including some 10,000 air defense personnel. Its main combat aircraft then consisted of two bomber squadrons with 8 Tu-16s and 12 Tu-22s. It had 11 fighter ground attack (FGA) squadrons: These include 1/10-15 Su-25s, 4/40 MiG-23BM, 3 with Su-7Bs and Su-20/22, 2/20 Mirage F-1EQE equipped with Exocet, and 2/23 Mirage F-1EQ-220. Its fighter strength included five squadrons with 1/25 MiG-25s, 1/25 MiG-29s, 200 MiG-21s, 30 Mirage F-1EQs, and 40 MiG-29s. 115 MiG-21s, and it had a small reconnaissance squadron with five MiG-25Rs. Its armed helicopters were assigned to the Army, and included 40-60 MiG-24s, 50 SA-342 Gazelles (some with HOT), 10 SA-321 Super Frelons (some with Exocet), 30 SA-316B with AS-12s, and 44 MBB BO-105s with SS-11s.[11]

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9 IISS, Military Balance, 1985-1986, op. cit., pp. 74-76.

10 See Anthony R. Tucker, "The Gulf Air War, Armed Forces, June, 1987, pp. 270-271.

11 Strength estimates based on various editions of the IISS, Military Balance.

The Iraqis have 8-12 Tu-22 Blinder and 7-10 Tu-16 Badger Bombers. These are various reported to have come from the USSR, Egypt, and the PRC. Iraq now has Chinese Silkworm missiles for their bombers and may also have longer-range Soviet AS-3 or AS-4 air-to-surface missiles. These missiles have a warhead of 1,000 kilograms, and are much more effective in sinking tankers and large ships than smaller missiles like Exocet. They also are faster. The Silkworm and AS-4 have maximum air launched ranges of around 460 kilometers. Iraq has made use of these bombers throughout the war. Neither aircraft provided particularly important, however, since the Tu-22 lacked the payload and accuracy to be much more effective in conventional missions than a modern fighter bomber, and the Tu-16 was so vulnerable that it rarely could be used for deep penetration missions.

Iraq's main combat aircraft at the start of the war were Su-7 and Su-20, the MiG-23B (and M), and various export versions of the MiG-21. The Iraqis had some 40 MiG-19s and up to several hundred MiG-21s.[12] The least sophisticated aircraft was the Soviet-made MiG-19s. The MiG-19 was the first Soviet supersonic fighter, and was mass produced as a successor to the MiG-15 and MiG-17. Iraq has the newer version of the MiG-19, which includes a large central air brake and a more powerful engine, the RD-9. All MiG-19s can carry the K-13A missile, or AA-2 Atoll, and its underwing pylons can carry two 176-gallon drop tanks and two 551-pound weapons or dispensers.

The MiG-19 was never a lead aircraft in Iraqi air operations, but the MiG-21 continued to perform ground attack and air defense operations throughout the war. The MiG-21 was Iraq's primary air defense fighter when the war began, and was provided to Iraq in the standard export version. This aircraft is a moderately effective medium to high altitude day fighter with a mediocre radar and avionics. The Iraqis indicate that their versions of the MiG-21 lack adequate radar range, look-up capability, gun computers and missile fire controls. They are "blind" in the look-down or low altitude combat mode, and the pilot must rely on visual sighting and fire control. This means the fighter has little or no low altitude or beyond visual range search and kill capability, except when he is vectored precisely to a target by external radars. Even then, the MiG-21 lacks modern gun sights and an effective air-to-air missile system for dogfighting against low flying attacker.

[12] The Iraqis had 12-15 Hawker Hunter aircraft when the war began. The Hunter is a vintage light fighter/fighter bomber. It has a maximum speed of 710 miles per hour at sea level and an initial climb rate of 5,500 feet a minute. Its range on internal fuel is about 490 miles. The Hunter is armed with four Aden cannon. The engine is a Rolls Royce-Avon single-shaft turbojet. It is no match for modern missile-armed fighters, but little information is available on the frequency on actual use or effectiveness of this aircraft. It is not thought to have played a significant role in the air war.

FIGURE 13.1 (OLD 4.19)
THE SHIFT IN IRANIAN-IRAQI AIR STRENGTH: 1980-85

FIGURE 13.2 (OLD 4.20)
COMPARATIVE COMBAT RADIUS OF AIRCRAFT

The MiG-23 has some times been described as a "miniaturized F-4," but this description is incorrect. The MiG-23 can perform the same general spectrum of roles, but has grossly inferior avionics. The export model of the MiG-23 is referred to as the "Flogger E" by NATO, and has the same high Mach airframe and systems as the MiG-23 fighter, but uses the inferior "Spin Scan" radar instead of the latter's "High Lark" nose radar. It lacks effective look-up and look-down capability, uses the inadequate Sirena-2 radar warning radar, has mediocre fire control avionics, and can only use the AA-2 air-to-air missile rather than the AA-7 and AA-8 used on Soviet versions of the MiG-23.

The same basic airframe is used for a dedicated air-to-ground aircraft (Flogger D and F), as well as for an interceptor/air superiority fighter. Although the MiG-23B was designed primarily for the strike role, later Soviet versions have emphasized the handling and maneuverability features necessary for effective air combat. The attack version, however, is simpler, capable of carrying more ordnance and designed to operate effectively at low levels. The R-29B afterburning turbofan in Soviet MiG-23s produces 25,350 lbs. of thrust. This does not give the MiG-23 performance approaching modern Western fighters, but it reflects a considerable improvement in Soviet fighter capabilities. .[13]

The Flogger E normally uses the less powerful R-27 engine instead of the R-29B, has a less capable ARK-9 radio compass instead of the ARK-15, has inferior navigation and attack munitions delivery aids, and does not have a laser. Nevertheless, Iraq had to use its MiG-23s in the air defense role before it obtained the Mirage F-1.[14]

The Iraqis are believed to have asked for improved MiG-23Bs early in the war, and and to have begun discussing purchase of the export versions of the MiG-29, Su-25, and Su-22T in 1984 or 1985. The Iraqis evidently received 25 sanitized versions of the MiG-29 Fulcrum in May-1987, b ut it did not play a major role in the fighting. The aircraft rapidly proved to be fuel hungry and difficult to maintain. It was also delivered without the advanced look down-shoot down radars and computers which are standard on Soviet models of the MiG-29, and the Iraqi version can only be used in day fighter roles. The Soviets evidently supplied the MiG-29s in this condition in spite of Iraqi demands for the Soviet version aircraft. They refused Iraq deliveries of more advanced versions of the MiG-23 and MiG-27 -- possibly on the grounds they already had a $10 billion arms debt to the USSR.

Iraq is also reported to have received at least ten Su-25 attack aircraft. This aircraft is an armored close support aircraft similar to the Northrop A-9. There are some reports it has been effective in a limited number of close air support missions, but no real details are available. [15]

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[13] Chris Chant, A Concise Guide to Military Aircraft of the World (London: Temple Press), p. 150.

[14] The Soviet Su-17/20 "Fitter C" includes SRD-5M "High Fix" radar, an ASP-5ND fire control system, and comprehensive communications and IFF, circa 1977. Given the state of Iraqi Air Force communications, i.e., C3 and IFF, it is unlikely that this kind of sophisticated equipment is operational on the Iraqi variant. See Bill Gunston, Modern Soviet Air Force (New York: ARCO, 1982), pp. 110-111, and Bussert, op. cit. pp. 137-138.

[15] Jane's Defense Weekly, July 18, 1987, p. 70; IISS, Military Balance, 1987-1988; Aharon Levran and Zeev Eytan, The Middle East Military Balance, 1986, Boulder, Westview, 1987, pp. 236-258.

Some reports have suggested that Iraq's Soviet-made aircraft, like their Soviet counterparts, contain onboard anti-jamming (ECM) gear, in contrast to the Western emphasis on specialized jammer planes. There is little evidence, however, of internal ECM capability onboard any Iraq MiGs or Sukhois, and the Iraqis have bought external ECM pods in the West. Iraq does seem to have improved its ECM and countermeasure capabilities in 1987 and 1988, but reliable details are not available.

The primary air-to-air missile utilized by Iraqi Soviet-made aircraft is still the AA-2 Atoll, which is carried by MiG-21, MiG-19/CH F-6, and Iraq's more modern Soviet-made aircraft. The AA-22 is an old infrared (IR) homing missile, which is thought to be a copy of the Raytheon-Ford Sidewinder. It has proved to be an unreliable "tail chase" missile with limited range and maneuver capability in the 1973 Arab-Israeli conflict, in the 1982 fighting in Lebanon, and in the Iran-Iraq War.[16] Iraq is, however, steadily expanding its use of more modern air-to-air missiles like the Soviet-,made AA-6, AA-7, and AA-8, and the French-made R-530 and R-550 Magic. Some Iraqis feel these changes distinctly improved Iraq's air-to-air combat capability by the mid-1980s.

In spite of the acquisition of newer types of Soviet fighters, the key shift in Iraq's air capabilities after the start of the war was the acquisition of two types of French aircraft, the Super Etendard and Mirage F-1. The Dassault Breguet Super Etendard was received on loan to deliver Exocet air-to-ship missiles while France was producing Mirage F-1EQ5s which were specially equipped to fire Exocet missiles. It was returned to France once the Mirage F-1EQ5 was delivered.

The Super Etendard was an obsolescent naval light strike fighter capable of high-supersonic speed. Intended as a replacement for the Etendard IVA carrier-based aircraft, it is powered by a SNECMA Atar 8K-50 single shaft turbojet. Its maximum speed is 745 miles per hour at low altitudes. This aircraft is able to refuel in flight. Its armament includes two 30 mm DEFA cannon. The Super Etendard has a nominal HI-LO-HI radius of 403 miles, or 650 km. This makes it a comparatively short-legged fighter. Nevertheless, it was the primary delivery system for Iraq's Exocet active radar-homing anti-ship missile, until mid-1985. The Super Etendard carried the Exocet under the starboard wing, with the drop tanks slung under the port wing. Magic air-to-air missiles are optional.

Iraq's use of the Exocet AM-39 missile was described in detail in Chapter XII . The Exocet is 4.69 meters long, 350 mm in diameter, weighs 655 kilograms at launch. The Exocet has a limited range of 31 to 43.5 miles, depending on launch altitude. It is a sea skimmer fed with target data before launch with inertial mid-course correction. It flies at Mach 0.93 at about 2.5 meters altitude, and switches an EMD Adac X-band monopulse active radar seeker to home in on its target.

The Exocet has a 165 kilograms Serat hexolite/steel block warhead. This penetrates armor at angles up to 70^{o}, and has proximity and delay fuzes. It explodes after penetrating the hull. The resulting fire inside oil tankers has not generally been sufficient to sink a large tanker, but it has worked well against smaller ships and warships. The Exocet has been in service with

16 Defense Electronics (February 1981), p. 161.

the Super Etendard since 1978, and the aircraft normally carries one to two missiles on wing pylons. The Exocet has been in service with the Mirage F-1EQ5 since 1985.

The Dassault Mirage F-1 has become Iraq's lead fighter and replaced its Super Etendards. By 1988, Iraq had six squadrons of Mirage F-1s. Two were air defense squadrons equipped with 30 Mirage F-1EQs. Four were attack squadrons equipped with a mix of 70 Mirage F-1EQ5s and Mirage F-1EQ200s.

The Mirage F-1 is a relatively modern multi-role aircraft with a relatively large payload, easy handling at low altitudes, and a high rate of climb. Dassault-Breguet claims that the Mirage F-1 has a higher maximum speed (Mach 2.2 rather than Mach 2) than the Mirage III, three times the endurance at high Mach numbers, three times the patrol time before and after an interception. It also claims the Mirage F-1 has twice the tactical range at sea level, a 30 percent shorter take-off run at greater maximum weight, 25 percent lower approach speed, and improved maneuverability at both subsonic and supersonic speeds.[17] In addition, the Mirage F-1 holds 40 percent more fuel capacity than its predecessor, which is achieved by eliminating bladder-type tanks and replacing them with the integral full space type. The Mirage F-1 can also use short unpaved runways.

The Mirage F-1 is powered by one 15,870-pound SNEMCA Atar 9K50 afterburning turbojet. It is armed with two 30 mm DEFA 553 cannon with 125 rounds per gun. In the interceptor role it normally carries two R550 Magic IR air-to-air missiles for short range combat and one Super 530F radar homing air-to-air missiles, and carries up to 4,000 kg (8,000 pounds) of ordnance in the attack role. Iraq currently has Mirage F-1EQ, F-1EQ-200, and F-1EQ5 aircraft. There is also a dual seat trainer. The basic version of the Mirage F-1EQ has the more advanced avionics required by the all-weather role, but does not have high radar range, an advanced avionics computer, or a true look-down capability. Some of the Mirage F-1s have been stripped of their air defense avionics to provide increased range, have extra fuel tanks and can carry the AM-39 Exocet.

As has been touched upon earlier, the Iraqis added the Super 550 and 530 missile to their air-to-air missile inventory. The Super 530 is a modern follow-on to the R530, and has a nominal maximum range of 35 km. It uses SARH with an EMD Super AD-26 radar matched to the Cyrano IV radar in the Mirage F-1. It has speeds of up to Mach 3, and can hit targets up to 10,000 km higher or lower than the launch aircraft. It is equivalent to the best U.S.-made, radar-guided types, and is one of the most lethal air-to-air missiles in service in the Third World. Both missiles are more sophisticated version of the Matra Magic and have longer ranges.

The Magic missile, or R-550, is an improved version of the Sidewinder with a 140^{o} attack hemisphere, head-on attack capability, high "G" launch and maneuver capability, a 0.32 to 10 km range, and advanced IR seeker. It has also reportedly achieved kills fired from Iraqi MiG-21s, and proved far superior to the standard Soviet-supplied infrared missile, the Atoll. The Mirage F-1s are reported to have shot down several Iranian aircraft with the Matra Magic 1 missiles, and to have scored kills even at very low altitudes.

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[17] Chris Chant, op. cit., pp. 69-70.

Iraqi Air Force officers feel the Mirage F-1 is hard to maintain, but is far superior to their Soviet-made fighters. They regard the avionics as far more effective in both the air-to-air and air-to-ground modes and regard French air-to-air missiles and air-to-ground weapons as far more lethal.

13.4.2 Iranian Aircraft

The Iranian Air Force was equipped with late-model U.S., weaponry under the Shah's regime. It began the war with the best mix of fighter capabilities and munitions of any Gulf air force, and any Third World air force except Israel. The Iranian Air Force had 70,000 men when the war began. Its main aircraft included the F-4, F-5 and F-14. It had 10 fighter ground attack (FGA) squadrons with 188 F-4D/F and eight squadrons with 166 F-5E/Fs. It had four interceptor squadrons with 77 F-14As, and one reconnaissance squadron with 14 RF-4Es. It had 205 AH1J attack helicopters in the Army and 6 P-3F Orions in the Navy.

During the period from 1980 to 1988, Iran was unable to support its air strength at anything like the level it had reached under the Shah. Its combat air strength increased from 445 aircraft in the air force alone in 1980 to only about 68-90 in 1988. At the time the ceasefire was agreed to in 1988, the air force also only had 35,000 men Its main combat aircraft then consisted 20-35 F-4D/Es, 30-45 operational F-5E/Fs, 10-14 F-14s, and 3 RF-4E. Army attack helicopter assets had declined to the point where less than 50 helicopters seem to have been operational. The Navy seemed to have 2 PF-3s still operational.[18]

The F-14 Tomcat was Iran's most advanced aircraft when the war began. It is a highly sophisticated, variable sweep wing aircraft. it has an advanced AWG-9 air defense radar, which utilizes the Phoenix missile in the air-to-air role for long-range defense. It has exceptional look-down/shoot-down capability, long-range radar surveillance capability, and can simultaneously attack several air targets.

The F-14A is a long-range aircraft and can fly CAP missions at radii up to 764 miles (1,167 km) and intercept missions up to 2,000 miles (3,200 km). It utilizes two 20,900 lb. thrust, Pratt & Whitney TF 30-412A afterburning turbofans. Initial climb rate is 30,000 feet per minute. Maximum speed is 1,564 miles per hour at height, and 910 miles per hour at sea level. The F-14 uses one 20mm M61-A1 multi-barrel cannon in fuselage, and carries four Aim 7 Sparrows and four or eight Aim Sidewinders or up to six Aim-54 Phoenixes and two Aim-9s. The maximum external weapon load for the F-14 is 14,500 pounds.

According to most sources, the Phoenix missile systems and/or guidance avionics in the Iranian F-14As were sabotaged when the war began, and have not been operational since. The Phoenix systems are reported to have been sabotaged by Iranian Air Force personnel friendly to the U.S. shortly after the Shah's fall, although some sources report they were sabotaged by Iranian revolutionaries to prevent air force operations. This meant Iran could not make optimal use of its best fighter, or use an advanced all-weather, air-to-air missile with good shoot-down capability and a range up to 124 miles (200 km).

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[18] Strength estimates based on various editions of the IISS, Military Balance.

The F-14As could, however, still operate their AN/AWG-9 radar. This radar has a range of well over 100 nautical miles, and which can track 24 targets with sufficient look-down capability to act as a "mini-AWACs." They also could still fire Aim-7 and Aim-9 missiles. This allowed Iran to achieve a kill against an Iraqi Mirage fighter using the Aim-9 as late as the spring of 1988.

The Iranians used the F-14 both as a recce and air combat aircraft, but have found this sophisticated aircraft to be difficult to keep in operational readiness without good maintenance crews and spare parts. Only three to ten still appear to be in full service. They are now used largely as airborne warning and control platforms, and as reconnaissance fighters. [19]

The McDonnell Douglas F-4 is a high-payload attack aircraft with relatively long ranges of between 250 and 420 miles. The F-4E version carries an internal 20mm M-61 multi-barrel, and the same gun can be carried in an external centerline pod. The F-4 carries centerline and wing tanks for bombs or other missiles, and carries up to 16,000 lb (7,257 kg). It can climb at 28,000 feet per minute. It has a maximum speed of 1,500 miles per hour at height. Its maximum range on internal fuel is about 1,750 miles.[20]

The F-4, however, is an aging design and a complex aircraft that is extremely difficult to maintain, particularly in terms of avionics. The Iranians were not been able to maintain the complex systems of the F-4E, even though they have cannibalized many aircraft. Indeed, it is doubtful that most of Iran's surviving F-4s can now fire radar-guided missiles like the Aim-7 Sparrow--although reports have surfaced that Iran received APQ-120 parts that allowed it to resume firing its Aim-7Es as part of its covert arms transfers from the U.S. It is also uncertain whether or not all of the F-4s have the avionics capabilities to use the Aim-9 Sidewinder.

The Iranian F-5E is a short range, low payload, minimal avionics aircraft. It has an optimal range of 150 to 250 miles. The F-5E has a maximum speed at altitude of 1,060 miles per hour and an initial climb rate of 31,000 feet per minute. It is armed with two 20mm M-39A2 cannon, each with 280 rounds in the nose, and Aim Sidewinders. The "E" version of the F-5 can carry 7,000 pounds in military loads. Although the F-5E is limited in range, it is still an effective and highly capable fighter. It also cannot be discounted as a possible vehicle for one-way suicide attacks. The F-5 has a low small radar profile.

13.5 Air-to-Air Combat

Air combat in the Iran-Iraq War was dominated largely by problems in command and policy, parts shortages, and personnel problems, rather than by aircraft numbers, technology, and tactics.[21] Both Iraq and Iran generally sought to conserve their aircraft, and refused battle whenever possible. Iraq emerged with air superiority largely because of Iranian maintenance and re-supply problems and not because of combat performance.

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19 Anthony H. Cordesman, "Policy Options and Regional Implications," American-Arab Affairs, No. 9 (Summer 1984), p. 12.

20 Bill Gunston, The Illustrated Encyclopedia of the World's Modern Military Aircraft (New York: 1977), p. 27.

21 Nick Cook, "Iraq-Iran: The Air War," International Defense Review (November 11, 1984), p. 1605; Kenneth Timmerman "Mirage Over Kharg," op. cit., pp. 53-54; and Jim Bussert, "Iran-Iraq War Turns Strategic," op. cit., pp. 143-145.

Fighter-against-fighter combat was only common during the first phase of the war. Iran's air force was the more successful force during this phase, but this was as much due to Iraqi incompetence and the lower performance of the sensors, avionics, and missiles on Iraqi fighters as to Iranian ability. In retrospect, there is little doubt that the Iraqis misjudged Iran's ability to fly air combat missions in spite of the revolution, and overestimated their own effectiveness. Iraqi planners also overestimated their own level of air combat training, the performance capabilities of their aircraft, the operational readiness of Iraq's best squadrons, their reconnaissance assets, and their command and control capabilities.

In the first phase of the war, the Iranians had the fuel and endurance to "win" most air encounters by either killing with their first shot of an Aim-9, or forcing Iraqi fighters to withdraw. They also seem to have had a distinct edge in training, although one observer of air combat between the two sides is reported to have commented, "They can fly, but either they can't shoot or they can't aim." Iran has since lost that edge. It has suffered from repeated purges and it has conducted only minimal training since 1979.

Most of the air-to-air combat seen by outside observers tended to be inconclusive. Engagements that should have taken less than two minutes have lasted as long as five. In most air-to-air combats, the successful pursuer either succeeded with his first missile, or was not able to keep his opponent from breaking off and escaping. This may reflect the fact that air combat tends to spiral down to altitudes where neither side was properly trained to fight, but it may also reflect the fact that many of the IR missiles held by both sides were relatively ineffective in anything other than tail chase firing at medium to high altitudes.

Iraq, however, steadily improved its training during the course of the war, and made increasingly effective use of its new French aircraft and missiles. After 1982, it had the edge in most of the few encounters that took place, although its kill capability per encounter remained low. It still is unclear how much Iraq really improved versus how much Iran degenerated in operational readiness.

Iran lost most of its few air-to-air encounters after 1983, unless it used carefully planned ambush tactics against Iraqi attackers flying predictable paths of attack. Iran not only lost its technical edge over Iraq, the entire Iranian Air Force probably could not generate more than 30 to 60 sorties per day under surge conditions after 1983. Iran also lost one F-4 or F-5 on January 17-18 1985, under conditions suggesting the Iranian aircraft had serious missile or radar problems. This indicates Iran has be committed fighters to air combat with at least some inoperable avionics. Iran has reported growing reliability and survivability problems with all of its U.S.-made missiles and smart ordnance since 1984.[22]

Iraq, in contrast, was able to generate fairly high sortie rates from 1983 onwards, increasing from a maximum of 65 sorties per day, early in the war, to levels of 150 per day in 1984, and over 250 in 1986-1988, with claims of peaks as high as 600. Iraq had little reason to devote much of this sortie generation capability to air defense after the early 1980s, but it did demonstrate that it could generate a high number of air defense sorties with well-armed and fully

[22] Anthony H. Cordesman, The Iran-Iraq War: 1984-1986 (Los Angeles, CA: Analytical Assessments Center, May 1986).

operational aircraft. It is also interesting to note that Iraq claimed in late 1988, that its pilots had flown a total of 400,000 sorties of all types during the war.[23]

This pattern of combat reinforces the lesson of the Arab-Israeli conflicts that the West supplies, supports, and trains air forces which can be far more effective, relative to Soviet bloc and PRC-equipped Third World forces than their force numbers indicate. It reinforces the doubts regarding the capability of Soviet export fighters raised in past wars, as well as doubts about the dogfight capability of Soviet air-to-air missiles, cannon, and avionics.

At the same time, the Iraqis join with the Egyptians, Syrians, and Jordanians, in noting the following problems in the support and training they received from the USSR:

- The USSR provided poor air combat training and little training in air operations. There was no real aggressor squadron training and no use of the advanced simulators common in the West, and available to nations like Saudi Arabia. Iraq had to turn to France and India for assistance in this area;

- The USSR did not provide detailed operational data on its fighters and missiles, as distinguished from technical data, which, in turn, the Iraqis lacked the background to interpret;

- There was little Soviet effort to go beyond classic GCI training and doctrine and deal with more fluid types of air defense; and

- The USSR failed to provide adequate training and capability in electronic warfare and countermeasures, and in low altitude combat. Training rarely dealt with combat below 5,000 feet.

Iraq has since gotten enough aid in all these areas from France, India, Egypt, and Jordan to adopt a "high low" concept which mixes Soviet mass with Western quality. It is far too soon to tell how well Iraq will succeed with this concept, but it is interesting to note that Libya and Syria have also actively sought Western air-to-air missiles and aid in avionics and electronic warfare upgrades. They too are pressuring the USSR to improve its equipment and support.

It is also interesting that Iraq's experience has combined with the impact of Arab defeats in previous wars with Israel, and with the lessons of the Falklands conflict, to make many Third World nations refuse to buy any fighters and missiles which are not in first line service in the U.S. and Western Europe. This may be a wise decision, given the far more advanced air combat avionics and weapons on such fighters. It is clear from the Iran-Iraq War, however, that such technology must, however, be combined with suitable training and doctrine in order to be effective.

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[23] Jane's Defense Weekly, January 21, 1989, p. 81

FIGURE 13.3 (OLD 4.21)
MAIN IRANIAN AIR BASES AND AIR DEFENSE CENTERS

13.6 Close Air Support

Both Iran and Iraq generally proved unable to use fixed wing air power effectively to provide close-air support of their military forces. The Iranian Air Force was marginally better able than Iraq in carrying out attack missions at the start of the war, but numerous observers confirm the fact that the Iraqi Army could still operate with near indifference to the risk of Iranian air attacks against anything other than large, fixed-area targets. This may have been because Iran was conserving aircraft, and flew very low sortie rates. Only about 18 to 50 percent of Iran's attack aircraft were fully operational at the outset of the war in 1979, and there are some indications that the avionics associated with attack missions failed earlier than those used in air-to-air combat. In any case, Iran rarely seemed able to locate and hit Iraqi forces effectively, even in the first few months of the war.

It is difficult to estimate what Iran's F-4s and F-5s could have accomplished if the Iranian Air Force had not been disrupted by revolution, and had been able to keep its attack avionics and munitions operational. Iran's lack of a sophisticated C3I/BM system, and reliance on reconnaissance assets with near real time processing capability, would unquestionably have limited its effectiveness.

Iraq also faced the problem that the use of conventional "iron bombs" and rockets from high speed jet aircraft that lacked sophisticated targeting and delivery aids does have low lethality even against exposed armor, and even less lethality against "dug-in" forces, regardless of pilot skill and willingness to take risks. Iran had no fighter aircraft with anything approaching modern attack avionics or heads up displays, although its F-4D/Es were relatively advanced for their time.

Iran lacked sophisticated area ordnance suited to close support against dispersed or well sheltered infantry targets from the start of the war to the ceasefire and there are no indications it was able to use Maverick with any effectiveness against Iraqi armor. It is unclear whether this was the result of command and support problems, or the technical and operational problems Maverick creates in finding a target, exposing the aircraft to SHORAD fire, and guiding it to a small moving ground target in the face of terrain problems, light problems, dust, etc.[24]

It is also important to note that even the highly trained and well equipped Israeli Air Force had low lethality against such targets in 1973, and most Western air forces have found that advanced attack avionics are absolutely critical to both achieve high kills per sortie and surviving ground based air defenses. Nevertheless, individual Iranian squadrons and pilots did show during the early weeks of the war that their U.S. training was far more effective in attack missions against fixed or area targets than the Soviet training provided Iraq.

Unfortunately for Iran, it never had the opportunity to restructure its air force to correct its initial deficiencies. After Iran's July 1982 offensive against Basra, Iraq was able to operate up 400 first line fighters in various forces of close air support and interdiction missiles versus fewer than 80 operational F-4s and F-5s for Iran. Many of the Iranian aircraft that were operational

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[24] Anthony H. Cordesman, "The Iran-Iraq War: Attrition Now, Chaos Later," Armed Forces Journal International (May 1983), p. 41.

lacked fully operational avionics and had to be held in reserve. As a result, Iraq was able to use its growing fighter and helicopter force with only token opposition. Iran was forced to rely largely on anti-aircraft guns and surface-to-air missiles to deprive Iraq of its advantage in local air superiority. [25] This rapid decline in Iran's offensive and defensive air capabilities furnishes an important lesson in the importance of reliability, serviceability, adequate parts stocks, and forward area maintenance technology. Iran lost its ability to field an effective air force in spite of what seemed to be massive pre-war purchases of parts, munitions, and service facilities.

The exact reasons for Iraq's continued problems in making its average air-to-ground sortie effective during most of the war are uncertain. It is clear, however, that Iraq suffered from problems in command, training, technology, and tactics. The Iraqi command system did not favor armed reconnaissance, and was slow to react to target opportunities, until comparatively late in the conflict. Field commanders often lacked the authority to get a rapid response from on-call air support, and requests could be delayed for hours or even a day. There is also little evidence that Iraqi pilots got intensive mission pre-briefs or that the command system normally provided feedback on mission effectiveness based on the effective use of reconnaissance aircraft or drones, until late in the war. It is surprising, for example, that Iraq has made comparatively little use of RPVs.

Iraq faced real tactical problems in that Iran conducted most movement and initial assaults at night, and rarely presented attractive targets for close air support. Iranian forces were normally well dug-in and dispersed, and even in many assaults, the main targets were infantry and fighters could only get a comparatively limited number of kills of low value targets per sortie at the risk of exposing very expensive aircraft. Iran also often made good use of bad weather, and had many well dispersed anti-aircraft weapons and SA-7s. These problems might have been solvable with more aggressive use of area munitions like cluster bombs, and by acquiring improved night combat capabilities, but the basic problem Iraq faced throughout the war was that it was generally only worth risking aircraft in close air support missions when Iran threatened a major breakthrough.

Iraq's technical problems were far more severe than those of Iran at the start of the war, although they were reduced with time. Iraq's Mirage F-1s were its most advanced attack aircraft, but they did not have fully modern attack avionics by Western standards, particularly in terms of computer capability and advanced heads up display capabilities. Iraq's export versions of Soviet fighters all had much less sophisticated attack capabilities, although its Su-20/Su-22s had relatively good navigation and basic weapons delivery capabilities.

Iraq also lacked the kind of advanced simulators and computerized training ranges that fully allow the pilot to exploit his aircraft's capability. These devices can be critical in Third World states which depend heavily on foreign training or advisors because pilot skills need constant refreshing once they pilot receives combat training, particularly because the pilot rarely has the time or visibility of target to appraise his own effectiveness.[26] It is also important to note that Iraq had truly massive amounts of artillery along the front during most battles, and that the incremental kill capability of attack fighters was often limited. Unlike Western forces, Iraq was

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[25] Cordesman, "Lessons: Part Two," op. cit., p. 40.

[26] Ibid., p. 40.

organized for mass barrages. It, therefore, had less priority to risk planes in close air support missions.

Once again, it is clear that most Western air forces would have an "edge" in such missions over their Third World counterparts. The value of this edge, however, could be seriously limited by the inability to bear the probable losses of flying close air support sorties in an environment with so many short range air defenses, and where the target mix is so poor. Given the fact that even the cheapest Maverick missile costs well over $50,000, and launching it involves at least some risk to a fighter that may cost well over $20 million, is is also unclear that such missions can ever be particularly cost-effective. They may prove necessary under crisis conditions -- and the West have more effective area and hard target ordinance available than were available to Iraq or Iran -- but it seems unlikely that close air support can ever act as a practical force multiplier against large ground force targets that are not dependent on a few high value weapons like main battle tanks.

13.7 Interdiction and Air Suppression Operations

Neither Iran nor Iraq showed great capability to hit small to medium-sized interdiction targets, like bridges, although Iraq's performance has improved since early 1987. Both sides also had trouble locating and attacking rear area targets like large daytime movements of armor, even when these movements were unaccompanied by any air defense. In the case of Iran, this was heavily influenced by problems in aircraft numbers, although there is little evidence that Iran ever made particularly effective use of its RF-4Es to locate rear area targets or was able to manage effective interdiction campaigns when it did commit its aircraft.

Iraq did slowly improved its effectiveness in interdiction missions during the war, but was still unable to hit key targets like defended bridges in 1987. While Iraq did improve its use of reconnaissance and armed reconnaissance from late 1986 onwards, and was substantially more effective by late 1987 than at the start of the war, it was surprisingly ineffective in organizing the kind of campaign that could pound steadily at meaningful targets in the rear of Iranian forces and locate and kill targets of opportunity during the relative short times they are exposed. This may partly have been due to the proliferation of Iranian short-range air defenses, but much of the problem seems to have stemmed from a desire to conserve air assets even at the cost of effectiveness, and from a failure to understand that far larger number of aircraft were required to receive decisive results. There also is no question that the photo and other capabilities provided by Iraq's MiG-25R reconnaissance fighters fell far short of the sensors and avionics needed for targeting and air battle management.

Both nations had severe problems in using air strikes on enemy bases and facilities to suppress the other side's air forces. Iraq attacked ten Iranian airfields and air facilities during the first day of the war and did virtually no damage. In fact, Iraq did not achieve sufficient shock value to impose more than minor delays on Iranian Air Force operations.

Iran, in contrast, was able to hit at least two Iraqi air fields on the first day of combat. These attacks seem to have had sufficient shock effect to force mass dispersals to Jordan that Iraq had not planned for when the war began. A few Arab experts, however, explain Iraq's forced dispersal of its aircraft as the result of the fact that it had comparatively few main operating bases, that most were near Iran, and that although Iraqi aircraft were sheltered, most bases had

large numbers of "soft" facilities. They believe it was the asymmetries in basing posture, rather than Iran's superior effectiveness, that forced Iraq to disperse.[27]

While some Iraqi have since charged that the cause of their failure to hit Iranian air fields effectively was was defective Soviet-made bombs, there can be little doubt that when the Iraqis first attacked Iran in 1980, they suffered from the kind of "delusional blindness" that affected the Arabs in 1967, and the Israelis just prior to October 1973. The Iraqi Air Force lacked the intelligence and operational capability to objectively evaluate its effectiveness against any time of target and the survivability of the enemy. As a result, the Iraqi Air Force was forced to make realistic preparations for the air battle after the war was well underway.

There are several important lessons inherent in this experience:

- First, one cannot assume that Third World airpower will be committed realistically or with a professional understanding of the results.

- Second, forces with more sophisticated training, reconnaissance capability, attack aircraft and munitions, and command structures may be far more effective relative to Third World air forces than there numbers indicate.

- Third, it is critical to assess both friendly and unfriendly Third World air forces in terms of "soft" capabilities like exercise performance, training, command capability and the other factors that shape readiness. Air strength alone, particularly as measured in terms of number of aircraft, may be virtually meaningless as an indication of real-world combat capability.

- Fourth, most Western air forces should have the aircraft, sensors and avionics, reconnaissance capabilities, and stand-off munitions to be far more effective in interdiction missions than most of their Third World counterparts. The practical problem will be to determine which missions have to most tactical or strategic effect -- something that may be far from easy given the different art of war and value judgements used by many Third World forces.

13.8 Strategic Operations

Both sides made use of strategic bombing against economic targets. Iran conducted most of its effort during the first year of the war. Iraq conducted a major strategic bombing effort against oil and economic targets, and the war ended in a ceasefire after a major strategic bombing effort against civilian targets.

13.8.1 Iranian Strategic Bombing Operations Against Economic Targets

The Iranians lost much of their strategic bombing capability after 1981, but generally had the edge in the early stages of the war.[28] Iran launched some relatively accurate and well-planned attacks. It exhibited good air strike planning in attacking Iraqi power plants, and demonstrated considerable coordination in several attacks. This coordination was particularly striking in an

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[27] Jeffrey Ullrich, "Jordan May Give Iraqis Military Aid," Washington Post (October 13, 1980), p. A-3.

[28] See Anthony R. Tucker, "The Gulf Air War, Armed Forces, June, 1987, pp. 270-271.

attack launched on Iraq's H-3 oil field complex and air base at al-Walid where Tu-22 and IL-28 bombers are based. This target is over 800 km from the nearest Iranian air base at Reza'iyeh. Iran retains some of this refueling and long-range strike capability. [29]

While the evidence is contradictory, informed Western and Arab observers agree on the following points relating Iran's initial superiority in strategic bombing missions:

- First, Iranian proficiency and accuracy in delivering conventional attack ordnance, like rockets and bombs, and owes a great deal to the fact that something like 100 U.S.-trained Iranian pilots were freed from jail in the first days of the war.

- Second, Iranian missions were better planned, and indicated far better use of maps and recce capabilities and pilot briefings.

- Third, Iran made effective use of the Maverick on at least some occasions, including strikes on Basra.

- Fourth, the superior range/payload of most Iranian fighter bombers proved critical against area targets. Iran's ability to deliver two to three times as many bombs or rockets per plane per sortie , made up for much of the Iranian Air Force's lack of accuracy in using such munitions, and had telling effect on dispersed targets, like refineries, tank farms, and petrochemical plants.

13.8.2 Iraqi Strategic Bombing Operations Against Economic Targets

Iran and Iraq did show early in the war that they could hit storage tanks, large facilities, and area targets. Discussions with some of the Iraqi experts involved -- and confirmed by Arab, Western, and Japanese observers -- indicate, however, that air power had a much greater effect in forcing both nations to temporarily shut down operations than in doing lasting and unrepairable physical damage. While each side occasionally did lasting damage to the other's refineries and chemical facilities, this is not true in most cases even when the press has reported major damage. The psychological impact of burning oil tanks and petrochemical plants tended to disguise the fact that most of the key equipment emerges intact, and that the key military result was to force a temporary shutdown of operations.

Iraq had a virtually monopoly on strategic bombing after 1982, but rarely achieved more significant strategic effects. This can be partly explained by the fact that many key Iranian targets were barely within range of Iraq's fighter-bombers when they flew demanding flight profiles, and were difficult for Iraq to attack. The key factors limiting the effectiveness of Iraqi strikes, however, seem to have been a mixture of political restraint to minimize the risk of more land attacks on Iraq, Iraq's exaggeration of the impact of limited attacks and failure to accurately appraise the limits to its success, and Iraq's desire to reduce aircraft losses. There is little doubt that if Iraq had repeatedly attacked in the numbers required against key targets like power plants, refineries, water facilities, and less protected oil facilities, it could have had a far more decisive effect.

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[29] Colonel William O. Staudenmaier, A Strategic Analysis of the Gulf War (December 9, 1981), p. 23.

Even so, it is difficult to determine why Iraq could not knock out Kharg Island and destroy all the loading jetties, knock out Iran's refineries, or knock out its power plants. Iraq had the resources to keep any one of these critical sets of targets from functioning if it concentrated its forces, and to do so with acceptable losses. The problem was that it either failed to understand the need to focus its strategic bombing and concentrate sufficient forces or failed to do so for political reasons.

13.8.3 Iranian and Iraqi Strategic Bombing Operations Against Urban Targets

In spite of occasional large scale raids, Iran and Iraq generally limited their strikes on each other's population centers until the "war of the cities" in 1988, which was heavily influenced by the use of long range surface-to-surface missiles and which will be discussed shortly. Iraq did used aircraft extensively in the "war of the cities", however, and made use of cluster bombs, napalm, and possibly some fuel air explosives.

Iraq also conducted high-altitude strikes with Tu-22 bombers. At least one of these strikes which produced extensive damage to Iranian auto and steel plants near Tehran. [30] Iraq's use of chemical agents also suggest that far more lethal strikes could be delivered by attack aircraft.[31] Once again, the Iran-Iraq War only hints at the potential lethality of future strategic bombing efforts.

13.8.4 The Overall Impact of Iranian and Iraqi Attacks in the Oil War

If one looks at the overall outcome of the oil war, rather than simply strategic bombing against land targets, Iran's major successes consisted of land and amphibious attacks on Iraq's oil loading facilities in the Gulf, and its political efforts in persuading Syria to cut off Iraqi oil exports through Syria. As **Figure 13.4** shows, Iran, however, was unable to do anything to prevent Syria from finding alternative ways to export oil through Turkey, Saudi Arabia, Kuwait, and Jordan. Iran never had the strategic bombing capability to prevent Iraq from creating new pipelines and new ways to export.

Similarly, Iraq's massive effort to attack Iranian oil facilities and Iranian and other tankers was only marginally effective in reducing the flow of Iranian exports. As **Figure 13.5** shows, there are only two points in the war where the combination of Iraqi air strikes against tankers, oil facilities, and Kharg Island may have produced a serious drop in Iranian exports: August-November 1986, and September and October, 1987.[32]

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30 Cordesman, "Lessons: Part Two," Chicago Tribune (November 15, 1985); Economist (November 2, 1985), p. 36.

31 See "Saudis Down Two Iranian Jets," Los Angeles Times (June 5, 1984), p. 1. However, subsequent reports corrected the number of kills to one.

32 Readers lacking in experience with oil export and Iraqi sortie claims should be very careful about taking such figures too seriously. They to some extent represent worst case estimates of the effect of Iraqi attacks, and they ignore the fact that the "oil glut" and rapid declines in prices often did as much to influence demand for Iranian exports as Iraq's strikes did to influence the Iranian capability to export.

Other data on Iraqi and Iranian oil export patterns during 1987 to 1988, also provided a very different picture of Iranian production levels at the end of the war. For example, the CIA and First Boston Corporation show the following data for export levels:

Iranian and Iraqi Average Monthly Oil Production in 1987 and 1988

Part of the reason for Iraq's lack of effectiveness in cutting Iraq's oil exports seems to be that Iraq flew comparatively limited numbers of sorties, and lacked the kind of accurate stand-off munitions and mission planning necessary to achieve high lethality per sorties. Similarly, Iraq lacked the maritime reconnaissance assets and high payload missiles to properly locate high value tanker targets and kill tankers, rather than damage them.

The data in **Figure 13.5** do suggest, however, that Iraq's mix of attacks on Iran's oil export capability may have become more effective in late 1987 than in early 1986, and that it might have been more decisive if the war had continued. It is also important to point out that Iraq did force Iran to use a tanker shuttle, massively discounted its oil, and spend hundreds of millions of dollars on repairing oil facilities and obtaining new tankers.

If the outcome of Iraq's strategic bombing efforts is measured in terms of competitive strategy, virtually all experts agree that cost Iran far more to try to deal with the results of Iraq's attacks than it cost Iraq to make its attacks. Further, the constant threat that Iraq might escalate to large numbers of sorties, as it did in late 1987, acted a constant pressure on Iran's leadership. Finally, it is unlikely that any future strategic air attacks on major oil or economic targets will be conducted without the use of more sophisticated targeting equipment and attack capabilities, and the Iran-Iraq War may not provide a clear picture of the future threat that local air power can poise to Gulf oil export capabilities.

This risk strategic bombing poses to key oil complexes like Ras Tanura (with its over-concentrated mix of oil and liquid gas facilities), and the other central oil export facilities in the

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Date	Iran	Iraq
1987		
May	2.6	1.9
June	2.5	2.0
July	2.5	2.0
August	2.7	2.2
September	2.1	2.3
October	2.4	2.5
November	2.2	2.6
December	2.2	2.6
1988		
January	2.0	2.4
February	1.9	2.5
March	2.0	2.5
April	2.2	2.7
May	2.2	2.6
June	2.2	2.7
July	2.3	2.8
August	2.3	2.6
September	2.4	2.7
October	2.4	2.7
November	2.5	2.7
OPEC January 1, 1989 Quota	2.64	-

Source: First Boston Corporation, Petroleum Monitor, October, 1988, Vol. 7, No. 10, pp. 16-17 and January, 1989, Vol. 8, No 1, pp. 16-17.

Gulf, cannot be judged by the Iran-Iraq War. Future conflicts may well involve the capability to selectively attack key point targets like the sensitive equipment involved in refineries and oil extraction with high lethality.

FIGURE 13.4

RELATIVE OIL PRODUCTION OF IRAN AND IRAQ FROM 1980-1988 AND EXPANSION OF IRAQI PIPELINE CAPABILITY

FIGURE 13.5

IMPACT OF IRAQI STRIKES ON IRANIAN OIL PRODUCTION-PART ONE

FIGURE 13.5

IMPACT OF IRAQI STRIKES ON IRANIAN OIL PRODUCTION-PART TWO

13.9 Air Reconnaissance and Identification of Friend or Foe (IFF)

Many of the problems in the reconnaissance and IFF capabilities of each side have already been discussed in Chapter XI. It is important to note, however, that Iran had an important advantage in maritime reconnaissance, and Iranian air reconnaissance over the Gulf was an important feature of the war from its start to the ceasefire.[33] Iran used its F-4s as well as two to three operational P-3F Orion surveillance and ASW aircraft. While the P-3Fs soon lost operational radar capability, they still gave given Iran an important advantage in locating Iraqi naval targets, and gave Iran an advantage in targeting reprisal strikes on tankers operating east of Qatar as the war escalated after mid-1983.

Iraq had no maritime patrol aircraft, and continued to experience serious problems in locating naval targets and tankers. This provides an lesson regarding the importance of airborne sensor systems. At the same time, Iran has had nothing approaching the U.S. E-3A and E-2C and this has left it without effective air and naval battle management in dealing with the U.S. and other Western forces in the Gulf.

The previous analysis of close air support and air interdiction operations also shows that both Iran and Iraq would have benefited from a forward area C^3I/BM system to control their helicopters, and from a targeting platform using ESSM, SAR, SLAR, FLIR, or electro-optics to locate targets beyond visual range, to provide warning of ground based air defenses, and to ensure against surprise on the ground. The lack of all these assets--with the limited exception of Iran's ability to use the F-14A as a "mini" AWACs, and its P-3C maritime patrol aircraft to locate naval targets--was a critical factor in depriving both sides of the ability to make proper use of their vast investment in air power.

It also seems fairly clear from the history of the war that both sides could have benefited from the use of remotely piloted vehicles or RPVs. Iraq did become increasingly more successful at using helicopters to find artillery targets towards the end of the war, but only at considerable risk to the helicopter. It also seems to have made some preliminary use of RPVs, although no details are available. Iraq displayed four RPVs -- the Al Yamama, Marakeb 1000, and Sahreb I and II -- at the Baghdad trade exhibition in October, 1988.[34]

13.10 Helicopters

Both sides developed the ability to use their helicopters successfully as gunships, troop carriers, and emergency supply transports, although Iran quickly experience major maintenance and supply parts problems and never was able to exploit the Shah's massive purchases of attack and transport helicopters. Iran and Iraq also found helicopters to be more useful in the close air support mission than fixed wing fighters.

In spite of the effectiveness of enemy curtain fire and SHORADs, Iranian and Iraqi helicopters were sometimes of great tactical importance. For example, early in the war, Iranian helicopters helped limit the Iraqi advance around Mehran. They were critical to the Iranian

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[33] Fred Hiatt, "Iran Sends Jets Over U.S. Ships in the Persian Gulf," Washington Post (December 30, 1983), p. 420.

[34] Jane's Defense Weekly, October 29, 1988, p. 1045.

supply of Abadan during the Iraqi siege, and both Iran and Iraq have increasingly substituted helicopters for fighter close air support since the start of its March 1982 offensive.

Since 1982-1983, Iraq was often successful in using helicopters as a substitute for fighters in support of its ground forces in daylight--perhaps because the Air Force command is still far too rigid and unresponsive to the needs of Army field commanders. While Iraqi helicopter pilots often stayed behind their own lines, and avoided flying high risk profiles, they were consistently more responsive in flying close air support missions than the Iraqi Air Force.

Iraq's newly formed Army Air Corps was created in early 1981, in response to the lack of air force support. It began with the Mi-24 attack helicopter as its main weapon, and now has Super Frelons with AM-38 Exocets, HOT-armed Gazelles, and MBB BO-105s. The Iraqi Army Air Corps has learned to fly low, use pop-up tactics, and to make better use of forward observers. It also has occasionally made good use of its 48 Mi-24s, firing Soviet UB-32 rockets, and machine guns to provide on-call fire against Iranian "human wave" assaults. Iraqi military communiques frequently stress the ability of combat helicopters to conduct sorties against well dug-in Iranian opposition. The Mi-24 acts as a mobile artillery for the army, with its UB-32 rockets and nose-mounted machine guns.[35]

The HOT-armed Gazelle helicopter fulfills the anti-tank role, and it reportedly has had considerable success against a wide variety of targets, from Chieftain tanks to coastal patrol craft. On the other hand, the Gazelle's IFF is reportedly poor, requiring visual identification on the battlefield. There is no information available on the efficacy of the HOT-armed B0-105 helicopters.

Iran's use of Cobra helicopters is also reported to have become steadily more effective in close support missions after early 1981, and to have stressed the use of nap-of-the earth tactics to surprise Iraqi troops.[36] This suggests that the Iranians learned how to avoid being targeted by Iraqi anti-aircraft weapons, such as tanks and the ZSU-23-4, which were reported very effective in the early months of the war. Iran's operations were badly hurt, however, by its lack of operational helicopter strength. Iran could have made far more extensive use of helicopters in supplying its FAW offensive in 1986, and in mountain fighting in 1984-1988. Both the Iranians and Iraqis have found helicopters critical in moving across water barriers, and in small tactical troop movements in mountain areas and to fly around terrain barriers.[37]

There seems to be a general consensus on both sides that combat helicopters are survivable when they are used with proper tactics and regard for terrain, and can play a critical role in making up for the lack of proper planning, armored maneuver capability, and combat support in emergencies.

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35 For one example, see Baghdad Voice of the Masses, "Armed Forces Command Communique No. 772," FBIS (Middle East-North Africa) (May 26, 1982), p. E-1; and Baghdad INA, "Army Battles Iranians to Control Khorramshahr," FBIS (Middle East-North Africa) (May 25, 1982), p. E-1.

36 Cook, op. cit., p. 1606.

37 Group Captain Bolton, "Military Lessons of the Iran-Iraq Conflict," Minutes of the RUSI Conference on the Gulf War (February).

Iranian and Iraqi helicopters also played an active role in transport and support missions. Iranian helicopters have provided an effective system for resupply in several instances during the Gulf War. The partial envelopment of Abadan Island during the early stages of the war could, for example, have led to an earlier Iranian defeat had the Iranians not resupplied their forces by using boats and helicopters.

Neither side ever used a large number of helicopters in a large heliborne offensive. If they had, such forces might have provided the means to bypass the slow-moving, dug-in defenses on both sides. As in Afghanistan, it should have been possible for Iraq and Iran to use helicopters to seek out and kill targets that jet fighters cannot find, and to operate in mountainous and built-up terrain where helicopters can locate and maneuver around light AA guns and man-portable missiles that fighters cannot spot and thus overfly.

Both sides unquestionably could have used helicopters even more effectively if they had had (a) the ability to mass them for more decisive tactical impact, (b) a suitable C^3I system for combined operations, (c) better beyond visible range targeting and intelligence, and (d) an adequate forward air control system. The need for such assets in every aspect of maneuver and air war is one of the major lessons of the conflict. This lesson, however, must be tempered with the fact such systems can only be effective if the USSR can develop the proper training and technical support capability.

13.11 Combined Operations

Combined operations in the Iran-Iraq War were marred by repeated failures of coordination and execution between services and branches within a service. The command problems that have already been noted in Iran were especially troublesome in any attempt to implement air/land operations. The Iranians managed to improve their combined operations after 1980, but only after repeated battlefields setbacks in which ground and air forces fought without meaningful coordination, and the partial consolidation of clerical power in Tehran. The impact of these improvements was then blunted by the attrition of Iranian aircraft and armor, and by the constant interference of senior Mullahs in the leadership around Khomeini in military operations. While Iran failed to use combined operations effectively in most campaigns after its invasion of Faw in 1986, this seems to owe more to the political interference of figures like Rafsanjani than to a lack of professionalism on the part of the regular Iranian military and experienced Pasdaran commanders.

Iraqi combined operations should have had more initial success than those of Iran, since the Iraq's command structure was not ravaged by revolutionary turmoil, (although it had been repeatedly purged). Nevertheless, Iraqi combined operations experienced problems throughout most of the fighting, and only became reasonably effective in 1988.

Many of the problems in Iraqi air/land operations appear to have two causes. The first cause was the separation of the command of land and air forces. This has badly slowed both the tempo and focus of the air units participating in combined operations, and has sometimes led to reactions times that robbed airpower of much of its effectiveness. Further, these problems have been compounded by a command level emphasis on preserving aircraft even at the cost of effectiveness.

The second cause stemmed from the tactical, training, and technical problems affecting Iraqi pilots. Many of these problems have already been discussed earlier, but it is also important to note that Iraqi pilots still display a tendency to bomb the Iranians from high altitudes which are far less effective than low level attacks.

Other causes of the problems in Iraqi air/land operations may have been caused by policies under which commanders, who repeatedly lost aircraft in combat, were punished, even if they inflicted significant damage on the enemy. This may also have helped make Iraqi air commanders claim to have inflicted absurd levels of damage on the Iranians, while failing to commit large numbers of aircraft.

Iraq did gradually make significant progress in dealing with these command and coordination problems in its land-air operations. The Iraqi leadership removed control of the attack helicopters from the air force, and placed them under the justification of the army. It then replaced the commander of the air force, and finally -- beginning in 1987 -- created the kind of command structure that allowed air forces to respond far more quickly to the needs of field commanders. Nevertheless, the problems in developing suitable C^3 technology, training, and organization for combined operations were obvious in the actions of both sides, and seem typical of Third World forces. Once again, this stress the lesson that such forces much be judged by a careful analysis of all the major qualitative factors shaping their effectiveness, and not in terms of force strength as measured by unit numbers, manpower, or equipment.

13.12 Surface-to-Surface Rockets and Missiles

Surface-to-surface missiles and rockets were used sporadically from the first day of the war onwards, but they did not play a major role until the end of the war. While they could penetrate to targets more safely than aircraft, the missiles available to Iran and Iraq had severe limitations in accuracy and range-payload, and neither side had any ability to target the missiles accurately. Nevertheless, both sides used 750-900 long range rockets and missiles during the course of the war.

Iraq had FROG missiles when the war started, and Iraq began the use of surface-to-surface rockets during the Iran-Iraq War by firing FROG-7s during the first weeks of the conflict. It soon found, however, that these rockets had little military effect. They lacked the lift to carry an effective conventional warhead, and Iraq lacked any means of effective beyond visual range (BVR) targeting. A good example of such ineffectiveness occurred early in the war when Iraq fired four FROG 7 surface-to-surface rockets in an attempt to disorganize some of the staging areas of the Iranian Army near Dezful and Ahwaz. The rockets exploded without any significant effect.

The reasons why are easy to understand. The FROG-7, which is also called the R65A or Luna, was designed for nuclear attack, and has only limited effectiveness as a conventional weapon. It has a single stage solid propellent rocket motor. It was first exhibited in 1967. It is 9.0 meters long, 61 centimeters in diameter, and weighs 5,727 kilograms. There is no guidance system other than a spin-stabilized ballistic trajectory. If any trajectory correction is made after launch, it will begin during boost. After boost, the trajectory is ballistic.

The FROG's warhead weight is 455 kilograms, and its maximum range is 60 kilometers. The FROG-7 can also carry a nuclear or chemical warhead. It is normally mounted upon, and launched from, a wheeled erector launcher called the ZIL-135. The main nozzle is surrounded by a ring of much smaller nozzles, and the system is far superior in reliability and accuracy to early FROGs.[38]

The FROG's lack of weapons accuracy, lethality, and targeting capability soon forced Iraq to fire its FROGs at cities and large economic targets, rather than military targets or assembly areas. Iraq started such firings during the first months of the war, but the resulting fire was also inaccurate, and often missed even city-sized targets or exploded without effect, when the target was beyond visual range. For example, the small town of Andimeshk was hit by FROG rockets early in the war, despite the fact that it had no military or economic value. The missile did hit the town, but it was almost certainly a rocket that was meant for Dezful, and had failed to strike its target.[39]

According to one estimate, Iraq fired 10 FROGs in 1980, 54 in 1981, 1 in 1982, and 2 in 1984, for a total of 64 missiles.[40] Even so, Iraq's FROG-7 operators continued to have serious problems in finding a meaningful use for the missile until the 1988 ceasefire, and the FROG never proved to be an effective conventional weapon.

The missile that did have an impact on the war was a variant of the Scud B. The Scud B first became operational in 1967. It is a Soviet design and the Soviet Union designates the system as the R-17E or R-300E. The Scud B has a range of 290-300 kilometers with its normal conventional payload. The missile is 11.25 meters long, is 85 centimeters in diameter, and weighs 6,300 kilograms. It has a single stage storable liquid rocket engine and is usually deployed on the MAZ-543 eight wheel transporter-erector-launcher (TEL).

The Scud is far more sophisticated than the FROG-7. It is a true guided missile. It has a strapdown inertial guidance using three gyros to correct its ballistic trajectory, and uses internal graphite jet vane steering. It has a warhead that detaches from the missile body during the final fall towards target. This provides added stability and allows the warhead to hit at a velocity above Mach 1.5. The Scud C is a larger missile and has more range. It is 12.2 meter longs, is one meter in diameters, weighs 10,000 kilograms, and has a range of 450 kilometers. The Scud D (SS-1e) was designed to deliver submunition busses and is more accurate than previous Scuds. It entered Soviet service in the early 1980s.

Iraq had limited holdings of Scud missiles when the war began, and a Scud regiment with nine launchers. It was not until October, 1982, however, that Iraq could make this unit combat effective. It began to fire regular Scud Bs on October 27, 1982, and fired a total of 3 missiles in 1982, 33 in 1983, 25 in 1984, 82 in 1985, 25 in 1987, and 193 in 1988. Iraq began to use Scud largely to conduct sporadic "terror attacks" on urban areas or military concentrations, and its strikes seems to have been designed largely to try to put political pressure on Iran. Most of the

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38 The World's Missile Systems, Seventh Edition, General Dynamics, Pomona Division, April 1982, pp. 65-66.

39 Scott James, "Does Western Technology Offset Larger Soviet Numbers?", Defense Electronics (February 1981).

40 Steven Zaloga, "Ballistic Missiles in the Third World," International Defense Review, 11/88, pp. 1423 to 1437.

time, Iraq used its Scud missiles against Iranian population centers to the rear of the battlefield.[41] Typical targets were cities relatively near the border like Dezful, Ahwaz, Khorramabad, and Borujerd (190 kilometers from the Iran-Iraq border). [42]

Iran acquired its Scuds later in the war -- first from Libya and then from North Korea. It deployed these units with a special Khatam ol-Anbya force attached to the air element of the Pasdaran, and fired its first Scuds in March, 1985. It fired as many as 14 Scuds in 1985, 8 in 1986, 18 in 1987, and 77 in 1988. Iran's missile attacks were more effective from the start than Iraq's attacks. This was largely a matter of geography. All of Iraq's major cities were comparatively close to its border with Iran, but Tehran and most of Iran's major cities that had not already been targets in the war were outside the range of Iraqi Scud attacks. Iran's missiles, in contrast, could hit key cities like Baghdad.

Iran could never exploit its range advantage, however, because it lacked the number of missiles needed to sustain frequent attacks, because Iraq had vastly superior air resources it could use as a substitute, and because most Iranian missiles struck outside Baghdad. The optimal theoretical accuracy of the Scud is in excess of a kilometer at long ranges, and its practical accuracy -- taking siting and other factors into account -- was often closer to five kilometers.

It is scarcely surprising, therefore, that many of the Iranian Scuds fired at Baghdad hit in the outskirts of the city. Further, even the missiles that did hit inside the city often hit in open spaces, and even hits on buildings rarely produced high casualties. Iran never hit any of its proclaimed major targets, which included the Iraqi Ministry of Defense, and Iraqi oil facilities. In fact, the net impact of using Scud missiles against urban targets was roughly similar to randomly lobbing a 500 pound bomb into a city every few days or weeks. The Scud strikes usually did little more than produce a loud bang, smash windows, and kill a few innocent civilians. The most lethal attacks on both sides seem to occurred when missiles hit targets like a school or a large funeral by sheer accident.

Until 1988, the net impact of Iranian and Iraqi missile strikes on the opposite side's public opinion and morale was limited, relatively short lived, and often ambiguous. The side doing the firing was able to propagandize the firing as lethal retaliation against the enemy. The side receiving the fire, however, experienced only brief periods of panic at worse, and panic often quickly changed into to anger and demands for reprisals as the civilians in the target area realized they could survived the enemy's attacks. Since each Scud missile cost around $500,000 - $1,000,000, such attacks were also extremely expensive. Nevertheless, both Iran and Iraq attempted to improve their ability to use long range missiles by acquiring much larger numbers or missiles and/or building their own.

Iran tried desperately to obtain large numbers of Scud missiles from Libya, North Korea and Syria, and to create its own missile manufacturing capabilities. It sought to buy additional Scud Bs, to manufacture them in Iran, to develop its own systems, and to obtain alternative systems like the PRC-made M-9. It succeeded in producing its own version of a Chinese Type-83 artillery rocket, which it called the Oghab, and tried to develop its own long range rocket, called

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41 "U.S. Reasserts Aim to Keep Oil Flowing From Persian Gulf," Washington Times (February 22, 1984), p. A-1.

42 "Iraqis Fire Missiles on Iranian Cities," Chicago Tribune (February 25, 1984), p. 20.

the Iran-130.[43] Iran claimed during the course of 1985-1988 that it had over 100 factories manufacturing some sort of part or equipment for missiles and rockets, with major production facilities at Sirjan and a launch facility at Rafsanjan.

Iran was only successful in the case of the Oghab. It started producing this system in 1985, and immediately began to use it in combat. It seems to have made about 325 Oghab rockets, and to have fired roughly 260-270 rockets out of this total. This allowed Iran to fire nearly 250 in 1988. The Oghabs only have a range of 40 kilometers, however, and they lack the range and/or accuracy to hit more economic or urban targets. The Oghabs also only have a 70-300 kilogram warhead, and their CEP is in excess of 1,000 meters.[44]

Iran had no way to target the Oghab. The most Iran could do was to launch the Oghabs at the Iraqi cities near the border. These targets included Basra, Abu al-Khasib, Al-Zuybar, Umm-Qasr, Mandali, Khanaqin, and Banmil, but the Oghab strikes generally had far less effect than artillery barrages. [45]

Iran did obtain additional Scud missiles from Libya or Syria in 1986, but it was still only able to fire a total of 18-22 missiles in 1987. Iran then turned to North Korea, and in June, 1987, it obtained agreement to ship 100 more Scuds as part of a $500 million arms package. These missiles were delivered to Iran in early 1988. Iran also seems to have sought Scuds from the PRC, but to have been unable to obtain them.

During the 52 days of the "war of the cites" in 1988, Iran fired at least 77 Scud missiles. Sixty-one were fired at Baghdad, nine at Mosul, five at Kirkuk, one at Takrit, and one at Kuwait. Iran fired as many as five missiles on a single day, and once fired three missiles within 30 minutes. This still, however, worked out to an average of only about one missile a day, and Iran was down to only 10-20 Scuds when the war of the cities ended.[46]

This situation might have been very different if Iran had ever made good on its claims to be able to produce the Scud. The Minister in charge of the Pasdaran, Mohsen Rafiqdust, started making such claims in November, 1987. Iran also claimed in April 1988 that it was working on a missile with a 320 kilometer range, and claimed that 80% of the Scuds it fired were produced in Iran. In fact, however, this was pure propaganda. Iran never succeeded in firing an Iranian-made Scud missile.

Iran also failed to develop and produce the IRAN-130 in any numbers. The full details of this system remain unclear, but it seems to have been an attempt to use commercially available components and a simple inertial guidance system to build a missile that could reach ranges of

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[43] The following details of the Iranian missile program are taken from W. Seth Carus and Joseph S. Bermudez, "Iran's Growing Missile Forces," Jane's Defense Weekly, July 23, 1988, pp. 126-131.

[44] Iran publicly displayed the Oghab at a military show in Libreville in 1989. It is 230 mm in diameter, 4,820 mm long, and weighs 320 kilograms, with a 70 kilogram warhead. Iran also displayed another rocket called the Nazeat, which is 355 mm in diameter, 5,900 mm long, weighs 950 kilograms and has a 180 kilogram warhead. Jane's Defense Weekly, February 11, 1989, p. 219.

[45] Jane's Defense Weekly, June 20, 1987, p. 1289

[46] One source claims Iran fired 231 Scuds in 1988. This total seems much too high. See Steven Zaloga, "Ballistic Missiles in the Third World," International Defense Review, 11/88, pp. 1423 to 1437.

anywhere from 130 to 200 kilometers. In practice, the missile proved highly unreliable until the August, 1988 ceasefire and reached a maximum range of about 120 kilometers with very poor reliability and accuracy. Some IRAN 130s were deployed to the regular Pasdaran, however, and the first such missiles were fired against Al-Amarah on March 19, 1988 and four more were fired against the city in April. It is unclear that these strike hit their targets or had any tactical effect.

It was Iraq that eventually was successful in finding the long range missiles it needed, although it took nearly half a decade to obtain them. Iraq tried actively from 1982 onwards to acquire longer range missiles. Various Iraqi statements made in early 1983, for example, suggested that the Soviet Union might be willing to supply newer Soviet missiles with longer ranges like the SS-12 to the Iraqis. No new missile capabilities materialized, however, until February 29, 1988, when Iraq launched five new extended-range missiles that it called the Al Husayn.[47]

These missiles were variants of the Scud-B, Scud C, or Scud-D,.[48] It is unclear when Iraq obtained these missiles, but they seem to have been based on 300 Scuds that the USSR delivered to Iran in 1986. Iraq announced it had tested a missile with a range of about 400 miles, or 650 kilometers, in August, 1987. These reports were initially dismissed as propaganda, but Iraq was almost certainly telling the truth. Iraq could have gotten the added range in several ways. It could have taken a standard Scud and modified it by (a) cutting its payload from 400 to 200 kilograms, (b) altering it to burn all the propellant at the cost of reliability, or (c) doing both.[49] Iraq also could have used strap-on boosters. There are reports of weld marks and other alterations on fragments of the Scuds recovered in Iran. It is still unclear which option was really involved, however, and the precise range capabilities of the Iraqi Scuds are unknown because the Iraqis regularly moved the missile launch sites during this phase of their attack. What did immediately become clear was that the Iraqi Scuds could reach Tehran and Qom from positions south of Baghdad.[50]

Estimates of the overall pattern of Scud strikes both sides made during the decisive phase of the war of the cities differ significantly according to source, but **Figure 13.6** provides an estimate of the overall interaction between the strategic bombing and missile wars between 1987 and 1988 based on Iraqi and Iranian claims. These claims are often exaggerated, but the data in **Figure 13.6** are almost certainly valid in indicating the general size of the sudden rise in Iraqi missile attacks and in the total number of air and missile attacks on urban targets.[51]

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[47] Iraq was only believed to have about 50 Scud missiles before it began this series of attacks. Rafsanjani claimed Iran had evidence that the missiles were standard Scud Bs which used reduced warhead weight on March 8, 1988. Washington Times, March 1, 1988, p. 3, and Washington Post, March 9, 1988, P. A-19. Economist, March 5,, 1988, p. 44; New York Times, March 2, 1988, p. A-1, March 4, 1988, p. A-8, March 12, 1988, p. A-3, May 1, 1988, p. 18; Washington Post, March 2, 1988, p. A-16; Baltimore Sun, March 6, 1988, p. 2-A.

[48] Economist, March 5,, 1988, p. 44; New York Times, March 2, 1988, p. A-1, March 4, 1988, p. A-8, March 12, 1988, p. A-3, May 1, 1988, p. 18; Washington Post, March 2, 1988, p. A-16; Baltimore Sun, March 6, 1988, p. 2-A.

[49] The USSR claimed that none of the Scuds it sold to Iraq had the range to reach Teheran. Iran claims to have recovered parts showing the Scuds used in the attacks were of recent Soviet manufacture. Some sources claim that Egypt, Italy, France, the FRG, PRC, and/or USSR helped the Iraqis add boosters or modify the missiles to use more of their fuel and/or a smaller warhead.

[50] Baghdad has 23% of Iraq's population and is only 80 miles from the border. Tehran is about 290 miles from the front lines.

[51] Steven Zaloga provides the following estimate of missile firings during the course of the war:

Figure 13.6
Strikes Reported by Iran and Iraq Affecting the "War of the Cities" in 1987 and 1988 -Part One

Date		Residential/Economic Attacks[1]			
		Iraq		Iran	
		Total Bombing & Missile	Scud[2]	Total Bombing & Missile	Scud[3]
A. 1987					
Jan	1-15	30	-	3	-
	16-31	18	-	15	3
Feb	1-15	27	-	5	3
	16-31	8	-	5	5
Mar	1-15	-	-	-	-
	16-31	4	-	-	-
Apr	1-15	5	-	-	-
	16-31	2	-	-	-
May	1-15	4	-	1	-
	16-31	1	-	1	-
Jun	1-15	-	-	-	-
	16-31	1	-	-	-
Jul	1-15	6	-	-	-
	16-31	-	-	-	-
Aug	1-15	2	-	-	-
	16-31	13	-	7	-
Sep	1-15	35	-	8	-
	16-31	19	-	3	-
Oct	1-15	12	-	6	-

	Iraqi Firings		Iranian Firings	
	FROG-7	Scud	Oghab	Scud
1980	10	-	-	-
1981	54	-	-	-
1982	1	3	-	-
1983	-	33	-	-
1984	2	25	-	-
1985	-	82	14	-
1986	-	-	8	18
1987	-	25	18	61
1988	-	193	231	104
Total	67	361	271	174

Source: Adapted from Steven Zaloga, "Ballistic Missiles in the Third World," International Defense Review, 11/88, pp. 1423 to 1437. Zaloga seems to have inverted the Iranian Scud and Oghab columns in his original article.

	16-31	4	-	8	4
Nov	1-15	14	-	9	1
	16-31	10	-	2	2
Dec	1-15	7	-	2	-
	16-31	1	-	-	-
TOTAL IN 1987		223	-	70	15

Figure 13.6
Strikes Reported by Iran and Iraq Affecting the "War of the Cities" in 1987 and 1988 -Part Two

Date	Residential/Economic Attacks[1]			
	Iraq		Iran	
	Total Bombing & Missile	Scud[2]	Total Bombing & Missile	Scud[3]
B. 1988				
Jan 1-15	1	-	-	-
16-31	-	-	-	-
Feb 1-15	3	-	-	-
16-31	5	-	3	-
Mar 1-15	215	101	73	31
16-31	130	36	143	14
Apr 1-15	78	40	96	11
16-31	33	26	63	5
May 1-15	2	-	-	-
16-31	2	-	-	-
Jun 1-15	-	-	-	
16-31	13	-	1	-
Jul 1-15	3	-	-	-
16-31	4	-	-	-
Aug 1-20[4]	5	-	-	-
TOTAL IN 1988	494	203	380	61

Source: Adapted from work provided to the author by Gary Sick, and W. Seth Carus and Joseph S. Bermudez, "Iran's Growing Missile Forces", Jane's Defense Weekly, July 23, 1988.
1. Bombing and missile attacks as reported in daily war communiques and other sources.
2. Includes all long range missiles, but not Oghabs or any Iran-130s that failed to hit economic or civil targets.
3. Includes Scud B missiles fired at Baghdad and other Iranian cities.
4. From beginning of the month to the Iranian acceptance of a ceasefire and UN Resolution 598.

Iraq fired an average of nearly three Scuds a day, and the impact of Iraq's missile and air strikes on Iran was far greater in 1988 than in the past. Where the Iranians had previously been able to adapt to the relatively limited and short lived Iraqi bombing efforts, the constant pounding of missiles interacted with a growing fear that Iraq might use chemical weapons, and this had a major impact on Iranian morale. So did the rumors and reports than senior Iranian officials -- including Khomeini -- had left Tehran. According to some reports, nearly a million Iranians had fled Tehran by mid-March and several million more had fled by late April.[52]

It is important to stress, however, that the Iraqi missile strikes alone would probably have had relatively little serious impact if they had not interacted with a number of other factors. The Scud strikes were audible over wide areas as they neared their target, made a loud bang, and blew out windows over a wide area. Nevertheless, the Scud strikes did not do serious physical damage to any Iranian target, and killed substantially less than an average of two dozen people a missile. The variants of the Scuds that Iraq was using only seem to have had a 130-250 kilogram warhead, and were scarcely "city killers".[53]

What gave the Iraqi missile barrage a radical new strategic impact was that it occurred in combination with (a) the growing fear of chemical weapons, (b) the impact of Iraq's air raids, (c) the effect on morale of Iran's military casualties during the previous year, (d) growing popular and military exhaustion with the conflict, (e) Iran's inability to retaliate, (f) rumors of internal divisions within Iran's leadership, (g) serious economic hardship and growing prices on the black market, and (h) the knowledge that Iran would no longer be threatened if it halted its offensives.[54] This experience reinforces a lesson from many previous conflicts. The effect of strategic bombardment with conventional weapons on the course of a war is likely to be determined far more by its effect in catalyzing public opinion, and in shaping the overall political conditions affecting the war, than by the size of the casualties or actual damage that is inflicted by the weapons involved.

It is also important to realize that such bombardments may well have limited effect in the future, unless they interact with a wide range of other factors. **Figure 13.7** shows the range and lethality of a wide range of current surface-to-surface systems, and indicates that missiles can deliver far less range-payload capability than most Third World fighter bombers. Further, it should be clear from **Figure 13.7** that the long-range missiles now available to Third World states lack the combination of accuracy and payload to be highly lethal as long as they use high explosive warheads. This is especially true because the velocity and vector of most such missiles produces less damage effect than an explosion by a similar amount of HE in a regular free fall bomb.

Conventionally armed ballistic missiles without terminal homing guided systems cannot even damage military targets as large as airfields except through sheer luck, since they have so

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[52] Based on discussions with Iranians present in the city at the time, Australian intelligence officers, and Robin Wright.

[53] The warhead may have been as small as 130 kilograms. Iraq announced in April, 1988, however, that it had an improve missile called the El-Abbas with a maximum range of 850 kilometers, and with a payload of 500-1,000 kilograms at a range of 650 kilometers. Jane's Defense Weekly, October 29, 1988, p. 1045.

[54] No missiles with chemical warheads were launched during the conflict, although Iraq did make extensive use of bombs, canisters, mortars, and 130mm and 155mm artillery shells. (UN working paper.)

little probability of hitting a meaningful target. They have less than a 0.3 Pk per round against a building-sized target when fired into a crowded city. Such missiles may have technical glamor, but they are no substitute for aircraft, multiple rocket launchers, and artillery, in inflicting damage.

This situation is only likely to change when user countries acquire chemical or biological warheads or cruise missiles with advanced guidance systems reach the Third World. Even missiles with chemical and biological warheads, however, may be more terror weapons than weapons of mass destruction. It takes tons of even lethal nerve gases to produce large amounts of casualties. To put this into perspective, under optimal weather and delivery conditions, it takes about 21 tons of phosgene to achieve 50% lethality over a one square kilometer area, four tons of mustard gas, two tons of Tabun, 0.5 tons of Sarin, or 0.25 tons of VK.[55] Under most real-world conditions, far larger amounts are required, and the actual number of deaths is far smaller.[56]

Biological warheads can be far more lethal, but are extremely difficult to engineer and require large and well planned testing efforts to produce predictable and effective results. Cruise missiles are the only missile systems which have the accuracy required to be lethal against strategic targets with conventional warheads at long ranges. Even these systems, however, require mapping and targeting capabilities that are far beyond the capabilities of most Third World nations, and they are unlikely to reach the Third World arms market until the middle to late 1990s.

No one can sensibly dismiss the risks inherent in weapons systems capable of killing thousands of weapons. It is far from clear, however, that long range surface-to-surface missiles are an effective way of delivering "cheap nuclear weapons".[57] In most cases, high payload, long range, fighter bombers with advanced avionics will offer a far more predictable and effective way to deliver the large payloads required under the highly specialized deliver conditions necessary to be effective. Until Third World states acquire either effective biological warheads for their missiles, or actual nuclear weapons, the effectiveness of missiles is likely to depend more on their political impact than their actual ability to inflict casualties or physical damage.

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[55] W. Seth Carus, "Chemical Weapons in the Middle East," Policy Focus, Number Nine, Washington Institute for Near East Policy, December, 1988, p. 7.

[56] Some 60 pounds of mustard gas were required in World War I per casualty. Only 2% of the casualties died.

[57] Most biological agents require extremely demanding dispersal conditions in terms of altitude, light and temperature conditions, wind patterns, and dispersal into some form of reentry. This requires the ability to deliver hundreds of liters of biological agents, and specialized bombs and extremely specialized missile warheads to allow proper delivery at the extreme velocities involved.

Figure 13.7

Comparative Range and Lethality of Surface-to-Surface Missiles - Part One

Source Country	Type	IOC	Range (Km)	Warhead Payload (Kg)	Nominal CEP at Range (Meters)		Warhead Types	
					Engineering	Operational		
USSR	SS-1b/ Scud A	1957	130		900	900	1,800	HE, N, CB
USSR	SS-1c/ Scud B	1965	290		900	900	1,600	HE, N, CB
USSR	Scud C	?	450		550	900	2,200	HE, N, CB
USSR	FROG-7	1965	60-70		455	400	900	HE, N, CB
USSR	SS-21	1978	8-120		1318-1557	300	900	HE, N, CB
USSR	SS-23	1980	500		350	350	900	HE, N, CB
USSR	SS-12	1969	800		300	750	3,000	Nuclear
USSR	SS-22	1979	900		300	300	700	Nuclear
USSR	Sepal SS-C-1b	1962	450		-	-	900	Nuclear
US	BGM-109G GLCM	1983	2,500		-	20	100	Nuclear
US	MGM-31A/B Pershing 1A	1962	160-720		350	400	800	Nuclear
US	Pershing II	1984	160-1,770		-	40	180	Nuclear
US	MGM-52 Lance	1972	110		250	150-400	400-900	HE, N
France	Pluton	1974	10-120		-	150-300	300-500	Nuclear
Argentina	Alacran/ Condor II	?	600-800		600-1000	-	-	?
PRC	CSS-2 DF-3	1970	2,700		1,800	800	2,000	HE, N
PRC	CSS-2 DF-3 (Saudi)	1987	2,400-3,000		2,200	800	2,000	HE, N
PRC	CSS-1 DF-2	1970	1,200		1,100	700	1,800	HE, N
PRC	M-9	198?	200-600		2,200	400	700	N, CB
PRC	M-11	1988	650-850		500-1,000	-	-	HE, C, B?

Figure 13.7

Comparative Range and Lethality of Surface-to-Surface Missiles - Part Two

Source Country	Type	IOC	Range (Km)	Warhead Payload (Kg)	Nominal CEP at Range (Meters)		Warhead Types	
					Engineering	Operational		
Iran		IRAN-130	1987	130-200	-	-	-	HE
Iran		Scud R-300/ R-17E	1985	320	-	-	-	HE, C?
Iraq		Scud C/D/ R-300/R-17E Variant Al Huseyn	1988	650	135-250	900	2,500	HE, C, B?
Iraq		Scud C/D Variant/ al Abbas	?	650-850	500-1,000	-	-	HE, C, B?
Israel		Jericho 1	?	200-480	250	-	-	Nuclear
		Jericho II	?	490-750	450-680	-	-	Nuclear
		Jericho III	?	800-1,450	750	-	-	Nuclear

Figure 13.8

Comparative Range and Lethality of Surface-to-Surface Missiles - Part Three

Source Country	Type	IOC	Range (Km)	Warhead Payload (Kg)	Nominal CEP at Range (Meters) Engineering	Nominal CEP at Range (Meters) Operational	Warhead Types
USSR	BM-21						
	122mm MRL	1964	20.5	40 X 17	400	900	HE, CW
USSR	M-1972						
	122mm MRL	1972	20.5	40 X	400	900	HE, CW
USSR	BM-14/16						
	140mm MRL	1952	9.8	40 X	300	800	HE, CW
PRC	T-63						
	107mm MRL		8.1	12 X 15	200	600	HE
PRC	140mm MRL		10	19 X 24	300	1,200	HE
US	MLRS						
	115mm MRL	1981	30+	12 X 40	50	200	HE
Iran	Oghab	1986	40	-	-	-	HE
Iran	Shanin 2	1988	70	180	-	-	HE
USSR	M-46						
	130mm Gun	1954	27.2	74	-	-	HE, CW
USSR	2S5						
	152mm Gun	1980	27	96	-	-	HE,CW
US	M-107						
	175mm Gun	1962	32.7	147	70	150	HE, CW
US	M-109A1						
	155mm How	1966	18-30	95	70	120	Nuc, HE, CW
US	M-110						
	203mm How	1962	21.3	170	70	120	Nuc, HE, CW

Adapted from various editions of the IISS Military Balance, Jane's Weapons Systems, and working papers by General Dynamics

13.13 Chemical/Biological Weapons and Defensive Systems [58]

Both Iraq and Iran used poisoned gas a number of times during the fighting. While most such uses did not have a decisive impact on a battle, Iraq unquestionably became steadily more competent in using gas weapons. As a result, Iraq's use of gas warfare began to have a major impact on the war in terms of both casualties and damage to Iranian military and popular morale. The details of these uses of chemical weapons have been discussed in earlier chapters. It is important to note, however, that the use of chemical weapons during the Iran-Iran War also provides an important lesson in the risks inherent in the proliferation of weapons of mass destruction.

13.13.1 Iraq's Chemical and Biological Weapons Efforts

Both Iraq and Iran signed the Geneva Protocols of 1925, which prohibit the use of poison gas, and both signed the Biological Warfare Convention of 1972, which bans the development, production, and deployment or stockpiling of biological weapons. Iraq, however, has been actively interested in biological weapons since the 1960s, and sought chemical weapons from Egypt and the USSR following Egypt's use of chemical weapons in the Yemens.

It is is not possible to precisely date when Iraq acquired chemical weapons, but it seems to have begun to serious examine acquiring such weapons in the 1960s, and to have decided to create its own production facilities following the October War in 1973. There are some indications that it acquired small numbers of chemical weapons from the USSR at this time, and that it may have had assistance from Egypt in developing suitable production and storage techniques in the period before the Camp David accords.[59] These are some indications that Iraq may have used poison gas shells or bombs against the Kurds during its campaigns of 1973-1975.[60]

Iraq seems to have begun the construction of its own chemical weapons plants in the mid-1970s, in response to reports that both Egyptian and Israeli forces were equipped with chemical weapons at the time of the October War, and the threat posed by Iran and its Kurdish rebels.[61]

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[58] General references for this section include "Chemical and Biological Warfare," Hearing Before the Committee on Foreign Relations, U.S. Senate, 91st Congress, April 30, 1969; Department of Political and Security Council Affairs, Chemical and Bacteriological (Biological) Weapons and the Effects of Their Possible Use, Report of the Secretary General, United Nations, New York, 1969; unpublished testimony of W. Seth Carus before the Committee on Governmental Affairs, U.S. Senate, February 9, 1989; W. Seth Carus, "Chemical Weapons in the Middle East," Policy Focus, Number Nine, Washington Institute for Near East Policy, December, 1988; unpublished testimony of Mr. David Goldberg, Foreign Science and Technology Center, U.S. Army Intelligence Agency, before the Committee on Governmental Affairs, U.S. Senate, February 9, 1989; unpublished testimony of Dr. Barry J. Erlick, Senior Biological Warfare Analyst, U.S. Army, before the Committee on Governmental Affairs, U.S. Senate, February 9, 1989; unpublished testimony of Dr. Robert Mullen Cook-Deegan, Physicians for Human Rights, before the Committee on Governmental Affairs, U.S. Senate, February 9, 1989; Elisa D. Harris, "Chemical Weapons Proliferation in the Developing World," RUSI and Brassey's Defense Yearbook, 1989, London, 1988, pp. 67-88; and "Winds of Death: Iraq's Use of Poison Gas Against Its Kurdish Population", Report of a Medical Mission to Turkish Kurdistan by Physicians for Human Rights, February, 1989.

[59] Based upon discussions with Israeli sources in January, 1989.

[60] The author visited the area several times during this period. Reports of such use were provided by both Iranian and Israeli officials, and confirmed by a British expert.

[61] Peter Dunn, "The Chemical War: Journey to Iran, NBC Defense & Technology International, pp. 28-37 and "Iran

Iraq seems to have weaponized mustard gas for use by mortars and artillery long before the Iran-Iraq War, and to have had shells for at least 120 mm mortars and 130mm artillery.

One of Iraq's first steps in acquiring a large scale domestic production capacity was to turn to the Pfaudler Company of Rochester, New York, for assistance in creating a major "pesticide" blending complex.[62] Pfaudler is a large producer of corrosion resistant, glass line steel vessels, of the kind suitable for producing large amounts of toxic chemicals. Iraq approached the Pfaudler Company in 1975, and asked about purchasing a relatively small production facility.

Once the company's representatives reached Baghdad, however, it became clear that Iraq sought to immediately create a massive production facility. It rejected the safety concerns of the Pfaudler experts, and asked for plans that meant with rushing ahead without a pilot plant. It also became clear that Iraq wanted to "blend" organophosphate pesticides with very uncertain value for agricultural purposes, and which are commonly recognized as "precursors" for the production of nerve gas.[63]

The Iraqi production goals called for the handling of 600 metric tons per year of Amiton, 300 metric tons of Demiton, 150 tons of Paraoxon, and 150 tons of Parathon. All of these agents are extremely toxic.[64] Amiton and Paraoxon are the most toxic agents, followed by Parathion and then Demeton. Even in 1974, all four were relatively outdated agents for agricultural purposes, and had been largely abandoned for safety reasons.[65]

During 1975-1976, Pfaudler sought to persuade the Iraqis proceed on a pilot plant basis. Iraq finally rejected this approached in mid-1976, and insisted on completion of a massive plant. The Iraqi negotiators also changed from the Ministry of Agriculture to the Ministry of Industry. The resulting impasse gradually led Iraq to break off negotiations.

Keep Chemical Options Open", pp. 12-14.

62 For a good discussion of the early Iraqi effort to acquire chemical weapons, see David Ignatius, "Iraq's 13-year Search for Deadly Chemicals," Washington Post, Outlook section, September 25, 1988.

63 The building block at the base of the organophosphorus industry is elemental phosphorus. Thus, at a minimum, a supply of phosphorus would be needed to make nerve agents such as the G agents, Tabun (GA), Sarin (GB) and Soman (GD), and the V agents, such as VX and Edemo (VM).

There is a very wide range of possible chemical precursors to the production of gas warfare. Ones which may have been sent to Iran and Iraq include Thiodiglycol and chloroethanol (mustard gas); dimethalmine, dimethalmine hydrochloride, and phosphorus oxychloride (Tabun or GA nerve gas); and dimethyl methylphosphonate, difluoro or methylphosphony, and potassium flouride (Sarin or GB nerve gas). For a good description of the technology of proliferation see Lois R. Ember, "Worldwide Spread of Chemical Arms Receiving Increased Attention," C&EN, April 14, 1988, pp. 8-16.

64 All are useful in the production of Tabun nerve gas. The corrosion resistant reactors, pipes, and pumps need for processing these pesticides can be rapidly converted to nerve gas production. See Ignatius, "Iraq's 13-year Search for Deadly Chemicals," Washington Post, Outlook section, September 25, 1988.

65 Tabun and the more lethal Sarin nerve gases were discovered in Germany in 1936, as part of an effort to develop more advanced pesticides. They could not be used for this purpose because they proved to be as effective in killing people as insects. The Nazis produced some 12,000 tons of nerve gas in World War II, but never used it because they believed that Britain and the U.S. were also aware of the technology. See John J. Fialka, "Fighting Dirty", Wall Street Journal, September 15, 1988, p. 1

Iraq then turned to Imperial Chemical Industries, PLC (ICI), with virtually the same proposal. Unlike Pfaudler, ICI was familiar with a British government list of items whose export was controlled because they could be used to produce gas weapons, and immediately recognized that Iraq was seeking the precursors for nerve gas. ICI refused to negotiate further.

This refusal did not discourage Iraq, however, which turned to West German, Swiss, French, Dutch, Belgian, and Italian firms, and seems to have obtained most of the components it needed.[66] While the precise source of its equipment is unclear, Iraq later seems to have received enough support to build a special "pesticide" plant from Pilot Plant, a unit of Karl Kolb, which is a major West German laboratory equipment supplier, and three other pilot facilities. The Kolb plant had some of the special equipment necessary to make Sarin, but not special pumps.[67]

Iraq also is believed to have purchased technical assistance from a West German firm called Fritz Werner.[68] It received heavy duty pumps and chemicals from Water Engineering Trading G.m.b.H of Hamburg which sold some $11 million worth of equipment and tons of chemical, including trichloride, a nerve gas precursor; and equipment from Quast, which provided reactor vessels, centrifuges, and piping line with Hastalloy.[69]

It is unclear how far these efforts had gotten when the war began, although at least one major pesticide plant was being operated by the Iraqi "State Ministry of Pesticide Production" in 1980-1981, some mustard gas was probably in production at Samarra, and two small pilot plants to produce nerve gas were completing construction at Samarra, with a capacity of around 30-50 tons per year.[70] These two plants, however, were only able to produce nerve agents using fairly advanced and specialized feedstock. Finally, Iraq may have obtained additional production equipment for the manufacture of plastics which could produce massive amounts of hydrogen cyanide as a byproduct. This equipment seems to have been modified for the production of cyanide gas.

In short, Iraq does not seem to have had large stockpiles of weapons when the war began or to have given gas warfare high priority while it was still on the offensive. Iraq does seem to have had enough CS gas and mustard gas to use some form of gas in the battles around Basra and Mandali in 1982, but evidently did not have the feedstock and the ability to increase its production capacity it needed for large scale use of gas in warfare.

It was only after Iraq was forced on the defensive and suffered major defeats that it seems to have begun to treat gas warfare as a possible solution to its military problems. In 1982, Iraq made major new efforts to acquire technology and feedstock overseas. For example, the Iraqi State Ministry of Pesticide Production turned to a unit of Phillips Petroleum Company in

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66 Based on work by Leonard Spector of the Carnegie Endowment for International Peace, and other working material.

67 Christian Science Monitor, December 12, 1988; and BBC Panorama, 1986.

68 Christian Science Monitor, April 13, 1988, p. 32

69 Some thirteen West German firms are now under investigation by the West German government. W.E.T

70 This is a small amount. About 15-20 tons of a nerve agent like Tabun are need to cover a signle square kilometer.

Tessenderloo, Belgium, to obtain 500 metric tons of a chemical called thiodiglycol.[71] Thiodiglycol is not suited for the production of nerve agents, but it can be easily combined with hydrochloric acid to produce mustard gas. About one ton of the chemical is required to produce one ton of mustard gas.[72]

Mustard gas offered Iraq significant military advantages. While mustard gas is 10 to 100 times less lethal than the simpler nerve agents in terms of direct exposure, it is easier to produce and handle and to deliver in actual practice. Mustard gas is also more effective when it is actually delivered against infantry, or exposed humans in other facilities. It is more persistent and the casualties consume large amounts of medical services and support. Lethality is not the only issue. Limited exposures to mustard gas can blind or blister for periods of 4 to 6 weeks. Mustard gas thus offered Iraq special advantages in dealing with Iranian infantry which often spent considerable time in static exposed locations, and which had relatively poor rear area medical facilities.

Phillips states it did not react to the order because it was placed by KBS Holland B.V., a Dutch trading firm. It was only after the trading firm began to ship its initial order in July, 1983, that Phillips learned that the actual customer was in Iraq, and then paid little attention because it was said to be a large "agricultural" organization. It early 1984, when the State Ministry of Pesticide Production placed a second order for 500 tons, Phillips grew suspicious and cancelled the order. Phillips then notified the Belgian government, which reacted by cancelling Phillips' license to produce the chemical.[73] By this time, Iraq already had enough feestock for nearly 500 tons of gas, and Iraq began construction of the special refinery and other facilities necessary to make its own thiodiglycol out of more commonly available chemicals. Iraq's industrial complex at Al Fallujah seems to have been able to make thiodiglycol before the ceasefire, as well as the precursors for nerve gas.

Iraq also acquired the equipment and feedstock to make nerve gas. By sheer coincidence, U.S. customs stopped another State Ministry of Pesticide Production order, for 74 barrels of potassium fluoride, another precursor of Sarin nerve gas, in February, 1984. The order was placed by Al-Haddad Enterprises Incorporated, owned by Sahib al-Haddad, a naturalized Iraqi citizen. The shipment was not then illegal, because it was not yet controlled, and there is no clear way of determining how many other shipments occurred in the U.S. or other countries. However, at least one Dutch firm -- Melchemie Holland B.V. -- has since been convicted of export violations for selling phosphorous oxychloride, another precursor of nerve gas. Iraqi agents also bought large amounts of equipment from a West German firm in Drereich that it seems to have

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71 John J. Fialka, "Fighting Dirty", Wall Street Journal, September 16, 1988, p. 1.

72 Mustard gas can be made by three easy routes. The first is the reaction of vinyl chloride (readily available or which can be made from ethylene or acetylene) and hydrogen sulfide. The second is the reaction of ethylene and sulfur monochloride. The third is reacting thiodiglycol with hydrogen chloride after making the thiodiglycol from ethylene oxide (from ethylene) and hydrogen sulfide. The sulfur and ethylene feedstocks can be drawn from a typical refinery and hydrogen chloride or chlorine gas are simple to make from a source of chlorine, such as salt, seawater, or produced brines from petroleum operations.

73 Phillips has since claimed that it did not react to the first order for thiodiglycol because such orders were routine. A number of experts disagree, however, and feel that only limited amounts could have credibly been assumed to be used in printing, textiles, and automotive manufacturing. John J. Fialka, "Fighting Dirty", Wall Street Journal, September 16, 1988, p. 1.

claimed would be used to make organophosphate fertilizer, but which could help manufacture nerve gas.[74]

These efforts paid off relatively quickly. A major Iraqi research center for chemical weapons was completed at Salman Pak.[75] The facilities necessary to produce mustard gas, and Tabun and Sarin nerve agents, were established at Iraq's Samarra chemical complex, which houses one of the insecticide plants obtained from the West.[76] The Samarra facility was heavily sheltered, and occupied 26 square kilometers in an area about 100 kilometers north of Baghdad. It was defended by troops and SA-2 missiles. Iraq established another major plant near Karbala, and at least one more gas warfare complex at Fallujah, 65 kilometers west of Baghdad.[77]

By 1983, Iraqi production of mustard gas was sufficient for Iraq to begin to deliver small amounts with artillery, fighters, and Mi-8 helicopters. It is unclear exactly when Iraq developed bombs using chemical agents, but Iraq seems to have used 250 kilogram bombs it bought from Spain, and to to have begun to use Fitter aircraft to deliver such bombs. This mustard gas was exceptionally pure, which indicates that Iraq was still producing batches under laboratory conditions, rather than mass producing mustard gas in tons. This mustard gas seems to have been produced at the Iraqi chemical weapons facility at Samarra.[78]

Iraq seems to have begun to produce significant amounts of non-persistent nerve gas Tabun or GA in 1984, and to have put Sarin or GB into full scale production in 1986. Its main production facility seems to have been at Samarra, although the complex at Al Fallujah may have produced the actual gas as well as the precursors. Iraq also seems to have at least experimented with hydrogen cyanide, cyanogen chloride, and Lewisite.

By late 1985, Iraq could produce about 10 tons a month of all types of gases. This seems to have expanded to a capacity of over 50 tons per month by late 1986.[79] In early 1988, Iraq could produce over 70 tons of mustard gas a month and six tons each of Tabun and Sarin.[80]

By mid 1989, Iraq had at least five major plants for chemical agent research and production.[81] Iraq also seemed to be actively working on the production of biological weapons and on developing a way to deliver gas and biological weapons with surface-to-surface missiles.

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74 Ibid.

75 Jane's Defense Weekly, January 9, 1988, p. 3; February 27, 1988, p. 336.

76 Unpublished "Statement of the Honorable William H. Webster, Director, Central Intelligence Agency, Before the Committee on Governmental Affairs, Hearings on Global Spread of Chemical and Biological Weapons", February 9, 1989.

77 Peter Dunn, "The Chemical War: Journey to Iran, NBC Defense & Technology International, pp. 28-37 and "Iran Keep Chemical Options Open", pp. 12-14. Jane's Defense Weekly, January 9, 1988, p. 3; February 27, 1988, p. 336.

78 Seth Carus, The Genie Unleashed: Iraq's Chemical and Biological Weapons Production, Washington, Washington Institute Policy Papers, No. 14., 1989, p. 11.

79 "Iraq's Scare Tactic," Newsweek, August 2, 1982; Washington Post, April 5, 1988, p. A-1.

80 "Iraq's Scare Tactic," Newsweek, August 2, 1982; Washington Post, April 5, 1988, p. A-1; Seth Carus, The Genie Unleashed: Iraq's Chemical and Biological Weapons Production, Washington, Washington Institute Policy Papers, No. 14., 1989, pp. 7-9.

81 Peter Dunn, "The Chemical War: Journey to Iran", NBC Defense & Technology International, pp. 28-37 and "Iran Keeps Chemical Options Open", pp. 12-14.

Some sources feel that Salman Pak is the Iraqi center for the development and production of biological weapons, as well as the development of chemical weapons. There is no reliable way to determine what biological weapons Iraq was developing, and whether actual production was underway. Logical biological weapons included Botulin toxin, anthrax, tularemia, and equine encephalitis. Iraq also seemed to be producing VX, a persistent nerve gas.[82]

13.13. 2 Iran's Chemical and Biological Weapons Efforts

Iran became serious about chemical warfare much later than Iraq, but it is hardly surprising that Iraq's attacks led Iran into a crash effort to develop its own chemical agents, and to purchase massive stocks of chemical defense gear.

The purchase of defense gear was relatively easy, and Iran purchased large stocks of chemical defense gear from the mid-1980s onwards. Iran also obtained large stocks on non-lethal CS gas, although it quickly found such aganst had very limited military impact since they could only be used effectively in closed areas or very small open air areas.

Acquiring poisonous chemical agents was more difficult. Iran did not have any internal capacity to manufacture poisonous chemical agents when Iraq launched its attacks with such weapons.[83] While Iran seems to have made limited use of chemical mortar and artillery rounds as early as 1985 -- and possibly as early as 1984 -- these rounds were almost certainly captured from Iran.[84]

Iran seems to have begun a crash effort to acquire an internal production capability in 1983-1984. Iran sought aid from European firms like Lurgi to produce large "pesticide" plants, and began to try to obtain the needed feedstock from a wide range of sources, relying heavily on its Embassy in Bonn to manage the necessary deals. While Lurgi did not provide the pesticide plant Iran sought, Iran did obtain substantial support from other European firms and feedstocks from a wide range of Western sources.[85]

These efforts began to pay off in 1986-1987.[86] Iran began to produce enough lethal agents to load its own weapons.[87] The Director of the CIA and informed observers in the Gulf have made it clear that Iran could produce blood agents like hydrogen cyanide, phosgene gas, and/or chlorine gas.[88] These gas agents were loaded into bombs and artillery shells, and were used sporadically in 1987 and 1988.

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82 W. Seth Carus puts the production of Tabun and Sarin at 50 tons per year, and of mustard gas at 720 tons per year. W. Seth Carus, "Chemical Weapons in the Middle East," Policy Focus, Number Nine, Washington Institute for Near East Policy, December, 1988, p. 4. Also see "Iraq's Scare Tactic," Newsweek, August 2, 1982; Washington Post, April 5, 1988, p. A-1.

83 Washington Times (October 29, 1986), p. 9-A.

84 Washington Times (October 29, 1986), p. 9-A.

85 Iran was caught trying to by 430 drums of thiodiglycol feedstock in April, 1988, for a U.S. firm called Alcolac. Baltimore Sun, February 11, 1988, p. 6.

86 While rumors surfaced in November, 1986, that Iran had bought nerve gas bombs and warheads from Libya -- which had obtained such weapons from the USSR-- these reports were almost certainly false. Iran does not seem to have used nerve gas at any time durng the conflict.

87 Washington Times , October 29, 1986, p. 9-A.

88 Unpublished "Statement of the Honorable William H. Webster, Director, Central Intelligence Agency,

By the time of the ceasefire, Iran was beginning to produce significant amounts ofmustard gas and nerve gas. It is interesting to note that debates took place in the Majlis in late 1988 over the safety of Pasdaran gas plants located near Iranian towns, and that Rafsanjani described chemical weapons as follows:

> "Chemical and biological weapons are poor man's atomic bombs and can easily be produced. We should at least consider them for our defense. Although the use of such weapons is inhuman, the war taught us that international laws are only scraps of paper."[89]

By mid 1989, it was clear that Iran had established a significant chemical weapons production capability, and was seeking to obtain and/or manufacture surface-to-surface missiles that could be used for both chemical and nuclear strikes. There also were some indications that Iran was actively working on biological weapons. Rumors of such biological weapons activity surface as early as 1982, along with reports that Iran was working on mycotoxins -- a simple biological agent that requires limited laboratory facilities. It is doubtful, however, that Iran had a major biological warfare research effort before the late 1980s.[90]

13.13.3 The Use of Chemical and Biological Weapons in the Iran-Iraq War

There is no evidence of large-scale use of lethal chemical synthetics and/or biological agents during the the initial stages of the Gulf War, although Iran claimed such Iraq used chemical weapons in the Susangerd area during the first six weeks of the war.[91] These Iranian claims are uncertain, and may reflect Iranian propaganda or a botched Iraqi attempt to use lethal chemical or biological agents.

Iraq first began to make significant use of chemical warfare against Iran when Iraq was put on the defensive. Beginning in 1982, Iraq began to use tear gas and non-lethal agents, and a broadcast over Baghdad's Voice of the Masses Radio stated in a reference to the Iranians that there was "a certain insecticide for every kind of insect."[92] Iraq made extensive use of lethal chemical weapons in July (Val Fajr 2) and October, 1983 (Panjwin offensive).[93] In December, 1982, Iraq began to use mustard gas to deal with human wave and night attacks.

Iraq again warned Iran that it might make extensive use of poison gas in September, 1983. The Iraqi high command issued a statement that it, "was armed with modern weapons that (will) be used for the first time in war...not used in previous attacked for humanitarian reasons...if

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Before the Committee on Governmental Affairs, Hearings on Global Spread of Chemical and Biological Weapons", February 9, 1989.

89 IRNA (English) October 19, 1988, as reported in FBIS, Near East and South Asia, October 19, 1988, pp. 55-56.

90 Such reports begin in the SIPRI Yearbooks in 1982, and occur sporadically through the 1988 edition.

91 Loren Jenkins, "Iraqis Press Major Battle in Gulf War," Washington Post (November 17, 1980), p. 1, and Taylor and Francis, SIPRI Yearbook, 1985, (Philadelphia, 1985), pp. 206-219. W. Andrew Terrill, "Chemical Weapons in the Gulf War," Strategic Review (Spring 1986), pp. 51-58.

92 "Iraq's Scare Tactic," Newsweek, August 2, 1982.

93 Loren Jenkins, "Iraqis Press Major Battle in Gulf War," Washington Post, November 17, 1980, p. 1; Taylor and Francis, SIPRI Yearbook, 1985, pp. 206-219; W. Andrew Terrill, "Chemical Weapons in the Gulf War," Strategic Review, Spring, 1986, pp. 51-58.

you execute the orders of Khomeini's regime...your death will be certain because this time we will use a weapon that will destroy any moving creature on the fronts."[94]

The warning was soon followed by further attacks. Iraq made extensive use of lethal chemical weapons in July (Val Fajr 2) and October, 1983 (Panjwin offensive).[95] Chemical warfare seems to have been used extensively on August 9 near Piranshahr, and then around Panjwin in in late October and early November 1983.[96] Two Iranian soldiers wounded by mustard agents during this campaign were sent to Vienna where they died. Two members of a second group of wounded soldiers were sent to Stockholm for medical treatment and also died.

94 Chubin and Tripp, Iran and Iraq at War, p. 59; BBC, ME, April 14, 1983.

95 Loren Jenkins, "Iraqis Press Major Battle in Gulf War," Washington Post, November 17, 1980, p. 1; Taylor and Francis, SIPRI Yearbook, 1985, pp. 206-219; W. Andrew Terrill, "Chemical Weapons in the Gulf War," Strategic Review, Spring, 1986, pp. 51-58.

96 "In the Pipeline," The Middle East (December 1981), p. 72; "Iraqis Trained for Chemical Warfare," Washington Post (November 3, 1980), p. 313. The Iraqis may also have been favorably impressed by the effectiveness of tear gas in instilling panic in Iranian troops. An August 1982 report in Newsweek stated an entire Iranian division fled in panic when they were exposed to Iraqi tear gas. The Iranians had no idea as to what type of agent they were being exposed to, and had no defenses against any kind of chemical agent.

FIGURE 13.8 (OLD 4.25)

CLAIMS OF USES OF CHEMICAL WARFARE - PART ONE

User/Area	Gas	Delivery Means	Effects/Casualties	Date
Iraq Susangerd	CS	Artillery	Limited	June, 1982
Iraq Mandali and Basra	CS/Mustard	Artillery/Mortars	Unclear	July, 1982
Iraq Southern front	Mustard	Unknown	Used against forces massing for human wave attacks. Effect unknown.	December, 1982
Iraq Haj Omran/ Piranshahr/ Mt. Kordeman	Mustard	Aircraft Helicopters	25-100 casualties	August, 1983
Iraq Panjwin	Mustard	Helicopters/ Artillery	Heavy casualties Significant Impact on Battle	October- November, 1983
Iraq Majnoon Islands	Mustard/CS	Aircraft	Heavy casualties Significant Impact on Battle	February- March, 1984
Iraq Basrah	Nerve/ Mustard	Artillery	Limited	March, 1984
Iraq Hawizeh Marshes	Nerve/ Mustard	Aircraft/ Artillery	Heavy casualties Significant Impact on Battle	March, 1985
Iraq Al Faw	Nerve/ Mustard	Aircraft Artillery	Heavy casualties Significant Impact on battle	February, 1986
Iraq Khorramshahr	Mustard	Bombs	disrupt build-up against Basra	January- February, 1987
Iraq and Iran* Basra	Nerve/ Mustard	Aircraft Artillery	Heavy casualties Significant Impact on battle	February- April, 1987
Iraq Khorramshahr	Mustard	Bombs	disrupt build-up against Basra	April, 1987

FIGURE 13.8 (OLD 4.25)

CLAIMS OF USES OF CHEMICAL WARFARE - PART TWO

User/Area	Gas	Delivery Means	Effects/Casualties	Date
Iran Mehran	Mustard/ Cyanogen	Artillery	Limited	July, 1987
Iraq Sardasht	Mustard	Bombs	650-3,500 Kurdish civilians	June- July, 1987
Iraq Somar	Mustard	Bombs	disrupt build-up against Basra	October, 1987
Iraq and Iran Halabjah	Mustard Cyanogen	Aircraft Artillery	Up to 5,000 Kurdish civilians	March, 1988
Iraq Al Faw, East of Basra	Nerve/ Mustard	Aircraft Artillery	Heavy casualties Significant Impact on Battle	April, 1988
Iraq Mehran	Nerve/ Mustard	Aircraft Artillery	Heavy casualties Significant Impact on Battle	May, 1988
Iraq Majnoon, Dehloran, Hawizeh	Nerve/ Mustard	Aircraft Artillery	Heavy casualties Significant Impact on Battle	June-July, 1988
Iraq Kurdistan	Nerve/Mustard	Aircraft	Terrorize Kurdish rebels and Population	August, 1988

Source: Estimate based on various editions of the SIPRI Yearbook; Edgar O'Ballance, The Gulf War, London, Brassey's, 1988; W. Seth Carus,"Chemical Weapons in the Middle East", Policy Focus, Research Memorandum, Number Nine, December, 1988; JCSS, Military Balance in the Middle East, 1987-1988, Boulder, Westview, 1988.

*Iran may have used gas artillery shells during this battle.

Further Iranian charges were made that Iraq used chemical weapons during the March, 1984 offensive which led to the Iranian seizure of Majnoon Island.[97] These charges stated Iraq had killed some 1,700 Iranian troops and used GD and GB nerve agents, as well as mustard gas. Many of the Iranian allegations about the Iraqi use of lethal synthetic gases during the following months also related directly to the fighting on the Islands.[98]

Iraq does not seem to have made extensive use of chemical agents between March, 1984 and Iran's Faw offensive in early 1986. It did, however, sporadically use chemical weapons when its forces have came under intense military pressure.

Iran attempted to deal with this situation by mobilizing world opinion. After Iran's protests failed to arouse a significant world reaction, it flew chemical warfare casualties to London. A UN team then flew to Iran and found several bombs for dispersing chemical agents with Spanish markings. These weapons were later found to have contained mustard gas. Other investigations after the 1984 attacks confirmed a high probability that Iraq was using a nerve gas agent called Tabun.[99] These conclusions were validated by a second UN investigation in 1986, and it later became apparent that Iraq also had Chlorine gas agents, and that Iraq had a major chemical weapons production complex.

Iran's efforts to make a propaganda issue out of Iraq's use of gas may have had some temporary success. Iraq made little use of chemical agents between 1984 and the new Iranian offensive in Faw in 1986. There are, however, alternative explanations. While this pause in Iraq use of gas may have been because of the hostile reaction in the West and Third World, it may also have been because Iraq lacked the organization and dispensers to use gas safely. There are indications that unfavorable winds caused Iraqi deaths at Haji Omran in August 1983, at Majnoon in March 1984, and near Fish Lake in 1987. Iran also seems to have become more cautious after the U.S. formally condemned Iraqi use of chemical weapons in March 1984.

Changes in the training of the Iraqi Chemical Corps also indicate that Iraq was attempting to become more selective in the use of mustard gas, and to attack Iranian rear areas with more care. Further, Iraq was clearly converting its forces to be able to use non-persistent nerve gases against attacking Iranian troops or in its own attacks on Iranian positions.

In any case, Iraq resumed extensive use of gas warfare in its defense of Faw in 1986, and made good use of gas in its defense of Basra in 1987. Iraq also found mustard and nerve gas were effective in defending against attacking Iranian troops in the north during their attacks on Iraq in

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97 "In the Pipeline", The Middle East, December, 1981; "Iraqis Trained for Chemical Warfare", p. 72; Washington Post, November 3, 1980.

98 Beginning in 1982, Iraqi agents bought extensive amounts of equipment from a West German manufacturer of equipment to make organophosphate pesticides. The manufacturer, located in Drereich, claims it had no way to know the Iraqis were buying extensive feedstock for nerve gas in other countries, including the U.S. There may now be five major chemical agent production plants in Iraq. See Gustav Anderson, "Analysis of Two Chemical Weapons Samples from the Iran-Iraq War," NBC Defense and Technology International (April 1986), pp. 62-66; Peter Dunn, "The Chemical War, Journey to Iran," Ibid., pp. 28-37; and "Iran Keeps Chemical Options Open," Ibid., pp. 12-14.

99 "Report of the Specialists Appointed to the Secretary General to Investigate the Allegations of the Islamic Republic of Iran Concerning the Use of Chemical Weapons, United Nations Security Council, Document S 16433, March 26, 1984. Also see the April, 1986, edition of NBC Defense & Technology International.

1987 and in the early months of 1988. Chemical weapons offered a potential solution to the problem of mountain or rough terrain warfare, and in many cases, it allowed Iraq to "secure" a mountainous area with relatively few troops. Iraq was particularly ready to used gas against those Iraqi Kurds fighting on the side of Iran, a group which the government regarded as nothing but traitors.

Iraq made massive use chemical weapons during its recapture of Faw in early 1988, and in its assaults to recover its positions outside Basra. By April, 1988, Iran claimed that the new round of attacks had raised the total number of casualties from chemical weapons since the start of the war to around 25,600, with some 260 dead. These claims may well be legitimate. Although Iran now had extensive defensive equipment, it did not organize or train to use it effectively. Many Iranians died, for example, because they did not shave often enough to allow their gas masks to make a tight seal.[100]

During the final months before the ceasefire, Iraq used chemical weapons in its attacks on Iranian positions in Mehran, the Majnoon Islands, the Hawizeh Marshes, and Dehloran.[101]By the time the war ended in a ceasefire, the Iraqi use of chemical weapons seems to have produced around 45,000 casualties, although there is no way to calculate the seriousness of these casualties or the number of dead.

More controversially, anti-Iraqi Kurdish factions charged that Iraq began to make extensive use of gas against non-combatant Kurdish villages and areas early in 1987. According to such reports, there were some fifteen such attacks between April 15, 1987 and February 26, 1988. Three of these attacks are claimed to have produced 100 or more casualties: Attacks on Arbil, Kanibard, Zeenau, Balookawa, Shaikwassan, the Derasheer mountains, and the Sawseewaken area on April 16, 1987; the Dahok/Amadia area on May 6, 1987, and the Sulaymania/Sergaloo, Yakhsamar, Haledan, Gweezeela area on February 25, 1987.[102]

While these charges cannot be confirmed, the worst single use of gas against civilians occurred when both Iraq and Iran used gas during an Iranian attack on the Kurdish town of Halabjah on February 26, 1988. Up to 5,000 Kurdish civilians were killed in the fighting.

Iraq seems to have begun such attacks, after its troops were driven from the area, by bombing the town with mustard gas that produced burning white cloud. Some of the gas victims seem to have fled toward Iraq, rather than Iran, and this may have confused Iranian forces into thinking they were Iraqi troops. Iran seems to have fired hydrogen cyanide gas into the area with artillery shells. The cyanide fired by Iran may have done much of the actual killing, and may have accounted for many of the casualties that Iran blamed on Iraq when it showed the results of the attacks on its state television network.[103]

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100 W. Seth Carus, "Chemical Weapons in the Middle East," Policy Focus, Number Nine, Washington Institute for Near East Policy, December, 1988, p. 7.

101 Washington Times, March 23, 1988, p. 1; Toronto Globe and Mail, March 24, 1988, p. 1; Washington Post, March 24, 1988, p. 1 and April 4, 198, p. 24.

102 Congressional Record, U.S. Senate, September 9, 1988, p. S12135

103 Washington Times, March 23, 1988, p. 1; Toronto Globe and Mail, March 24, 1988, p. 1; Washington Post, March 24, 1988, p. 1 and April 4, 198, p. 24; Wall Street Journal, September 16, 1988, p. 1.

In spite of the hostile outside reaction to Halabjah, Iraq seems to have begun a major new offensive against its own Kurds on August 25, 1988, and seems to have made considerable use of gas warfare as part of an effort to depopulate hostile areas. While the exact scale of Iraq's use of gas is uncertain, some 65,000 Kurds fled to Turkey, and many of the refugees gave convincing reports of the use of gas warfare. These attacks only halted after a new wave of world protests tended to isolate Iraq from its supporters and extensive diplomatic pressure from the U.S.[104]

As for other Iranian uses of chemical weapons, Iran seems to have made its first use of chemical weapons in 1984 or1985, using mortars and artillery to deliver gas rounds. Some of these rounds may initially have been captured from Iraq. While reports are controversial, Iran seems to have made more extensive use of chemical weapons in the area near Fish Lake during the fighting around Basra in early 1987, and again during the battle to retake Mehran..

The exact nature of the chemical agents available to Iran during the war is unknown. In early 1988, however, Iran seems to have been able to produce mustard, phosgene and hydrogen cyanide gas towards the end of the conflict, and was actively working on the production of nerve gas.[105]

If the Iran-Iraq War should resume at anything like the level of conflict that existed before the ceasefire, it seems likely that there will be further use of gas, and possibly of biological agents as well. It is important to note, however, that neither Iran or Iraq has yet demonstrated an effective capability to deliver gas and chemical weapons by missile.

As for the overall impact of chemical weapons, it is clear that Iraq had substantially greater success in using such weapons after 1987. While 45,000 casualties from gas was a relatively minor part of the well over one million military and civilian casualties that resulted from the war, chemical weapons also seem to had a critical effect on Iranian military and civilian morale in the Iraqi counteroffensives and "war of the cities" in 1988. Sheer killing power also is not the issue. Troops that feel they are defenseless may well break and run after limited losses. Populations which fear chemical attacks may well cease to support a conflict. These are lessons that many developing nations have already taken to heart, and further uses of chemical weapons, and possibly biological weapons, now seem all too likely.

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[104] See Peter W. Galbraith and Christopher Van Hollen Jr., "Chemical Weapons Use in Kurdistan: Iraq's Final Offensive", A Staff Report to the Senate Committee on Foreign Relations, September 21, 1988, and Physicians for Human Rights, Winds of Death: Iraq's Use of Poison Gas Against its Kurdish Population, February, 1989.

[105] Such reports begin in the SIPRI Yearbooks in 1982, and occur sporadically through the 1988 edition.

FIGURE 13.9

MAJOR CHEMICAL AGENTS THAT MAY HAVE BEEN USED DURING THE IRAN-IRAQ WAR

AGENT Gas Effects/Casualties

CONTROL AGENTS: Agents which produce temporary irritating or disabling effects which in contact with the eyes or inhaled. They can cause serious illness or death when used in confined spaces.

Tear: Cause flow of tears and irritation of upper respiratory tract and skin. Can cause nausea and vomiting:

Chlororacetophenone (CN)
O-Chlorobenzyl-malononitrile (CS)

Vomiting: Cause irritation, coughing, severe headache, tightness in chest, nausea, vomiting:

Adamsite (DM)

INCAPACITATING AGENTS: Agents which cause short term illness, psycoactive effects, (delirium and hallucinations). Can be absorbed through inhalation or skin contact:

BZ

BLISTER AGENTS: Agents that destroy skin and tissue, cause blindness upon contact with the eyes, and which can result in fatal respiratory damage. Can be absorbed through inhalation or skin contact. Some have delayed and some have immediate action:

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Sulfur Mustard (H or HD)
Nitrogen Mustard (HN)
Lewisite (L)
Phosgene Oxime (CX)

CHOKING AGENTS: Agents that cause the blood vessels in the lungs to hemorrhage and fluid to build up until the victim chokes or drowns in his own fluids. Can be absorbed through inhalation. Immediate to delayed action:

Phosgene (CG)

BLOOD AGENTS: Interfere with use of oxygen at the cellular level. CK also irritates the lungs and eyes. Rapid Action:

Hydrogen Cyanide (AC)
Cyanogen Chloride (CK)

NERVE AGENTS: Agents that quickly disrupt the nervous system by binding to enzymes critical to nerve functions, causing convulsions and/or paralysis, often resulting in death. Can be absorbed through inhalation or skin contact.:

Tabun (GA)
Sarin (GB) - nearly as volatile as water and delivered by air.
Soman (GD)
GF
VK - a persistent agent roughly as heavy as fuel oil.

Adapted from Matthew Meselson and Julian Perry Robinson, "Chemical Warfare and Chemical Disarmament," Scientific American, Vol. 242, No. 4, April, 1980, pp. 38-47; and unpublished testimony to the Special Investigations Subcommittee of the Government Operations Committee, U.S. Senate, by Mr. David Goldberg, Foreign Science and Technology Center, U.S. Army Intelligence Center on February 9, 1989.

13.14 Nuclear Weapons

Neither Iraq or Iran seem likely to acquire nuclear weapons in the near future, but both sides have been actively trying to acquire them for over a decade. Given their use of chemical weapons, it also is not possible to reject the possibility that if either side had had such weapons, they would have used them.

13.14. 1 Iraq's Nuclear Weapons Effort

Iraq began its efforts no later than the early 1970s. The Osiraq reactor that Iraq purchased from France in 1976 was unusually large and had special features for irradiating Uranium which allowed it to be used to produce significant amounts of Plutonium -- enough to produce a bomb over a several year period. In 1981, when Israel attacked and destroyed the reactor, Iraq was negotiating to buy a heavy water power reactor from Italy and a sizable reprocessing facility whose purpose was almost certainly Plutonium production.

Earlier, in 1980 and 1981, Iraq had brought large amounts of natural uranium from Brazil, Portugal, Niger, and Italy. Iraq also placed an order in early 1980 for 25,000 depleted uranium fuel pins from a West German firm called NUKEM. They were sized for irradiation in the Osiraq reactor, and had no other real purpose than to produce about ten to twelve kilograms of weapons grade plutonium. While the reactor was under IEA inspection, and French technicians were to remain until 1981, Iraq seemed to be following the bomb development plan Sweden had used in the early 1960s, and was developing an open ability handle Plutonium technology while stockpiling for weapons purposes. Iraq also seems to have tried to buy Plutonium illegally from Italian sources after the Israeli raid on Osirak.

Iraq has had little success since 1981 in either obtaining aid in building new reactors suitable for weapons purposes, or obtaining fissile materials. Iraq continues to hold 12.5 kilograms of French-supplied highly enriched uranium, and could theoretically make one nuclear weapon, but there is no indication it has done so.[106] It tried unsuccessfully to obtain 33.9 kilograms of Plutonium from an Italian smuggling ring, but could not find any substitute. [107]

It seems highly likely, however, that Iraq will continue to try to find a replacement for Osirak, and try to expand its facility at Tuwaitha to create some capability to process Uranium or Plutonium. Iraq still has a 10 megawatt reactor built by the Soviet Union operating at Tuwaitha, but this is under tight Soviet control. Tuwaitha has also acquired massive new surface-to-air missile defenses since the Israeli attack.[108]

In the longer run, Iraq may be able to use larger power reactors. It is seeking to provide 10% of its power needs with nuclear power, and contracted with the Soviet Union in 1984, to build at 440 megawatt plant at a cost of $2 billion. The plant is supposed to be built by the Soviet Atomenrgo group, but there is no current sign that Iraq has been able to get the USSR to start

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[106] It takes 15 to 25 kilograms to make one relatively simple nuclear weapon. More advanced weapons take substantially less.

[107] Leonard S. Spector, The New Nuclear Nations, New York, Vintage, 1985, pp. 44-54.

[108] James Bruce, "Iraq and Iran: Running the Nuclear Technology Race," Jane's Defense Weekly, December 5, 1988, p. 1307.

construction or Soviet support in building a new reactor Iraq could integrate into a weapons development cycle. Iraq is also evidently seeking Latin American support in building an uncontrolled reactor somewhere in Northern Iraq. In the long run, Iraq is likely to succeed in obtaining at least some fissile material and in becoming a nuclear power.[109]

13.14. 2 Iran's Nuclear Weapons Effort

Like Iraq, Iran has an extensive nuclear effort, and for all its rhetoric about popular warfare, the Khomeini regime seems to have revived the nuclear weapons program begun under the Shah. The Shah established the Atomic Energy Organization of Iran in 1974, and rapidly began to negotiate for nuclear power plants. By the time he fell in January, 1979, he was attempting to purchase some 12 nuclear power plants from the FRG, France, and U.S. Two 1,300 megawatt German plants at Bushehr were 60% and 75% completed, and work had begun on two 935 megawatt French plants at Darkhouin. Thousands of Iranians were training in nuclear technology in France, the FRG, India, the U.K., and U.S. In addition, Iran had negotiated for long term supplies of enriched fuel with France, the U.K. and U.S, had bought a 10% share of EURODIF in 1975, and was negotiating to by a share of COREDIF.[110]

Far less publicly, the Shah began a nuclear weapons research program, centered at the Tehran Research Center, whose operations were never affected by the Shah's fall. This research effort included a laser enrichment program which began in 1975, and led to a complex and highly illegal effort to obtain laser separation technology from the U.S. This effort continued from 1976 until the Shah's fall, and three lasers operating in the critical 16 micron band were shipped to Iran in October, 1978. At the same time, Iran worked on ways to obtain Plutonium. It created a secret reprocessing research effort to use enriched uranium, and and set up a small nuclear weapons design team. In 1976, Iran also began to try to purchase 26.2 kilograms of highly enriched uranium. The application to the U.S. was still pending when the Shah fell.

The Khomeini government initially led the Shah's program slide, but revived it in 1981. It kept a small 5 megawatt reactor working under IAEA safeguards at Tehran University. Iran revitalized its laser separation program in 1983, and held several conference on the subject, including an international conference in September, 1987. It opened a new nuclear research center in Isfahan in 1984, and sought French and Pakistani help for a new research reactor for this center.

The government began to restart work at the Bushehr in 1984, although the FRG officially refused to support the effort until the war ended. Iran got around this by obtaining Argentine support in completing the Bushehr 1 reactor, which is 75% finished. Reports surfaced in April,1987 that the Argentine nuclear power agency, CNEA, had signed an agreement with Iran. CNEA works closely with West Germany's Kraftwerke Union (KWU), which had the original contract for the reactor. The Spanish firm Impressarios Agupados may also be part of the

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[109] This analysis is based on the work of Leonard Spector of the Carnegie Endowment, and Steve Weissman and Herbert Krosney, The Islamic Bomb, New York, New York Times Books, 1981, pp. 94, 100, and 266-268; Jed C. Snyder, "The Road to Osiraq: Baghdad's Quest for the Bomb", The Middle East Journal, Autumn, 1983; and Richard Burt, "U.S. Says Italy Sells Iraq Atomic Bomb Technology", New York Times, March 18, 1980, p. 1.

[110] The bulk of this analysis is based on research by Leonard Spector of the Carnegie Endowment.

consortium.[111] While the FRG firm Kraftwerk Union pulled out of the Bushehr project in September, 1980, it was working on the reactor when Iraqi aircraft bombed it on November 17, 1987. Several Kraftwerk technicians were injured and one was killed.

Argentina also sold Iran enriched uranium for its small Tehran university reactor in May, 1987. The five megawatt university reactor uses a core with 93% enriched uranium, which is suitable for some forms of nuclear weapon. A CENA team visited Iran in late 1987 and early 1988, and seems to have agreed to sell Iran the technology necessary to operate its reactor with 20% enriched Uranium as a substitute for the highly enriched core. Argentina has not ratified the nuclear non-proliferation treaty but Iran is an NPT signatory, and Argentina has agreed to IAEA safeguards. It is unclear what impact the Argentinian agreement with Iran will have on Iran's nuclear weapons program.

There are significant uranium deposits in the Sarghand region of Iran's Yazd Province, but Iran's enrichment plant at Pilcaniyeu has so far been unable to reach enrichment levels above 8%.[112] Iran has also suffered a major blow to its program because Iraq has successfully and repeated bombed its reactor projects at Bushehr. Iraq first struck the reactor on March 4, 1985, and then launched major raids on November 17 and 19, 1987. This may have been in response to the fact that Iran had begun to move IAEA safeguard material to the area in February, 1987.[113]

Given this background, it is unlikely that either Iraq or Iran will have any nuclear capability before the mid-1990s, or a significant delivery capability until well after the year 2000. It is clear, however, that both nations are likely to continue their weapons efforts, as well as efforts to improve their chemical weapons and develop biological weapons. Further, their difficulties in nuclear proliferation may well accelerate their chemical and biological efforts.

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111 Washington Times, April 22, 1987, page 6; Economist, Foreign Report, April 2, 1987, p. 7.

112 Washington Post, April 12, 1987, p. D-1; James Bruce, "Iraq and Iran: Running the Nuclear Technology Race," Jane's Defense Weekly, December 5, 1988, p. 1307..

113 Many of the details relating to Iraq and Iran are drawn from working papers provided by Leonard Spector of the Carnegie Endowment.