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Since the initial USAF aircraft losses to North Vietnamese air defenses, electronic combat has become an increasingly vital element of modern air warfare. Initially a self-protective defensive tactical reaction to a hostile anti-aircraft environment, electronic combat has steadily evolved into a full-fledged offensive element central to an air campaign. The present study traces this evolution over the course of four conflicts--Vietnam, the 1973 Yom Kippur War, the 1982 Bekka Valley Campaign, and Desert Storm--and contrasts it with the more slowly changing substance of the Air Force's basic doctrinal manual, Air Force Manual 1-1, over the same period of time.

Based on the variance between AFM 1-1 and the emphasis placed on electronic combat by the Desert Storm air campaign, the study explores the manual's relevance to the currently practiced "realities" as they apply to electronic combat. Further, the study questions AFM 1-1's insufficient discussion of both the need to equip the force for the "next war" and to examine trends, first evident during Desert Storm, that may well be crucial in future conflicts. The immediate challenge for doctrine is to adequately emphasize the pervasive nature of electronic combat in modern air war and to apply those lessons with an eye toward the future as well as the past.

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AIR WAR COLLEGE

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THE EVOLUTION OF ELECTRONIC COMBAT DOCTRINE

by

Robert R. Jensik
Lt Colonel, USAF

A RESEARCH REPORT SUBMITTED TO THE FACULTY

IN

FULFILLMENT OF THE CURRICULUM

REQUIREMENT

MAXWELL AIR FORCE BASE, ALABAMA

28 APRIL 1994

Table of Contents

The Evolution of Electronic Combat Doctrine

In July 1965, the Air Force in general and the Tactical Air Command in particular received an object lesson in the relevance of electronic combat[1] to modern air warfare when an SA-2 Guideline surface to air missile (SAM) shot down an F-4 over North Vietnam. In the nearly three decades since that event, gleaned from a variety of foreign and domestic "lessons learned" and increasingly codified in supporting regulations, electronic combat has matured steadily from a nascent conceptual state into a full-fledged war planning and war fighting principle. Since the late 1980s, official publications from the joint level to Air Force operational manuals have exhorted air component commanders to place electronic combat as the centerpiece of their effort to achieve aerospace superiority. One notable exception, however, has been the painfully slow pace at which Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force, has addressed electronic combat as a function of employment and acquisition doctrine.

The Air Force approach to doctrine, in a definitional framework, has been relatively constant. The prefaces of the 1971 through 1984 volumes cite three prime categories: basic doctrine, relating to fundamental and enduring beliefs about the employment of aerospace forces; operational doctrine, describing the use of aeropsace forces as they relate to campaign objectives and force capabilities; and tactical or functional doctrine which addresses the details of accomplishing specific, identifiable objectives. The 1992 edition holds a different tack, generically stating that "doctrine is what we have learned about aerospace power" and then detailing three levels of war--

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[1]The term "electronic combat" evolved from "electronic warfare" in the mid-1970s. Electronic warfare includes electronic countermeasures (ECM), electronic counter countermeasures (ECCM), and electronic support measures (ESM). ESM involves the search for, identification of, and location of radiated electromagnetic energy for immediate threat recognition. Electronic combat further incorporates command, control, and communications countermeasures (C^3CM) and suppression of enemy air defenses (SEAD). For simplicity, this study will use the term "electronic combat" where possible. See Electronic Combat (EC) Operations, Air Force Manual 2-8 (Washington: Department of the Air Force, 30 June 1987), pps. 3 - 9, (paragraphs 1-1 through 2-1)

strategic, operational, and tactial--in Essay F.[2] Yet a key tenet of the five manuals since 1971 has been that doctrine must not remain static. As the current version asserts,

> Doctrine should be alive--growing, evolving, and maturing. New experiences, reinterpretations of former experiences, advances in technology, changes in threats, and cultural changes can all require alteration to parts of our doctrine even as other parts remain constant.[3]

Of the five iterations of AFM 1-1 since that first SAM drew blood in Vietnam (1971, 1975, 1979, 1984, and 1992), the first four were little affected by the lessons of Vietnam, the Yom Kippur War, and the 1982 engagements in the Bekka Valley. Only the 1992 version has come closer to the mark in grasping the various aspects of electronic combat and relating them to doctrinal standards of war fighting. Some inadequacies remain, but the first question arising from this exceedingly slow process is whether AFM 1-1 has, at least in terms of electronic combat, ceded its position as "the cornerstone doctrinal manual from which the Air Force develops operational and tactical doctrine."[4] In effect, if the 1992 AFM 1-1 has simply "caught up" with the times--or at least come to grips with the lessons derived from operational and tactical experience--then one must question whether the "cornerstone" of doctrinal development has become irrelevant.

Since 1965, as the evidence of electronic combat's central role in an air campaign has inexorably mounted, the Air Force has operationalized and intellectualized key precepts involving the control of the electromagnetic spectrum. Initially, changes in air tactics and *ad hoc* modifications to create ersatz electronic combat forces stemmed the hemorrhage in Vietnam. After the shocking early losses of the Israeli Air Force during the Yom Kippur War, electronic combat took on an air of immediacy as Air Force leadership

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[2]Basic Aerospace Doctrine of the United States Air Force, Air Force Manual 1-1 (Washington: Department of the Air Force, March 1992), Vol I, p. vii and Vol II, pps. 43-49

[3]Ibid, Vol. I, p. vii

[4]Assignment of Responsibility for the Development of Aerospace Doctrine, Air Force Regulation 1-2 (Washington: Department of the Air Force, 10 September 1990) p. 3, (paragraph 6a)

Subordinate regulations and manuals, at first simply probing the nature of electronic combat, began to specify policy and outline employment concepts essential to defeating an enemy's ground defenses as well as his airborne capability. Reinforced by the pronounced Israeli success in the Bekka Valley, electronic combat assumed doctrinal status--at operational and tactical levels--through 2- and 3- series manuals that conceptually evolved from limited notions such as radar jamming and threat avoidance to integrated electronic combat forces that could blind, destroy, and defend against anti-aircraft threats. The capstone of that evolution was the Desert Storm air effort that placed a premium on electronic combat and achieved a remarkably low loss rate despite a well-dispersed array of surface defenses boasting modern, western-built systems.

Throughout this evolution, AFM 1-1 remained relatively constant in its approach to electronic combat. As this analysis will show, the 1971 through 1984 versions made little progress, in spite of the obvious lessons, toward embracing electronic combat as a multi-faceted concept central to aerospace offensive missions. The 1992 edition represents a distinct improvement as it makes the first serious effort to view the varied elements of electronic combat as a unified concept. Yet it does not complete the evolutionary process--the transition from a limited self-protection concept to an integral element of **planned**, offensively applied airpower--in that it fails to stress the pervasive nature of electronic combat and its imperative relevance to a wide range of air missions. Neither does it look toward either equipping the force or examining new trends in war that have not yet acquired the popularized status of a "lesson learned." These shortfalls raise yet another question--can AFM 1-1 fulfill its charter as a "guide for the proper use of aerospace forces in war?"[5]

[5]IBID, p. 3, (paragraph 6a)

The Vietnam Era

As early as 1964, the growing dichotomy between AFM 1-1 and the experience of events, as intellectualized in subordinate Air Force publications, was evident. The United States became aware of the SA-2 in 1957 and experienced its capability in 1960 when one such missile downed the Gary Powers U-2 flight.[6] Even before the SA-2's similar success over Cuba in 1962, AFM 51-3, Electronic Warfare Principles had warned "the importance of ECM in modern warfare must never be underestimated. Without ECM, ...electronically controlled defensive systems could inflict unacceptable attrition on attacking forces."[7]

The reigning edition of AFM 1-1, published ironically only 9 days after the first Air Force U.S. aircraft loss in Vietnam from anti-aircraft artillery (AAA), noted only that one required characteristic of aerospace power was the capacity to counter, evade, or destroy enemy ground based defenses to ensure the ability to penetrate hostile airspace.[8] The manual made no reference to electronic combat in its discussion of counter air doctrine, stating only that air superiority would depend on air to air combat.[9]

The exclusivity of air-to-air thinking had both theoretical and practical roots. Though ground fire killed more U.S. aircraft in World War II than any other Axis weapon,[10] the Air Force was clearly steeped in the Mitchell-Douhet doctrinal tradition that the airplane was vulnerable only to another aircraft.[11] As jet technology, with its increased speed and altitude capabilities, eased memories of AAA effectiveness, the concurrently

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[6]Kenneth Werrell, Archie, Flak, AAA, and SAM: A Short Operational History of Ground-based Air Defense, (Maxwell AFB AL: Air University Press, 1988), pps. 104-5

[7]Electronic Warfare Principles, Air Force Manual 51-3 (Washington: Department of the Air Force, 1 November 1962), p. 1-9

[8]Basic Aerospace Doctrine of the United States Air Force, Air Force Manual 1-1 (Washington: Department of the Air Force, 14 August 1964), p. 2-2 (paragraph 2-3a)

[9]IBID, p. 5-2, (paragraph 5-4)

[10]Werrell, op. cit., p. 57

[11]John R. Bode, Stuart W. Bowen, Richard P. Dowell, and Leonard J. Siegert, "Impact of Maturing Ground Based Technologies on Tactical Air Doctrine: End of the Mitchell Era", White paper prepared for the 1977 Air University Airpower Symposium, Maxwell AFB AL, 29-31 March 1977

developing American defense policy sought to emphasize strategic forces at the expense of tactical capabilities in the 1950s. With the Tactical Air Command bearing the brunt of budget cuts,[12] the development of electronic warfare capability was clearly going to be secondary at best to the impetus to acquire tactical aircraft. Equally, technology had yet to develop cooling systems and power sources that would not penalize weight-sensitive tactical aircraft.[13]

Doctrinally and technically unprepared, the Air Force began its effort in Vietnam with the Rolling Thunder campaign in 1965. With a loss of 50 aircraft to ground defenses by the middle of that year, campaign planners faced a lose-lose dilemma--fly safely at 25,000 feet to the total detriment of bombing accuracy or risk high speed, maneuver-intensive bomb runs in a heavily defended low altitude environment.[14] Though the Air Force introduced the retrofitted EB-66C as a standoff ECM platform to jam the AAA radars, the introduction of SA-2 batteries now threatened even the higher altitudes.[15]

The American response from late 1965 until the end of the war assumed two principal forms--modification of tactics as required by the move-countermove duel with the Vietnamese and the introduction of ECM-capable, role-specific aircraft to counteract radar guided ground threats. Rapid heading changes, different approach routes to targets, and fast low level flight before popping up for the bomb release were somewhat effective, and air crews learned that diving toward an SA-2 in flight and pulling out abruptly prior to missile impact could defeat the threat.[16] Major technological upgrades included the APR-

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[12]Lt Col Phillip S. Meilinger, "The Problem with our Airpower Doctrine", Airpower Journal, 6 (Spring 1992), p. 26

[13]Lt Col Richard Rash, USAF, "Electronic Combat--Making the Other Guy Die for his Country", (research report, Air War College, Maxwell AFB AL, 1982), p. 7

[14]Lon O. Nordeen Jr., Air Warfare in the Missile Age, (Washington: Smithsonian Institution Press, 1985), p. 13.

[15]IBID, pps. 13-16

[16]Werrell, op. cit., p. 107

25 radar homing and warning receiver to tip off an air crew that it was being highlighted by either a SAM or AAA radar,[17] the EB-66, and most significantly, the Wild Weasel dedicated to radar threat suppression.[18]

With this greater capability, tactical air forces formed the first hunter-killer teams with F-100F Wild Weasels that would electronically locate and initially assault a ground defense position, while the F-105D killer component employed iron bombs to finish the attack.[19] The North Vietnamese continued to complicate the American problem by altering their radar frequencies and developing a remarkable capability to quickly move and camouflage SA-2 sites.

To counter the dynamics of an increasingly sophisticated air defense net, the Air Force placed great reliance on its Quick Reaction Capability (QRC) to design, build, test, and employ ECM systems in an extremely rapid fashion. QRC produced the first self-protection jamming "pods" which enabled designated aircraft to be retrofitted into an ECM role.[20] Pod-equipped aircraft demonstrated their better survivability rate within a week of their arrival when on a mission to a heavily defended area, they experienced only light and inaccurate AAA while pod-free sorties in the same area were heavily targeted by SAM and AAA.[21]

North Vietnam was quick to counter the hunter-killer threat and the pod capability by employing its in-depth integrated air defense system (IADS), upgrading SAM systems, and sending the newly introduced MIG-21 aircraft to counter the less maneuverable pod-equipped jamming platforms. Using IADS, a SAM site could receive initial threat tracking

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[17]"The Radar Warning Story", Asian Defence Journal, (January 1982), p. 71

[18]Tom Wilson, "The Wild Weasel Legacy-The Early Days", Defense Electronics 20 (September 1988), p. 54

[19]IBID, p.54

[20]Werrell, op. cit., pps. 118-9

[21]"Wild Weasel Employment", Tactics Review Brochure, Tactical Air Command, Southeast Asia, volume II, April 1973

information from a geographically separate early warning radar and thereby cut its radiating time to a point where a Wild Weasel would be hard-pressed to program its Shrike anti-radiation missile to "follow" the SAM's radar beam.[22] The MIG-21s also relied on the IADS, receiving ground controlled intercept instructions enabling them to approach in the most advantageous manner. In air to air combat, the kill ratio was even for both sides.[23] Finally, SAM upgrades now incorporated new frequency capability and, more ominously, an optical tracker that reduced reliance on increasingly vulnerable radars.[24]

The final chapter of the air war, Linebacker II, became a fitting climax to the nearly 7 years of technical upgrades and tactics adjustments by both sides. Dedicated electronic combat strike support forces provided standoff jamming packages, SEAD with hunter-killer teams, and sewed chaff corridors--blankets of lightweight foil designed to saturate radars with false returns--over which B-52s would fly bomb runs, simultaneously employing their own jamming capability. The North Vietnamese operated radar outside U.S. jamming frequencies where possible and barrage-fired terminally guided SAMs at bomb run turn points that had become predictable due to unimaginative American tactics.[25] Before the Vietnamese literally depleted their supply of SAMs, they inflicted a loss rate on the B-52s of five percent or better, finding particular success against B-52G models that did not possess upgraded ECM capability.[26]

The evident lesson of the Vietnam air war was that electronic combat had come of age. The initial successes of pod-equipped aircraft carried over for the balance of Rolling Thunder, leading to the conclusion that the lower loss rate was attributable to ECM.[27]

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[22]Nordeen, op. cit., p. 24

[23]IBID, p. 38

[24]IBID, p. 34

[25]Major Stanley J. Dougherty, USAF, "Defense Suppression: Building Some Operational Concepts", (thesis, School of Advanced Airpower Studies, Maxwell AFB AL, 1992), p. 21

[26]Werrell, op. cit., p. 121

Losses during Linebacker II, had aircraft lacked ECM, were estimated to have been between 75 and 100 B-52s.[28] Beyond this obvious conclusion, however, was the realization that air defenses could be networked (IADS) and that mission-specific electronic combat aircraft, like the EB-66 and Wild Weasels operating with separate tasking, would be required to suppress an enemy defensive system that could threaten air superiority.[29]

These same lessons were also starting to appear in print, but not as a part of basic doctrine. AFM 2-8, Tactical Air Operations-Electronics, issued in 1969, noted that "actions that affect the efficient use of the electromagnetic spectrum will have a major impact on the success of military operations,"[30] and then added tellingly

> ...continuous operations, usually conducted in the hostile environment of the enemy's air defense system, are directed at the destruction of the enemy's fighters, interceptors, AAA guns, SAMs, and other defensive forces. To a large extent, these weapon systems are controlled by an elaborate network of radar and communication data links, all of which may be vulnerable to ECM.[31]

Similarly, AFR 55-90, Electronic Warfare Policy, was updated to "reflect the increased importance that the JCS and the Air Force place on electronic warfare."[32] However, the 1971 edition of AFM 1-1 did not reflect this same concern.

In modifying its 1964 predecessor, the 1971 AFM 1-1 simply linked the destruction of air defense sites and "air control systems" with the counter air mission and

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[27]"Electronic Gear Cuts SEA Aircraft Losses", Air Force Times, 28 (25 October 1967), p. 14

[28]"Special Report: Electronic Warfare", Aviation Week and Space Technology, 102 (27 January 1975), p. 42

[29]Wild Weasel Employment, op. cit., p. 2

[30]Tactical Air Operations-Electronic, Air Force Manual 2-8, (Washington: Department of the Air Force, 17 November 1969), p. 1-1 (paragraph 2)

[31]IBID, p. 5-4 (paragraph 5-2a)

[32]Electronic Warfare Policy, Air Force Regulation 55-90 (Washington: Department of the Air Force, 15 July 1970), p. 8

cited electronic warfare as a "sub-element activity"--along with air refueling and search and rescue, among others--of the basic operational tasks of aerospace forces.[33] The new manual further maintained only that "continued effective operations in a sophisticated enemy electromagnetic environment" was a required aerospace capability.[34] This was the first instance where the manual viewed defense suppression as a distinct element from electronic warfare. The manual made no mention of the importance of assaulting either the IADS or command and control systems, and it provided no direction for equipping aircraft with the capabilities necessary to survive in that hostile "electromagnetic environment." Clearly, by 1971, subordinate manuals were not only well ahead of 1-1 in details (as is their charter), but also in conceptualization of the element of the war that was proving extremely costly in lives and treasure.

The Yom Kippur War

Any lingering doubts over the dominance of electronic combat in modern air war evaporated in October 1973 when Arab states attacked Israel and rapidly demonstrated the lethal potential of in-depth air defenses. While the Israeli Air Force had stripped electronic combat gear from many of their aircraft to bolster speed and maneuverability, the Egyptians constructed a dense air defense net comprised of Soviet-built SA-2s, SA-3s, SA-6s, and ZSU 23-4 AAA, the last three of which had excellent low altitude capability. When the Israelis responded as in 1967 with aircraft to support its armored columns, they were met with a withering fusillade and lost 50 aircraft in the first 3 days of the war.[35] That figure climbed to 102 by the end of the conflict, representing nearly 37 percent of Israel's pre-war assets.[36] For two key reasons, the tide began to turn after these high

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[33]Basic Aerospace Doctrine of the United States Air Force, Air Force Manual 1-1 (Washington: Department of the Air Force, 28 September 1971), p. 2-1, (paragraph 2-2)

[34]IBID, p. 2-4, [paragraph 2-3(a)(3)]

[35]Dougherty, op. cit., p. 25

[36]Major Donald J. Alberts, USAF, "Call from the Wilderness", Air University Review, 28 (November-December, 1976), p. 39

initial losses: an intense American resupply of the Israeli Air Force, complete with Vietnam-style jamming pods and warning receivers retuned for the SA-6, [37] and a successful Israeli Army counter attack after the Egyptians had ventured out from the protection of their air defenses.[38] That ECM helped level off the steep attrition rate was not surprising, but almost by accident, the Israelis discovered their air force was not the only means of air defense suppression. As the army pushed the Egyptians back, it was able to neutralize many of the SAM and AAA emplacements, affording the air force nearly free reign by the time the cease-fire occurred.

If the end of the Vietnam War might have prompted a decrease in interest in electronic combat, the Yom Kippur conflict provided the impetus to address the issue more aggressively. As Israel was regaining a measure of air superiority over the Suez Canal, Air Force Chief of Staff General George S. Brown directed an Air Force Systems Command-Tactical Air Command joint study which ultimately led to the Pave Strike program, a research and development effort to field equipment that could more precisely locate hostile radar emplacements, modify the F-111A into an EF-111 standoff jamming platform, upgrade later model F-4Es to a Wild Weasel configuration, develop remotely piloted vehicles (RPV) to saturate defenses, and improve existing electro-optically guided weapons.[39] Israeli success at communications disruption also prompted work to modify C-130s into EC-130 Compass Call aircraft, specifically designed to carry out a C^3CM mission.[40] Research and development efforts by Westinghouse, McDonnell-Douglas, and Loral, among others, began to focus on increasingly sophisticated methods of jammer power management--the more effective employment of limited electrical power generated

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[37]Rash, op. cit., pps. 15-16

[38]Werrell, op. cit., p. 144

[39]Robert F. Futrell, Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, 1961-1984, Vol II, (Maxwell AFB AL: Air University Press, 1989), p. 489

[40]Neil Munro, The Quick and the Dead, (New York: St. Martin's Press, 1991), pps. 223-4

by a tactical aircraft--and near real time on-board computer analysis of enemy radar signal parameters.[41]

The lessons of the Yom Kippur War were not lost upon the highest echelons of the military establishment. Chairman of the Joint Chiefs of Staff, Admiral Thomas Moorer noted during 1975 Senate procurement hearings that

> ...the classic doctrine that the priority of employment of air assets must be given to gaining and maintaining air superiority over the battlefield has been proven again. Today, gaining air superiority includes defeating enemy SAMs in detail. Until enemy air defenses are degraded, any application of aerial firepower will be costly.[42]

In parallel House hearings, Major General Robert P. Lukeman, assistant Chief of Staff for Studies and Analysis, reinforced Admiral Moore's theme, but added importantly that tactical electronic combat resources would also involve "direct attack" on hostile control elements.[43]

With industry and military leaders clearly committed to bolstering U.S. electronic combat capability, a new version of AFM 1-1 was published on 15 January 1975. Inexplicably, this edition recoiled from its already modest 1971 position by including electronic combat as a part of counter air operations through the most oblique implication, maintaining that offensive counter air operations would normally be conducted against those elements which supported the enemy air order of battle.[44] Additionally, the manual changed electronic warfare from a "sub-element" to a "direct combat support" activity and noted that survival in "sophisticated hostile environment" was a required characteristic of

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[41]Aviation Week, 27 January 1975, op. cit., p. 77

[42]Futrell, op. cit., p. 485

[43]IBID, p. 488

[44]Basic Aerospace Doctrine of the United States Air Force, Air Force Manual 1-1 (Washington: Department of the Air Force, 15 January 1975), p. 3-2 (paragraph 3-5b)

aerospace forces.[45] The manual provided no guidance for equipping the combat force to accommodate the growing electronic threat.

Arguably, the delays and coordination difficulties associated with publishing a new AFM 1-1 could explain why the digested lessons of Vietnam and Yom Kippur "didn't make the deadline." Yet four years later, with the release of yet another AFM 1-1, few of these shortfalls were corrected. The 1979 manual restored SEAD as an element of the air superiority equation, while "electronic warfare" was accorded a new status as an Air Force "specialized task."[46] "Electronic warfare" and SEAD continued to be treated as separate issues, however, and electronic warfare was placed at the same level as search and rescue, psychological operations, and combat documentation (photography). The manual further stated the Air Force would invest its energy in research and development to enrich its technological base,[47] hardly a clarion call for the necessary emphasis on developing measures to counter expected upgrades in Soviet-built air defense systems.[48]

Later in 1979, the doctrine office of the Air Staff published AFM 1-9, Doctrine for Electronic Combat, in recognition of the expanding significance of the electromagnetic spectrum.[49] The manual provided the normal litany of objectives as part of its appointed role to "expand" upon AFM 1-1; however, the key difference was not an expansion but rather an amalgamation of the various elements of electronic combat. This effort also included an attempt, albeit somewhat abstruse, to apply that unified concept across the

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[45]IBID, p. 2-1, (paragraph 2-2c)

[46]Basic Aerospace Doctrine of the United States Air Force, Air Force Manual 1-1 (Washington: Department of the Air Force, 14 February 1979), p. 2-28

[47]IBID, p. 4-11

[48]The SA-6 had clearly been a technical surprise for both Israel and the United States in 1973, and well before the 1979 doctrine was published, unclassified sources noted the existence of new Soviet radar guided and infrared threat systems, the SA-8 and SA-9. For instance, see Air Force Magazine's annual report on the Soviet threat, December 1977, p. 69

[49]Doctrine for Electromagnetic Combat, Air Force Manual 1-9 (Washington: Department of the Air Force, 18 September 1979), Preface

breadth of the war fighting spectrum. That both manuals were published by the same Air Staff directorate (XOX) in the same year is not particularly illuminating; as noted above, the fitful machinations of bureaucracy render such apparent disconnects not uncommon. What is significant is that the thought process is clearly different from one manual to the next. AFM 1-1 pigeonholed separated portions of electronic combat thought into different areas, while AFM 1-9 sought to bring those elements together and view the concept as recent history had taught--electronic combat was beginning to dominate the battlefield air space and needed to be regarded in such a light. Given this tack taken by AFM 1-9, along with the lessons of the Bekka Valley, it is noteworthy that the follow-on AFM 1-1, issued in 1984, continued to miss many of the key points of electronic combat.

The Bekka Valley

In concert with a modern prototypical electronic combat force, Israeli fighter-bombers launched an intensive 2 day campaign against Syrian air defenses in the Bekka Valley. Seeking air superiority to cover a ground assault against Palestinian positions in Lebanon, the Israelis began with RPV sorties that coaxed Syrian radars onto the air. Complementary electronic intelligence (ELINT) drones relayed the signal characteristics and locations back to a standoff collection platform which in turn mapped out the entire Syrian electronic order of battle.[50] With E-2C Hawkeye Airborne Control and Warning Aircraft (AWACS) to augment the counter air mission, the Israelis attacked, based on this information, using jamming to blind radars along with standoff munitions and iron bombs to destroy the SAM sites. Employing the combined doctrine learned during the 1973 war, the Israeli army assisted in defense suppression with artillery and rocket barrages, and successfully inserted a commando team which destroyed an air defense communications center.[51] In short order, the Syrian rebuilding effort, carried on carefully since 1973, was

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[50]"Lebanon Proved Effectiveness of Israeli EW Innovations", Defense Electronics, 14 (October 1982), p. 42

[51]Werrell, op. cit., p. 147

reduced to rubble by an integrated force effectively using the elements of electronic combat.

Able to draw on the fresh lessons of the Bekka Valley, the 1984 edition of AFM 1-1 made some improvements over its predecessor, but still failed to capture two emerging trends in electronic combat--a dedicated airborne force to support a strike package and the utility of combined forces in a SEAD role. The 1984 manual was the first to cite SEAD as a component of electronic combat, though the latter remained a "specialized task" that could "enhance" the execution and successful completion of Air Force missions.[52] The manual underscored the significance of electronic combat as a major factor in the success or failure of military operations, but there the hopeful intellectual trend stopped. There was no attempt to influence the development of operational thinking[53]in terms of fashioning an air element dedicated to control of the electromagnetic spectrum to facilitate any air mission. Equally, there was no recognition of the capability of combined arms surface forces to support the air mission which proactive doctrine might have addressed well before such an employment was again demonstrated in Desert Storm.[54]

While Air Force doctrine had, to this point, failed to adequately incorporate several of the clearly evident lessons of campaigns from Vietnam to the Bekka Valley, many of the concepts still found their way into subordinate regulations with an increasing degree of exactitude and ripened reflection. This dichotomy between the "real world" and basic doctrine appeared sharply in focus as the air campaign plan for Desert Storm was executed with such pronounced effect.

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[52]Basic Aerospace Doctrine of the United States Air Force, Air Force Manual 1-1 (Washington: Department of the Air Force, 16 March 1984) pps. 3-6 through 3-7 (paragraph 3-4)

[53]Giving due credence to "territorial" boundaries, it is not beyond the scope of AFM 1-1 to discuss the general characteristics of employment of aerospace forces at the operational level. As per AFR 1-2, cited above, the "broad guidelines on how air forces are prepared and employed" certainly lends AFM 1-1 the latitude to lay the groundwork for operational concepts.

[54]Lt Col Price T. Bingham, USAF, "Air Power in Desert Storm", Airpower Journal, 5 (Winter, 1991), p. 35

Desert Storm and Electronic Combat

The Desert Storm air campaign was designed to gain air superiority as quickly as possible to permit unimpeded Coalition air and ground operations. The plan listed among its first two objectives the telecommunications/C^3 systems and as a function of air supremacy, the strategic IADS radar sites, SAMs, and IADS control nodes.[55] Throughout the Desert Shield precursory phase, planners collected key pieces of intelligence on the disposition of the Iraqi C^3 and IADS networks to determine the location and parametrics of threat and early warning radars alike. The Iraqis were helpful in this regard, regularly holding radar defense exercises until November 1990 when they realized they were providing a treasure trove of intelligence.[56]

This rich ELINT harvest enabled planners to select key targets for electronic combat as well as to determine the strongest sectors that could threaten Coalition air assaults. Constructing the electronic combat strike package for the first night, planners incorporated B-52-launched cruise missile and Navy Tomahawk attacks on command and control nets, high speed anti-radiation missile-equipped F-4G Wild Weasels, EF-111A and Navy EA-6B standoff jammers, EC-130 communications jamming aircraft, AWACS and ELINT collectors, and of course F-117 and F-16 fighter-bombers. The plan included army attack aviation to help open the first holes in the defense.[57] Shortly after the beginning of the air war, planners also tasked the E-8 Joint Surveillance Target Attack Radar System (JSTARS) for its first operational use, given total control of the electromagnetic spectrum by the Coalition by that stage.

The initial attacks neutralized the defense network, and air defense sites acting autonomously had only minor incidents of success when electronic combat assets were

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[55]U.S. Department of Defense, Conduct of the Persian Gulf War, Final Report to Congress, April 1992, p. 95

[56]Brigadier V K Nair, VSM, War in the Gulf: Lessons for the Third World, (New Delhi: Lancer International, 1991), p. 101

[57]Final Report to Congress, op. cit., p. 119

unavailable to support a particular strike package. Coalition forces had virtual sanctuary above 10,000 feet[58] and continued to play out an integrated electronic combat campaign as the air war unfolded. Asked why Iraqi radar-guided defenses were ineffectual, Major General John Corder, the air campaign director of operations, noted

> ...we did SEAD, we did C^3CM, and we had our own on-board self-protection EW. We set about in a very deliberate manner ... we bombed all the operations centers and we jammed everything we could on the first day. ...we went into a very aggressive campaign to beat up on all the [early warning/ground controlled intercept] sites. ...to me, it was a classic campaign.[59]

One clear contribution of electronic combat could be readily measured in numbers of Coalition aircraft NOT shot down--radar-guided SAMs destroyed or damaged only 13 aircraft during the war, while the balance of losses were caused by unguided AAA or infrared homing SAMs. Notably, the Coalition loss rate was 14 times less than that experienced by U.S. forces during Linebacker II despite the higher sortie rate and the greater depth and sophistication of the Iraqi net.[60]

Certainly, there are mitigating factors regarding the low loss rate of the Coalition--Iraq's ability to react to initial assaults, poor training, low morale, the intelligence "gift" of the pre-war air defense exercises, and the length of time available to assemble Coalition forces are considerations. Yet the fact remains that the Coalition, like the Israelis in the Bekka Valley, had absolute control over the electromagnetic spectrum and this control was all-pervasive. The key is gaining such control--and the options it provides--more than focusing on fortuitous circumstances that allowed that control to become a reality. As noted by a third world observer, electronic combat allowed for

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[58]IBID, p. 127

[59]Hal Gershanoff, "EC in the Gulf War", Journal of Electronic Defense, 14 (May 1991), p. 44

[60]Eliot A. Cohen and Thomas A. Keaney, Gulf War Air Power Survey Summary Report, p. 62

> ...surveillance and target acquisition; identification of friend or foe; damage assessment; command and control in force management; communications for decision making and passing of directions; planning operations; communicating real time information; prosecution of psychological operations; provision of brains to weapons to seek, engage and destroy hostile targets; navigation of third generation weapon systems; degrading hostile electronic devices and command structures; locating mobile missile launchers and directing friendly fires; integrated computerized fire control systems; night fighting devices compatible to weapon platform and mission; deception and so on.[61]

Against such a "lessons learned" backdrop, the new AFM 1-1, published only a year after the cease-fire[62], is already outdated.

AFM 1-1--1992 and Beyond

In the context of electronic combat, the 1992 AFM 1-1 represents a distinct improvement over the 1984 volume. Several key lessons have been incorporated in the manual; however, while it focuses on some important "trees," it may be overlooking the larger "forest." Equally, future editions of the manual will have to make a determined effort to address some watershed lessons of Desert Storm.

The manual retains the linkage between SEAD and offensive counter air, noting that this "sub-mission" of counter air was prompted by the high priority assigned to eliminating ground defenses.[63] This version also cites the importance of combined arms in the task of defense suppression, specifically citing the Israeli example from 1973.[64] Essay S builds upon the 1984 manual's unifying discussion of electronic combat's elements--electronic warfare, C^3CM, and SEAD--remarking that the synergism electronic combat and other war fighting missions can produce cumulatively disastrous effects on the enemy's overall war-making capability.[65]Yet two elements of that discussion suggest that

[61]Nair, op. cit., p. 92

[62]The current AFM 1-1 was in the final stages of coordination during Desert Storm; obviously, incorporation of any Persian Gulf experience would have been impossible. The dogging question is whether the lessons of that war will be only slowly incorporated in the next versions of the manual.

[63]AFM 1-1, March 1992 op. cit., Vol. II, p. 196 (footnote 14)

[64]IBID, p. 141

[65]IBID, p. 192

AFM 1-1 still fails to grasp--and thus communicate--the conceptual significance of electronic combat.

First, the manual asserts that

> Enemy defenses can further reduce a commander's offensive capability if they cause him to dedicate forces, which otherwise could be used for attacks against air bases and launch facilities, to defense suppression.[66]

The implication here is that air power not dedicated to "pure" counter air--such as an enemy's runways and aircraft on the ground--is not being used offensively. This misses a basic point that electronic combat, which includes SEAD, is offensive. "Hard kills" of ground defenses which allow aerial penetration are no different than the destruction of an enemy's artillery capability which would allow ground troops to advance. Moreover, electronic combat, as shown first in the Bekka Valley, can be conducted in the context of a strike force that used a variety of tools, from jamming communication systems to peering into the distance to find targets ripe for interdiction well behind the battle line. This flexibility factor leads to the manual's second key shortfall--characterizing electronic combat as a "force enhancement" mission.

As defined, "force enhancement" includes "missions that directly support both aerospace and terrestrial combat forces but do not by themselves counter or apply force against enemy targets."[67] For the other force enhancement missions--airlift, aerial refueling, and surveillance/reconnaissance--that statement holds true. But electronic combat has become all-pervasive, and because its basic premise is control of the electromagnetic spectrum, electronic combat underpins every Air Force role that relates to offensive operations. AFM 1-1 hints at this when it asserts that the aerospace control and force application roles rely on a "wide variety" of force enhancements for success.[68] Yet

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[66]IBID, p. 140

[67]IBID, p. 285

[68]IBID, p. 108

that assertion ignores, or at least dilutes, what has become obvious in theory and practice; the combatant that cannot control the electromagnetic spectrum, irrespective of his airlift, aerial refueling, or surveillance assets, will not prevail without significant losses. Certainly AFM 1-1 gives credence to controlling the spectrum, but to label such a pivotal concept as a "force enhancer" suggests the manual has yet to come to terms with **how** to use that control once it has been established.

AFM 1-1's non-discussion of equipping the force is another shortcoming. Without becoming wrapped up in the question of whether doctrine drives technology, and not wanting to force an inappropriate predictive role on the manual, one can arguably ask if AFM 1-1 has ceded it doctrinal "leadership" role by constraining itself to a simple statement that higher speeds, operating ceilings, ECM, SEAD, and low-observable technologies have been pursued in the past to reduce attrition, and therefore follow-on "equipment must be designed to lessen vulnerability."[69] This rather aimless exhortation pales in the face of real world developments that demand doctrinal attention. Stealth design is certainly today's leading edge technology,

> [b]ut stealth technology does not make the aircraft truly invisible to radar or other sensors. There are many powerful radars that can detect even very small non-metallic objects such as insects or birds at very long range, so even the best stealth aircraft will have to rely on a noisy and confusing electromagnetic battlefield to conceal their approach.[70]

Such an observation may be scientifically arguable, but history and logic combine to teach that no weapon has ever remained indefinitely invulnerable, and since stealth is predicated on defeating the radar portion of the electromagnetic spectrum, is there a part of that spectrum (i.e. "other sensors") that could be readily employed against stealth? Based on

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[69]IBID, p. 255

[70]Munro, op. cit., p. 105

the much-heralded performance of the F-117 during Desert Storm, it seems likely that stealth capability will be a prime target for a developing technology.

Additionally, the majority of SAM kills in Desert Storm were caused by infrared missiles, yet doctrine makes no call for the ability of aircraft to be aware they are under attack, early in the engagement.[71] Similarly, there is a proliferation of western-built systems moving into the third world, some of which may be indigenously modified well beyond their original electronic parameters; the next AFM 1-1 must make the connection between determining the characteristics of these revised threats and reacting as required to blunt this changed capability.[72] Russia has been selling its highly capable SA-10 for $75 million per copy, about half the price of a comparable Patriot.[73] As spare parts become rarer, purchasers of these SA-10s will be forced to modify their systems, as the alternatives of acquiring different equipment or selecting a different means of air defense are likely to be prohibitively expensive. U.S. systems may not provide protection against these modified threats. The problem is not unique to modern equipment, as some 1950s-vintage Iraqi systems proved difficult for updated U.S. gear to counter during Desert Storm.[74]

One final area which future doctrine must address is the "new" trends that had not been significant factors in warfare before Desert Storm, but came of age in that conflict. One such lesson, the ability to promulgate information--or to deny the enemy the same

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[71]Doctrine has lagged in this particular aspect. The Electronic Warfare Division of the Wright Laboratory has taken the initiative to fund the Missile Approach Warning System for aircraft. See "USAF Striving to Keep Current Funding Levels", Aviation Week and Space Technology, 137, (19 October 1992), p. 67

[72]Until precision munitions are available, the B-2 will use conventional 500 pound bombs, which obviously require close-in action. See David A Fulghum, "Loh Outlines Bomber Plans", Aviation Week and Space Technology, 139 (5 July 1993), p. 27. The loss of such an expensive asset due to an unanticipated change in a system's capability suggests that doctrinal attention to indigenous modification--and the effort necessary to discern it--would be well spent.

[73]"Get Yer Red Hot Bombers, Tanks, and Missiles", Business Week, No. 3284, (21 September 1992), p. 44

[74]Robert K. Ackerman, "Electronic Warfare Explodes as Threats Spawn Diversity", Signal, 46, (March 1992), p. 37

option--is likely to be increasingly important in the future. As Air Force Chief of Staff General Merrill A. McPeak commented,

> Desert Storm really opened our eyes. It is well understood, I think, that our fabulous combination of space-borne sensors and command and control capabilities produced a lopsided win in the contest for what some are now calling information dominance. Information dominance is a relatively new concept, one that is moving to occupy center stage in our thinking about modern war. It means the ability to observe the whole theater, to rapidly assess threats and opportunities and to precisely navigate to those targets.[75]

With terrestrially based fiber optic technology, the information battle may not simply turn on U.S. space superiority, but it will involve electronic combat, quite likely in a complex and potentially "target elusive" environment. This will mandate a sophisticated next step in the evolutionary process, placing an ever higher premium on the offensive nature of electronic combat as an airpower campaign centerpiece that impels the specific application of available weapon systems. If this potential for "information dominance" can (and did in Desert Storm) become a critical war fighting capability, then AFM 1-1 must give it due consideration in a future volume. The intellectual basis for such an off-shoot of electronic combat--called "cyberwar"--has gone beyond mere theory toward a more practical concept for employment.[76]

The evolution of doctrine, in terms of electronic combat, has been a slow process, generally incorporating lessons of the past well after they have been discussed in subordinate regulations and employed in battle. If basic doctrine is in the mode of "catching up," then it risks irrelevance The variance between the Desert Storm campaign plan and the then current basic doctrine manual endorses such a conclusion. This

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[75]General Merrill A. McPeak, "The Air Force Role in Space", Air Force Update got Senior Air Force Leaders, (Washington: Secretary of the Air Force Office of Public Affairs, 27 April 1993), p. 1

[76]John Arquilla and David Ronfeldt, "Cyberwar is Coming!", Comparative Strategy, 12, (April-June 1993), p. 146. The authors define "cyberwar" as warfare conducted according to information-related principles, ...meaning disruption, if not destroying, information and communications systems. This concept seeks to turn the "'balance of information and knowledge' in one's favor, especially if the balance of forces is not."

evolution still awaits a final chapter that adequately stresses the pervasiveness of electronic combat, rather than relying on simple inferences that such a concept is important to the conduct of military operations. The manual has improved upon its predecessors by refocusing our attention on the primacy of controlling the airspace, but that supremacy is unlikely without first gaining control of the electromagnetic spectrum. Once accomplished, the other missions follow; given fewer and drastically more expensive assets, it is the essential precursor in a modern air campaign.

Though basic doctrine was never intended as a force employment checklist, a clear imperative for remaining "relevant" stems from the manual's impact on the development of joint doctrine. In the wake of Desert Storm, the terms "airpower" and "Air Force" are not likely to be strict synonyms again; however, the doctrine of such joint forces is equally susceptible to intellectual atrophy unless it benefits from the proactive stimulus of a forward-looking Air Force "entering argument." Though it is not with any exclusive mandate that AFM 1-1 should exercise a preponderant influence on joint doctrinal change, the manual is clearly charged with "providing the foundation for Air Force contributions to joint doctrine."[77] A manual that lacks clarity, relevance, or currency is simply not up to such a task.

Finally, doctrine that centers principally on the past will be of dubious value. Without trying to predict the future or becoming inappropriately specific, doctrine must to some measure be predicated on the notion that the next war will not be like the last. Toward that end, it must look to preempting potential weaknesses. For example, if technology is ever able to threaten U.S. conventional strength, it is likely to be an electronic/sensory breakthrough. Doctrine's proper role in this setting is a clear call for the necessary research and development to cement our current capability to control the electromagnetic spectrum.

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[77]AFR 1-2, op. cit., p. 1, paragraph 2b(6)

Yet rather than considering the foregoing a failure of doctrine, it may be better seen as a challenge to its future utility. Basic doctrine need not be rendered irrelevant simply by the pace of change or the difficulty in characterizing a wide-ranging concept in order to "set the table" for operational and/or tactical doctrines. It is clearly possible for the basic manual to become proactive rather than reactive and in so doing fulfill its obligation to be the cornerstone of doctrine.

Bibliography

1. Ackerman, Robert K., "Electronic Warfare Explodes as Threats Spawn Diversity", Signal, Vol. 46, No. 7, (March 1992).

2. Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force. Washington: Department of the Air Force, 14 August 1964

3. Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force. Washington: Department of the Air Force, 28 September 1971

4. Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force. Washington: Department of the Air Force, 15 January 1975

5. Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force. Washington: Department of the Air Force, 14 February 1979

6. Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force. Washington: Department of the Air Force, 16 March 1984

7. Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force, Vol. II, Washington: Department of the Air Force, March 1992

8. Air Force Manual 1-9, Doctrine for Electromagnetic Combat. Washington: Department of the Air Force, 18 September 1979

9. Air Force Manual 2-8, Tactical Air Operations-Electronic. Washington: Department of the Air Force, 17 November 1969.

10. Air Force Manual 51-3, Electronic Warfare Principles. Washington: Department of the Air Force, 1 November 1962

11. Air Force Regulation 1-2, Assignment for the Responsibility for the Development of Aerospace Doctrine. Washington: Department of the Air Force, 10 September 1990

12. Air Force Regulation 55-90, Electronic Warfare Policy. Washington: Department of the Air Force, 17 July 1970

13. Alberts, Major Donald J., USAF, "Call from the Wilderness", Air University Review, Vol. 28, No. 1 (November-December 1976)

14. Arquilla, John and Ronfeldt, David, "Cyberwar is Coming!", Comparative Strategy, Vol. 12., No. 2 (April-June 1993)

15. Bingham, Lt Col Price T., "Air Power in Desert Storm", Airpower Journal, Vol. 5, No. 4, (Winter 1991)

16. Bode, John R., Bowen, Stuart W., Dowell, Richard P., and Siegert, Leonard J. "Impacting of Maturing Ground Based Technologies on Tactical Air Doctrine: End of the Mitchell Era", Air University Air Power Symposium, 19-21 March 1977

17. Cohen, Eliot A. and Keaney, Thomas A. eds., Gulf War Air Power Survey Summary Report.

18. Conduct of the Persian Gulf War: Final Report to Congress. U.S. Department of Defense, April 1992.

19. Dougherty, Major Stanley J., "Defense Suppression: Building Some Operational Concepts", A thesis presented to the School of Advanced Airpower Studies, Maxwell AFB AL, May 1992.

20. "Electronic Gear Cuts SEA Aircraft Losses", Air Force Times, Vol. 28, No. 11, (25 October 1967)

21. Fulghum, David A., "Loh Outlines Bomber Plans", Aviation Week and Space Technology, Vol 139, No. 1, (5 July 1993).

22. Futrell, Robert F., Ideas, Concepts, Doctrine: Basic Thinking of the USAF 1961-1984, Maxwell AFB AL: Air University Press, 1989.

23. Gershanoff, Hal, "EC in the Gulf War", Journal of Electronic Defense, Vol. 14, No. 5 (May 1991).

24. "Get Yer Red Hot Bombers, Tanks, and Missiles", International Business, No. 3284, (21 September 1992).

25. "Lebanon Proved Effectiveness of Israeli EW Innovations", Defense Electronics, Vol. 14, No. 10, (October 1982).

26. McPeak, General Merrill A., "The Air Force Role in Space", Air Force Update for Senior Air Force Leaders. Washington: Secretary of the Air Force of Public Affairs (27 April 1993).

27. Meilinger, Lt Col Phillip S., "The Problem with our Air Power Doctrine", Airpower Journal, Vol. 6, No. 1, (Spring 1992).

28. Munro, Neil, The Quick and the Dead, New York: St. Martin's Press, 1991.

29. Nair, Brigadier V.K., War in the Gulf: Lessons for the Third World. New Delhi: Lancer International, 1991.

30. Nordeen, Lon O. Jr., Air Warfare in the Missile Age, Washington: Smithsonian Institute Press, 1985.

31. Petersen, John H., "Infor Wars", U.S. Naval Institute Proceedings, Vol. 119, No. 5, (May 1993).

32. Rash, Lt Col Richard A., "Electronic Combat--Making the Other Guy Die for His Country", unpublished thesis. Air University Library,Maxwell AFB AL, March 1982.

33. "Special Report: Electronic Warfare", Aviation Week and Space Technology, Vol. 102, No. 4, (27 January 1975).

34. Tactics Review Brochure, Vol. II, "Wild Weasel Employment", Tactical Air Command, Southeast Asia, April 1973. Available from Air University Library, Maxwell AFB AL.

35. "The Radar Warning Story", Asian Defence Journal, Vol. 72, No. 11, (January 1982).

36. "USAF Striving to Keep Current Funding Levels", Aviation Week and Space Technology, Vol. 137, No. 16, (19 October 1992).

37. Werrell, Kenneth P., Archie, Flak, AAA, and SAM: A Short Operational History of Ground-based Air Defense, Maxwell AFB AL: Air University Press, 1988.

38. Wilson, Tom, "The Wild Weasel Legacy--The Early Days", Defense Electronics, Vol. 20, No. 10, (September 1988).