

# **Chapter Six: Desert Storm: Shaping Coalition Air Power and the Air Campaign, and Fighting the War for Air Supremacy**

Any analysis of the lessons of the air war creates a problem in levels of analysis. There is a tendency in military history to concentrate on the actions of high ranking commanders. Such a focus is valid in the sense that the determination and skill of political and military leadership does shape much of the outcome of war. In practice, however, many of the most important factors in understanding the lessons of the air war come at a different level: They come through detailed analysis of the tactics and technical factors that shaped the struggle for air supremacy, the Coalition's strategic bombing campaign, the attacks on Iraqi ground forces before the ground battle began, and the interdiction and close air support campaigns fought in support of the ground battle. Leadership is important, but leadership occurs at many different levels and it is usually at the lower and intermediate levels of command levels where the specific details of organization, technology, tactics, readiness, training, and sustainability teach lessons that may shape the course of future wars.

This chapter focuses on the efforts of each side to build-up effective air power, and the struggle for air supremacy -- a struggle where the Coalition won an early and decisive victory against both the Iraqi air force and Iraqi land-based air defenses.. The Coalition showed within days that it had a decisive advantage in sensors, battle management systems, and beyond-visual-range (BVR) air combat. It showed that it had the active and passive defenses to protect its offensive aircraft. It showed that it could not only suppress Iraqi air activity, but find ways to seek out and destroy sheltered Iraqi aircraft.

## **The Unique Conditions of the Air War**

The battle between Coalition air forces, the Iraqi Air Force, and Iraqi land-based air defenses war for air supremacy is one of the best documented aspects of the air war. At the same time, the data do have uncertainties. There are many detailed differences between US sources, sometimes even within the data provided by a given source. More details are available on US air capabilities than on the performance of other Coalition air forces. Only limited data are available on Iraqi perceptions of how the air war developed, and the motives for given Iraqi actions. Reporting at the air unit and weapons system level often exaggerates effectiveness. Much of the data imply that US and allied forces and equipment

were fully combat effective at the time they were deployed to the Gulf, and ignore the many changes that took place during Desert Shield, in terms of tactics, equipment, maintenance systems, sustainability, and training.

What is more important in terms of drawing lessons from the conflict is that air war was fought under what may well be unique conditions. As is the case with every aspect of the Gulf War, the preparation time that Iraq granted the Coalition is likely to be unique. The Coalition had more than five months to prepare for the air battle. Even so, US and Coalition planners were constantly revising the details of the air campaign down to the last moment before it began, and continued to revise many aspects of their planning during the war.

The differences between Iraq's military culture and that of the West have been discussed in Chapter Three, but it is unlikely that Iraq's fundamental misunderstanding of air power will be repeated in future campaigns. Iraq's air combat experience in the Iran-Iraq War did not prepare it for Desert Storm. Although Iraq suffered some serious initial reverses when Iran used air power in 1979 and 1980, Iran quickly lost the ability to use its air force effectively because of its inability to import parts and supplies, its loss of foreign advisors and technical support, and the impact of political upheavals and purges. Iraq acquired air superiority by 1983-1984, without having to win it.

This was a gift of fortune that Iraq largely wasted. It never organized its air force effectively for close support or interdiction missions, or even defense of its homeland, and never mastered the battle management techniques for large scale operations. It dealt with airpower as a deterrent reserve, rather than as a serious instrument of warfare. As a result, Iraq saw air power largely in terms of attrition and survivability. It did not develop the capability to suppress Saudi and other southern Gulf air bases and ports with airpower, missiles, or special forces. It did not realize the vulnerability of its air force, ground based air defenses, sheltered headquarters, and units in the field. It relied on an air strategy that ceded the strategic initiative to the UN without understanding the potential cost.

Iraq was not prepared for air forces that had modern, near-real time targeting capability, sustained air superiority, the ability to sustain massed offensive attack strength over the battlefield, modern sensors and all-weather combat systems, effective passive and active countermeasures against ground based air defenses, and precision-guided weapons capable of killing at ranges outside the coverage of Iraq's short-ranged air defenses.

It is unlikely -- given the outcome of the Gulf War -- that other nations will repeat Iraq's failure to understand the potential vulnerability of its land-based air defenses, command and control facilities, and land forces. Iraq understood the need to shelter, disperse, and camouflage its air and land power. Iraq had long made efforts to create

modern shelters for its air and air defense forces, and to camouflage its ground forces, but the techniques it used were suited largely to defense against another Third World air force.

The Gulf War is likely to be unique in other ways. Once the war began, the Coalition could fight the air war at its pace without fear of Iraq gaining the initiative. The Coalition could take the time to change its tactics and methods of attack, and defer starting the land battle until it was ready to do so. It did not need to fear resupply or aid from other nations. It did not have to cope with the problems of air war in mountain areas and could be extremely selective in striking targets in populated areas. It did not have to attack infantry or guerrilla forces, or attack targets covered by forest or jungle canopy. It also was often able to repetitively attack a nearly static target base -- avoiding the problems of attacking maneuvering forces.

Weather was another special factor affecting the course of air operations. The sand and grit blown into air facilities, or ingested by aircraft, was a major maintenance problem even in normal weather. Even though air planners shaped their plans on the basis of careful consideration of what was known about weather patterns in the area, they were not prepared for what actually happened. There were occasional violent winds and heavy downpours, and these created marsh-like terrain in some areas. There were Shamals, or sand storms, which blasted grit throughout the area. Further, Iraq set some 700 oil wells on fire at the end of the war, which created mixes of rail and oil smoke, and rapid shifts in the smoke clouds that complicated mission planning. These factors often disrupted operations, and forced the Coalition to cancel missions because of its desire to minimize losses and collateral damage, which had led to stringent rules of engagement. This also led to an exceptionally heavy reliance on precision strike aircraft, and the use of special purpose aircraft like the F-117.

Studies shortly after the war indicated that the impact of weather on air operations was twice as bad as the climatological history of the region suggested before the Gulf War began. In fact, the weather came closer to approximating a rainy European summer than a desert. Cloud cover exceeded 25% at 10,000 feet over central Iraq on 31 days of the 43 day war. It exceeded 50% on 21 of those days, and 75% on 9 days.<sup>1</sup> In many ways, the lesson is not that the weather was unusual, but that the US and regional planners simply did not know enough about regional weather patterns for effective planning -- an shortcoming that should be corrected in planning for future major regional conflicts.

## Comparative Air Strength And Capabilities

It is equally important preface any analysis of the less of the Gulf War with an analysis of the Coalition air forces that dominated the air phase of the Gulf War. The most

significant factor shaping the role that given Coalition air forces played in the fighting was not the number of aircraft engaged, but rather the number and quality of sorties flown. Air combat capability is never a function of aircraft numbers alone; aircraft on the ground are simply targets. It is the employment of aircraft in combat that determines a given air force's combat capability. This point is illustrated in Table 6.1, which summarizes the total sorties flown by each allied air force in Desert Storm. This table not only provides an overview of how many sorties a given allied air force flew during the war, it provides an overview of the complexity of the air battle, an overview of the different missions flown, and a rough indication of the capability of each air force to fly demanding strike/attack, air defense, reconnaissance, command and control, electronic and refueling missions.

Table 6.1 shows that wide a range of countries and types of aircraft contributed to the air battle. It shows that European air forces like the RAF, French Air Force, and Italian Air Force flew over 4,000 major combat sorties. The British Royal Air Force provided that only strike-attack capabilities that matched those of the US Air Force and was the only other air force to take on the burden of demanding offensive missions. It also provided air defense squadrons and reconnaissance aircraft, tankers, transports, and helicopters. The French air force provided tactical strike squadrons, tankers, transports, reconnaissance aircraft, maritime patrol aircraft, and helicopters. The Royal Canadian Air Force provided air superiority and ground attack fighters for defensive counter air missions and the support of ground forces. The Italian Air Force deployed attack fighters, transports, tankers, and reconnaissance aircraft for air intercept and interdiction missions. A contingent of European aircraft deployed to Turkey to deter an Iraqi attack as part of the NATO Allied Command, Europe, and Mobile Forces (Air). These included 18 German Alpha jets with 800 personnel, and reconnaissance aircraft with 125 support personnel.<sup>2</sup>

Table 6.1 shows that the Arab members of the Coalition flew as many sorties as European air forces, and the Saudi Air Force flew more combat sorties than all of the European air forces combined. The Saudi Air Force and other southern Gulf Air forces provided air superiority and ground attack fighter aircraft to offensive counter air, defensive counter air, and interdiction sorties. They also carried out refueling, airborne command and control, reconnaissance, utility, and airlift missions, and provided logistical and operational support. Table 6.1 also shows that the Kuwaiti Air Force played a larger role in the total air battle than Kuwaiti ground forces were able to play in the land battle, and that even small air forces like those of Bahrain played a meaningful role in combat.

Table 6.1

The Impact of Coalition Air Forces: Number of Sorties by Mission Type - Part OneMajor Combat Missions

Country	Strike Attack									TOTAL	
	Interdiction			Air Support			Counter-Air				
	Interdiction	Battlefield	Total	CAS	FAC	Total	Defensive	Offensive	Total		
US											
Air Force	23,756	536	24,292	1,438	682	2,120	4,558	6,422	10,980	37,392	
Navy	5,060	0	5,060	21	0	21	4,245	1,936	6,181	11,262	
Marine Corps	4,015	249	4,264	2,937	1,019	3,956	0	757	757	8,977	
Special Forces	32	0	32	31	0	31	0	0	0	62	
Army	0	0	0	0	0	0	0	0	0	0	
Subtotal	32,863	785	33,648	4,427	1,701	6,128	8,803	9,115	17,918	57,693	
Saudi Arabia	1,133	523	1,656	0	0	0	2,391	277	2,668	4,324	
U.K.	1,256	0	1,256	0	0	0	696	890	1,586	2,842	
France	491	40	531	0	0	0	340	230	570	1,101	
Canada	48	0	48	0	0	0	693	144	837	885	
Kuwait	568	212	780	0	0	0	0	14	14	794	
Bahrain	122	0	122	0	0	0	152	0	152	274	
Italy	135	0	135	0	0	0	0	0	0	135	
UAE	58	0	58	0	0	0	0	0	0	58	
Qatar	43	0	43	0	0	0	0	0	0	43	
Subtotal	3,854	775	4,629	0	0	0	4,272	1555	5,827	10,456	
Total	36,717	1,560	38,277	4,427	1,701	6,128	13,075	10,670	23,745	68,149	

Electronic Warfare and C<sup>4</sup> Missions

	Reconnaissance				C <sup>4</sup>				Electronic Warfare			
	Recce	SLAR	Observ.	Total	ABCCC	Early	C <sup>4</sup>	Total	ECM	ESM	EW	Total
					Warning							
US												
Air Force	869	0	442	1,311	201	379	24	604	0	190	1,388	1,578
Navy	1,190	0	241	1,431	1,143	0	0	1,143	5	260	0	265
Marine Corps	3	0	0	3	157	0	0	157	0	17	326	343
Special Forces	2	0	0	2	0	0	0	0	0	0	84	84
Army	0	147	0	147	0	0	0	0	6	547	15	568
Subtotal	2,064	147	683	2,894	1,501	379	24	1,904	11	1,014	1,813	2,838
Saudi Arabia	118	0	0	118	0	85	0	85	0	0	0	0
U.K.	156	0	0	156	0	0	0	0	0	80	0	80
France	62	0	0	62	0	0	0	0	0	0	0	0
Canada	0	0	0	0	0	0	0	0	0	0	0	0
Kuwait	0	0	0	0	0	0	0	0	0	0	0	0
Bahrain	0	0	0	0	0	0	0	0	0	0	0	0
Italy	0	0	0	0	0	0	0	0	0	0	0	0
UAE	6	0	0	6	0	0	0	0	0	0	0	0
Qatar	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	336	0	0	336	0	85	0	85	0	80	0	80
Total	2,406	147	683	3,236	1,501	464	24	1,989	11	1,094	1,813	2,918

Table 6.1The Impact of Coalition Air Forces: Number of Sorties by Mission Type - Part TwoRefueling and Support Missions

	<u>Refueling</u>			<u>Airlift</u> <u>Forces</u>	<u>Special</u>	<u>Support</u>	<u>Training</u> <u>CAP</u>	<u>Surface</u>	<u>Other</u> <u>TOTAL</u>	<u>GRAND</u>
	<u>Refueling</u>	<u>Tanker</u>	<u>Total</u>							
US										
Air Force	11,024	0	11,024	16,628	134	203	174	0	358	69,406
Navy	0	2,782	2,782	0	3	41	262	198	916	18,303
Marine Corps	453	8	461	9	1	714	14	0	4	10,683
Special Forces	56	0	56	19	808	64	76	0	90	1,262
Army	0	0	0	201	0	0	0	0	0	916
CRAF	0	0	0	800	0	0	0	0	0	800
Subtotal	11,533	2,790	14,323	17,657	946	1,022	526	198	1368	101,370
Saudi Arabia	485	0	485	1,829	0	9	2	0	0	6,852
U.K.	711	0	711	1,384	0	40	90	40	74	5,417
France	223	0	223	855	1	0	4	0	12	2,258
Canada	64	0	64	277	0	0	64	0	12	1,302
Kuwait	0	0	0	0	0	0	0	0	0	0
Bahrain	0	0	0	4	1	0	0	0	0	293
Italy	89	0	89	13	0	0	0	0	0	237
UAE	0	0	0	45	0	0	0	0	0	109
Qatar	0	0	0	0	0	0	0	0	0	0
Subtotal	1,572	0	1,572	4,407	2	49	160	40	98	16,468
Total	13,105	2,790	15,895	22,064	948	1,071	686	238	1,466	117,838

Note: The data cover the period from January 16, 1991 to February 28, 1991. There are significant national differences in definition, and some countries do not report special forces and support sorties. ABCCC = airborne battlefield command and control center. ECM = electronic countermeasures. ESM = electronic support measures or intelligence. C4 = command, control, communications, and computers. CAP = combat air patrol. SLAR = side looking airborne radar.

Source: Adapted by the author from the data in Cohen, Dr. Eliot A, Director, Gulf War Air Power Survey, Volume V, Washington, US Air Force/Government Printing Office, 1993. The data are generally selected from the tables on pages 232-233, although some data and categories are modified to reflect different data in pages 235-386.

## **The Role of US Air Forces**

On the other hand, Table 6.1 shows that US air units provided the mass and decisive force that shaped the outcome of Desert Storm. If one counts only shooter and combat support sorties for fixed wing aircraft, the USAF flew 57% of the 92,517 sorties in Desert Storm. The US Navy flew 18.5%, and the USMC flew 10.8%, and all US forces flew a total of 86.3%. The RSAF flew 5.4%, the RAF flew 4.1%, the French Air Force flew 1.5%, the Canadian Air Force flew 1.0%, the Kuwaiti Air Force flew 0.8%, the Bahraini Air Force flew 0.3%, the Italian Air Force flew 0.2%, and Qatar and the UAE each flew less than 0.1%.<sup>3</sup> US forces flew nearly 90% of all strike-attack sorties, and nearly 85% of all strike, attack, and air defense sorties. US air forces dominated every aspect of reconnaissance, electronic warfare, and command and control activity. They flew 90% of all reconnaissance missions, 96% of all command and control missions, and 97% of all electronic warfare missions.

These figures on sortie numbers reflect the fact that US forces had superior numbers and power projection capabilities. They also reflect the fact that the air battles in Desert Storm were dominated by US air forces that were high technology forces, and which integrated attack and air defense aircraft with a complex mix of command and control, reconnaissance and targeting, intelligence, electronic warfare, and refueling and support aircraft.

Some aspects of this complexity are reflected in the range of different types of major combat aircraft shown in Table 6.2 -- which shows the maximum strength of US air units just before the air campaign began. Table 6.2 shows that the US had an effective monopoly of medium and long range bombers (F-111 and B-52G), the only "stealth" aircraft (F-117A), the only forward air control aircraft, the only gunships, and the only dedicated tank-killing close air support aircraft. The US had a near monopoly of dedicated electronic warfare aircraft like the EA-6B and EF-111, and while the Tornado and Mirage 2000 are excellent combat aircraft, the F-14B, F-15C, F-15E, and A-6E had an important margin of superiority in terms of strike and beyond visual range combat capabilities.

These unique US capabilities, which were reinforced by the US monopoly of cruise missile strike capabilities, have an importance that goes far beyond Desert Storm. It is easy to talk about cooperative security and coalition warfare. However, the reality is that the US brought air assets to Desert Storm that no other nation -- except possibly Russia -- could project into the theater. As was the case with the intelligence assets discussed in Chapter Five, other nations could make an important contribution to the air war, but no combination

of other Western and Third World nations could fight coalition warfare with anything approaching the capabilities of US air power.

Table 6.2

US Air Force Strength In Theater

<u>Type</u>	<u>Early</u>	<u>January, 1991</u>	<u>Final</u>
B-52G	0	80	80
A-10 ground-attack	108	132	144
F-15C/D interceptors	72	96	120
F-15E strike-interceptor	48	48	48
F-16 fighter-bomber	120	216	249
F-117A stealth strike	20	36	44
F-111E medium bombers	0	60	(84)
F-111F medium bombers	32	60	64
OA-10 forward air control	6	10	10
EF-111A electronic jammers	12	18	18
F-4G Wild Weasel anti-radiation missile	24	48	48
RF-4C	12	18	18

Source: Adapted from USAF briefing aid to Congress, March, 1991, and corrections by Lt. General Buster Glosson.

The full complexity of US air deployments is illustrated by the detailed air order of battle of all US military services during the peak period of Desert Storm shown in Table 6.3. Unlike tables which only show the strength of the US Air Force, or US combat aircraft, this table provides a picture of the massive size and sophistication of the air assets that the US was able to deploy. Table 6.3 also shows the critical role of rotary wing aviation, and allied air bases and infrastructure. US air units were located in more than 20 different locations in Saudi Arabia by the time that Desert Storm began. Even a comparatively small deployment like the US presence in Turkey involved over 130 planes. These included 28 F-15Cs for air superiority operations; a mix of 46 F-18C, F-111E, and F-4 strike airplanes; and a mix of 32 RF-4C, F-18C, and EF-111A Wild Weasel and electronic warfare aircraft. It also included 30 other support aircraft for AWACS, reconnaissance, tanking, and intelligence gathering.<sup>4</sup>



Table 6.3

US Air Power Deployed in Desert Storm on February 24, 1991 - Part One

<u>LAND-BASED</u>	<u>Fixed Wing</u>		<u>Rotary Wing</u>	
	<u>Combat</u>	<u>Support</u>	<u>Combat</u>	<u>Support</u>
<u>In Saudi Arabia</u>				
King Abd Al Aziz	62 AV-8B		18 OV-10	
King Fahd	132 A-10 8 AC-130 A/H		12 OA-10 27 C-130 2 EC-130	
NAF Jubayl			4 KC-130 (3rd MAW)	28 AH-1 23 CH-46 8 CH-53 18 UH-1
KKIA			46 KC-135A/Q/R	
Al Jahf (1st Armored Division, 3rd ACR)				4 HH-60
AA Midway (1st Armored Division, 3rd ACR)			36 AH-64 31 AH-1 57 OH-58	40 UH-60 6 EH-60
AA Roosevelt (1st Infantry Division)			18 AH-64 31 OH-58 8 AH-1	18 UH-60 3 EH-60 11 UH-1H
AA Hinesville/AA Columbus 12th Aviation Brigade, 24th Mechanized Division			56 AH-64 8 AH-1 31 OH-58	39 UH-60 3 EH-60 11 UH-1H 8 CH-47
AA Horse (1st Cavalry Division, 3rd Armored Division)			64 AH-64 21 AH-1 31 OH-58	32 UH-60 6 EH-60 11 UH-1H 8 CH-47
AA Bastogne (101st AA Division, 2nd ACR, 11th Aviation Brigade)			73 AH-64 34 AH-1S 97 OH-58	126 UH-60 54 CH-47 3 EH-60 41 UH-1H 12 UH-60V 8 MH-53 8 MH-60 11 OV-1D 7 RU-21H 5 RV-1D

Table 6.3US Air Power Deployed in Desert Storm on February 24, 1991 - Part Two

	<u>Fixed Wing</u>		<u>Rotary Wing</u>	
	<u>Combat</u>	<u>Support</u>	<u>Combat</u>	<u>Support</u>
Al Mishab (3rd MAW)			12 AH-1	36 CH-46 20 CH-53 12 UH-1
Ras Alghar (3rd MAW)				26 CH-53
Dhahran	48 F-15C		10 AH-1 1 AH-64 (XVIII ABN Corps)1 UH-1V	5 UH-60 44 UH-1H 24 UH-60V  58 CH-47 3 C-12
Al-Kharj	24 F-15C 48 F-15E 24 F-16A 18 F/A-16A	16 C-130		
Riyadh		2 E-8 11 E-3 7 RC-135 7 EC-130 10 KC-135Q 8 C-21 1 C-20		
Jiddah		4 C-130 62 KC-135A/E 13 KC-10 3 PC 2 EA-B		
At Taif	18 EF-111 66 F-111F			
Tabuk	24 F-15C			
<u>In Bahrain</u>	84 F-18A/C/D			
Shaikh Isa	20 A-6E 48 F-4G 12 EA-6B 18 RF-4C	4 KC-130		

Table 6.3US Air Power Deployed in Desert Storm on February 24, 1991 - Part Four

	<u>Fixed Wing</u>		<u>Rotary Wing</u>	
	<u>Combat</u>	<u>Support</u>	<u>Combat</u>	<u>Support</u>
Bahrain International			1 C-130 12 KC-130 2 EP-3 1 P-3B	
<u>In Qatar (Doha)</u>	24 F-16C			
<u>In UAE</u>				
Al Dhafra	72 F-16C		7 KC-135R	
Al Minhad	72 F-16C			
Bateen			16 C-130 6 EC-130	
Abu Dhabi			12 KC-135E	
Dubai			12 KC-135E	
Sharjah			16 C-130	
Al-Ayn			40 C-130	
<u>In Oman</u>				
Seeb			15 KC-135R 10 KC-10	
Masirah			1 EP-3 16 C-130 10 KC-135R 3 P-3C	
Thumrait			16 C-130	
<u>In Turkey (Incirlik)</u>	37 F-16 28 F-15C 18 F-111E 12 F-4G 6 RF-4C 6 EF-111		3 EC-130 3 E-3B 13 KC-135A	

Table 6.3US Air Power Deployed in Desert Storm on February 24, 1991 - Part Four

	<u>Fixed Wing</u>		<u>Rotary Wing</u>	
	<u>Combat</u>	<u>Support</u>	<u>Combat</u>	<u>Support</u>
<u>In U.K. and Outside Areas</u>				
RAF Fairford	8 B-52G			
Moron	22 B-52G			
Diego Garcia		5 KC-135R 7 KC-10 4 P-3C		
Cairo West		15 KC-135E		
<u>SEA BASED</u>				
<u>Persian Gulf</u>				
USS Midway	30 F/A-18 14 A-6E 4 EA-6B	4 E-2 4 KA-6D 6 SH-3H		
USS Ranger	20 F-14 22 A-6E 4 EA-6B	4 E-2 8 S-3B 4 KA-6D 6 SH-3H		
USS Roosevelt	20 F-14 19 F/A-18 18 A-6E 5 EA-6B	4 E-2 8 S-3B 4 KA-6D 6 SH-3H		
<u>Red Sea</u>				
USS America	20 F-14 18 F/A-18 14 A-6E 5 EA-6B	4 E-2 8 S-3B 6 SH-3H 4 KA-6D		
USS Kennedy	20 F-14 24 A-7E 13 A-6E 5 EA-6B	5 E-2 8 S-3B 3 KA-6D 6 SH-3H		

Table 6.3US Air Power Deployed in Desert Storm on February 24, 1991 - Part Five

	<u>Fixed Wing</u>		<u>Rotary Wing</u>	
	<u>Combat</u>	<u>Support</u>	<u>Combat</u>	<u>Support</u>
USS Saratoga	20 F-14 18 F/A 18 14 A-6E 4 EA-6B	4 E-2 8 S-3B 4 KA-6D 6 SH-3H		
<u>Arabian Sea/Gulf of Oman</u>				
4th MEB			15 AH-1	24 CH-46 14 CH-53 6 UH-1
5th MEB			20 AH-1	24 CH-46 4 CH-53 12 UH-1
13th MEU (SOC Afloat)			4 AH-1	12 CH-46 4 CH-53 2 UH-1

Source: Adapted by the author from Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 142-146, and various tables in US Air Force Gulf War Air Power Survey, April 15, 1993, and Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992. The reader should be aware that the rotary wing bed down is as of January 16, 1991, and the land-based support and carrier based aircraft strength is as of February 21, 1991. Data are not available on all forces for the same day.

## The Iraqi Air Force

As the discussion of the Iraqi Air Force in Chapter Three has made clear, there are conflicting estimates of Iraq's air strength before the Gulf War, many of which seem to reflect under counts of deliveries after 1987. Table 6.4 shows a typical overview of the strength of Iraqi forces as listed in open sources. There is no way, however, to be certain of what estimate of Iraq's operational strength is correct.

It is doubtful that Iraq had much more than 750 fixed wing aircraft operational in any kind of combat status.<sup>5</sup> If one looks at different estimates of Iraq's strength by aircraft type, it also seems likely that the Iraqi Air Force had two bomber squadrons with 7-12 Tu-22 Blinders, and 8-14 Tu-16 Badgers (including 4 PRC-made B/H-Ds). It had roughly 22 Fighter-ground attack squadrons: one with 16-48 Su-24s, five with 70-90 MiG-23BM/Ns (24 Flogger E and 50 Flogger F), four with 23-34 Mirage F-1EQ-200s with Exocet, and 35 Mirage F-1EQ5s and EQ6s), four with 40-60 Su-25A/Bs, 4 with 70 Su-20/Su-22s, 2 with 30 Su-7s, and 2 with 30 J-6s. According to some reports, it also had up to 40 MiG-27 Flogger Js.<sup>6</sup>

The Iraqi Air Force seems to have had 13-17 interceptor squadrons. Its all-weather fighters included 22 MiG-25A/Es, 35 Mirage F-1EQs, 35 MiG-29s. Its day fighters included 40 J-7s, and 206 MiG-21s.<sup>7</sup> This gave Iraq a total of at least 300 air defense aircraft. This count, however is somewhat misleading in that a number of Iraq's attack fighters were dual-capable in air defense roles. If these aircraft were added, Iraq's air defense assets would include 159 all-weather air defense fighters (35 MiG-29, 65 Mirage F-1EQ, 37 MiG-23G, 22 MiG-25A/E), and 246 day/visual flight rule fighters (206 MiG-21 and 40 MiG-23E).<sup>8</sup>

Iraq had one reconnaissance squadron with 5 MiG-21s and 7-8 MiG-25s, two types of Soviet-made remotely piloted vehicles (RPVs), and developmental versions of two Iraqi-built RPVs. The first was called the Al Yamamah-A, a multi-mission RPV carrying daylight and infra-red cameras. The second was called the Sarab-3, a modification of the British TTL-3 Banshee target drone. Iraq also had the Il-76 Candid that Iraq modified to act as an "Adnan" AEW aircraft. Iraq's aircraft were normally based at main operating air bases at H-3, H-2, Al-Asad and Al Taqaddum in the West; Qayyarah West, Tall Afar, Mosul, and Kirkuk in the north; Balad, Rasheed, Shayka Mazar, and Al Jarah in the center-east; and Kut al Hayy, Talil, Jalibah, and Shaibah in the south.<sup>9</sup>

As has been discussed earlier, the Iraqi Army air corps added at least 160 combat helicopters to Iraq's air strength, including 40-45 Mi-24 Hind with the AT-2 Swatter, 20-

50 SA-342 Gazelle (some with HOT), 56 Bo-105 with SS-11 and HOT, 30 SA-316B Alouette III with AS-12, and 10-13 SA-321 Super Frelons. Some of the Super Frelons were equipped with Am-38 Exocet and some with AS-12 missiles. Iraq's transport aircraft included two squadrons with 10 An-12s, six An-24s, two An-26s, 19 Il-76s, 19 Il-14s, and one DH Heron. Iraq had been using the Il-76 as a tanker since 1985, and had modified some of its MiG-23BNs (Flogger Hs) for airborne refueling by using the same system as on its Mirage F-1EQs.<sup>10</sup> The Iraqi Air Force had large reserves of training aircraft, including MiG-15s, MiG-21s, MiG-23Us, 2 Tu-22s, 16 Mirage F-1BQs, 50 PC-7s, and 21 EMB-312s.<sup>11</sup>

Table 6.4

Iraqi Air Strength in Desert Storm

<u>Element of Force Strength</u>	<u>August 1,</u> <u>1990</u>	<u>January 1,</u> <u>1991</u>	<u>February 1</u> <u>1991</u>	<u>April 1,</u> <u>1991</u>
<u>Air Force</u>				
Personnel	18,000	18,000	18,000	18,000
Fighters/fighter bombers	718	728	699	362
Bombers	15	15	9	7
Reconnaissance	<u>12</u>	<u>12</u>	<u>12</u>	<u>0</u>
Subtotal	745	755	720	369
Combat capable trainers	<u>370</u>	<u>400</u>	<u>400</u>	<u>252</u>
Total	1,115	1,155	1,120	621
Helicopters	517	511	511	481
Transports	76	70	70	41
Civil Transports	59	60	60	42
<u>Air Defense Force</u>				
Personnel	17,000	17,000	17,000	17,000
Surface-to-air missile Batteries	120	120	200	85
Anti-aircraft guns	7,500	7,600	7,600	5,850

Source: Adapted by the author from Eliot A. Cohen, ed., Gulf War Air Power Survey, Volume V, Part I, pp. 17-19.

In spite of Iraq's large numbers of combat aircraft, Coalition planners worried more about Iraq's surface-to-air missile and anti-aircraft defenses than its fighters. As Chapter Three has shown, Iraq had a low quality air force and did not correct its problems during the time provided by Desert Shield. Iraqi air activity fluctuated over the course of time during Desert Shield, and varied sharply from day to day. During August, Iraq normally flew 60-80 sorties per day, with peaks of 170-190 sorties during August 29-31, 1990. Iraq

flew about 80 sorties per day during September, with peaks of 115-123 sorties at the end of the month. Activity increased during October, with levels that often exceed 100 sorties per day, and which rose to peaks of 170-180 sorties during a few days where extensive training took place. Levels increased slightly in November, with a peak of 186 sorties on November 6, and rose to an average of over 140 sorties per day during December, with a peak of 231 sorties on December 29, 1990. Activity generally dropped below 70 sorties per day during the first two weeks of January, but rose to 221 sorties on January 12, 1991 and 142 sorties on January 13. (Iraq was evidently taking advantage of a rare day of good weather over the KTO to train just before the UN deadline expired).<sup>12</sup>

These activity levels are anything but impressive for an air force preparing to fight against a force of the size the Coalition was deploying. If one looks only at the tactical level, the US alone was flying about as many sorties per day in the combat air patrol mission during Desert Storm as the entire Iraqi air force was flying combat training sorties of all types. The US also flew 8,408 air-to-air combat training missions, and 37,805 air-to-ground training missions.<sup>13</sup> Other Coalition nations were far more active than the Iraqi air force. They flew a total of 4,532 combat air patrol missions, 11,045 air-to-ground training missions, 5,522 air-to-air missions, 512 AWACS missions, and 753 tactical and strategic reconnaissance missions.<sup>14</sup> Coalition aircraft also flew far more demanding training sorties in every combat mode, and trained as packages of forces and in a mode where they trained to fly as part of a unified air force.<sup>15</sup> Iraqi training had little realism in either the air-to-air or air-to-ground mode, and rarely attempted realistic force on force training.

Comparisons of Coalition and Iraqi air activity during Desert Storm reveal just how ineffective Iraq was in terms of effective strength. The Coalition flew a total of 112,000 sorties during the 43 days of Desert Storm, and over 90,000 combat related sorties. UN aircraft flew nearly 2,500 sorties the first day of the war, which dropped to around 2,000 sorties per day during January 17-21 because of weather factors, and then flew around 3,000 sorties per day for the rest of the war.<sup>16</sup> As Figure 6.1 shows, Iraq's air force flew less than 100 sorties the first day, and less than 55 sorties involving combat aircraft. Iraq flew nearly 120 sorties, the second day, but only about 25 combat sorties. From that point on, Iraq never flew more than 60 combat sorties per day, and by January 24th, Iraqi combat aircraft activity virtually ceased.

The Coalition flew a total of 69,103 combat or "shooter" sorties during Desert Storm, and Iraq flew around 430: About 0.006% of the Coalition total. The Coalition flew a total of 23,414 support sorties during Desert Storm, and Iraq flew around 180: About 0.008% of the Coalition total. In overall terms, the Coalition flew a total of 92,517 combat sorties during Desert Storm, and Iraq flew around 610: About 0.007% of the Coalition



total.<sup>17</sup> If one allows for the very different conditions of combat, the Iraqi Air Force ultimately proved to be less active against the Coalition during Desert Storm than the Kuwaiti Air Force had been against Iraq during the first two days of Iraq's invasion of Kuwait.

Figure 6.1

Iraqi Air Activity During Desert Storm

Source: Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, p. 204.

## Coalition Air War Planning and The Importance of Air Supremacy

The opposing sides differed fundamentally in terms of the integration of their air forces into an effective strategy and war plan. As has been discussed in Chapter Four, USCENTCOM acted as the de facto planner for all Coalition forces during much of Desert Shield, and steadily refined its air strategy to the point where it was able to develop a war plan that it could impose on its enemy with unique success.

### **Strategic Bombing and "Instant Thunder"**

The Coalition air strategy and war plan evolved out of an early US Central Command Air Force (USCENTAF) battle plan -- called "Instant Thunder." This plan was drafted by Colonel John A. Warden and a small group of experts in the US Air Force Air Staff in Washington. The Air Staff began this planning effort because USCENTAF lacked the staff to deal with both the immediate crisis and draft a detailed operational plan, and General Schwarzkopf had asked for this assistance on August 8, 1990. The resulting plan was called "Instant Thunder" to distinguish it from the slow grinding process of escalation symbolized by the "Rolling Thunder" campaign in Vietnam. It drew heavily on the ideas set forth in Warden's book, The Air Campaign, which emphasized using strategic bombing to achieve "decisive action" against leadership targets, oil and electricity, infrastructure, population, and fielded military forces.<sup>18</sup>

The first draft of this plan was completed in outline form on August, and was briefed to Schwarzkopf at USCENTCOM headquarters in Florida on August 10.<sup>19</sup> It focused on carrying out a decisive strategic bombing effort. As has been touched upon briefly in previous chapters, it had five major categories:

- o The first category was "leadership" and included two target sets: The Iraqi leadership -- which was to be disrupted and isolated -- and Iraqi C<sup>4</sup>I/BM -- which included Iraqi military C3 and civilian telecommunications.
- o The second category was "production" and had four target sets: Electric facilities, POL stocks and distribution, a key nuclear research facility in Baghdad, and military production and storage facilities -- including those for the Scud.
- o The third category was "infrastructure" and included railroads as a set with a key rail and a key road bridge as a subset.
- o The fourth category was population and had three sets: Iraqis, foreign workers, and the Iraqi military. It was a non-lethal effort focusing on psychological warfare and the delivery of leaflets and use of radio and television.

- o The fifth category was Iraqi forces in the field and had two target sets: The Iraqi land-based air defense system and the bombers, major strike aircraft, and missiles in Iraq's offensive forces.

This plan reflected Warden's theories about striking at a nation's "centers of gravity" and Schwartzkopf supported its focus on striking at the Iraqi leadership because of Saddam Hussein's extreme behavior and because a retaliatory plan was the only plan he had the assets to execute. At the same time, the draft plan was necessarily limited in scope, and reflected the fact that Warden and his staff had to plan an attack against a poorly understood target base. Its strengths were that it focused on decisive offensive action in an effort to simultaneously strike against every aspect of Iraq's military power and use offensive air power to help win air supremacy. Its weaknesses were that it gave no priority to attacking Iraqi ground forces. Seen from the wisdom of hindsight, the plan also exaggerated what strategic bombing could accomplish -- a problem that was to continue to affect planning for the air campaign throughout the changes made in the plan during Desert Shield, and which Chapter Seven shows led to significant problems in the strategic bombing effort during Desert Storm.<sup>20</sup>

General Schwarzkopf directed Colonel Warden to brief the plan to General Powell on August 11, 1990. General Powell expressed reservations about whether the plan could be executed with the resources then available and directed that a follow-on phase be developed to attack Iraqi armor. He also directed that Instant Thunder be transformed into a joint plan. During August 11-17, Colonel Warden revised the plan to add an Instant Thunder Phase II, with four additional goals: Winning air superiority over the KTO, attacking Iraq's stocks of chemical weapons, attacking Iraqi military C<sup>4</sup>I/BM capabilities in the KTO, and attacking Iraqi armored units inside the KTO. In the process, planners from the Joint Staff joined the Air Staff in drafting a plan that expanded to 180 pages of operations orders. The plan also came to have ten target sets instead of nine: It added Iraqi airfields and ports and combined Iraqi nuclear-biological-chemical (NBC) targets and regular Iraqi military production facilities.

Colonel Warden briefed General Schwarzkopf again on August 17, 1990. Colonel Warden and his staff, however, briefed on the revised attack plan against Iraq's "centers of gravity," and only one slide out of 35 addressed Iraqi ground forces. This slide only described the aircraft that could be used if Iraq invaded Saudi Arabia. (Four A-10, two AV-8B, three F/A-18, two AH-1W, and four AH-64 squadrons.) Schwarzkopf reacted favorably, and sent Colonel Warden and three of his staff to brief Lt. General Charles A Horner -- who was the Commander of USCENTAF, and who was then serving as USCENTCOM's forward commander in Riyadh, on the night of August 18/19, 1990.

## **The CENTAF Air Campaign Plan and the AirLand Battle**

At this point, however, General Horner's focus was on the risk of an Iraqi invasion of Saudi Arabia. He had been warned that an attack was imminent on August 17, and he asked Brigadier General Buster Glosson to assume responsibility for preparing a Joint Strategic Air Campaign on August 17. Brigadier General Glosson had already assumed responsibility as Deputy Commander of the Joint Task Force Middle East and was now given responsibility for developing an air campaign that included a strategic operational plan and tactical element that would then be used to prepare the operations order, execution order, and the air tasking order (ATO) for the first 48 hours of the campaign.

During August 17-20, CENTAF had created its own plan for air operations to defend Saudi Arabia called the "D-Day Game Plan." This plan focused on using air power to hit Iraqi ground force concentrations, key choke points, and Iraqi follow-on forces. It called for EF-111s and F-4Gs to escort other aircraft in deep penetrations, and for other aircraft to fly armed reconnaissance within a grid system somewhat similar to the more complex "kill box" system adopted later in the war. It was already developed to the point of creating an ATO, and CENTAF had also created its own "strategic" plan to strike at targets in Iraq which directly supported an Iraqi offensive.

Sources differ over the exact sequence of events that took place when Colonel Warden briefed General Horner on August 20, 1990, but General Horner was focused on a fundamentally different approach to using air power and evidently felt that the Air Staff had interfered with his command prerogatives and was repeated the kind of external interference in the major commander's planning efforts that had taken place during Vietnam. Horner asked the three planners who had assisted Colonel Warden to stay in Riyadh, but Colonel Warden returned to Washington.<sup>21</sup>

It was at this point that Brigadier General Glosson formed the Special Planning Group (SPG) or "Black Hole" discussed in Chapter Four. The SPG rapidly expanded the CENTAF plan to improve its effectiveness against invading Iraqi ground forces, to include a more realistic and surgical strategic bombing effort (although it kept 60 of the 78 original strategic targets), and to focus on targets outside Baghdad as well as in the city, and to include attacks on Iraqi ground forces.<sup>22</sup> At the same time, General Schwarzkopf decided to include the broader strategic bombing effort called for in Instant Thunder in the CENTAF air plan as his retaliatory option. This decision created the four phase war plan discussed in Chapter Two: (I) Strategic air campaign based on Instant Thunder, (II) Air superiority over Kuwait to permit unchallenged use of the skies, (III) attrition of Iraqi ground forces, destruction of the Republican Guard, and reduce ability to deliver chemical weapons, and (IV) eject Iraqi forces from Kuwait.

General Schwarzkopf briefed this plan to the Secretary of Defense and Chairman of the Joint Chiefs on August 25, and a more detailed revision was briefed to General Powell in Riyadh on September 12. By mid-September, the plan had reached a form that Brigadier General Glosson felt could actually be executed if Iraq attacked. It is important to note, however, that Lt. General Horner and Brigadier General Glosson never saw the phases in the plan as sequential and always felt that Phase II would have to be executed simultaneously with Plan II, and that the CENTAF planning effort never disregarded the need to plan to attack Iraqi ground forces.<sup>23</sup>

As is discussed in Chapter Five, the Special Planning Group (SPG) then continued to expand and refine the air war plan to the point where it called for air power to destroy much of the Iraqi ground forces in the KTO before the ground war began. The revised plan was then formally briefed to the Joint Chiefs on October 10, 1990, and to the President on October 11. Brigadier Glosson had inputs from Warden's staff in part of this planning effort, although he stressed the need to give high priority to attacking the Republican Guard. Other members of the Coalition became informally involved in September, the RAF formally joined in the effort in October, and RSAF planners were formally integrated into the planning effort in late November. At each step in this process, air war planning improved in sophistication, and in its use of new technologies and weapons. This process of innovation, and "ideas and action" continued throughout the actual air campaign, and as Chapter Seven makes clear, important changes took place in Coalition air tactics and targeting until virtually the last day of the war.

This process of evolution is reflected in the fact that the names of the four phases of the war were changed to reflect the increase in the size of Coalition forces and the scope of the air campaign and AirLand battle. The title of Phase I, the "Strategic Air Campaign", remained the same, although it should be noted that it included early attacks on the Iraqi Republican Guards and other key Iraqi ground forces from the start. The name of Phase II, however, was changed from "Kuwait Air Campaign" to "Air Supremacy in the KTO" (which included many areas outside the KTO in Iraq) largely to make it easier for civilians to understand. The name of Phase III was changed from "Ground Combat Attrition" to "Battlefield Preparation" and the name of Phase IV was changed from "Ground Attack" to "Offensive Ground Campaign". While these changes are minor, they consciously or unconsciously reflected the steadily more confident and aggressive attitude of the Coalition planners, and the fact that the air planners came more and more to see these phases as simultaneous activities in which the focus shifted to concentration on support of the AirLand battle over time.<sup>24</sup>

Further major reviews of the CENTAF plan took place on November 8, and November 14. By mid-November, the air plan included a long air campaign to destroy the Iraqi ground forces before the AirLand battle began that was tailored to support General Schwarzkopf's plan to launch a major "left hook" from the West. Lt. General Horner briefed further revisions to the plan to Secretary Cheney and General Powell on December 20, and this became the basic war plan -- although further detailed revision continued after the air war began on January 17, 1991 and continued until the cease-fire.

The basic Coalition combat activities in each phase of the war are shown in Table 6.5.<sup>25</sup> It is important to note that by January, enough air power had arrived in theater so that the phases of the air campaign had ceased to be sequential -- although the original division of the air effort into phases still affected some aspects of planning -- and the Coalition was in a position to begin carrying out the first three phases of the war plan nearly simultaneously. This build-up in air strength and ability to attack all major targets at once, vastly increased the shock value of applying decisive force. It also increased the ability of air power to play a more decisive role than in previous conflicts.

Throughout the planning effort, winning and maintaining air supremacy as quickly as possible was viewed as the key to conducting "unhindered" air and ground options. Planning also focused on using air power to isolate and incapacitate the Iraqi leadership, and destroy Iraq's known NBC warfare capability. It focused on using air power to eliminate Iraq's offensive military capability by destroying key military production, infrastructure, and power capabilities, and on attacking sufficient Iraqi armor and artillery to make the Iraqi Army ineffective for combat and cause its collapse.

Winning early air supremacy was critical because the Coalition war plan was dependent upon the use of air power to win the ground and naval battles. The final Coalition plan for a ground offensive called for a highly demanding war of maneuver which exploited both surprise and deception. Its key objectives were to draw Iraq's reserve forces away from the main attack by exploiting deception, feints, and two supporting attacks -- although Coalition planners did not have to make surprise a pre-requisite for success because Iraq lacked the force numbers and maneuver capabilities to counter the Coalition "left hook" from the West.. The supporting attacks were supposed to defend the right flank of the main attack from a counterattack by Iraq's tactical reserves, draw forces away from the main attack, and block Iraqi LOCs. The main attack was to bypass Iraqi forces and attack west of the Kuwaiti border, occupying a position to the West of the Republican Guards Forces Command (RGFC) to prevent a successful counterattack by Iraq's strategic reserve and attack the RGFC.

The ability to execute these maneuvers in a way that achieved surprise depended heavily on the ability of Coalition air defenses to prevent Iraqi air reconnaissance. It also depended on air supremacy over much of the battlefield and of the ability of Coalition aircraft to reduce the effectiveness of Iraqi ground forces -- including those deep in the northern part of the KTO -- by 50% before the ground offensive began. Phase One -- the strategic air campaign, and Phase Two -- preparation of the battlefield -- were both designed to support these goals.

Once the land attack began, the Coalition was to complete the envelopment of the Republican Guards Forces Command in the KTO with a US corps sized armored force positioned West of the Republican Guards Forces Command (RGFC) and a US corps-sized armored force that was positioned south of the RGFC. The Coalition was to use psychological operations (PSYOPS) to degrade Iraqi morale; Special Operations forces for deception, direct action, and surveillance; and ground-based electronic warfare to disrupt Iraqi communications from corps to brigade before the Western supporting attack began, and after the first supporting attack began. Calling Phase IV the "offensive ground campaign," however, was a misnomer. Phase IV relied on the full implementation of the AirLand battle, and it required continuing air supremacy to protect Coalition land force operations and to allow Coalition strike/attack aircraft to freely carry out interdiction missions and deep strikes.

There was also a close relationship between the air and naval war plans. Naval forces provided extensive air support to the air and air land campaigns from both carrier aircraft and ship-based missile and gun-fire platforms. The objectives of the naval component of the Coalition forces were to support the air campaign with carrier-based aircraft, and cruise missiles, to ensure sea control, provide mine countermeasure operations in the Northern Gulf, and strike at shore facilities threatening naval operations. At the same time, naval and amphibious forces were to conduct feints and demonstrations during Phase IV of the campaign to keep Iraqi forces deployed along the coast, while being prepared to conduct amphibious operations and line up with the 1 MEF near Ash Shuqaybah. At the same time, the naval forces were to support the maritime interception operations, and defend the coastlines of Saudi Arabia, the UAE, Qatar, Bahrain, and Oman, and also patrol adjacent maritime areas. These naval maneuvers, however, required air supremacy to protect them from the Iraqi Air Force.

### **Planning for Air Supremacy and the Shift to Simultaneity**

This interdependence between the campaign for air supremacy and the rest of the offensive campaign, and the need for simultaneous action in all key use of airpower, are important lessons of the Gulf War. So is the fact that every aspect of air war planning and



the Coalition air build-up involved a steadily escalating effort to win air supremacy, and suppress Iraq's ground-based air defenses. As time went on, for example, the air war plan was modified to include a much more sophisticated strike plan against Iraqi ground-based air defenses. This strike plan expanded from 84 targets to more than 300. This expansion reflected the result of improved planning and targeting capabilities and the fact that the number of aircraft with precision strike and laser designation capabilities rose from fewer than 75 aircraft early in Desert Shield to over 107 in mid-August, and to more than 200 after November. Once the air campaign actually began, war planning also had to be revised to shift from air base suppression to shelter killing, and seeking and killing dispersed aircraft.

This need to expand and reshape the offensive aspect of the battle for air supremacy is also an important lesson for future wars. The USAF lacked meaningful contingency plans for major regional conflicts at the time that Iraq invaded Kuwait to fight a battle for air supremacy. As a result, both "Instant Thunder" and the CENTAF planning effort that followed had to be rushed forward in ways that under-estimated the size of the strategic bombing effort needed to support the battle for air supremacy, as well as every other aspect of strategic bombing. USCENTAF was forced to constantly revise and expand its war plan, Kuwait, and Chapter Two provides a strong indication that Coalition forces lacked the strength and sustainability to win air supremacy with anything like the speed that was achieved in Desert Storm until mid September and possibly late November to mid-December.<sup>26</sup>

Fortunately for the Coalition, Iraq's passivity gave the Coalition the time it needed. The Coalition had the time to deploy both the aircraft it needed, and the required support systems and C<sup>4</sup>I/BM capabilities. The Special Planning Group had the time to prepare an air war plan that could win the war for air supremacy, and implement all of the goals set forth in USCINCENT's broader war plan. By mid-January, the Coalition could pose "strength against weakness," and could count on being able to exert "decisive force" in all of the areas needed to win the air campaign and support the AirLand battle. Coalition forces had high confidence of winning early and effective air superiority, and superior ability to acquire intelligence throughout the theater, including "unimpeded access to space."

Iraq also gave the Coalition the time that it needed to create the battle management capabilities to win the war for air supremacy. As the Department of Defense report on the war points out, "At the beginning of Operation Desert Shield force deployment, there essentially was no existing US military command, control, communications, and computer (C<sup>4</sup>) infrastructure in the region. By mid-January, the Coalition had established the largest C<sup>4</sup> network ever assembled."<sup>27</sup>

This experience strongly argues that full scale war planning to win air superiority or air supremacy in major regional contingencies like the Gulf and Korea should be completed in peace time in order to prepare for a sudden or surprise attack, and should then be regularly updated. So does a detailed review of the day-to-day problems that occurred in deploying an effective fighter screen, deploying and integrating the airborne C<sup>4</sup>I/BM net, providing suitable refueling assets, minimizing the risk of hostile encounters between Coalition aircraft, creating an air management system and suitable zones for fighter and ground-based air defense operations and a host of other factors. The more one examines the details of the preparation for winning air supremacy, the greater the achievement of the Coalition air forces appears. At the same time, so do the problems that Coalition air forces had to overcome during the months before the air campaign began.<sup>28</sup>

Table 6.5

Coalition Theater Campaign Plan and Military Objectives

<u>Theater Objectives</u>	<u>Phase 1</u> Strategic <u>Air Campaign</u>	<u>Phase 2</u> Air Supremacy <u>in the KTO</u>	<u>Phase 3</u> Battlefield <u>Preparation</u>	<u>Phase 4</u> Ground Offensive <u>Campaign</u>
Attack Leadership/C <sup>3</sup>	X	X	X	X
Win Air Supremacy	X	X		
Cut Supply Lines X	X	X	X	
Destroy NBC Capability	X		X	
Destroy Republican Guards	X		X	X
Liberate Kuwait City				X

Adapted from Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, p. 99, corrected by Lt. General Buster Glosson.

**The Iraqi Air War Plan -- or Lack of It**

Iraq's strategy for air combat during the Gulf War was a sharp contrast to the strategy chosen by the Coalition. Rather than seeking to actively engage Coalition air forces, Iraq chose a defensive strategy that attempted to use its fighters, land-based air defenses, and passive defenses to force the Coalition into a costly battle of attrition. This Iraq rejected the offensive use of air power during at least the initial phases of the war, and depended on the ability of Iraqi air defenses to inflict high losses on Coalition aircraft when they penetrated Iraqi-controlled air space.

This strategy for fighting an air war was as passive as Iraq's actions during Desert Shield. It meant that an air force that had never been particularly effective during the Iran-Iraq War -- and which was much slower in reacting and less cohesive than its opponent -- had to be almost completely reactive to the actions of its enemy. It meant that Iraq had to absorb damage while relying primarily on its land based air defense during the air phase of the war, and could only use its aircraft to strike selectively at UN air forces or land targets for political or strategic purposes.

Iraq's success ultimately depended on its ability to effectively mass and use its air force to attack vulnerable Coalition air and land operations once the land battle began. This, however, meant that Iraq could not even begin to act effectively if it did not have survivable and effective ground-based air defenses and command and control system, and if Iraq's sheltered and dispersed air assets could not survive the Coalition air campaign.

Like so much of Iraq's strategic planning, this approach to the air war exhibited a fundamental conceptual failure to understand the nature of its opponent. It might have made sense against a regional air threat like Iran that was limited in scale, technological sophistication, and endurance. However, Iraqi planners should have understood from US and NATO and US exercises, Israel's victory over Syria in 1982, and even from the US use of air power in Vietnam that they were not dealing with Iraq. Once again, they prepared to refight their last war while the Coalition prepared to fight the next.

## Winning Air Superiority

The Coalition battle for air superiority and air supremacy did not start with Desert Storm. The Coalition flew a total of 13,887 combat air patrol missions before Desert Storm began, and was able to test and refine its air defense system long before the actual fighting. As was the case in preparing for the land battle, the Coalition carried out a massive series of air training activities and exercises, and prepared the battlefield before the air campaign formally began.

Just before Desert Storm, the Coalition executed a deception plan that mixed sudden surges of sorties with periods of lower activity. It flew defensive missions in the same orbits that it later used for offensive missions, and claimed before the start of the war that it was putting aircraft on ground alert because it feared an Iraqi offensive. It flew F-16s in place of F-15C air defense sorties to allow the F-15C forces to build-up their maximum surge capability. During the final days before Desert Storm, the number of Coalition aircraft also rose to 2,430 fixed wing aircraft -- about 25% of which belonged to countries other than the US. About 60% of these aircraft were combat aircraft or "shooters".<sup>29</sup>

The Coalition began the air campaign -- and Desert Storm -- at 3:00 am., on January 17, 1991.<sup>30</sup> Coalition strike aircraft and tankers assembled outside the range of Iraq's land based early warning radars. Three USAF MH-53 Pave Low special operations helicopters (which had GPS receivers and advanced low light vision and navigation aids) led nine AH-64 attack helicopters in a long earth-hugging attack to destroy two of Iraq's early warning radars about 21 minutes after the war had begun.

By this time, F-117 Stealth fighters had already passed over the helicopters on their way to destroy the key intercept operations center (IOC) in Southern Iraq, and then the regional air defense sector operations center (SOC). Almost precisely at H-Hour, the first two F-117s delivered the first strikes over Baghdad. A second wave of attackers that included 30 F-117s struck at H-plus 3 hours, and the Coalition launched 54 TLAMs. These forces which struck 45 target sets in the first hours of the war, 20 of which were in Baghdad. The targets included key air defense sites, C<sup>4</sup> sites, electric power plants, and leadership sites. By the end of the second day (D+2) the US Navy had fired a total of 216 TLAMs against Iraq, 64% of the total fired during all of Desert Storm.<sup>31</sup>

The Coalition had launched a carefully coordinated mix of B-52s armed with air-launched cruise missiles, Tomahawk sea-launched cruise missiles, F-117 Stealth fighters, AH-64 attack helicopters, and F5-E and Tornado GR1 strike fighters. US air and missile attacks had hit Iraqi command and control facilities, communications systems, air bases, and land based air defenses. AH-64 Apache attack helicopters knocked out Iraq's forward radar system, sea-launched cruise missiles hit critical communications targets, and F-117 stealth attack fighters struck Iraq's most heavily defended targets with precision weapons.

This, however, was only the beginning. As Table 6.1 shows, the Coalition flew a total of 13,075 defensive counter air sorties during Desert Storm, 10,670 sorties that attacked Iraqi air capabilities, and a little over 2,900 electronic warfare sorties. It is important to note that only a handful of the 13,075 defensive counter-air sorties involved any kind of encounter with Iraqi aircraft, and that almost as many sorties were flown in offensive strikes against Iraqi air capabilities on the ground to protect against Iraqi aircraft in the air.

The principal aircraft the US used in the defensive counter-air effort included about 100 USAF F-15Cs and 100 US Navy F-14As, plus 89 US Navy F/A-18s in a dual role. As Table 6.12 shows, the US Navy performed a far larger proportion of the defensive counter-air missions -- including ship protection patrol missions -- than of the interdiction, air support, and offensive counter-air missions. The key allied air defense aircraft included 69 Saudi F-15Cs and 24 Tornados, 18 British and 18 Canadian Tornados, 12 French Mirage 2000s, and 12 Bahraini F-16s. Coalition combat air patrol aircraft were able to fly

some 340 sorties per day, and won virtually every air-to-air battle as well as struck repeatedly at Iraqi ground targets.

Defensive counter-air operations, however, were only part of the story. A wide range of Coalition aircraft flew offensive counter-air sorties, and many strike/attack aircraft were dual capable in the air combat role. The key air activity in the battle for air supremacy included:

- o Bahraini F-16s: 152 defensive counter air sorties, and 14 offensive counter-air sorties.
- o British Tornado F-3s: 696 defensive counter air sorties.
- o British Tornado GR1s: 740 offensive counter air sorties.
- o Canadian CF-18s: 693 defensive counter air sorties, and 144 offensive counter-air sorties.<sup>32</sup>
- o French Jaguars: 50 offensive counter-air sorties.
- o French Mirage 2,000s: 340 defensive counter air sorties, and 172 offensive counter-air sorties.
- o French Mirage F-1-CRs: 8 offensive counter-air sorties.
- o Saudi Arabian F-5s: 62 offensive counter-air sorties.
- o Saudi Arabian F-15Cs: 1,940 defensive counter air sorties, and 140 offensive counter-air sorties.<sup>33</sup>
- o Saudi Arabian Tornado ADVs: 451 defensive counter air sorties.
- o Saudi Arabian Tornado IDSs: 75 offensive counter-air sorties.
- o USAF B-52s: 82 offensive counter-air sorties.
- o USAF F-4Gs: 2,676 offensive counter-air sorties.
- o USAF F-15Cs: 4,558 defensive counter air sorties, and 1,109 offensive counter-air sorties.
- o USAF F-15Es: 136 offensive counter-air sorties.
- o USAF F-16s: 432 defensive counter air sorties, and 1,110 offensive counter-air sorties.
- o USAF F-111Es: 134 offensive counter-air sorties.
- o USAF F-111Fs: 720 offensive counter-air sorties.
- o USN F-14s: 2,802 defensive counter air sorties, and 607 offensive counter-air sorties.
- o USN F/A-18s: 1,436 defensive counter air sorties, and 291 offensive counter-air sorties.
- o USMC F/A-18s: 1,978 defensive counter air sorties, and 677 offensive counter-air sorties.

This use of allied air assets in air defense missions was conducted with an astounding lack of "blue on blue" collisions and fratricide, and allowed the US to concentrate its dual-capable aircraft on the attack mission, and to make more effective use of the offensive assets of the USAF. The US flew 67% of all counter-air missions, versus 85% to 90% of the other missions.<sup>34</sup> Similarly, combat air patrol zones were organized so that high performance RSAF and USAF F-15 air defense aircraft could operate over the most threatened areas in the KTO while other allied aircraft operated over the Gulf to defend Saudi and southern Gulf air space. The value of this specialization by country and mission capability is another lesson of the war.

### **Air to Air Combat**

The Coalition's performance in air-to-air combat was one of the great successes of the war. During Desert Shield, various experts made a wide range of predictions about air losses. In one USAF briefing chart, the "optimists" predicted a .005 loss rate (150 aircraft over 30,000 sorties). They predicted that these aircraft losses would result in 25% of all air crew killed, 25% captured, and 50% rescued or able to return to friendly territory. Another estimate of losses projected 10-15% losses of the total force with 3% losses on the first day, and 0.5% losses per day thereafter. Estimates by "pessimists" predicated an average daily loss rate of 2%, similar to that of Israel in 1967, although some estimating 3%. References were also made to a worst case estimate similar to the 10% loss rate suffered by US and British Bombers in worst days of 1943.<sup>35</sup>

Coalition air planners were more optimistic. USCENTAF informally predicated that the Coalition would lose no more than 80 aircraft. Brigadier General Glosson told President Bush on September 12, 1990, that losses would probably be less than 50 during whole campaign. Several Generals in the Royal Saudi Air Force and UAE Air Force were equally optimistic because of Iraq's poor performance during the Iran-Iraq War.<sup>36</sup>

In the event, even the most "optimistic" estimates turned out to be "pessimistic." In spite of the fact that Iraq had more than 750 operational combat aircraft, 24 main operating bases, 30 dispersal bases, and a massive network of some 3,000 surface-to-air missiles, it flew only 50 sorties on the first day of the war, and an average of only 30 sorties per day during the first week of the war. Fighter sweeps of Coalition F-14s and F-15Cs killed five Iraqi fighters in the first air defense sweep of the war, and the Coalition rapidly established that a combination of the E-3A AWACS, F-15Cs, and AIM-7C radar-guided missiles was extremely lethal. The Coalition soon converted from large fighter sweeps to smaller combat air patrol groups. In contrast, Iraq lost 39 aircraft during the first week and 14 of them in air-to-air combat. It lost 16 of its best aircraft (Mirage F-1s, MiG-29s, and MiG-25s) in air-

to-air combat by January 24, and 33 fixed wing and 5 rotary wing aircraft to Coalition fighters by the end of the war.<sup>37</sup>

The overall pattern of air combat activity is shown in graphic form in Figure 6.2, which compares Iraqi air activity to Coalition air-to-air kills and overall Coalition air-to-air sortie activity. While Iraq seems to have counted on finding and killing isolated or vulnerable Coalition aircraft, it never had the opportunity to do so. Coalition air forces were so superior that Iraq failed to win more than one air-to-air engagement. An Iraqi MiG-25 may have shot down a USN F/A-18 on the first night of the war.<sup>38</sup> The total pattern of Coalition combat losses during the entire war is shown in Table 6.6. The Coalition lost a total of 38 aircraft in combat, and 15 aircraft to other causes, during the entire war. It shows that the only major risk was from Iraqi surface-based air defenses, which killed some 22 Coalition aircraft.

Even the data in Table 6.6, however, understate the Coalition's achievement. The Coalition's ratios of 33:1 in air-to-air kills did not equal Israel's record of 85:0 against Syria in June, 1982, but Syria deliberately flew its air force into an Israel killing zone as a political gesture, and the combat conditions are not comparable. Ratios of air-to-air kills are also only one measure of the effectiveness of an overall battle for air superiority. Table 6.7 broadens the comparison to show losses and damage in terms of losses per sortie flown.

The Coalition loss rate was only 0.00055 for all 69,103 shooter sorties. This compares with loss rates of 0.00261 to 0.00783 during different periods of Vietnam. As a result, the UN survivability rate exceeded the normal survivability of aircraft involved in peacetime exercises.<sup>39</sup> The Coalition's survival rate per sortie was also notably higher than in previous wars. Air losses averaged about 0.01 loss per sortie in World War I and World War II, or about 1%. They dropped to 0.0017 loss per sortie in Korea, or 0.17%, and then to 0.00081 loss per sortie in Korea, or 0.081%.<sup>40</sup>

Figure 6.2

Iraqi Air Activity Versus Coalition Air-to Air Combat Activity

Iraqi Flight Activity Versus Coalition Kills

Coalition Air-to Air Sorties

Source: Adapted from Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume II, Part II, Washington Department of the Air Force, 1993, pp. 120 and 121.



Table 6.6Coalition Air Losses in Combat During Desert Storm

<u>Country/Service</u>	<u>Aircraft Type</u>	<u>AAA</u>	<u>IR SAM</u>	<u>Radar SAM</u>	<u>Other</u>	<u>MiG-25</u>	<u>Unknown</u>	<u>Total</u>
				Direct	Enemy Action			
USAF	A-10	0	4	0	0	0	0	4
	AC-130	0	1	0	0	0	0	1
	EF-111	0	0	0	1	0	0	1
	F-15E	1	0	1	0	0	0	2
	F-16	1	0	2	0	0	0	3
	F-4G	1	0	0	0	0	0	1
	OA-10	0	2	0	0	0	0	2
	<b>Total</b>		<b>3</b>	<b>7</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>0</b>
USN	A-6E	2	0	1	0	0	0	3
	F-14	0	0	1	0	0	0	1
	F/A-18	0	0	0	0	1	1	2
	<b>Total</b>	<b>2</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>6</b>
USMC	AV-8B	2	3	0	0	0	0	5
	OV-10	0	2	0	0	0	0	2
	<b>Total</b>	<b>2</b>	<b>5</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>7</b>
Total US		7	12	5	1	1	1	27
Saudi Arabia	F-5	0	0	0	0	0	1	1
	Tornado GR1	1	0	0	0	0	1	2
	<b>Total</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>3</b>
UK	Tornado GR1	1	1	4	0	0	1	7
Italy	Tornado GR1	0	0	0	0	0	1	1
Kuwait	A-4	0	0	1	0	0	0	1
<b>Grand Total</b>		<b>9</b>	<b>13</b>	<b>10</b>	<b>1</b>	<b>1</b>	<b>4</b>	<b>38</b>

Source: Adapted from: Eliot A. Cohen, ed., Gulf War Air Power Survey, Volume V, Part II, Washington Department of the Air Force, 1993, p. 641.

Table 6.7

Coalition Air Attrition in Desert Storm Due to All Causes

<u>Country/Service</u>	<u>Aircraft Type</u>	<u>Total</u> <u>Sorties</u>	<u>Aircraft Damaged</u>		<u>Aircraft Lost</u>	
			<u>No.</u>	<u>Per 1,000 Sorties</u>	<u>No.</u>	<u>Per 1,000 Sorties</u>
USAF	A-10	7,983	13	1.6	4	0.5
	AC-130	101	1	9.9	1	9.9
	B-52G	1,741	5	2.9	0	0
	EF-111	1,105	0	0	1	0.9
	F-111F	2,420	3	1.2	0	0
	F-15C	5,674	1	0.2	0	0
	F-15E	2,142	0	0	2	0.9
	F-16	13,066	4	0.3	3	0.2
	F-4G	2,678	0	0	1	0.4
	OA-10	657	1	1.5	2	3.0
	<b>Total</b>	<b>37,657</b>	<b>28</b>	<b>0.7</b>	<b>14</b>	<b>0.4</b>
USN	A-6E	4,800	4	0.8	3	0.6
	F-14	3,916	0	0	1	0.3
	F/A-18	4,316	0	0	2	0.5
	<b>Total</b>	<b>13,032</b>	<b>4</b>	<b>0.3</b>	<b>6</b>	<b>0.5</b>
USMC	A-6E	793	4	0.8	3	0.6
	AV-8B	3,349	2	0.6	5	1.5
	F/A-18	4,934	8	1.6	0	0.0
	OV-10	482	0	0	2	4.1
	<b>Total</b>	<b>9,558</b>	<b>11</b>	<b>1.2</b>	<b>7</b>	<b>0.7</b>
Allies	A-4	651	0	0.0	1	1.5
	F-5	1,129	0	0.0	1	0.9
	Jaguar	571	4	7.0	0	0.0
	Tornado GR1	2,482	1	1	9	10
	<b>Total</b>	<b>4,833</b>	<b>5</b>	<b>8</b>	<b>11</b>	<b>13</b>

Source: Adapted from: Eliot A. Cohen, ed., Gulf War Air Power Survey, Volume V, Part II, Washington Department of the Air Force, 1993, p. 641.

There was no single cause of the Coalition's victories in air-to-air combat, although technology, training, and boldness were certainly the primary causes. Iraq's strategy aided the Coalition, and Iraq faced several critical technical limitations in air-to-air combat. The Coalition had decisive force, and was able to exert massive air cover of its positions, and over the battlefield, while simultaneously attacking Iraq. The Coalition flew a total of 13,075 counter-air sorties in the 43 days of Desert Storm vs. 13,887 combat air patrol sorties in all of Desert Shield. Iraq had nothing approaching the E-3A AWACS, or a fighter with the long range kill capabilities of the F-15C or F-14. It had nothing approaching the UN's electronic warfare capability. It had nothing approaching the automated air-to-air combat ranges used by the key Coalition air forces, and it had little capability to fight beyond visual range combat.

As a USAF analysis of Iraq's performance noted,<sup>41</sup>

"...the overall performance of the Iraqi air force in Desert Storm in air-to-air combat was abysmal...Although Iraqi pilots sometimes started encounters with decent set ups, the consistent and overriding pattern evident in debriefs of kills by US F-15 pilots indicates a startling lack of situational awareness by their Iraqi adversaries. In general, the Iraqi pilots shot down did not react to radar lock-ons by Coalition fighters. They attempted very little maneuvering, either offensive or defensive, between the time when the intercept radar locked on to them and the time when they were hit by air-to-air missiles (or, ...before running into the ground)."

### **The Role of Key Aircraft Types in Air Combat**

All of the Coalition's advantages over Iraq in air combat are lessons of the Gulf War. This, however, makes it impossible to precisely assess the relative value of a given advantage. The E-3A, for example, was a major force multiplier, but the advantages that it provided cannot be compared in any quantitative sense to the advantage provided by the F-15C. The Gulf War showed that the F-15C was a highly effective air-to-air combat aircraft. It shot down 31 Iraqi aircraft, killing 23 with the radar-guided AIM-7 and eight with AIM-9 infra-red guided missiles.<sup>42</sup>

At the same time, the Gulf War tells little about the F-15C's capability relative to the MiG-29 or the other advanced fighters in Coalition forces. Iraq lacked the competence to use its advanced fighters effectively, and the way in which responsibility for given air defense sectors was assigned ensured that the F-15C would dominate the Coalition's victories in air combat. Although the US flew 67% of the air defense sorties in Desert Storm -- versus more than 90% of other types of combat sorties -- the combat air patrols over the KTO were generally flown by about 100 USAF F-15C and 69 RCAF F-15Cs.<sup>43</sup>

The USN F-14A had a longer range kill capability than the F-15C, but lacked the F-15s ability to provide non-cooperative target recognition and hostile identification of friend or foe interrogation. Using the F-14A presented a risk of "blue on blue" encounters in the dense air-to-air combat environment over the KTO. In most wars, the F-14A would have been used to engage beyond visual range targets in spite of these problems, but because Coalition air power dominated the skies without it, the F-14A operated under much stricter rules of engagement. As a result, the F-14A only flew six intercepts during the war.<sup>44</sup>

The F/A-18 was a dual role fighter, and played a major role in providing air cover and suppression of enemy air defenses (SEAD) -- but the 89 USN F/A-18s had only limited air engagement opportunities. The threat proved so limited that the 18 Canadian CF-18s switched from the air combat to the attack role. Even before the limits to the Iraqi

threat became apparent, the USMC F/A-18s -- which had dominated air patrol activity during Desert Shield (4,461 combat sorties to 3,580 for all USAF aircraft) had been switched to strike/attack and SEAD missions.<sup>45</sup>

The USAF F-16s and 12 Bahraini F-16s were also dual-role fighters, but the fact that Iraqi fighters ceased operation so quickly meant that they could be reserved for the attack role. The 12 French Mirage 2000s, 24 RSAF Tornado ADVs, and the 12 RAF Tornado F3/ADV generally flew outside the normal range of air-to-air engagements -- although the RAF Tornados attempted some engagements. This use of the Mirage 2000 and Tornado was a product of the lack of any meaningful Iraqi threat, coupled with the fact that the USAF found it easier to integrate its own F-15Cs, the E-3As, and special purpose aircraft into air combat teams in ways that eliminated any risk of "blue on blue" encounters. It was not a reflection of the air combat capability of the Mirage 2000 or Tornado and neither fighter was really tested in air combat.<sup>46</sup>

### **Air-to-Air Missiles and the Importance of Beyond Visual Range Air Combat**

It is clear, however, that beyond visual range (BVR) combat proved to be particularly valuable in ensuring the Coalition's success. The USAF and Saudi F-15C had a decisive advantage in long range radar detection and air-to-air missile capability, as did a number of other Coalition aircraft. The E-3A AWACS provided extraordinary situational awareness, and the ability to ensure that Coalition aircraft could fire without fear of hitting friendly aircraft. As a result, beyond visual range combat (BVR) played a decisive role for the first time in history.

As Table 6.8 shows, over 40% of the Coalition air-to-air kills came from AIM-7 radar guided missiles. The AIM-7 achieved 23 kills for 67 missiles fired, and 16 kills were achieved beyond visual range. In contrast, none of the Israeli kills in 1982 were achieved under beyond visual range conditions. It is not clear, however, how the AIM-7 would have compared with other long range radar-guided missiles like the AIM-120A AMRAAM and AIM-54 Phoenix, since these missiles were not used. It is also important to note that advanced shorter range infra-red missiles also played an important role and that the AIM-9M Sidewinder got six kills for 11 firings.<sup>47</sup>

The Gulf War validated the need for a steady upgrading of existing air-to-air missiles and for the acquisition and deployment of more advanced beyond-visual-range air-to-air missiles like the AMRAAM. It also demonstrated the value of basing this upgrading on demanding test and evaluation and combat validation. Both the US Aim-7 and Aim-9 had been subject to this process as a result of problems exposed during Vietnam and lessons from Israel's experience with the systems. This greatly improved their capability.<sup>48</sup>

The AIM-7s used in Desert Storm were far more advanced than earlier versions of the missile, which were far less successful in combat. They were vastly superior to the AIM-7s which had proved to be a failure in Vietnam during the early 1960s. The AIM-7F had doubled the warhead size and adopted solid-state electronics. The AIM-7M - the primary version of the missile used in the Gulf War -- added another major mix of improvements in the AIM-7M -- which was the primary version used in the Gulf War. The AIM-7P added still more capability, including sixteen times the memory expansion and twice the processor speed of the AIM-7M. It was modified to attack low altitude targets, including anti-ship missiles, and had the ability to receive mid-course up-link information in the same format provided to the Navy's Phoenix, the AMRAAM, and the Standard. As a result of the Gulf War, the US is likely to upgrade the AIM-7 even further, and provide the AIM-7R with better terminal phase control, IR-seeker capability, and electronic countermeasures.

The AIM-9 Sidewinder is one of the oldest names in air-to-air missiles, but the AIM-9M used in Desert Storm represented generations of improvement. Even so, the AIM-9 will receive infra-red countermeasure improvements as a result of Desert Storm, and the improved AIM-9R will substantially improve range, countermeasure, and clutter rejection capability.<sup>49</sup>

The added range provided by air-to-air missiles like the AIM-54 Phoenix (100 NM+) was never exploited during the Gulf War because the F-14 did not engage Iraqi fighters. It is obvious from operational logs, however, that the ability to use the E-3A or an AWACS platform, and improved IFF gear, solved many of the previous engagement problems in long-range beyond visual range combat, and that firing opportunities occurred at long ranges and some firing opportunities were lost because of range limitations in the AIM-7.<sup>50</sup> The AIM-120A AMRAAM, with a 30+ mile range, was deployed to the Gulf, but could not be used on the F-15C because the radars had false target problems and there was a risk of "blue on blue" engagements. The USAF 33rd Tactical Fighter Wing, deployed at Tabuk, did have the AMRAAMS but did not use them. In future wars, it should provide better kill capability than the AIM-7, since it has less weight and longer range. The AMRAAM is already being upgraded in terms of ECM, propulsion, signal process, detectors, fuses, warhead, and wings.<sup>51</sup>

It is also obvious that the advanced APG-63 and APG-70 radars and computer, related avionics, and software capabilities of the F-15C were of great value. They provided excellent range (100 NM) and look-down shoot-down capability (clutter resistant against drones flying at 500 feet). The value of this electronic kill capability had already been repeatedly demonstrated in Israel, and in Saudi patrols against Iran. The F-15C's radar

demonstrated the ability to spot the MiG-25 and MiG-29 before Iraqi pilots became aware they were under attack, and its avionics then aided the pilot with automatic targeting and lock capability, digital radar control, and an advanced heads up display.<sup>52</sup> All of these capabilities proved to be of value, but Iraqi pilot training and air control was so poor that there is no way to make realistic comparisons of the inherent advantage an F-15C may have over the MiG-25 and MiG-29 based. Similarly, US air-to-air engagement training was so superior that it is difficult to make dogfight and energy of maneuver comparisons.

More broadly, the value of this mixture of advantages in beyond visual range combat capability, missiles, radars, avionics, and air combat training cannot be separated from the advantages provided by Coalition air strikes on Iraqi ground-based radars and ground-controlled intercept sites, Coalition efforts to kill and suppress Iraqi ground-based aircraft and air defenses, and the Coalition's overwhelming advantage in electronic warfare aircraft.<sup>53</sup> It is clear that all these advantages were important but it is not possible to rank or weight them.

Table 6.8

Iraqi Air Losses in Air to Air Combat

<u>No. of Kill</u>	<u>Date</u>	<u>Coalition Shooter</u>	<u>Iraqi Loss</u>	<u>Kill by</u>
1	17 Jan	F-15C	MiG-29	AIM-7
2		F-15C	Mirage F-1	AIM-7
3		F-15C	Mirage F-1	Grounding
4		F-15C	Mirage F-1	AIM-7
5		F-15C	MiG-29	AIM-7
6		F-15C	MiG-29	AIM-7
7		F/A-18 (USN)	MiG-21	AIM-9
8		F/A-18 (USN)	MiG-21	AIM-7
9	19 Jan	F-15C	MiG-25	AIM-7
10		F-15C	MiG-25	AIM-7
11		F-15C	MiG-29	Grounding
12		F-15C	MiG-29	AIM-7
13		F-15C	Mirage F-1	AIM-7
14		F-15C (RSAF)	Mirage F-1	AIM-7
15	24 Jan	F-15C (RSAF)	Mirage F-1	AIM-9
16		F-15C (RSAF) (2)	Mirage F-1	AIM-9
17	26 Jan	F-15C	MiG-23	AIM-7
18		F-15C	MiG-23	AIM-7
19		F-15C	MiG-23	AIM-7
20	27 Jan	F-15C	MiG-23	AIM-9
21		F-15C	MiG-23	AIM-9
22		F-15C	MiG-23	AIM-7
23		F-15C	Mirage F-1	AIM-7
24	28 Jan	F-15C	MiG-23	AIM-7
25		F-15C	MiG-23	AIM-7
26	2 Feb	F-15C	IL-76	AIM-7
27	6 Feb	F-15C	MiG-21	AIM-9
28		F-15C	MiG-21	AIM-9
29		F-15C	Su-25	AIM-9
30		F-15C	Su-25	AIM-9
31		A-10A	helicopter	30mm gun
32	7 Feb	F-14 (USN) (2)	Mi-8	AIM-9M
33		F-15C	Su-7/17	AIM-7
34		F-15C	Su-7/17	AIM-7
35		F-15C	Su-7/17	AIM-7
36		F-15C	Attack helo	AIM-7
37	11 Feb	2 X F-15C	helicopter	AIM-7
38	15 Feb	A-10A	Mi-8	30mm gun
39	20 March	F-15C	Su-22	AIM-9
40	22 March	F-15C	Su-22	AIM-9
41		F-15C	PC-9	grounded

Source: Adapted from: Eliot A. Cohen, ed., Gulf War Air Power Survey, Volume V, Part II, Washington Department of the Air Force, 1993, p. 654.

## The Coalition Battle Against Iraqi Surface-to-Air Missile Forces

Iraqi surface-to-air missile forces had more success than Iraq's fighters in attacking Coalition aircraft, but as Table 6.8 has shown, this success was still extraordinarily limited. This is particularly the case if one considers the strength of the Iraqi air defense system. As has been discussed in chapter Three, Iraq had approximately 129-130 surface-to-air missile sites and complexes, and 18 major surface-to-air missile support facilities. These included 20-30 operational SA-2 batteries with 160 launch units, 25-50 SA-3 batteries with 140 launch units, and 36-55 SA-6 batteries with well over 100 fire units.<sup>54</sup> Baghdad had more dense air defenses at the start of the Gulf War than any city in Eastern Europe, and more than seven times the total surface-to-air missile launcher strength deployed in Hanoi during the height of the Vietnam War.

The extensive coverage of Iraq's heavy surface-to-air missile defenses is shown in Figure 6.3. Yet, this system only killed 10 Coalition aircraft with radar-guided missiles, some of which included shorter range radar-guided missiles, during the entire war.<sup>55</sup> This had a negligible impact on an air war where the Coalition used an average of 1,600 combat, and 540 combat support aircraft per day, and which flew a total of nearly 70,000 combat related sorties.

### **The Counter Surface-to-Air missile Effort and the Value of Penetrating Bombs**

Coalition aircraft encountered some initial problems in dealing with Iraq's surface-to-air missiles because of weather (a weather front stalled over Iraq on the third day of the war and remained there for three days), which led to the difficulty of synchronizing the arrival of mixed packages of attackers and defenders, and the diversion of some key aircraft to the "Scud hunt." Iraqi air defenses shot down eight Coalition aircraft during the first week of Desert Storm.

Even during the first few days of the war, however, the Coalition executed a counter-surface-to-air missile strategy that had an immediate impact on Iraq's capabilities. Even before Desert Storm, the Coalition had used electronic surveillance aircraft like the RC-135 and EP-3, and wide-area reconnaissance aircraft like the TR-1 and U-2, to locate and characterize the Iraqi threat. On the first day of the war, the Coalition began to attack Iraq's Sector Operating Centers, early warning sites, and command and control nodes. F-117s and TLAM missiles attacked air defense centers.

During the first two days of the war, the Coalition used A-10s to strafe reporting posts in remote areas of Iraq. The A-10s flew over 110 sorties the first day, 20 the second,



and flew 23% of the shooter missions against the KARI system. The A-10 was not used again until three days before the ground war began because General Schwarzkopf wanted to preserve them for the ground campaign.

F-117s flew 30 strikes during this period against hardened targets like the KARI Sector Operating Centers (SOCs) and the Interceptor Operations Centers (IOCs). The first two waves of F-111s attacked twenty-one air defense nodes, normally using I-2000 penetrating laser-guided bombs. At the same time, the Coalition sent F-111Fs with I-2000s to attack other targets; airborne decoys to provide false tracks to Iraqi radars; and aircraft equipped with anti-radiation missiles mixed with bombers to attack Iraq's surface-to-air missile units. F-117s and F-111s flew 20% of all strikes against KARI targets during the war.

The value of such penetrating weapons -- which played an equally important role in attacking other critical targets -- is one of the lessons of the Gulf War. The I-2000 bomb was an improved 2,000 pound bomb with a slimmer and harder case than the regular 2,000 pound bomb. It contained 54 pounds of tritonal high explosive in its BLU-109 blast warhead, versus 945 pounds in the regular bomb, and its case was a single forged piece of one inch of steel. It was mated with a laser guidance kit to form the GBU-101, GBU-24 A/B or GBU-27 -- depending on the delivery aircraft and the altitude and type of release. The F-117 generally delivered one such weapon against a target, while an F-111F would deliver two to four bombs against a target. The F-111Fs dropped a total of 897 GBU-24A/Bs during the entire war, and the F-117s dropped 739 GBU-27s.

It is not possible to determine the exact effect of these strikes because the Coalition determined that a facility was killed if it ceased functioning, and could not precisely estimate the physical damage inside a facility. A number of SOCs were abandoned almost immediately, and inspection later showed they had not been penetrated at all. Other sides kept operating in spite of repeated attacks, and the bombing did not destroy communications between sites, which proved far more survivable than the Coalition air planners originally estimated. Portions of the system kept regenerating throughout the war.<sup>56</sup>

The I-2000s were scarcely perfect hard target killers. After the war, the USAF found that it had a requirement to provide increased range and higher lethality, to develop a warhead structure that would not be deflected upwards by loose concrete rubble, and to develop a more powerful warhead, and a "smart" fuse that could be set from the launch aircraft to explode after penetrating a given number of rooms or floors, or reset to explode on contact, if the aircraft had to divert to a secondary target. Some sources provide data indicating that Coalition air planners became over-confident and used too few bombs. Pre-

war tests showed that it took about four I-2000s to kill one hard target and Coalition planners -- using a half of function as a measure of kill capability -- often cut the number used in a given attack to only one to two bombs.<sup>57</sup> Key air planners state, however, that they realized they could not destroy commander bunkers and felt that repeated strikes of this kind provided the ability to disrupt the activity of the Iraqi leadership.<sup>58</sup>

At the same time, the value of guided penetration weapons in bunker and shelter busting rapidly became as much a lesson of the war as the general need to improve hard target kill capability. Iraq had four types of bunkers. These included bunkers under buildings, which presented problems, because the bomb was generally deflected by the building structure before it hit the shelter. They also included shelters deep in mountains that were difficult to find and attack. The I-2000 did, however, prove effective against the more common earth covered bunker, which had 20 feet of earth over reinforced concrete, and may have worked against some super hardened bunkers -- which had sixteen feet of earth covering 6.5 feet of reinforced concrete above a five-foot prefabricated steel mat.

### **Strikes Against Iraq's Ground-Based Air Defense System**

Coalition planners saw land-based air defenses as a more serious and enduring threat than Iraq's fighters. As a result, the Coalition also flew a series of 25 large strikes against Iraq's ground-based air defense system using suppression of enemy air defense (SEAD) aircraft. A typical "package" of such aircraft -- that struck targets near Baghdad during the first 40 minutes of the war included 12 F-4G Wild Weasels with HARM, 3 EF-111 ECM aircraft, 6 BQM-74 drones, 2 EA-6B jammer aircraft with HARM, 10 F/A-18 with HARM, 8 A-7 with HARM, and 4 A-6s with tactical air-launched decoys (TALDs).

In the south, BQM-74 drones were deliberately fired over Iraqi positions to stimulate radar activity, where the EF-111 jammed, forcing Iraq to use maximum radar power. F-4G Wild Weasels with HARMs then killed the Iraqi radars. In the west, EA-6Bs jammed, causing radar activity, and A-7s and F/A-18s used HARMs to attack the radars. The EF-111s initially flew in the direct support role, providing target-area suppression by flying between the target and the attack force. The EA-6s flew behind their strike groups.

The Coalition eventually flew a total of 630 strikes against some part of the KARI system, and used a wide variety of aircraft in addition to precision strike systems. These aircraft included F-16, F-11E, F-15E, Tornado GR1, F/A-18, A-6E, and B-52 aircraft, which flew 58% of all the strikes on the Iraqi system.

The Coalition attacks exploited the fact that gaps existed in the coverage of the Iraqi surface-to-air missile system, while Iraq's SA-2, SA-3, and SA-6 missiles were concentrated around key urban areas and Iraqi air bases. This meant there were many parts of the KTO with only limited long-range surface-to-air missile coverage. Further, the

effectiveness of the KARI system depended on the survival of a network of some 55-85 radars and related command centers, and on Iraq being able to maintain high levels of radar activity.

As a result, the Coalition had several options for selectively attacking the Iraqi air defense system, for suppressing it, or for avoiding it. It was not necessary to attack and destroy all of Iraq's surface-to-air missile sites. The Coalition could attack each key part of the Iraqi system separately, and create corridors through which it could pass to attack key targets. Suppressing Iraqi radar activity allowed the Coalition to attack the less dense parts of the system at will, and fly medium to high altitude missions with comparatively safety. There were also many areas in the KTO and Iraq where the Coalition could simply bypass the long range surface-to-air missile sites and only face a threat from Iraq's shorter range air defenses.

These vulnerabilities in the Iraqi system are important because many similar Third World systems have much the same vulnerabilities or even greater ones. The Iranian air defense system, for example, is substantially less effective than the Iraqi system was before the Gulf War. There are grave technical problems and vulnerabilities in the Syrian system and in that of Libya and North Korea. Most other European, Warsaw Pact and Chinese supplied systems have even more severe weaknesses.

### **The Value of Anti-Radiation Missiles and Decoys in Air Defense Suppression**

The value of anti-radiation missiles suppressing Iraqi radars is illustrated by the fact that the Coalition used a total of 2,151 anti-radiation missiles during Desert Storm. These missiles included a total of 2,039 US HARM and other anti-radiation missiles and 112 British air-launched anti-radiation missiles (ALARM). The USAF fired 1,120 missiles (55% of the total), the US Navy fired 679 (33%) and the USMC fired 240 (12%). Almost all of these missiles were HARMs, because the older US Shrike missile had too short of a range to safely engage Iraq's air defenses. It is interesting to note that the total number of anti-radiation missiles was 28% of the total of 7,659 air-to-surface missiles fired during the war, and 12% of the total of 18,127 precision air weapons used during the war, including laser guided bombs.<sup>59</sup>

The HARM anti-radiation missile played a particularly important role in suppressing Iraqi air defense activity. The AGM-88 HARM is a joint development system of the USN and USAF that is about 4.17 meters long, weighing 360 kilograms. It uses a passive radar seeker and advanced processor, and has a 66 kilogram pre-fragmented high explosive warhead. Like the AIM-7 and AIM-9, it demonstrated the advantage of steady upgrading, demanding testing and evaluation, and combat validation.

The AGM-88Bs used in the Gulf had been upgraded to use a PROM memory that allowed external programming of software changes to meet the threat, and was on its fourth generation of software. It could be fired in a target of opportunity, pre-briefed, and self-protect mode. A command launch computer aided the programming and launching of the missile, and US aircraft like the F-4G, and EA-6B had on-board electronic support measures (ESM) to locate enemy emitters and allow the HARM to be launched on long-range off-axis attacks, and have its flight corrected in mid-course. Since the war, the HARM has been steadily upgraded, and is getting a new seeker. Some USAF experts believe, however, that the war shows that there is need for a new missile, with about twice the range of the HARM, and that US airpower needs new hard kill weapons that can destroy land-based air defenses, rather than disrupt them.<sup>60</sup>

When the US fired some 200 HARMs on the first night of the war, this changed the behavior of Iraqi air defenses to the point where it caused the near shut down of Iraqi radars. A massive reduction took place in Iraqi radar activity by the third day of the war, and the played a critical role in giving Coalition aircraft near sanctuary against Iraq's heavy surface-to-air missiles at altitudes above 10,000-15,000 feet. By the fourth day of the war, the Coalition attacks on key command and control facilities and sensors in the Iraqi KARI air defense network were successful enough so that strike aircraft, accompanied by "packages" of jammer and anti-radiation missile aircraft, could focus on other targets. At the same time, jamming aircraft patrolled key areas, and "roving surface-to-air missile killers" like the Wild Weasel roamed over the theater, locating and firing at active radar emitters.

The roving F-4Gs with HARM were so effective in suppressing Iraqi radar activity that they came to be known as the "Weasel police." Iraq was so intimidated by these aircraft that the F-Gs no longer had to fly with individual strike packages, but could cover 30-40 attack formations. None of the aircraft lost to Iraqi radar guided surface-to-air missiles during the Gulf War were covered by F-4Gs. The 35th Tactical Fighter Wing, which was the main Wild Weasel formation firing the HARM, fired 905 missiles and recorded 254 radars destroyed, for a 28% success rate.<sup>61</sup>

In addition, the RAF used six Tornados which had been modified to carry the British ALARM anti-radiation missile. This missile was rushed into service just before the Gulf War and was still developmental when it went into combat. It is about 4.3 meters long and weighs 265 kilograms. It uses a Marconi wide band passive radar seeker, a mission control unit, a forward looking range finding fuse, strap down inertial navigational unit, and a high explosive fragmentation warhead. The ALARM is designed to be highly autonomous because the RAF lacks the special purpose aircraft in US inventory. It can be programmed

by a ground station or aircraft, and can be used in a direct attack mode by penetrating aircraft, in a corridor or wide-area suppression mode, in a loiter mode (using a parachute to increase wait time, in a dual mode where it uses a long trajectory to search for late switch on, and in a high altitude launch mode.<sup>62</sup>

It was this "on-line kill capability" to use anti-radiation missiles to suppress Iraq's radar's -- rather than the physical destruction of Iraq's surface-to-air missile units and radars -- that did the most to make Iraq's ground-based air defenses ineffective. This success is measured in Figure 6.4, and it is clear that Iraq's entire sensor system was crippled by D+3. Coalition aircraft acquired virtual sanctuary at altitudes above 10,000 feet, and the Coalition only had eight more aircraft killed or damaged during the rest of the war. Yet, even Figure 6.4 understates the effectiveness of the radar suppression effort. It does not measure other radar activity like counter-battery and Scud radars, and POW interviews indicate that Iraqi units became so scared of the HARM and other anti-radiation missile attacks that these radars virtually ceased operation as well.

The US showed the value of deception in suppressing Iraq's ground-based air defenses. It used programmable BQM-74C drones as decoys to get Iraq to turn on its radars early in the war, and make them vulnerable to anti-radiation missiles. This tactic proved to be highly effective in some cases. The BQM-74C is a three meter-long drone that flies at 300-550 NM/H at a range of about 450 nautical miles. It can fly at altitudes up to 500 to 40,000 feet and has an endurance of about an hour. It uses special radar augmentation devices so that it appears to be a high priority aircraft. It can be flown in preprogrammed flight, but requires some operator assistance.<sup>63</sup>

The US also used a new system called the ADM-141 Tactical Air-Launched Decoy (TALD). The TALD was an expendable unpowered decoy about the size and weight of a 500 pound bomb, and US Navy and Marine Corps aircraft like the F/A-18, A-6, A-7, and S-3 could launch up to eight TALDs per aircraft from altitudes of 100-40,000 feet. Once launched, a TALD could glide up to 83 miles at speeds of 250 to 500 knots, and it had both an active and passive radar return to simulate an incoming fighter. US forces launched large numbers of TALDs during the initial phases of the air attack. These launches confused the Iraqi air defense system -- which "saw" each decoy as an incoming aircraft. They led to large numbers of pointless Iraqi missile launches, and helped excite Iraqi radar activity that could then be attacked by anti-radiation missiles.<sup>64</sup>

The combined value of attacks on radars, anti-radiation missiles, and decoys is a key lesson of the war. Since the Gulf War, the US is upgrading the F-15C and F-16 to improve their SEAD intelligence gathering capability. It is eventually replacing its F-4G Wild Weasels with these aircraft in the late 1990s, while adding secure data links to aircraft like

the JSTARS and ELINT aircraft to provide improved targeting data and programming information. If the plan is fully funded, all 72 F-15Cs will be upgraded to give them the capability to fire HARMs, followed by upgrades to the last block of 72 F-16s that will add a HARM targeting system and improved mission integration capabilities. It will also upgrade the ALR-56M radar warning receiver on other F-16s to provide better accuracy for firing the HARM. The US has decided not to provide such aircraft with the APR-47 emitter location and characterization system used in the F-4G because it is so heavy that it requires a dedicated aircraft. This will leave the US with more HARM-capable aircraft, but they will be more reliant on external intelligence and targeting data, and the F-16 will only have one pilot. These changes are driven as much by the need to cut the cost of US forces, however, as by any decision regarding the merit of dedicated anti-radiation missile (ARM) launch aircraft.<sup>65</sup> Although preliminary tests of the F-16 in the SEAD role have been successful, the use of this aircraft still presents a risk because it is unclear that a single man aircraft can perform the world load of a two man aircraft like the F-4G.<sup>66</sup>

At the same time, the Gulf War shows the need to be able to counter anti-radiation missiles. The Coalition had a de facto monopoly of such systems. Large numbers of such missiles are being exported by nations like Russia, Britain, France, and the US, however, and there is a clear need to provide more advanced countermeasures to such missiles for Western and friendly forces. It is far from clear how cost-effective such efforts can be in the near term. Efforts to provide decoy emitters have produced large costly systems, and interruption means losing capability. It is clear, however, that a counter-ARM effort has high priority.

This is why the US is expanding its counter-radar strike capabilities to include strikes that are capable of killing an entire radar site with one weapon and of striking non-emitting radars using Maverick and the Joint Stand-off Weapon (JSOW). At least some senior USAF officers would like to replace the mix of HARM and jamming with an aggressive first strike kill capability that would destroy a nation's radar capability, and reduce the requirement for follow-up. Lt. General Buster Glosson, who led much of the ATO activity during the Gulf War stated,<sup>67</sup>

"With today's precision weapons and standoff capabilities, we're not going to deal with radars the way we dealt with them in the past. We are going to obliterate that site and everything in its close proximity...So when you turn on the radar in the future, it is not going to do any good to turn it off when a HARM is in route. Because once you turn it on, you're going to die....There will always be a need for a limited HARM capability, but were not going to ride the back of HARM to do all the SEAD for us."

There is also no reason that radar killing may have to depend on manned aircraft. It is interesting to speculate on what would have happened if the USAF had succeeded in deploying the long-range long-endurance UAV it had designed to loiter over the battlefield and attack radar emitters. While the USAF version of this system encountered serious technical problems, Israel has already deployed a shorter range system. A radar hunting and killing UAV might have played a significant role in Desert Storm, and a number of countries other than Israel are now refining their own approach to such a system.

Figure 6.3

Range of Iraqi Early Warning Radars and Heavy Surface-to-Air Missiles

Source: Eliot A. Cohen, Gulf War Air Power Survey, Volume IV, Part I, p. 185. or better, combine tables in Eliot A. Cohen, Gulf War Air Power Survey, Volume II, Part II, pp. 132 and 134.



Figure 6.4

Iraqi Surface-to-Air Missile/EW Radar Activity During the Gulf War

Source: Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, p. 202.

## **Iraq's Shorter Range Surface-to-Air Missiles: The Other Side of the Story**

Iraq's shorter range surface-to-air missiles presented a different kind of threat, although a very real one. According to US estimates, Iraq had 137-154 medium surface-to-air defense sites in Iraq (plus 20-21 in Kuwait). These sites were widely dispersed, and those that used missiles, infra-red guidance did not require the use of radar, and could be fired on a target of opportunity basis. The missiles deployed on the sites in Iraq included at least 20 SA-8 batteries with 30-40 fire units, 60-100 SA-9 fire units, and 50 to 66 Rolands.<sup>68</sup> Iraq also had 6,500 SA-7, 400 SA-9, 192 SA-13s, and 288 SA-14 short range missile fire units; it had 972 anti-aircraft artillery sites, 2,404 fixed anti-aircraft guns, and 6,100 mobile anti-aircraft guns.

Separate US estimates indicate that Iraq had dispersed extensive numbers of crew/vehicle deployed SA-9s and SA-13s, and man-portable SA-14s, and SA-16s throughout the KTO. They also indicate that Iraq had deployed more than 3,700 anti-aircraft guns in the KTO with barrels larger than 14.5 mm, and that these medium to heavy AA guns were supplemented by more than 10,000 guns with barrels of 14.5mm or less in the ground forces in the KTO that could be used in some form of anti-aircraft role. While such weapons lacked accuracy, range, and high lethality, they could be deployed to expose aircraft flying under 10,000 feet to substantial cumulative risk and had been the dominant cause of aircraft losses in many previous wars.<sup>69</sup> This led Brigadier General Glosson to restrict most Coalition flying to altitudes above 10,000 feet until the ground campaign began.

As a result, the Coalition did not experience serious losses to shorter range Iraqi surface-to-air missiles and air defense guns during Desert Storm. It lost a total of nine aircraft to anti-aircraft artillery, 13 aircraft to infra-red guided short-ranged surface-to-air missiles, and 10 aircraft to radar guided surface-to-air missiles of all types.<sup>70</sup> Although Iraq had large numbers of such systems, it had organizational and training problems in employing its weapons effectively, and Coalition radar suppression was as effective against Iraq's radar-guided shorter range systems as against its long-range surface-to-air missiles.

Nevertheless, the Coalition was scarcely able to ignore such systems. Air Vice Marshall William J. Wratten, the British Deputy Commander and Air Commander in the Gulf War, summarized the strengths and weaknesses in the Iraqi ground-based air defense system as follows,<sup>71</sup>

" They (the Iraqis) were far less efficient in using their radar guided missiles because they...chose not to hold the radar guidance on our aircraft for a sufficient length of time. Rather, they would switch it on initially and then

barrage fire radar-guided missiles, and then switch the radar guidance off. So, in effect, the missiles were ballistic -- which is rather wasteful and totally inefficient.

"...They did have a basic early-warning system in that even if their radar sites were taken out...provided them with early warning...They seemed to have some sort of basic telephone system...whereby an ingressing package would be heard or seen and the airfields would be warned, and this wall of triple A (anti-aircraft artillery) would go off.

"...Their infra-red missiles were sometimes effective, but their only strength, their only threat to aircraft, stemmed primarily from his visually laid triple A, which only are effective up to a given height. They did have some radar laid triple A, but the majority of it was either visually laid or not laid at all. It was simply just pointed skywards and fired. Some of the larger airfields did have a significant ring of triple A around them, so by cross-aiming there was not alternative for us but to either fly through it or get jolly close to it. So everyone concluded at about the same time -- all of those of us who were operating at low level and the Tornado wasn't the only aircraft -- that there really was no point in pursuing it. We needed to get up out of the low-level air defense threat and... pursue other means of weapons delivery."

The Coalition decision to fly medium altitude missions for ingress, weapons release, and egress had its operational costs. It degraded the effectiveness of some Coalition strike missions. Chapter Seven shows that medium altitude missions with dumb bombs or area munitions proved to inflict only limited damage, in spite of greatly improved navigation aids, and the use of advanced radar bombing. This led the commander of the Strategic Air Command and the commander of USAFE to seek authority to fly the B-52 and F-111 at lower altitudes.

Brigadier General Glosson rejected these pressures. Iraq's low level air defenses would certainly have increased the attrition of Coalition fixed and rotary wing aircraft in combat if the Coalition had not decided to fly its fixed wing aircraft at altitudes above 10,000-15,000 feet wherever possible, and limit the operation of the A-10, helicopters, and a number of other special purpose aircraft to areas where they faced only a limited threat. As it was, infrared guided missiles and anti-aircraft artillery were still a chief cause of the Coalition's limited fixed-wing losses.

The fact that helicopters took only limited losses to Iraqi short ranged air defenses, and that only 17 short-ranged missiles were fired at helicopters -- with all of them seeming to miss -- may also not be typical of future wars.<sup>72</sup> Helicopter losses were limited by the

fact that the Iraqi air defenses were shattered before helicopters were employed in large numbers. Helicopters were used most extensively where deception achieved surprise, and since Iraqi ground troops in the KTO were often so disrupted, they could not use their assets.

Further, helicopter losses might have been substantially higher if Desert Shield had not given the Coalition time to correct an intelligence failure. As the US Army began to deploy what later became a massive force of helicopters, it assigned a new priority to analyzing the Iraqi short-range surface-to-air missile threat. In the process, it found that Iraq had many more SA-14 and SA-16 systems than it had previously estimated, and had developed tactics to mix the use of such missiles with SA-8s, SA-9s, and with warning data from other radars.

This revised estimate was a contributing factor in a countermeasure program that led the US Army to rush in more than 3,000 radar jammers, countermeasure systems, and radar warning receivers to deal with the threat during Desert Shield, and had "force fed" its helicopters with additional survivability equipment like the AN/ALQ-144A improved infra-red jammer system, AN/ALQ-136 Quick Jam radar jammer, and APR-39A (V) 12 radar warning receiver. This cost \$10 million to fix the problem that would never have been possible without months of warning and preparation.<sup>73</sup> As Chapter Nine discusses, both Britain and France had to improve the counter measure capabilities of their helicopters as well.

The key lesson from this experience is that shorter range air defenses can be countered if the threat is properly characterized, if suitable countermeasures are available, if appropriate air tactics are adopted, and if a combination of air defense suppression and stand-off strike capability allow fixed and rotary wing aircraft to be effective while operating outside the most lethal range of such defenses. The Gulf War reinforces the lesson of past conflicts that forces the need to be trained and ready for short-range air defense suppression and avoidance before a conflict. It also highlights the need for highly-trained and highly- sophisticated forces. The Coalition would have had far higher losses if it had not made use of sophisticated avionics and countermeasures, radar suppression systems, and stand-off targeting and strike capabilities.

## **Air Base Attacks and Killing Iraqi Aircraft in Their Shelters**

The successful exploitation of this combination of air combat capability, SEAD aircraft, and attacks on Iraq's ground-based air defenses, led USCENTCOM to estimate that it had achieved decisive air superiority as early as January 17. Coalition air forces achieved enough air superiority by January 20, to steadily expand their attacks on Iraq's air defenses

to key headquarters, civil and army communications, electric power plants, and Iraq's facilities for the production of weapons of mass destruction, and the Coalition attacks were so effective that they only left three of Iraq's 16 IOCs operational by D+7.

To win decisive win air supremacy, however, the Coalition had to destroy the ability to the Iraqi Air Force to ride out the air campaign in survivable air bases and shelters. This explains why the Coalition flew a total of 2,990 strikes against such Iraqi air bases during the war -- a mission which ranked second in weight of effort against the 23,430 strikes against Iraqi ground targets.<sup>74</sup>

The Coalition began by focusing on air base suppression. It struck virtually all of the military airfields in Iraq during the first three days of the war, concentrating on strikes against runways, taxiways, ramp space, hangars, and munitions areas. These strikes concentrated on the twenty-six main air bases in Iraq, but also attacked two more bases in Kuwait, twenty-one deployment bases, and nineteen dispersal bases capable of providing instrument approaches and fuel. The Coalition averaged over 60 sorties a day against airfields, and continued to strike them until the end of the war.<sup>75</sup>

### **The Tornado GR1 and JP233**

While a number of aircraft attacked Iraqi air bases, the RAF's Tornado GR1s were assigned the key mission of runway suppression during the first days of the air campaign. The Tornados were assigned the mission for a number of reasons. The US had previously treated runway suppression secondary mission and was only equipped with the lighter French Durandal bomb. Using the Tornados to attack Iraqi air bases also freed the US to use its limited numbers of F-117s and F-111F to use precision bombs against other targets. In contrast, the Tornado units were trained and equipped for the mission, could use the JP233 airfield attack munition -- although the high cost of the JP233 had precluded extensive training with the munition before the Gulf War.<sup>76</sup> Each GR1 aircraft carried two JP233s. The JP233 combines the ability to crater a runway with scattered mines that are intended to delay repair. Each JP233 ejects 30 SG357 26 kilogram surface penetrating and cratering submunitions and 215 HB876 2.2 kilogram area denial munitions. The JP233 was, however, designed to attack airfields in Eastern Europe, which were smaller than those in Iraq.

The Tornado GR1s generally flew airfield attack missions in packages supported by USAF and USN aircraft, including EA-6 ECM aircraft, F/A-18's with HARM, F/A-18 escorts, and F/A-18s with TALD decoys. They attacked 21 Iraqi runways by January 17, delivered 106 J-233s, and succeeded in damaging some Iraqi runways. It soon became apparent, however, that the mission was extremely difficult. The majority of Iraq's bases were deep in Iraq around Baghdad or well north of the KTO. All of the major facilities

were sheltered, and each base had two to three long main runways and a number of dispersal strips. The Coalition could only be certain of suppressing activity at an airfield if no unbroken stretch of 3,000 foot runway remained. The GR1s had to fly at very low altitudes of around 180 feet to deliver the JP233. Even at these altitudes, a mild crosswind could disperse some of the munitions. Too much area had to be attacked for limited numbers of sorties to outpace Iraqi repair capabilities, and the runway craters were not deep enough, and the mines were not lethal enough, to have much impact on the repair work.

The kinds of passes the Tornados had to make over Iraqi runways to use the JP233 were also predictable. Iraqi anti-aircraft crews and short range surface-to-air missile crews could not be suppressed with EW and HARM, and could bring heavy fire to bear once the first aircraft altered them to an attack. The Coalition air planners had recognized from the start that the Tornados could only be used for a limited number of missions before Iraqi land-based air defense units learned how to target them. It had planned to shift to attacks on aircraft shelters. These factors led the RAF to cancel the mission on January 23, after it had lost a total of four aircraft. By this time, the Coalition's success in air-to-air combat was suppressing Iraqi air activity in any case, and the runway suppression mission risked a high value strike aircraft in a low value mission without inflicting damage on Iraqi aircraft or critical facilities, because these were sheltered.

Somewhat similar factors affected the Italian Tornado attacks on Iraqi targets, although the Italian Tornados used a submunition delivery system called the MW-1, which can be loaded with either anti-armor or anti-airfield munitions. This system can deliver up to 4,536 armor piercing bomblets or a mix of anti-tank mines, anti-armor mines, and airfield denial munitions, but reliable data on the effectiveness of this munition are not available. The fact that Britain lost several Tornados in such missions, and Italy also had some losses, has led some observers to conclude that aircraft were too vulnerable in low altitude missions to deliver the JP233, and that airfield suppression was not lethal enough to be effective. There is evidence to support this position. The British Joint Commander in the Joint Headquarters in London, Air Chief Marshall Sir Patrick Hine, described the mission as, "going on putting holes in the runways, which they would fill in within 24 hours, and running the risk of losing more aircraft."

The CINC of British forces, Sir Peter de la Billiere, stated,<sup>77</sup> "It had become standard practice to go in against big targets with four or eight formations: now it became clear that in the face of concentrated low level defenses, such tactics were asking for trouble, and greater unpredictability was asked for."<sup>78</sup> It is almost certain that US and French aircraft would unquestionably have experienced even more problems in the runway

suppression mode, since they use the French Durandal bomb, which must also be dropped at low altitudes and is less effective than either the JP233 or MW-1.

One must be careful, however, about turning the RAF's experience into a firm "lesson". The Coalition could afford to give up low altitude missions after the first few days because it no longer faced a significant higher altitude threat, and because the airfield suppression mission had already achieved most of its goals, and because it could shift to attacking Iraq's aircraft shelters. Air Vice Marshall William Wratten, summarized the situation as follows:<sup>79</sup>

"Now to close an airfield totally, one needs to look at the size and shape of the airfield, and then calculate how many JP233s are needed to deny it completely to fixed-wing aircraft. The Iraqi airfields, or a significant number of them, are very large airfields indeed. We knew from the start that the total over-target requirement for Tornado missions to achieve total denial would have been very large indeed. So, in consultation with CENTAF and those who were planning the initial part of the campaign in particular, we agreed that it would be better to endeavor to harass the Iraqi Air Force with a combination of Tornado GR1s and JP233s -- and aircraft like B-52s, A-6s, and F-111s -- all forming part of a total package which would go against an airfield.

"We reached that conclusion...because of the perception we all shared of Iraqi air capability, and that came to us gradually in the months preceding the outbreak of hostilities, through observing the very little amount of flying that the Iraqis were doing...in spite of the number of fixed wing aircraft they had, in spite of the number of huge airfields they had, and in spite of the potential they had, the actual training they were doing means that they probably were not going to pose a significant threat, and therefore it became less urgent to insure that they were totally nailed down to their airfields...And, in the event, that's how it turned out. They showed very little inclination to fly and when they did fly, they were absolutely no match for our fighter assets...They proved to be...something of a non-event.

Later analysis also showed that only one of the five Tornados lost by January 25 was carrying a JP233. Much of the vulnerability of low flying aircraft depended on repeated sorties over the same target alerting enemy SHORAD crews in time to direct their missiles or establish a significant curtain of AA fire that low flying aircraft would fly into. Most of the Tornados lost in the Gulf War were not lost to short-ranged air defenses flying low over their targets. Further, it is not clear that the runway suppression "lesson" of the Gulf

War applies to other wars. Few countries have as many large airfields as Iraq or so well sheltered a force, and many may not keep their aircraft in shelters.<sup>80</sup>

### **Attacking Iraqi Airfields and Aircraft in Their Shelters**

The fact that Iraq's aircraft stayed in their shelters led Coalition planners to shift to a focus on attacking Iraqi aircraft shelters. Long before Desert Storm began, it was clear that Iraq might choose not to engage Coalition air power. Saddam Hussein had stated on January 12, that Iraqi forces would take shelter, and be "safe and sound and ready for battle" after allied air attacks. Even before the full weight of the Coalition's air power became apparent, the Iraqi Air Force seemed to have decided to conduct only limited air defense operations to harass Coalition operations, while attempting to "ride out" the Coalition air attacks in what it thought were bomb proof shelters. This plan drew on Iraq's experience during the Iran-Iraq War, when it generally reserved the air force as "a force in being" that was only used to deal with critical Iranian breakthroughs.<sup>81</sup>

Iraq seems to have based its calculations on the assumption that its shelters could not be successfully attacked. It had three main kinds of shelter: A "Tab-Vee" shelter that was relatively vulnerable, a Trapezoid shelter that was somewhat better protected, and a Yugoslav-made shelter copied from Soviet designs that is sometimes reported to have been designed to resist nuclear blast.<sup>82</sup> The Tab-Vee shelter was most common, and was deployed on 17 out of Iraq's 22-23 main air bases. The trapezoid shelter was deployed on 7 air bases, and the Yugoslav shelter was deployed on three. The Yugoslav shelter was the only shelter that presented a major challenge to conventional air attacks, and its numbers were limited. The full details of this shelter are classified, but it was not without design errors. It was vulnerable to certain angles of attack, and had no venting. It contained the blast of penetrating bombs, sometimes adding the blast effect from the burning fuel in the aircraft in the shelter. In one case, the shelter's doors were blown 430 feet by the contained blast.<sup>83</sup>

Once it became apparent that the Iraqi air force would not engage, and that there was little prospect of permanently suppressing Iraq's air bases with the resources available, the Coalition was ready to change tactics. This led to a shift in missions from "bunker busting" to direct attacks on aircraft shelters, and the true vulnerability of Iraq's shelters became clear on the night of January 22/23. The suppression of Iraq's air defense allowed USAF F-111s to operate near airfields with considerable security, and the Coalition experimented with the use of I-2000 bombs against Iraq's aircraft shelters. The USAF began by launching a concentrated attack on the shelters at the Al Asad Air Base from altitudes outside the effective range of most Iraqi short-ranged air defenses. Each F-111 carried four bombs and made two passes over the airfield. The results showed that Iraq



could neither run nor hide. The F-111 strikes were very effective, and sometimes hurled the entire 60 ton blast door assemblies of the shelters into the air.

This success, and the beginning of Coalition combat air patrols in the area around Baghdad sent a message to both sides. The next day, Iraq ceased to attempt active resistance in the air. On January 24, Iraqi aircraft began to flee to Iran. They succeeded in evading Coalition fighters because their flight times to Iran were so short, the Coalition did not maintain air patrols over northeastern Iraq, and the Coalition did not want to engage in air-to-air combat near to the Iranian border. Some two dozen Iraqi aircraft fled to Iran on January 26, and approximately 80 aircraft had fled across the border by January 29.<sup>84</sup> These flights eventually cost Iraq much of its air force. There is some question about the exact number of aircraft involved, and how many are flyable. Some sources report as few as 106 combat aircraft, but Iraq has claimed that they total 139 aircraft. Table 6.9 provides one detailed estimate of the total number of Iraqi aircraft involved.<sup>85</sup>

The author's estimate, based on conversations with various experts, is similar to the estimates in Jane's: 24 Mirage F-1s, 22 Su-24s, 40 Su-22s, 4 Su-17/20s, 7 Su-25s, 4 MiG-29s, 7 MiG-23Ls, 4 MiG-23BNs, 1 MiG-23UB, and 1 Adnan. This is a total of 112 combat aircraft. The transport and support aircraft included 2 B-747s, 1 B-707, 1 B-727, 2 B-737s, 14 IL-76s, 2 Dassault Falcon 20s, 3 Dassault Falcon 50s, 1 Lockheed Jetstar, 1 A-300, and 5 A-310s. This is a total of 31 aircraft, and would give a grand total of 145 aircraft -- not counting aircraft Iraq had seized from Kuwait.<sup>86</sup>

The Coalition reacted by expanding its F-111 attacks on shelters, and used F-117As against key shelters deep in Iraq. For two weeks, the F-111Fs devoted 40% of their sorties to attacks on shelters, until they were shifted to striking Iraqi tanks and ground force equipment in preparation for the ground battle. The F-117 stealth aircraft devoted 18%-26% of their missions to shelter attacks.

Shortly thereafter, RAF Tornados and Buccaneers joined in, and the Tornados used laser-guided bombs to attack shelters. The Tornados were not equipped with laser designators at the start of the air campaign, and US aircraft with designators could not be provided because they had been diverted to the Scud hunt.<sup>87</sup> As a result, the RAF rushed in 12 Buccaneers with Pave Spike Laser designators to provide "buddy system" lasing for the Tornado GR1s. This deployment presented some initial problems because the Buccaneers were trained and equipped for missions in NATO, and were deployed in Cornwall and Gibraltar. Nevertheless, they were re-called, refitted and given special training, repainted in desert colors, and flown to the Gulf within five days. The first Buccaneers began operations out of Muharraq on February 2, and the rest began operations out of Dhahran on February

5. The first package of Tornados and Buccaneers flew on February 2, and two Buccaneers and four Tornado GR1s successfully attacked a bridge over the Euphrates.<sup>88</sup>

The use of Buccaneers as secondary designators did, however, present problems that may be important in future conflicts. Air Vice Marshall William Wratten, the deputy British Commander in the Gulf War, noted that,<sup>89</sup>

"The use of the Buccaneers limited our ability to play a role in preparing the battlefield. One disadvantage of second-part designation is that it does demand rather slick coordination between the designator and the bomber. The bomber has got to release his bombs in precisely the right place into what is termed the 'basket', which embraces the cone of reflected energy. Now, if he drops it outside that basket, then the bomb doesn't glide. So, it does require significant aircraft coordination, which a single aircraft, self-designating, does not need to the same degree. But, what we were able to do in going against static targets like bridges and hardened aircraft shelters was to release other self-designating aircraft from those missions, the F-111 in particular. "

The RAF also rushed in a new system for the Tornados called the Thermal Imaging Airborne Laser Designator (TIALD). The TIALD was a targeting pod that could be fitted to the GR1 and offered both TV optics and thermal imaging. It was part of a broader update program for the GR1 designed to provide added electronic stealth, new computers, stand-off weapons. It also stores management systems, and converts it to the GR4. The TIALD was self-contained, except for the cockpit display and controls, and communicated to the aircraft through a MIL STD 1553B bus in the GR1's standard attachment points. The pilot could use the TIALD to select a target from either video or thermal imaging. After that point, it automatically tracked the target even when the aircraft maneuvered. The TIALD was just entering production when the first units arrived in theater on February 10. It was used with the Paveway II laser-guided bomb to attack both shelters and bridges, although the Tornados concentrated on attacking aircraft shelters after February 13.<sup>90</sup>

This conversion to the use of laser guided bombs had major benefits in improving the effectiveness of the Tornado. Approximately 28% of the British precision bombing effort was eventually devoted to striking shelters, but the Tornado also played an important role in attacking key targets in Iraq's lines of communication and providing precision bombing. It would never had played an important role if it had simply been shifted from using the JP233. Like all other aircraft that attempted to use radar bombing and free fall "dumb" bombs at altitudes well above 10,000 feet, bomb damage assessment showed its strike sorties had little effectiveness in such a mode. As the British commander, General Sir Peter de la Billiere put it,<sup>91</sup>

"For the next week or so, the Tornado crews were tasked, still at night, against a variety of targets, including radar sites, petroleum refineries, and ammunition depots, all from medium altitude (around 20,000 feet), using radar to deliver free-fall 1,000 pound bombs...it was not possible for several days to obtain accurate battle damage assessment...because extensive cloud cover prevented satellites from contributing their photographic imagery. When BDA did become available, we see that the radar bombing had been largely ineffective. This was not surprising...the Tornado weapon system had been designed primarily for low level delivery....The Americans...found...their aircraft...were having no better success."

By the end of the war, Coalition air attacks destroyed up to 30-40% of the shelters with hard-target penetrating laser-guided bombs.<sup>92</sup> They proved that the ability to successfully attack sheltered aircraft is a key lesson of the war. The most that Iraq could do in response was to move the rest of its aircraft in and out of different shelters, disperse them in fields, or make other attempts to play a "shell game" to hide them from Coalition attack. This limited Iraqi operations, however, to 10-15 minute dashes between airfields or flights to Iran and still did not ensure the survival of Iraq's remaining aircraft. According to some estimates, Iraq still lost a total of 403 aircraft, and 375 of its 600 hard shelters, by the end of the war .

At the same time, this lesson merits some caveats. The use of laser-guided bombs requires the ability to operate relatively freely over the battlefield, and bad weather and smoke can greatly reduce the ability to use such bombs. In many conflicts, the use of such weapons would require next generation weapons with much longer ranges and smarter guidance kits.<sup>93</sup>

The combination of F-117s, F-111Fs, Tornados, and Buccaneers also tied up a substantial part of the Coalition's best aircraft, and the resulting forces still provided only limited resources to attack a total of 71 airfields. The Coalition damaged a total of 41 airfields in Iraq and three airfields in Kuwait before the war ended, but shelter killing was a process of slow attrition -- not a quick method of defeating an enemy air force. The Coalition was still killing shelters at the end of the war. This is an important lesson to remember, particularly since other air forces may not be as weak or passive, and other air defense systems may have more effective coverage of threat air bases.

The total of 403 Iraqi aircraft lost during the war, only included a maximum of 141 destroyed in shelters and bunkers. The other losses consisted of 33-36 air-to-air kills, 131 destroyed in the open, and 121 that escaped to Iraq.<sup>94</sup> The effectiveness of Coalition air attacks on shelters was restricted by the fact that the Coalition could not launch a matching

campaign from Turkey, the range-payload problems and added vulnerability in flying long missions deep into Iraq, and the need to concentrate F-15Cs in other areas.

At the same time, the Coalition suffered from an inability to determine which shelters had aircraft, and which attacks on shelters killed destroyed aircraft as well. The Coalition estimates of shelter damage may well be too high, and the estimates of aircraft killed in shelters may under-estimate the number of Iraqi aircraft that survived by dispersal into fields or populated areas. As is the case with virtually every aspect of the Gulf War, it is not possible to resolve many important issues because insufficient battle damage data exist to transform estimates into facts.

Table 6.9Iraqi Aircraft Seized by Iran after the Gulf WarFrom the Iraqi Air ForceFrom Kuwait Airlines

24 Mirage F-1		
24 Su-24 Fencer	2	767-200
40 Su-22 Fitter H	1	Airbus A300C4-600
4 Su-20 Fitter C	5	A310-200's
7 Su-25 Frogfoot	2	Boeing 767-200ER
4 MiG-23 Flogger F	2	Gulfstream IIIs
4 MiG-29 Fulcrum	2	BAe 125s
4 MiG-23ML Flogger G		
<u>1 MiG-23U Flogger C</u>	14	Total

112 Subtotal

2 Boeing 747's  
 1 Boeing 707  
 2 Boeing 737's  
 1 Boeing 737 ?  
 5 Airbus 310's  
 1 Airbus 300  
 15 IL-76's  
 2 Mystere Falcon 20  
 3 Falcon 50's  
1 Lockheed Jetstar  
 33 Sub-Total

145 GRAND TOTAL

Source: Adapted from Jane's Defense Weekly, April 27, 1991, p. 684.

## The Impact of Electronic Warfare

All of the previous counter-air activity involved electronic warfare, as did most of the Coalition air strikes discussed in the next chapter. Coalition electronic warfare (EW)

capabilities played a critical role in winning air supremacy, and in allowing Coalition strike/attack aircraft to survive over the battlefield. At the same time, it is not possible to transform this lesson of the Gulf War into some precise ranking of the importance of electronic warfare capabilities relative to other Coalition activities.

Much of the unclassified data on electronic warfare provides only a limited or inaccurate picture of the role of such systems.<sup>95</sup> More generally, the electronic warfare effort was only part of the effort to "blind" the Iraqi Air Force and ground-based air defenses. It interacted with a massive series of strikes on Iraqi air sensors and command and control facilities, the F-4G Wild Weasel, Tornados, and other aircraft using anti-radiation missiles. Further, special intelligence aircraft to the rear monitored Iraq communications and Iraqi radar activity. Some of these Coalition aircraft could instantly detect Iraqi radar activity, characterize the emitter, and locate it from deep behind the battlefield. They played a role in "blinding" the Iraqi forces by allowing the ABCCC and AWACS aircraft to guide strike/attack aircraft away from emitters and vector in aircraft with anti-radiation missiles.

Two key Coalition strike systems -- the F-117 and cruise missile -- did not require extensive protection from electronic warfare, although the F-117 had protection from EF-111 jammers even in flying missions that minimized exposure to Iraqi radars. It used such support on the first day of the war, and in some of its later attack sorties.<sup>96</sup> Virtually all of the other strike/attack aircraft and helicopters, however, were protected by on-board EW electronics in the aircraft, pods mounted on the aircraft, and specialized electronic warfare aircraft that flew as escorts.

Many aircraft carried their own electronic warfare protection. This was true of many British, French, Saudi and US aircraft -- although the RAF was forced into a crash upgrade effort to provide electronic warfare capability. The RAF's Tornado GR1 did have the Marconi Sky Shadow jamming/deception pod, a radar warning and homing receiver, and dispensable chaff and flares. However, the RAF air defense variants of the Tornado F3 had a radar warning and homing receiver, but was not rigged to carry expendable chaff and flare countermeasures before the Gulf War, although the same aircraft supplied to the RSAF had such capability. This experience illustrates the level of risk inherent in underfunding first line combat forces in peacetime.<sup>97</sup>

The Jaguar had an adequate jamming pod and chaff/flare dispenser, but lacked an effective radar warning receiver. The RAF's Buccaneers, Chinooks, and Pumas also lacked effective radar warning receivers. New types of more effective radar warning receivers had to be rushed to the Gulf. Once the war began, both the Tornado and the Jaguar required modification to use radar absorbent materials, because the systems developed did not last

through extended use, and were left as kits for application during the transition to full war time readiness. These problems illustrated the need to fully fund all aspects of wartime readiness. At the same time, the RAF found that it experienced unanticipated problems with its electronic warfare avionics because pilots had routinely ignored system failures during peacetime. This again illustrates the need for full combat readiness.<sup>98</sup>

Specialized electronic warfare aircraft played a major role in the war for air supremacy. As Table 6.1 shows, the Coalition flew nearly 3,000 dedicated missions in this role, in addition to the tens of thousands of sorties other aircraft from other aircraft with their on-board EW systems or pods. Virtually all of these specialized electronic warfare aircraft were US aircraft. The US flew all but 80 of fixed-wing electronic warfare sorties during the Gulf War, which were flown by British Nimrod aircraft in the naval defense role.<sup>99</sup> The only other specialized electronic warfare activity came from a French DC-8 Sarigue, a French EC-160, and two modified SA-330 Puma helicopters -- whose function and activity level remains classified.<sup>100</sup>

This dependence on specialized US electronic warfare assets is an important lesson for coalition warfare and cooperative security. Table 6.10 provides a "snapshot" of the strength, type, location, and role of such US aircraft on a typical day of the counter air campaign, and the total sortie activity by type during the entire war. As has been mentioned earlier, the US also employed two drones to support the electronic warfare mission by decoying radars, providing tactical deception, and designating targets. The BQM-74 was a drone used to decoy radars, and create confusion, by providing false targets. It was used extensively on the first night of Desert Storm and aided Wild Weasel targeting. It provoked a major reaction from Iraq anti-aircraft guns and missile batteries and surveillance radars.<sup>101</sup> The TALD, or tactical air-launched decoy, was used extensively by US Navy and USMC aircraft during Desert Storm, and met roughly the same mission need as the BQM-74.<sup>102</sup>

Table 6.10US. Electronic Warfare Aircraft in the Gulf War - Part One

<u>Type/Location</u>	<u>Service</u>	<u>Type</u>	<u>Number on Jan 20,91</u>	<u>Total Sorties Flown in War By All Aircraft of Type</u>
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Dedicated EW Aircraft Listed on January 20, 1991EF-111A Raven

At-Taif, Saudi Arabia	USAF	EF-111A	18	
Incirlik, Turkey	USAF	EF-111A	<u>18</u>	
			36	1,105

--The normal strength in theater was 24 aircraft. The EF-111 uses the AN/ALQ-99E jamming subsystem, which scans across frequency bands under computer or manual control. When threats are identified, it initiates countermeasures either automatically or under EW officer's control. Jammed the radars in the integrated Iraqi KARI air defense net. Often operated in direct support role because Iraqi air defenses were too weak to require stand-off jamming. Operated in the heavily defended areas around Baghdad, H2/H-3 and Scud launch zones during the war. Has terrain-following capability and is able to keep up with strike/attack aircraft even in demanding high speed mission profiles. No combat losses and only one non-combat loss.

King Fahd Saudi Arabia	USAF	EC-130H	2	
Riyadh, Saudi Arabia	USAF	EC-130H	7	
Bateen, UAE	USAF	EC-130H	6	
Incirlik, Turkey	USAF	EC-130H	<u>3</u>	
			18	450

EA-6B Prowler

Aircraft Carriers	USN	EA-6B	27	1,126
Shaikh Isa Bahrain	USMC	EA-6B	12	504

--Capabilities similar to EF-111. Jammed the radars in the integrated Iraqi KARI air defense net, and tracking radars. Launched TALD decoys to lead Iraqi radar operators to emit, and jammed to force increased radar activity, so Iraqis could be attacked by HARM. Often operated in direct support role because Iraqi air defenses were too weak to require stand-off jamming. Operated in the heavily defended areas around Baghdad during the war. Some speed problems in keeping up with strike/attack aircraft. Could fire a maximum of two HARM. Accompanied virtually all USN air strikes into Iraq. Currently being upgraded along with the EF-111.

F-4G Wild Weasel

Shaikh Isa, Bahrain	USAF	F-4G	48	
Incirlik, Turkey	USAF	F-4G	<u>12</u>	
			60	2,683

--Were used to accompany Coalition strike packages early in war, and then acted as "Weasel Police" to continuously suppress Iraqi radars by patrolling the area over the battlefield. Used HARMs to attack Iraqi radars, particularly air defense radars.

F-16C

Incirlik, Turkey,	USAF	F-16C	13	--
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--Launched HARM missiles



Table 6.10US. Electronic Warfare Aircraft in the Gulf War - Part Two

<u>Type/Location</u>	<u>Service</u>	<u>Type</u>	<u>Number on Jan 20,91</u>	<u>Total Sorties Flown in War By All Aircraft of Type</u>
<u>US Navy Special Purpose</u>				
Jiddah, Saudi Arabia	USN	EA-3B	2	-
Bahrain Intl., Bahrain	USN	EP-3E	2	-
Masirah, Oman,	USN	EP-3E	1	-
Bahrain Intl., Bahrain	USN	P-3B(RP)	<u>2</u>	-
			7	

--Performed a wide range of naval jamming and electronic warfare functions.

Total in Theater on January 20, 1991 173

Other Aircraft Not Counted Above:RC-135V Rivet Joint

USAF	EC-135	24
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--Worked with AWACS and ground stations as electronic intelligence collection platform that provided enhanced awareness of enemy air and ground activity. Precisely located and characterize enemy radio and radar activity. Provided direct near-real time support to theater and tactical commanders in some cases. Flew standoff missions as close to Iraqi airspace as threats permitted.

EC-130H Compass Call

USSOCENT	EC-130	8	450
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-Were used confuse and disrupt Iraqi command and control communications, in either a manual or automatic mode. Gathered intelligence on Iraqi communications, and disrupted Iraqi voice systems. Provided 24 hour a day surveillance of Iraqi communications for 44 days. Air EW activity limited by lack of Iraqi air activity, but effectively jammed tactical air, anti-aircraft, artillery, surface-to-air missile, and battlefield communications. Supported EW training of US and Egyptian forces during Desert Shield.

RC-12, RV-1D Quick Look,EH-60A Quick Fix

<u>IIB</u>	US Army	-	-	-
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-Two fixed wing aircraft and helicopter providing electronic support to forces in rapid flanking movements during ground campaign.

Note: Some aircraft (F-4Gs and F-16Cs) were later used for other missions.

Source: Department of Defense, Conduct of the Persian Gulf War: Final Report, pp. 217-218; Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, pp. 184-185; Electronic Defense, May, 1991, pp. 37-39; Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, pp. 184-185; and Stan Morse, ed., Gulf Air War Debrief, London, Aerospace, 1991, pp. 36-37. Does not include related SIGINT and ELINT aircraft. Sortie data for some specialized EW aircraft not available. Sources disagree as to total number of each aircraft in theater.

## January 27, 1991: "Air Supremacy" and Environmental Warfare

The full combination of Coalition air combat tactics, attacks on Iraq's ground-based air defenses, airfield attacks, and attacks on aircraft shelters was so successful that USCENTCOM declared that the Iraqi Air Force no longer existed as a combat effective force on January 27, and that Coalition forces had achieved air supremacy.<sup>103</sup> The Coalition then proceeded to strike Iraqi ground targets with comparative immunity for the rest of the war.

Iraq found only two ways to retaliate. The first was the Scud campaign described in Chapter Eleven. The second was environmental warfare. While the timing is probably coincidental, Iraq began to flood the Gulf with crude oil on January 25 -- roughly the same time as its aircraft began to flee to Iran. This oil spill reached a level of several million gallons before two F-111Fs were able to use 2,000 pound GBU-15 bombs to destroy the pumping system and manifolds, and cut the flow of oil into the Gulf. Iraq's motives for these actions are uncertain.

Some experts feel that Iraq hoped creating an environmental crisis might help it terminate the war. Others feel that Iraq was seeking to show world opinion that it could retaliate against the Coalition in spite of the defeat of its air force, while others feel it may have felt that clogging the desalinization plants in the Southern Gulf could put pressure on the Southern Gulf states. In any case, this oil spill may be the first deliberate effort at "environmental warfare" in modern military history. It was followed by setting hundreds of Kuwaiti oil wells on fire, and it may have well set a precedent for environmental warfare in the future.

## The Cost of the Gulf War to the Iraqi Air Force

Important as Iraq's air losses were, they scarcely destroyed the Iraqi air force. While there are again significant differences in official US estimates, Table 6.11 shows a US Marine Corps estimate of Iraqi losses by Iraqi aircraft type:

Table 6.11Iraqi Combat Aircraft Losses in Desert Storm

<u>Aircraft Types</u>	<u>Number on January 12, 1991</u>	<u>Lost in Air Combat</u>	<u>Total Destroyed</u>	<u>Fled To Iran</u>	<u>Remaining on March 1, 1991</u>
Mirage F-1	75	8	10	30	35
Su-24 Fencer	25	0	2	14	9
MiG-29 Fulcrum	41	5	9	7	25
Su-7/17/20/22 Fitter	119	5	14	34	71
MiG-25 Foxbat	33	2	8	0	25
Su-25 Frogfoot	61	2	4	7	50
MiG-23 Flogger	123	8	17	10	96
MiG 21 Fishbed	<u>208</u>	<u>4</u>	<u>16</u>	<u>0</u>	<u>192</u>
TOTAL	685	34	80	102	503

Source: Adapted by the author from Lt. General Walter E. Boomer, "Desert Storm, MARCENT Operations in the Campaign to Liberate Kuwait," U.S. Marine Corps Headquarters, August 31, 1991, and Eliot Cohen, ed., Gulf War Air Power Survey, Volume V, Part I, pp. 653-654

In spite of these losses, however, the Iraqi Air Force still had roughly at least 30,000 men in 1995, including some 15,000 air defense personnel. It still retained approximately 330 to 370 combat aircraft -- although about half of the Iraqi aircraft counted in this total are probably damaged or lack spare parts and have limited or no operational combat capability. These totals also do not count the 112 Iraqi combat aircraft that flew to Iran and which were seized by the Iraqi government.<sup>104</sup> In 1992, Iraqi Prime Minister Muhammed Hamzah al-Zubayed described this Iranian seizure as part of a plot by Iran that had begun before the Gulf War. He stated that, "we realize that all this (Iranian) enthusiasm and readiness to fulfill our demands (before the war) -- followed by a chapter of treason and treachery by Iranian elements -- was part of a prepared plan. Thus, all that plundering, burning, and destruction within the chapter of treason and treachery took place."<sup>105</sup>

Iraq's total surviving inventory of combat aircraft seemed to include 6-7 HD-6, Tu-16, and Tu-22 bombers. It also included 130 J-6, MiG-23BN, MiG-27, Mirage F-1EQ5, Su-7, Su-20, and Su-25 attack fighters; 180 J-7, MiG-21, MiG-25, Mirage F-1EQ, and

MiG-29 Air defense fighters; MiG-21 and MiG-25 reconnaissance fighters, 15 old Hawker hunters, a surviving Il-76 Adnan AEW aircraft, 2 Il-76 tankers, and large numbers of transports and helicopters. Estimates of total surviving inventory by aircraft type vary sharply by source, but Iraq seems to have retained about 6 Tu-22, 1-2 Tu-16, 30 Mirage F-1s, 15 MiG-29s, 60 MiG-23s, 15 MiG-25s, 150 MiG-21s, 30 Su-25s, and 60 Su-17s, Su-20s, Su-22s.<sup>106</sup>

It is unclear how many air munitions Iraq retained after the Gulf War, and some estimates put this figure as low as 50%. Iraq still, however, retained significant numbers of modern air-to-air and air-to-ground munitions. These included AA-6, AA-7, AA-8, AA-10, Matra 530, Matra 550, and Matra Super 530 air-to-air missiles, and AM-39 Exocet, HOT, AS-11, AS-12, AS-6, AS-14, AS-301, AS-37, C-601 Silkworm air-to-surface missiles laser-guided bombs, and Cluster bombs.

Iraq also retained comparatively large numbers of combat-capable trainers, transport aircraft and helicopters, and remotely piloted vehicles. The trainers included some Mirage F-1BQs, 25 PC-7s, 30 PC-9s, 50-60 Tucanos (EMB-312s), 40 L-29s and 40 L-39s. Transport assets included a mix of Soviet An-2, An-12, An-24, An-26, and Il-76 jets and propeller aircraft, and some Il-76s modified to act as tankers. The remotely piloted vehicles (RPVs) included some Iraqi-made designs, Italian designs, and Soviet designs. It is unclear how effective Iraq was in using any of these RPV systems, but it did make use of them during the Gulf War.<sup>107</sup>

There is no expert consensus on Iraq's holdings of surface-to-air missiles, but Iraq also seemed to have retained a total of 20-25 Improved Hawk launchers seized from Kuwait, 130-180 SA-2 launchers, 100-125 SA-3 launchers, 100-125 SA-6s, 20-35 SA-8s, 30-45 SA-9s, some SA-13s, and around 55-65 Crotale/Roland surface-to-air missile units. Some of these systems were operated by the army. In addition, Iraq had large numbers of man-portable SA-7s and SA-14s, and some SA-16s.<sup>108</sup>

Most of this equipment was operational, although the Improved Hawks are not generally included in this total. It is not clear whether Iraq had learned enough from the Jordanian officers that assisted it during the war, and during the initial period after the war, to operate its Hawks. It may also be avoiding any use of the weapons because it fears the US would attack any captured hawks that showed signs of becoming operational.<sup>109</sup>

Iraq's ground-based defenses were concentrated around Baghdad, Basra, and Kirkuk, as they were during the pre-war period. Iraqi territory is too large to attempt territorial defense, and Iraq has always concentrated on defending strategic targets, and deploying air defense zones to cover critical land force deployments. Iraq did, however,

redeploy some missiles to create surface-to-air missile "traps" near the "no-fly zones" that the Coalition established after the war. These traps were designed to attack aircraft with overlapping missile coverage when they attack launchers deployed near the no-fly zones.

Iraq also made extensive efforts to improve its use of shelters, revetments, dummies, and other passive defenses. It had used such defenses since the beginning of the Iran-Iraq War, and deployed new decoys after the Gulf War in an effort to reduce its vulnerability. According to most experts, it repaired many of the bases and air facilities that were destroyed or damaged during the Gulf War. It has 16-20 major air bases, with H-3, H-2, and Al Asad in the West; Mosul, Qayarah, and Kirkuk in the north, Al Jarah, Talil, and Shaybah in the South, and 5-7 more bases within a 150 kilometer radius of Baghdad. Many of these bases had at least some surface-to-air missile defenses.

Iraq was able to restore much of its battle control and management system, reactivate its damaged airfields, and even build one new military airfield in the South.<sup>110</sup> Many of its shelter air defense and air force command and control centers remained operational, and its French-supplied KARI air defense communications and data-link system used fiber optic, and many of these links may have survived the bombing.<sup>111</sup> Some radars and limited elements of Iraq's air defense C<sup>4</sup>I system were also operating, including such pre-war systems as the Soviet Spoon Rest, Squat Eye, Flat Face, Tall King, Bar lock, Cross Slot, and Thin Skin radars. Iraq also had Soviet, Italian, and French jamming and electronic intelligence equipment.

Most of Iraq's surface-to-air missile units, radars, automated data processing and transfer system, and central command and communications facilities had only limited operational capability. There is no way to know how many of Iraq's underground command and personnel shelters survived the war, and the various Coalition attacks on Iraq's air defenses that were made to enforce the security of the no-fly zones, but it seems likely that 50% to 66% survived the Coalition bombing campaign.

The fact that many Iraqi forces surviving the Coalition attacks is not surprising. They were never intended to destroy the entire Iraqi air force or to destroy -- as distinguished from suppressing Iraqi ground defenses. Yet, these survivals are also a lesson in the fact that conventional warfare still cannot easily destroy an enemy force, as distinguished from crippling its capabilities in a given conflict. Even "air supremacy" is relative.

## The Revolution or Non-Revolution in Defensive Air Warfare

There are obvious dangers in trying to select a few key lessons about the counter-air and counter ground-based air defense campaigns during the Gulf conflict. This chapter has highlighted a number of major issues and uncertainties, and has touched on a number of aspects of the Gulf War that are not likely to be repeated in future conflicts. At the same time, several lessons do seem clear.

One is the value of the "edge" that the Coalition had, an advantage in beyond-visual-range warfare, air defense aircraft, air-to-air missiles, anti-radiation missiles, precision target kill capability, and C<sup>4</sup>I/BM capability. The history of Coalition air activity during Gulf War also makes it clear that the importance of this technical edge depended on matching training, tactics, readiness, and sustainability. It was the integration of many different technical elements into a sustainable and adaptable air combat system that gave the Coalition so decisive an edge. In contrast, the Gulf War confirmed the lessons of many previous wars that any system dependent on ground-controlled intercepts and fixed surface-to-air missile defenses is obsolete and ineffective.

In fact, the struggle for air supremacy indicates that the world's air forces may now be divided into two basic kinds of forces: Air forces that can integrate systems like the AWACS, fighters with full beyond-visual-range air combat capability, related intelligence and sensor capabilities, and related air combat training, and air forces that lack these capabilities. Whether or not this division constitutes a "revolution in military affairs" may be a matter of opinion, but it certainly seemed like a revolution in military affairs to the Iraqi pilots that attempted air combat. It is also a division that is likely to produce similar results, wherever a "First World" air force meets a "Third World" air force.

The Gulf War demonstrated that the Coalition had an equally decisive advantage in offensive counter-air and ground-based air defense suppression capability. It demonstrated that an air strategy based on sheltering and air base defenses is impractical, and is a recipe for defeat. Ultimately, Iraq could not hide, and it had to run. At the same time, the Gulf War revealed serious weaknesses in the kind of semi-automated and over-centralized air defense system that Iraq possessed during the Gulf War. The vulnerabilities in Iraq's land-based air defenses are scarcely unique to Iraq. If anything, Iraq had a system far superior to most Third World systems and one with many automation and C<sup>4</sup>/BM capabilities superior to those in a Soviet-supplied system like the one operated by Syria.

The fact that the Coalition could improvise the mix of strike/attack and air defense systems necessary to win decisive air supremacy over Iraq in a matter of days is a critical lesson of the Gulf War that its also likely to be repeated wherever the qualitative differences between air forces are as great as those between the capabilities that the US and Britain deployed against those held by Iraq.

The Coalition's defensive and offensive counter-air efforts also demonstrated the fact that readiness, tactics, training, ideas and boldness are at least as important as force numbers. Order of battle comparisons of weapons numbers and types are almost always failed intelligence, but the war for air supremacy shows just how important force quality really is. The Coalition did have time to mass decisive force in the air war. However, it was the matrix of many different Coalition qualitative advantages that decided the outcome, not force numbers, weapons performance specifications, or the size of an order of battle.

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<sup>1</sup> USAF Congressional Affairs, briefing paper, May, 1991.

<sup>2</sup> Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 148.

<sup>3</sup> See Eliot A. Cohen, Gulf War Air Power Survey: Volume II, Part II, pp. 106-107. Note that the definition of these figures differs somewhat from similar data used in Chapter Three.

<sup>4</sup> Department of Defense press briefing slide, February, 1991.

<sup>5</sup> The range of different estimates of Iraqi strength is illustrated in Norman Friedman, Desert Victory, Annapolis, Naval Institute Press, 1991, p. 308; Bruce W. Watson, Military Lessons of the Gulf War, London, Greenhill, 1991, pp. 61-81; James F. Dunnigham & Austin Bay, From Shield to Storm, New York, Morrow, p. 323; Roy Braybrook, Air Power: The Coalition and Iraqi Air Forces, London, Osprey, 1991, p. 7.

<sup>6</sup> The high end of the range seems more correct and is based on Dick Palowski, Changes in Threat Air Combat Doctrine and Force Structure, 24th Edition, Fort Worth, General Dynamics DWIC-01, February, 1992, p. II-361. Some estimates of the Mirage F-1 strength go as high as 70 aircraft, but seem to include aircraft in the air defense role. These same estimates show 60 Su-20s in the FGA units, and 40 F-6s and 40 Su-7s in other combat units.

<sup>7</sup> Many of the MiG-21s were not operational. Iraq had up to 40 MiG-19s in quasi-operational status and possibly some F-6s.

<sup>8</sup> The US count is based upon slides circulated by the US Air Force in introducing the April 15, 1993 draft of the Gulf War Air Power Survey.

<sup>9</sup> The US count and list of air bases is based upon slides circulated by the US Air Force in introducing the April 15, 1993 draft of the Gulf War Air Power Survey.

<sup>10</sup> Defense News, May 8, 1989, p. 6.

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<sup>11</sup> Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 13-15; Dick Palowski, Changes in Threat Air Combat Doctrine and Force Structure, 24th Edition, Fort Worth, General Dynamics DWIC-01, February, 1992, p. II-361.

<sup>12</sup> Eliot A. Cohen, Gulf War Air Power Survey: Volume V, Part II, pp. 211-213.

<sup>13</sup> Eliot A. Cohen, Gulf War Air Power Survey: Volume V, Part II, pp. 142, 166, 163, 211-213.

<sup>14</sup> Eliot A. Cohen, Gulf War Air Power Survey: Volume V, Part II, pp. 206-207.

<sup>15</sup> See Eliot A. Cohen, Gulf War Air Power Survey: Volume V, Part II, pp. 155-204.

<sup>16</sup> Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, p. 221.

<sup>17</sup> See Eliot A. Cohen, Gulf War Air Power Survey: Volume II, Part II, pp. 107.

<sup>18</sup> Colonel John A. Warden, The Air Campaign: Planning for Combat, Washington, National Defense University Press, 1988.

<sup>19</sup> The reader should be aware that official US histories of the war conflict on a number of the details relating to the timing and content of decisions relating to "Instant Thunder," and that a wide range of "insider" histories have been issued since the war provided very contradictory accounts of the roles of key personalities and the relative views of General Powell, General Schwarzkopf, and subordinate officers, and of conflicts between various groups in the USAF and in USCENTCOM. The author draws heavily on the work of Dianne T. Putney, "From Instant Thunder to Desert Storm," Air Power History, Fall, 1994, pp. 39-50 in the following discussion, on Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, and on comments from several of the officers involved.

<sup>20</sup> In addition to the sources in footnote 19, see Chapter Seven for a detailed discussion of the problems in the strategic bombing plan even after the war plan had been fully revised, and for tables showing the vast expansion of the original targeting effort. Also see James P. Coyne, "Plan of Attack," Air Force, April, 1992, pp. 40-46; Michael Palmer, "The Storm in the Air: One Plan, Two Air Wars," Air Power History, Winter, 1992, pp. 24-31. For an "insider" discussion of the role of personalities in the initial development of the air war plan, see Michael R. Gordon, and General Bernard E. Trainor, The General's War: The Inside Story of the Conflict in the Gulf, Boston, Little Brown, 1994, pp. 77-94.

<sup>21</sup> The author relies on the work of Dianne T. Putney, "From Instant Thunder to Desert Storm," Air Power History, Fall, 1994, pp. 39-50, in this discussion.



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<sup>22</sup> For a good summary of the development and deployment of this analytic capability, see Colonel Thomas A. Cardwell, "The Wizard Warriors of Desert Storm," *Electronic Defense*, March, 1992, pp. 56-

<sup>23</sup> James P. Coyne, "Plan of Attack," *Air Force*, April, 1992, pp. 40-46; Michael Palmer, "The Storm in the Air: One Plan, Two Air Wars," *Air Power History*, Winter, 1992, pp. 24-31; Dianne T. Putney, "From Instant Thunder to Desert Storm," *Air Power History*, Fall, 1994, pp. 44-45.

<sup>24</sup> Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, p. 90.

<sup>25</sup> The reader should be aware that every effort is made throughout this chapter to rely primarily on official US histories of the war and briefing aids. As is the case throughout this chapter, the Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, is regarded as the key source of such material. (See pages 98-102)

<sup>26</sup> Also see Dianne T. Putney, "From Instant Thunder to Desert Storm," *Air Power History*, Fall, 1994, pp. 39-50 and Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993

<sup>27</sup> Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, p 140.

<sup>28</sup> A partial day by day list of these problems is provided in the air portions of the chronology in Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume V, Part II, Washington Department of the Air Force, 1993

<sup>29</sup> Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 140-141. For details of this phase of the campaign, see Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume II, Part II, Washington Department of the Air Force, 1993, p. 105-130.

<sup>30</sup> Note that most military messages are in Greenwich Mean time or "Zulu" ("Z") time. Local time was 3 hours behind of local time, so the war began at 23:39 on January 16 in military communications.

<sup>31</sup> Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 152-156, 165.

<sup>32</sup> The Saudi F-15Cs and Canadian CF-18s were shifted to strike missions when it became apparent that maintaining massive air cover was not necessary. Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, pp. 197-198.

<sup>33</sup> The Saudi F-15Cs and Canadian CF-18s were shifted to strike missions when it became apparent that maintaining massive air cover was not necessary. Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, pp. 197-198.

<sup>34</sup> Estimate based on the data in Cohen, Dr. Eliot A, Director, Gulf War Air Power Survey, Volume V, Washington, US Air Force/Government Printing Office, 1993. The data are generally selected from the tables on pages 232-233, although some data and categories are modified to reflect different data in pages 235-386.

<sup>35</sup> Based on the range of estimates in USAF RgrpUSAFitgw-35 April, 1991. Also see Michael R. Gordon, and General Bernard E. Trainor, The General's War: The Inside Story of the Conflict in the Gulf, Boston, Little Brown, 1994, pp. 77-94.

<sup>36</sup> Interviews.

<sup>37</sup> Estimates differ according to source. These figures are taken from the revised USAF estimates in Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington Department of the Air Force, 1993, p. 58. Also see Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 162-163, 167, 168, and Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume IV, Part I, Washington Department of the Air Force, 1993, p. 195-202, 212-215.

<sup>38</sup> For further background on this possible loss, see New York Times, September 15, 1992, p. A-5.

<sup>39</sup> Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume II, Part II, Washington Department of the Air Force, 1993, p. 116.

<sup>40</sup> These comparisons are based on a USAF briefing slide, but have only tenuous comparability or reliability. More meaningful data would require a breakout by type of loss relative to sorties flown. The US experience in Vietnam also changes over time. Another USAF estimate is shown below:

	<u>Total Sorties</u>	<u>Total Losses</u>	<u>Losses per Sortie</u>	<u>Percent of Losses</u>
World War I	28,000	289	.010	1.0
World War II	1,746,570	18,289	.010	1.0
Korea	341,269	605	.0017	0.17
Vietnam	1,992,000	1,606	.00081	0.081
Gulf War	29,393	14	.00047	0.047

<sup>41</sup> Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume IV, Part I, Washington Department of the Air Force, 1993, p. 34.

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<sup>42</sup> Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume IV, Part I, Washington Department of the Air Force, 1993, pp. 105-106.

<sup>43</sup> Estimate based on the data in Cohen, Dr. Eliot A, Director, Gulf War Air Power Survey, Volume V, Washington, US Air Force/Government Printing Office, 1993. The data are generally selected from the tables on pages 232-233, although some data and categories are modified to reflect different data in pages 235-386.

<sup>43</sup> USAF RgrpUSAFitgw-35 April, 1991.

<sup>44</sup> Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington Department of the Air Force, 1993, pp. 197-198; Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume II, Part II, Washington Department of the Air Force, 1993, p. 123.

<sup>45</sup> Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington Department of the Air Force, 1993, pp. 197-198;

<sup>46</sup> Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington Department of the Air Force, 1993, pp. 197-198;

<sup>47</sup> Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington Department of the Air Force, 1993, pp. 197-198; Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume IV, Part I, Washington Department of the Air Force, 1993, pp. 114-116, and Volume II, Part II, pp. 112-114 and 119-130. These sections of the report provides a more detailed discussion of air-to-air tactics and encounters at the tactical level.

<sup>48</sup> See the discussion of this issue in Richard Hallion, Storm Over Iraq, p.. 46-53.

<sup>49</sup> Aviation Week, July 22, 1991, pp. 52-53; Col. Walter J. Boyne, Weapons of Desert Storm, p. 50.

<sup>50</sup> Based on discussions with USAF personnel, and review of a limited number of flight logs.

<sup>51</sup> Richard Hallion, Storm Over Iraq, p.. 46-53; Aviation Week, July 22, 1991, pp. 52-53; Col. Walter J. Boyne, Weapons of Desert Storm, p. 50.

<sup>52</sup> Interviews and Aviation Week, February 4, 1991.

<sup>53</sup> Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington Department of the Air Force, 1993, p. 60, 195-196.

<sup>54</sup> See Dr. Eliot A. Cohen, Director, Gulf War Air Power Survey, Volume V, Washington, GPO, 1993, pp. 218-219; Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 13-15; Slides to US Air Force presentation of the April 15, 1993 draft of the Gulf War Air Power study; Brigadier General Robert H.

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Scales, Certain Victory: The United States Army in the Gulf War, Washington, Office of the Chief of Staff, US Army, 1993, pp. 115-116. These estimates were projected by different sources and the launcher or fire unit counts seem to be either rounded or based on standard Soviet battery holdings. According to Palowski, Iraq had the following radar order of battle:

#### Early Warning & Surveillance

- Spoon Rest D/ P-12M	USSR(147-161 MHz)
- Flat Face A/ P-15	USSR(800-900 HHZ)
- Squat Eye/ P-15M	USSR(800-900 HMz)
- Bar Lock/ P-35/37	USSR(2695-3125 MHz)
- Tall King/ P-14	USSR(160-180 MHz)
- TRS-2215 (mobile)	FR (E/F)
- TRS-2230	FR (E/F)
- AN/TPS-32 (3D)	US (2905-3080)
- AWACS (IL-76)	FR

#### Surface-to-Air Missile Systems

- SA-2 Fansong/Guideline	
- SA-3 Low Blow/Goa	
- SA-5 Square Pair/Gammon	
- SA-6 Straight Flush/Gainful	
- SA-7 Grail (IR Hand Held)	
- SA-8 Land Roll/Gecko	
- SA-9 Gaskin (IR Vehicle Mounted)	
- SA-13	Gopher (IR Vehicle Mounted)
- SA-14	Gremlin (IR Hand Held)
- SA-15	Track with Tube Launched Missiles (not confirmed)
- SA-16	(not confirmed)
- SA-19	Mounted on 2S6 Gun-Track (not confirmed)
- ROLAND	
- HAWK	
- ASPEDITE	

London Financial Times, April 29, 1989, p. 11, July 26, 1989, p. 20; Jane's Defense Weekly, May 13, 1989, p. 837; April 22, 1989, p. 687, August 12, 1989, p. 255, September 30, 1989, p. 674, Defense News, May 8, 1989, p. 6; International Defense Review, 6/189, pp. 835-841.

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<sup>55</sup> For a detailed discussion of this phase of the air war see Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume II, Part II, Washington Department of the Air Force, 1993, p. 130-145.

<sup>56</sup> Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume II, Part II, p. 139.

<sup>57</sup> Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume IV, Part I, Washington Department of the Air Force, 1993, p. 174-178; Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume II, Part II, p. 139.

<sup>58</sup> Interview.

<sup>59</sup> Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington Department of the Air Force, 1993, pp. 200-203; ; Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume II, Part II, p. 140.

<sup>60</sup> Interviews, Defense News, September 27, 1993, p. 4; Aviation Week, July 22, 1991, pp. 52-53; Jane's Defense Weekly, March 30, 1991, pp. 500-501.

<sup>61</sup> There is some doubt about this rate since a failure to function was often assessed as a kill. The actual kill rate may have been much lower. Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington Department of the Air Force, 1993, pp. 229-230.

<sup>62</sup> Jane's Defense Weekly, March 30, 1991, pp. 500-501; Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington Department of the Air Force, 1993, p. 196.

<sup>63</sup> Aviation Week, August 19, 1991, p. 65; Eliot A. Cohen, ed., Gulf War Air Power Survey, Volume IV, pp. 92, 102-103, 186, 188.

<sup>64</sup> Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. T-196 to T-197; Eliot A. Cohen, ed., Gulf War Air Power Survey, Volume IV, pp. 103, 186, 203.

<sup>65</sup> Aviation Week, August 19, 1991, p. 65; Jane's Defense Weekly, November 7, 1992, p. 12.

<sup>66</sup> For a discussion of these issues, see Zachary A. Lum, "Air Force Lethal SEAD, Goodbye Weasel...Hello Shark," Journal of Electronic Defense, February, 1994, pp. 35-39.

<sup>67</sup> Defense News, September 27, 1993, pp. 4, 37.

<sup>68</sup> See Dr. Eliot A. Cohen, Director, Gulf War Air Power Survey, Volume V, Washington, GPO, 1993, pp. 218-219; Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 13-15; Slides to US Air Force presentation of the April 15, 1993 draft of the Gulf War Air Power study; Brigadier General Robert H.

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Scales, Certain Victory: The United States Army in the Gulf War, Washington, Office of the Chief of Staff, US Army, 1993, pp. 115-116. These estimates were projected by different sources and the launcher or fire unit counts seem to be either rounded or based on standard Soviet battery holdings. According to Palowski, Iraq had the following radar order of battle:

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- TRS-2215 (mobile)	FR (E/F)
- TRS-2230	FR (E/F)
- AN/TPS-32 (3D)	US (2905-3080)
- AWACS (IL-76)	FR

Surface-to-Air Missile Systems

- SA-2 Fansong/Guideline
- SA-3 Low Blow/Goa
- SA-5 Square Pair/Gammon
- SA-6 Straight Flush/Gainful
- SA-7 Grail (IR Hand Held)
- SA-8 Land Roll/Gecko
- SA-9 Gaskin (IR Vehicle Mounted)
- SA-13 Gopher (IR Vehicle Mounted)
- SA-14 Gremlin (IR Hand Held)
- SA-15 Track with Tube Launched Missiles (not confirmed)
- SA-16 (not confirmed)
- SA-19 Mounted on 2S6 Gun-Track (not confirmed)
- ROLAND
- HAWK
- ASPEDITE

London Financial Times, April 29, 1989, p. 11, July 26, 1989, p. 20; Jane's Defense Weekly, May 13, 1989, p. 837; April 22, 1989, p. 687, August 12, 1989, p. 255, September 30, 1989, p. 674, Defense News, May 8, 1989, p. 6; International Defense Review, 6/189, pp. 835-841.

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<sup>69</sup> Brigadier General Robert H. Scales, Certain Victory: The United States Army in the Gulf War, Washington, Office of the Chief of Staff, US Army, 1993, pp. 115-116.

<sup>70</sup> Eliot A. Cohen, ed., Gulf War Air Power Survey, Volume V, Part II, Washington Department of the Air Force, 1993, p. 641.

<sup>71</sup> Author's interview with Air Vice Marshall William Wratten, March 21, 1991.

<sup>72</sup> Discussions indicate the US Army detected at least nine launches of IR missiles and eight radar guided short-ranged missiles against eight of its helicopters. It may have lost one AH-64 to such missiles.

<sup>73</sup> Defense News, April 29, 1991, p. 21.,

<sup>74</sup> There are problems in this and the similar counts which follow. The data base was never able to characterize 5,660 strikes.

<sup>75</sup> Eliot A. Cohen, ed., Gulf War Air Power Survey, Volume II, Part II, p. 151.

<sup>76</sup> The RAF used 106 JP233s in the Gulf War. It also used 1,117 laser guided bombs, 4,459 free-fall 1,000 pound bombs, eight BL755 cluster bombs, 104 ALARM missiles, 387 CBU-87 cluster bombs (these were bought from the US because the BL755 can only be delivered at low levels, and 34 CRV-7 rockets pods to deliver rockets with warheads designed to attack Iraqi ships like patrol boats. House of Commons, Defense Committee, Preliminary Lessons of Operation Granby, Tenth Report, London, HMSO, July 17, 1991, p. 86.

<sup>77</sup> General Sir Peter de la Billiere, Storm Command, pp. 231.

<sup>78</sup> General Sir Peter de la Billiere, Storm Command, pp. 234.

<sup>79</sup> Author's interview with Air Vice Marshall William Wratten, March 21, 1991.

<sup>80</sup> For sources of this discussion see General Sir Peter de la Billiere, Storm Command, pp. 86-87, 203-204, 229-233; Power Survey: Summary Report, Volume IV, Part I, Washington Department of the Air Force, 1993, pp. 192-208; New York Times, January 25, 1991; Stan Morse, ed., Gulf Air War Debrief, London, Aerospace, 1991, pp. 56-57, 152-153; Colonel Walter J. Boyne, Weapons of Desert Storm, p. 22; Aviation Week, July 1, 1991, p. 48; Air International, March, 1992, pp., 129-132.

<sup>81</sup> Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington Department of the Air Force, 1993, p. 57; Sawt-Al-Shab (Amman), January 12, 1991, p. 15.

<sup>82</sup> Nuclear hardness is not a direct measure of survival against conventional weapons. It consists of resistance to sudden uniform overpressures from the blast effect of nuclear weapons, not resistance to direct strikes by penetrating weapons.

<sup>83</sup> Eliot A. Cohen, ed., Gulf War Air Power Survey: Summary Report, Volume IV, Part I, Washington Department of the Air Force, 1993, pp. 208-212.

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<sup>84</sup> Eliot A. Cohen, Gulf War Air Power Survey, Volume II, Part II, p. 129.

<sup>85</sup> Jane's Defense Weekly, April 27, 1991, p. 684.

<sup>86</sup> IISS, The Military Balance, 1993-1994, IISS, London, 1993, pp. 115-117; USNI Data Base. Military Technology, World Defense Almanac: The Balance of Military Power, Vol. XVII, Issue 1-1993, ISSN 0722-3226, pp. 139-142; and working data from the Jaffee Center for Strategic Studies.

<sup>87</sup> Interviews with General Horner, CINC CENTAF, March 14, 1991, and Air Vice Marshall William Wratten,, March 21, 1991.

<sup>88</sup> General Sir Peter de la Billiere, Storm Command, pp. 229-231; Stan Morse, ed., Gulf Air War Debrief, London, Aerospace, 1991, pp. 56-57, 152-153.

<sup>89</sup> Author's interview with Air Vice Marshall William Wratten,, March 21, 1991.

<sup>90</sup> Jane's Defense Weekly, March 30, 1991, p. 501; Aviation Week, July 1, 1991, p. 48.

<sup>91</sup> See the section on radar bombing in Eliot A. Cohen, Gulf War Air Power Survey: Volume IV, Part I; and General Sir Peter de la Billiere, Storm Command, p. 231 and Stan Morse, ed., Gulf Air War Debrief, London, Aerospace, 1991, pp. 56-57, 152-153.

<sup>92</sup> Alfred Price, "Tornado in the Desert," Air Force Magazine, December, 1992, p. 44; Department of Defense, Conduct of the Persian Gulf War: Final Report, pp. 124, 127, 129, 169-171.

<sup>93</sup> For a good discussion of this issue, see Clifford Beal, Mark Hewish, and Bill Sweetman, Bolt from the blue: making dumb bombs smart," International Defense Review, 12/1992, pp. 1173-1180, and Chicago Tribune, October 13, 1992, p. 9.

<sup>94</sup> Eliot A. Cohen, Gulf War Air Power Survey: Volume II, Part II; pp. 155-158

<sup>95</sup> All portions of this discussion are unclassified, and no attempt has been made to validate them with interviews. See Electronic Defense, May, 1991, pp. 37-39; Aviation Week, February 4, 1991, p. 26, May 10, 1993, pp. 25-26; Eliot A. Cohen, Gulf War Air Power Survey: Volume IV, Part I; pp. 90-97; Volume I, Part I; pp. 82-85, 104, 130, 158, 327; Stan Morse, ed., Gulf Air War Debrief, London, Aerospace, 1991, pp. 36-37.

<sup>96</sup> Electronic Defense, May, 1991, pp. 37-39.

<sup>97</sup> See Jane's Defense Weekly, August 10, 1991, p. 250; and Alfred Price, "EW additions for the RAF," Military Technology, 12/1991, pp. 82-84.

<sup>98</sup> and Alfred Price, "EW additions for the RAF," Military Technology, 12/1991, pp. 82-84.

<sup>99</sup> Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington Department of the Air Force, 1993, pp. 195-197.

<sup>100</sup> Stan Morse, ed., Gulf Air War Debrief, London, Aerospace, 1991, pp. 36-37.

<sup>101</sup> Eliot A. Cohen, Gulf War Air Power Survey: Volume IV, Part I; pp. 102-103.



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<sup>102</sup> Eliot A. Cohen, Gulf War Air Power Survey: Volume IV, Part I; pp. 103-104.

<sup>103</sup> Department of Defense, Conduct of the Persian Gulf War: Final Report, pp. 124, 127, 129.

<sup>104</sup> The author's estimate of aircraft lost to Iran is discussed in the section on the Iranian Air Force.

<sup>105</sup> FBIS NES 92-054, March 19, 1992, p. 16.

<sup>106</sup> The IISS estimates are similar.

<sup>107</sup> In addition to the sources listed at the start of the Iraq section, see Kenneth Katzman, "Iraq: Future Policy Options," Congressional Research Service, CRS 91-596F, December 12, 1991, pp. 23-30; FBIS, October 13, 1991; Washington Times, August 2, 1991, p. B-5; London Financial Times, October 4, 1991, p. 4; AP AM cycle, June 12, 1991; New York Times, March 25, 1991, p. A-1; W

<sup>108</sup> The reader should be aware that these estimates are extremely uncertain and are based largely on expert estimates of the estimated losses during the Gulf War. There is a sharp difference of opinion among some US experts as to the size of Iraq's losses during the conflict.

<sup>109</sup> The SAM launcher estimates are based on discussions with an Israel expert and are highly uncertain. Iran's decision was reported in the New York Times, July 31, 1992, p. 6.

<sup>110</sup> Wall Street Journal, August 19, 1992, p. A-3.

<sup>111</sup> Michael Eisenstadt, "The Iraqi Armed Forces Two Years On," Jane's Intelligence Review, pp. 121-127. March, 1993.