The AN/VRC-46/47 and the AN/GRC-106 give the Hawk units only AM/VHF/FM and high frequency single side band (HFSSB) capabilities. The CRC, on the other hand, conducts all ground-to-air coordination with interceptors using UHF communication. Without UHF capability in the Hawk system, there can be no interchange of information between interceptors and surface-to-air units without going first through the CRC. This fact alone makes autonomous operations (operations without CRC control) by either Hawk or interceptors extremely difficult. In contrast, when simulating Soviet IADS in Red Flag exercises and Tactical Fighter Weapons Center tests, Red Force interceptors flying autonomous combat air patrols would oftentimes "listen in" on simulated surface to air missile (SAM) UHF early warning nets and exchange target information. This tactic proved extremely successful for both interceptor pilots and SAM operators.[11] These types of integration, however, cannot be practiced in United States IADS employment, because the UHF equipment is not operationally available to Hawk and SHORAD units.

This lack of interceptor/Hawk integration capability is unfortunate, for Hawk units possess significant organic target early warning and acquisition equipment. The information received from this equipment is first displayed in the Hawk battery control central (BCC) or in the platoon command post (PCP) (see Fig. 25). The BCC is the location for

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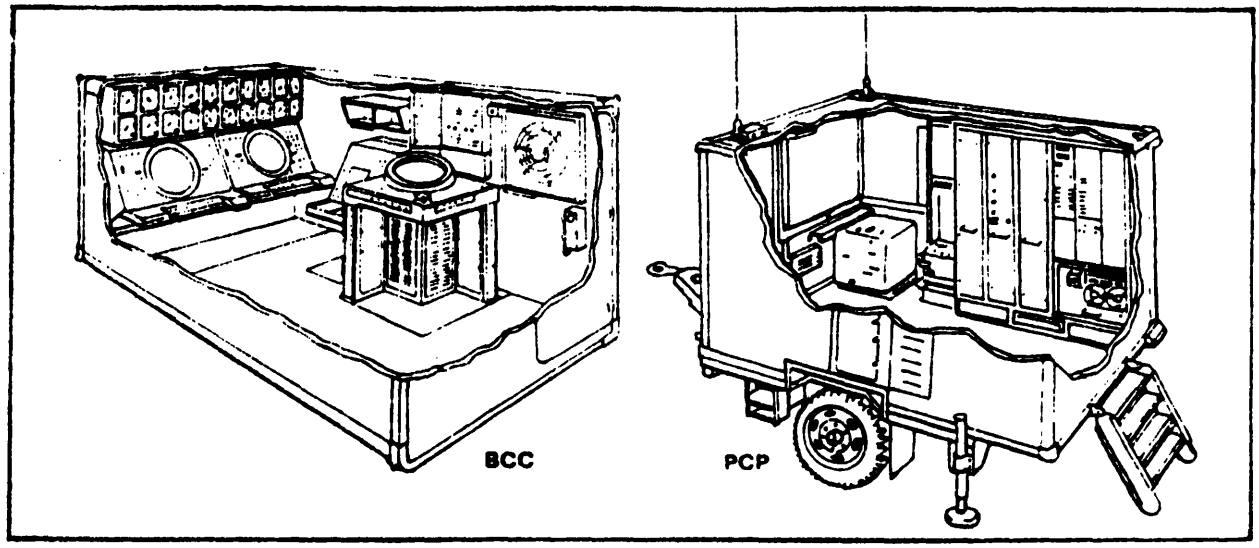
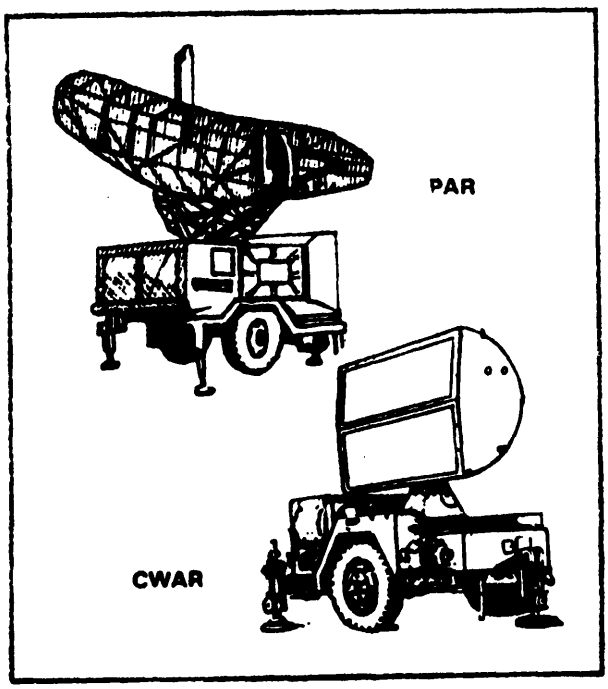
[11]Personal experience by this writer, who participated in Red Flag exercises and Tactical Fighter Weapons Center tests during the period 1973-1977.



SOURCE: Department of the Army, U.S. Army Air Defense Artillery Employment: Hawk, FM 44-90 (30 November 1977), p. 4-2.

Fig. 25. Battery Control Central (BCC) and Platoon Command Post (PCP).

the Tactical Control Officer, a lieutenant who executes the fire order. A pulse acquisition radar (PAR) and a continuous wave acquisition radar (CWAR) (see Fig. 26) feed early warning target information to the BCC.



SOURCE: Department of the Army, U.S. Army Air Defense Artillery Employment: Hawk, FM 44-90 (30 November 1977), p. 4-3.

Fig. 26. Hawk Radars

The PAR can detect targets at low and medium altitudes in excess of 100 kilometers. The CWAR, using doppler principles, can detect very low targets in excess of 60 kilometers. For target tracking, a separate high power illuminator radar (HIPIR) is used. The HIPIR also operates on doppler principles and can track targets in excess of 100 kilometers. The ranges mentioned are approximations and do not account for line of sight and electronic countermeasures limitations. Due to terrain features, low-altitude enemy detection ranges could be reduced to approximately 23 kilometers.

Target information received by organic Hawk radars is displayed on radar scopes in the BCC or the PCP. It is then data-linked to the Hawk BOC. Without the TSQ-73 equipment, target information would terminate at the BOC and would then have to be manually relayed through an AADCP to the CRC for plotting and updating. With the deployment of the TSQ-73, this information is automatically relayed into the CRC.[12]

Short-Range Air Defense Control Equipment

The C/V units are controlled from the tactical operations center (TOC), which is collocated with the C/V battalion command post. There is no standard layout for the TOC; its layout depends upon unit needs and the commander's desires. Figure 27 shows a typical TOC layout. The C/V squads and Redeye section leaders are required to maintain

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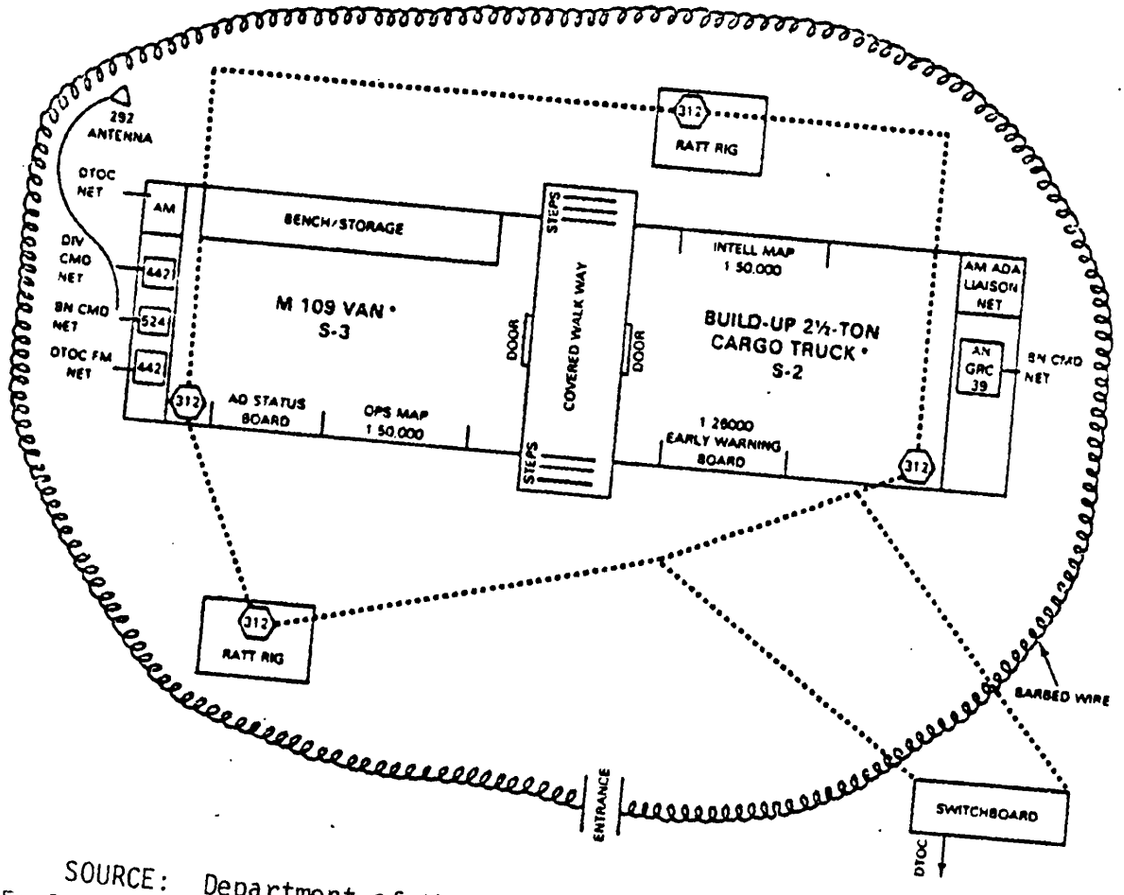
[12]DA, FM 44-90, pp. 4-2 through 4-9.

communication links with the TOC to obtain changes in air defense rules, procedures, weapons control status, and early warning information.[13]



SOURCE: Department of the Army, U.S. Army Air Defense Artillery Employment: Chaparral/Vulcan, FM 44-3 (30 September 1977), P. I-2.

Fig. 27. Chaparral/Vulcan Battalion Tactical Operations Center

Unfortunately, the C/V TOC and SHORAD units do not have the capability to receive long range early warning information from Hawk or Air Force radars. The SHORAD units are solely dependent on visual means

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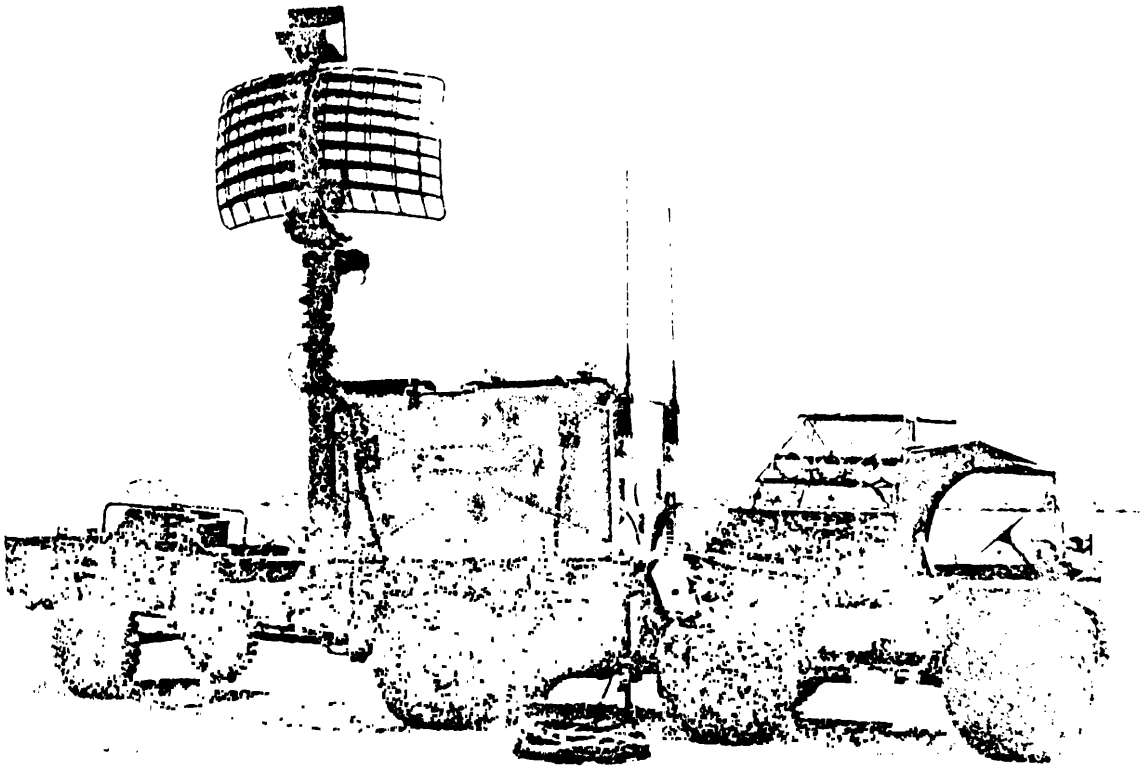
[13]Department of the Army, U.S. Army Air Defense Artillery Employment: Chaparral/Vulcan, FM 44-3 (30 September 1977), pp. I-1 through I-5 (hereinafter cited as DA, FM 44-3).

or the forward area alerting radar (FAAR) system AN/MPQ-49 (see Fig. 28).

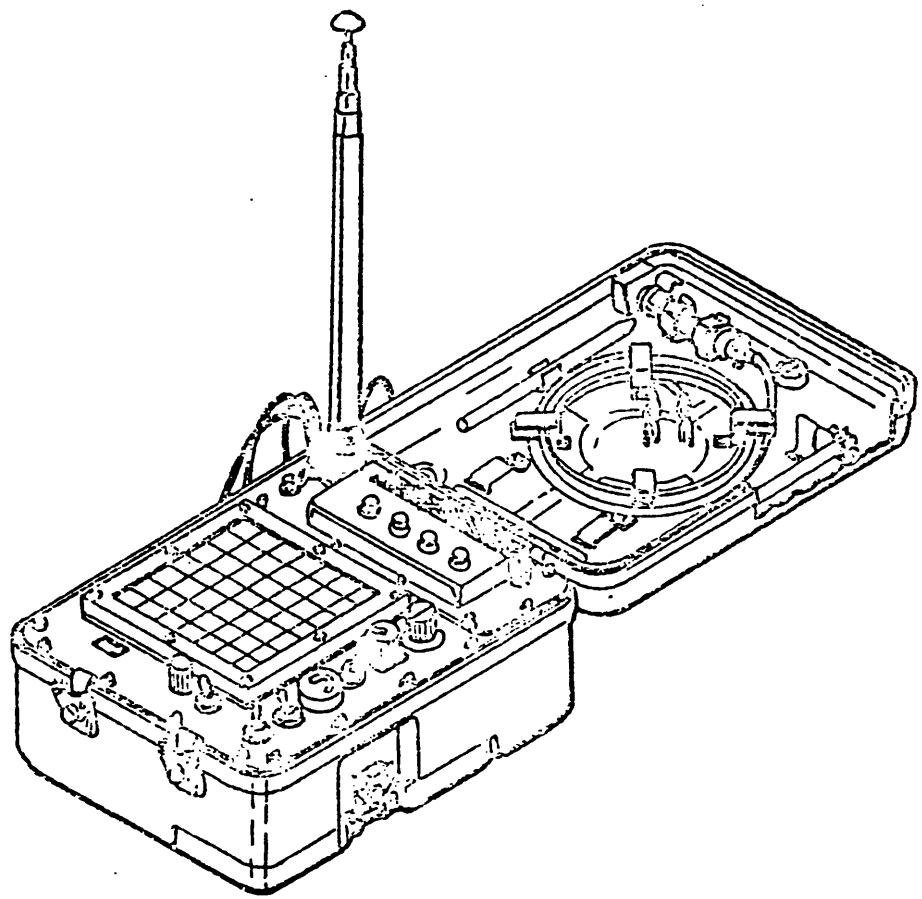


SOURCE: Department of the Army, U.S. Army Air Defense School, Air Defense Artillery Reference Handbook (1977), p. 6-3.

Fig. 28. Forward Area Alerting Radar

The FAAR is a lightweight, short range, mobile radar set that is capable of detecting targets out to 20 kilometers. The FAAR displays target information on a grid system on the target alert data display set (TADDS) that is carried by each C/V squad and each Redeye team (see Fig. 29). Target information is relayed to the TADDS via FM radio frequency data link.[14] This target information cannot be passed back up

[14] DA, USAADS, pp. 6-3 & 6-4.



Equipment

Field Emplacement

SOURCE: Department of the Army, U.S. Army Air Defense School, Air Defense Artillery Reference Handbook (1977), pp. 6-3 & 6-5.

Fig. 29. Target Alert Data Display Set (Equipment and Field Emplacement)

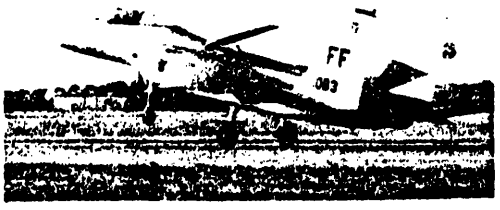
the chain of control (i.e., Hawk or Air Force) for integration into the air defense system. Thus the SHORAD units are basically "on their own" as far as early warning and target information are concerned.

Weapons

Air defense weapons form the final link in the integrated system. Both the Air Force and the Army are in the midst of a modernization program. Vast improvements in air defense capabilities are being incorporated into the IADS, with weapon systems such as the F-15, F-16, Patriot, Roland, and Stinger. It must be remembered, however, that the optimistic capabilities of these weapons are limited to a large extent by the organizational control placed on their employment due to the integration problems discussed earlier. These new systems and current IADS weapons (the F-4E, Nike-Hercules, I-Hawk, Chaparral, Vulcan, and Redeye) must be effectively integrated with existing doctrine.

F-15 Eagle

The F-15 Eagle (see Fig. 30) is becoming the primary Air Force contribution to the IADS weapons family. As a single mission air superiority fighter, its most important improvement over older aircraft is



SOURCE: S. H. H. Young, "Gallery of USAF Weapons," Air Force Magazine, p. 118.

Fig. 30. F-15 Eagle

its ability to detect high-speed, low-altitude targets with its pulse-doppler radar. Four radar-guided, long-range (28 miles) AIM-7F Sparrow missiles (see Fig. 31) are carried externally on the F-15. In addition, four short-range (two miles), maneuverable, infrared-guided AIM-9J/L Sidewinder missiles (see Fig. 32) are also carried. The F-15 also has an internally mounted 20mm Gatling gun for close-in aerial combat.[15]

The major limitations to the F-15 are its high unit cost and the small numbers being purchased (729). Despite its advance notices as a technical panacea for future aerial combat, a recent joint test to evaluate air combat verified the fact "that superior numbers generally are an advantage in a free-wheeling aerial engagement."[16] In this test the F-15 only generated an average kill ratio of 2:1 over a less sophisticated Soviet threat presumed for the 1980s. Thus, while the F-15 is a major improvement in air superiority capability, additional forces will be required to counter numerically superior forces.

F-4E Phantom II

The F-4E Phantom II (see Fig. 33) remains the workhorse of the U.S. Air Force's tactical inventory. As the "swing-force" (multirole) aircraft of tactical air forces, it is capable of performing air superiority, close air support, and interdiction missions. Although the F-4

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[15]S. H. H. Young, "Gallery of USAF Weapons," Air Force Magazine, May 1977, pp. 118 & 127-28.

[16]Donald E. Fink, "Flight Tests Confirm New Missiles Need," Aviation Week & Space Technology, 6 February 1978, p. 89.

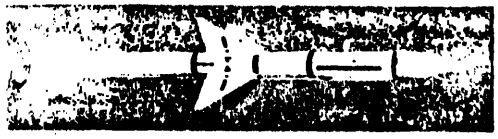


Fig. 31. AIM-7F Sparrow

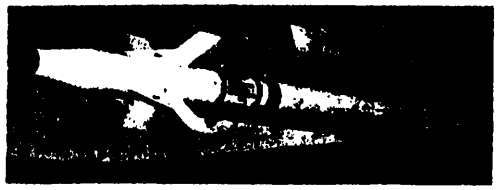


Fig. 32. AIM-9J Sidewinder

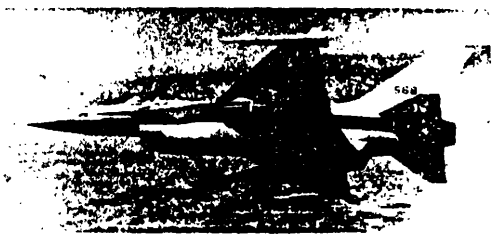
Fig. 33. F-4E Phantom II

SOURCE: S. H. H. Young, "Gallery of USAF Weapons," Air Force Magazine, p. 127 (Fig. 31), p. 128 (Fig. 32), & p. 117 (Fig. 33).

does not possess the radar and performance capability of the F-15, due to the numbers deployed and weapons carriage (4 Sparrows, 4 Sidewinders, and a 20mm gun), the F-4E represents a potent weapon in the IADS arsenal.[17]

F-16

In the near future, the F-16 (see Fig. 34) will replace the F-4 as the swing-force fighter of tactical air forces. Its primary mission will be air-to-ground; however, like the F-4E, the F-16 can perform in a secondary air-to-air role. The major limitation to its replacing the F-4E in the air superiority role is its lack of a long range missile capability. Current production models carry only two Sidewinder missiles with a range of two miles and a 20mm gun. This limits the F-16 to primarily visual short-range engagements.[18]



SOURCE: S. H. H. Young, "Gallery of USAF Weapons," Air Force Magazine, p. 118.

Fig. 34. F-16

Nike-Hercules

The Army's Nike-Hercules system (see Fig. 35) is a long-range, high-altitude radar-guided surface-to-air missile system. It is a semipermanent strategic defense system that is capable of engagement

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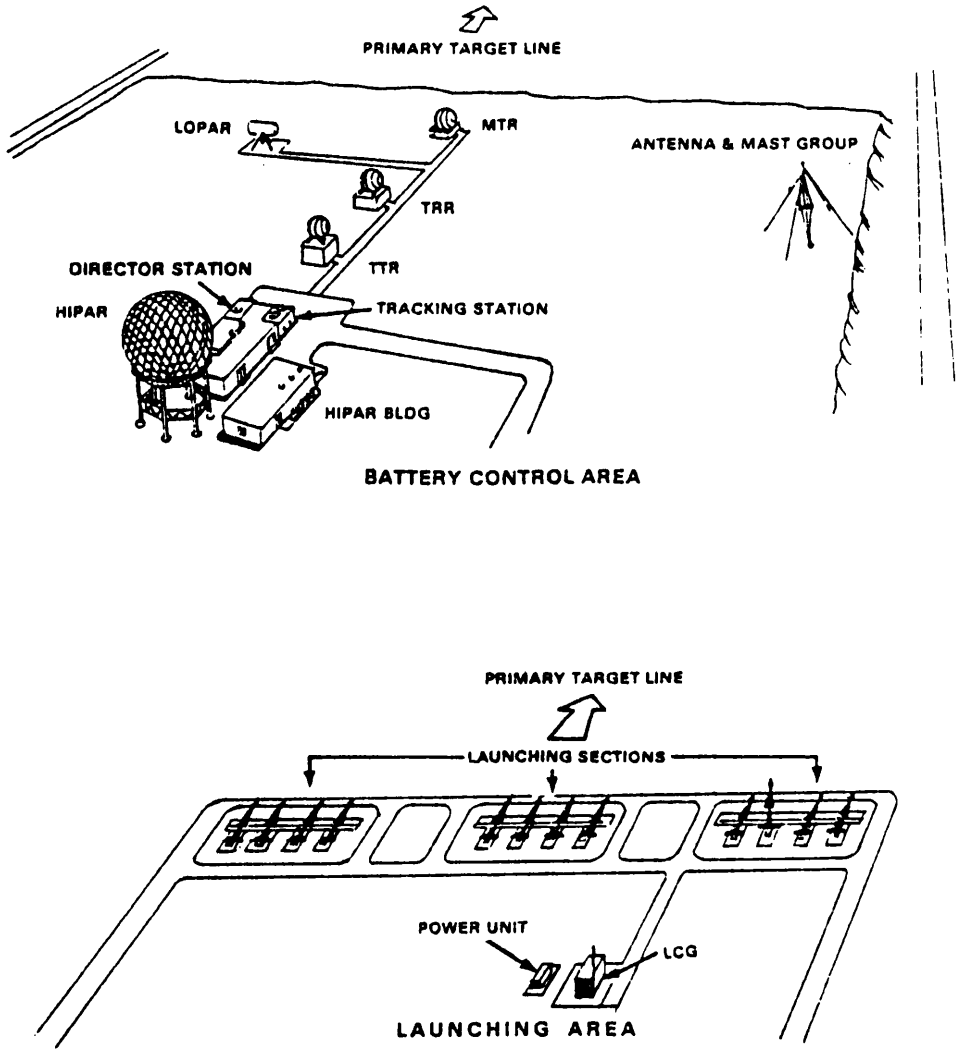
[17]Young, p. 117. [18]Young, p. 118.



SOURCE: Department of the Army, U.S. Army Air Defense School, Air Defense Artillery Reference Handbook (1977), p. 3-6.

Fig. 35. Nike-Hercules

ranges from 75 to 100 miles and altitudes of 150,000 feet. It can carry either a conventional or nuclear warhead and can also be employed effectively in a surface-to-surface mission.[19]

Improved Hawk (I-Hawk)

The I-Hawk (see Fig. 36) is the mainstay of the Army's present air defense artillery inventory. It is a medium range, low-to-medium altitude, radar-guided missile system. The altitude capability of the I-Hawk ranges from 100 meters to 40,000 meters. The system is relatively mobile since all of its major components are trailer mounted and air portable. The Hawk system is presently the Army's only operational low-altitude air defense weapon that utilizes radar guidance for all-weather intercept capability.

Chaparral

The Chaparral (see Fig. 37) is a highly mobile surface-to-air missile system designed against the low-altitude threat. Simply stated, the Chaparral is a tracked vehicle with four Sidewinder missile launching stations. It can carry up to 12 missiles. The major limitation to the Chaparral, as with other SHORAD weapons, is that it is strictly a visual detection system. It has no radar for search or track and it must rely on the FAAR system, discussed earlier, for early warning. Target acquisition and identification are accomplished visually, and

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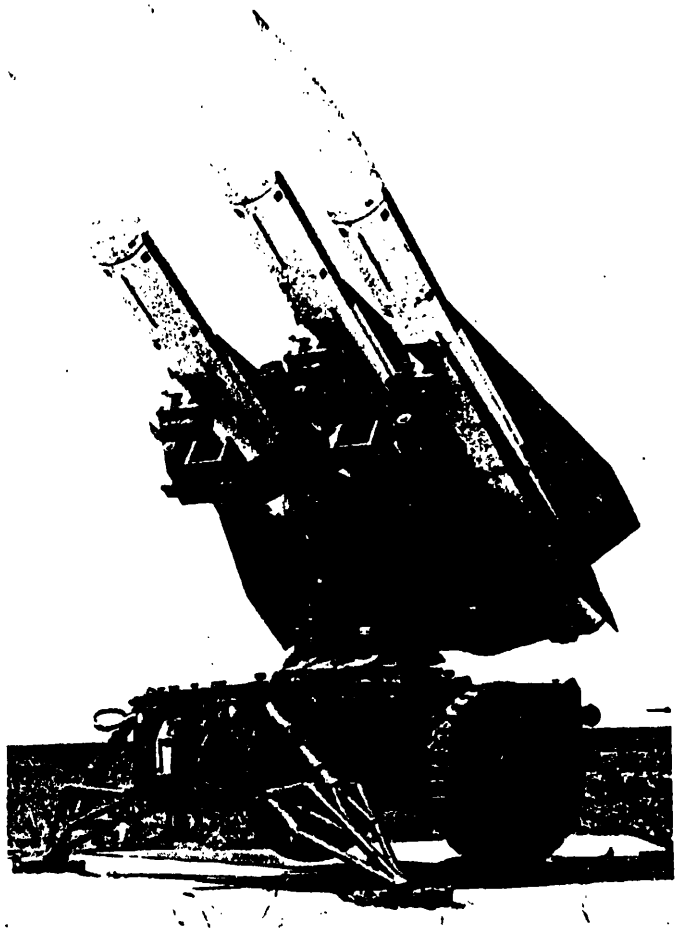
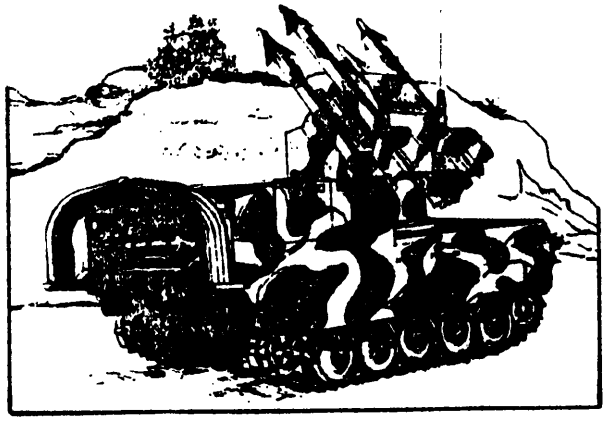
[19]DA, USAADS, pp. 3-3 through 3-6.



SOURCE: Wilfred L. Ebel, "Japan's Developing Army," Military Review, April 1978, p. 31.

Fig. 36. I-Hawk



SOURCE: Department of the Army, U.S. Army Air Defense Artillery Employment: Chaparral/Vulcan, FM 44-3 (30 September 1977), p. 4-2.

Fig. 37. Chaparral

infrared heat sources guide the missile. The Chaparral cannot be fired while it is on the move.[20]

Vulcan

The Vulcan (see Fig. 38) is the Army's primary antiaircraft gun system. Simply, it is a self-propelled tracked vehicle with a 20mm Gatling gun mounted on its chassis. The Vulcan, like the Chaparral, does not have a target acquisition radar associated with its gun. All tracking is accomplished manually by using visual acquisition and identification. The Vulcan does possess a range-only radar, but it provides only lead information for the fire control system.[21]

Redeye

The last of the current SHORAD systems, in addition to the Chaparral and Vulcan, is the Redeye (see Fig. 39), a man-portable missile system. The Redeye is a shoulder-fired, heat seeking missile that is designed to counter low-altitude aircraft and helicopters. It has an effective range of about 3 kilometers. The Redeye is primarily a tail-chase type weapon. Like the other SHORAD weapon operators, the Redeye operator must visually acquire and identify the target.[22]

Patriot

As stated previously, the Army, like the Air Force, is in the

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[20]DA, FM 44-3, p. 4-3. [21]DA, FM 44-3, pp. 4-3 & 4-4.

[22]DA, FM 44-3, pp. 4-5 & 4-6.

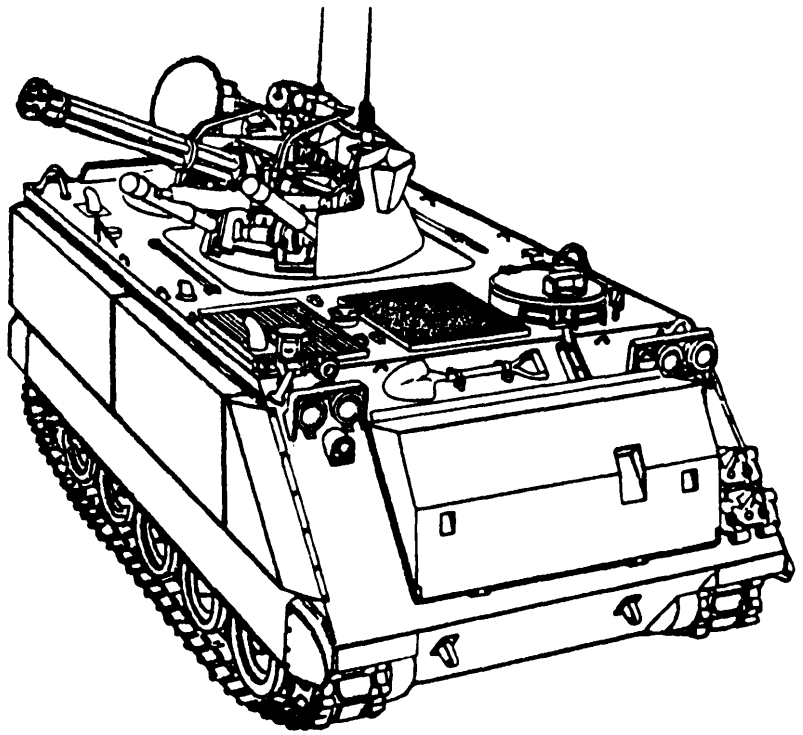


Fig. 38. Vulcan

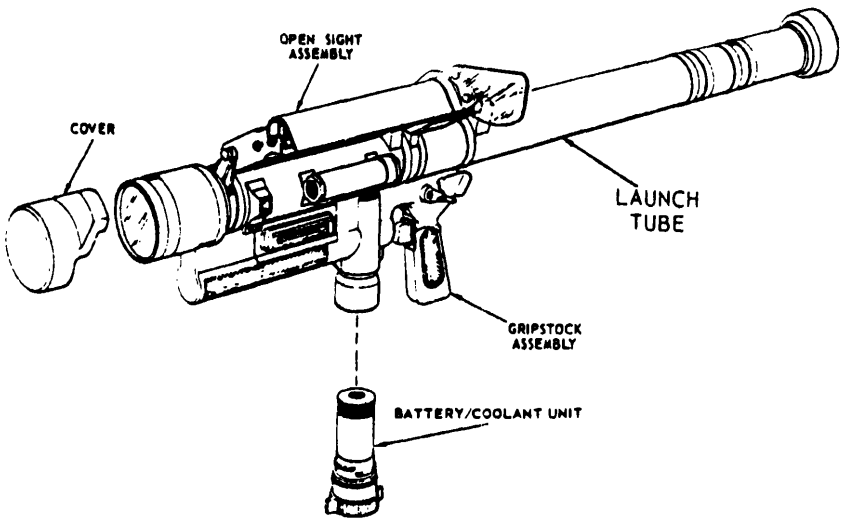
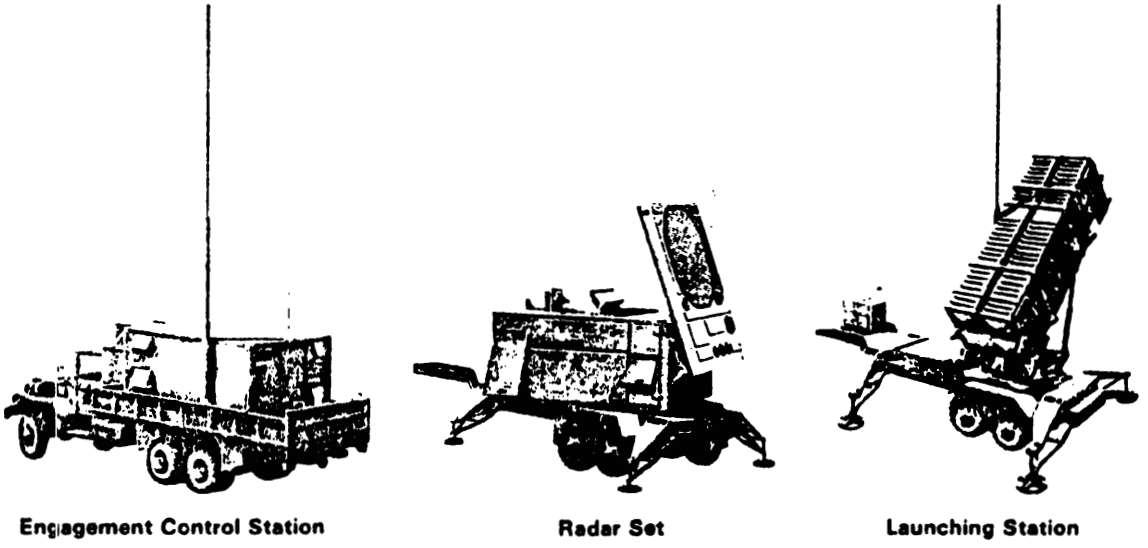


Fig. 39. Redeye

SOURCE: Department of the Army, U.S. Army Air Defense School, Air Defense Artillery Reference Handbook (1977), p. 2-2 (Fig. 38) & p. 3-3 (Fig. 39).

midst of a massive modernization effort to replace air defense weapons with newer systems. These weapon systems, called the Patriot, Roland, and Stinger, will become operational in the late 1970s and early 1980s. The Patriot (see Fig. 40) is the foremost of the new systems and is just now completing final developmental testing.



SOURCE: Department of the Army, U.S. Army Air Defense School, Air Defense Artillery Reference Handbook (1977), p. 7-4.

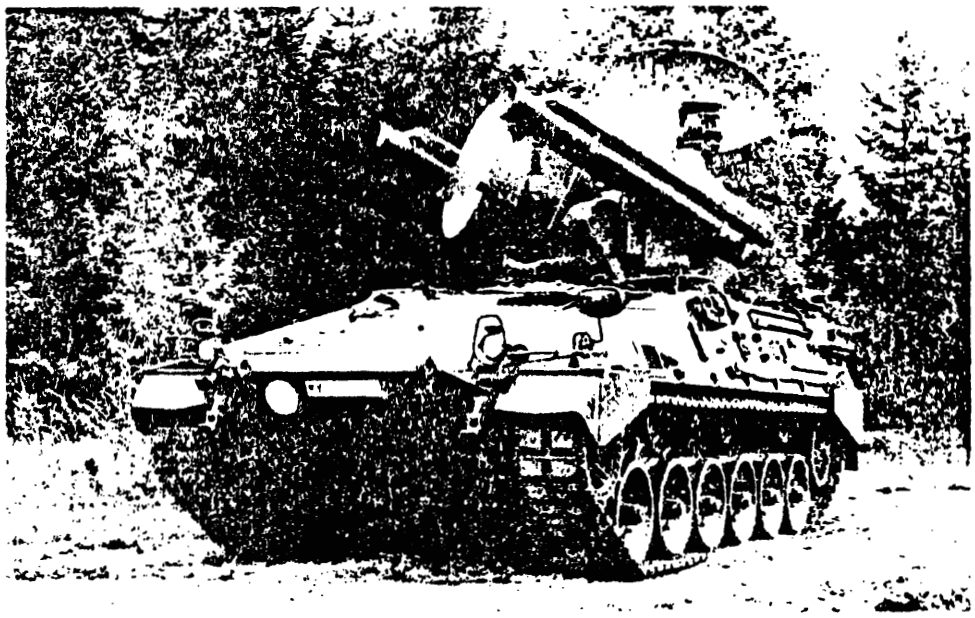
Fig. 40. Patriot Missile System

When operational, the Patriot will be the replacement for the Nike-Hercules and the Hawk systems. Advance notices on the Patriot are impressive. It has a single phased array radar that performs the simultaneous functions of search, detect, identify, and track. The weapon system can simultaneously handle more than 50 targets and a total of 8 missiles, including 3 in the terminal mode. The Army places high hopes for the Patriot as the "cornerstone of the mid-1980 family of air

defense weapons."[23] One disadvantage of the Patriot is that it is less mobile than its self-propelled Soviet counterparts, the SA-4 and SA-6.

Roland II

As a replacement for the Chaparral, the Army has adopted a United States version of the French/German Roland II (see Fig. 41)



SOURCE: "Roland Weapon System Reaches Production Stage," Military Review, March 1978, p. 101.

Fig. 41. Roland II

short-range, all-weather air defense system. The Roland missile can be either radar or optically guided to its target and it has a range of 8 kilometers. The fire unit, mounted on a tracked vehicle, contains a search radar that can identify friend or foe, a tracking radar, an

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[23] DA, USAADS, pp. 7-3 & 7-4.

optical sight, two automatic reloading launchers, and two missile magazines, each of which holds four missiles.[24] With the introduction of the Roland II and its self-contained search/track radars into the inventory, centralized integration of air defense weapons will become even more complex.

Stinger

The Stinger (see Fig. 42) is a man-portable air defense missile

SOURCE: Department of the Army, U.S. Army Air Defense School, Air Defense Artillery Reference Handbook (1977), p. 7-1.

Fig. 42. Stinger

system that is designed to replace the current Redeye weapon. Although the Stinger uses the same infrared homing principle as the Redeye, it has an improved seeker and an advanced guidance unit that gives it an all-aspect capability. The Stinger also has improved range and velocity capabilities and an identification, friend or foe (radar), challenge

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[24]John Marriott, "Roland II," NATO's Fifteen Nations, April-May 1975, pp. 101-102.

receiver. It is expected that the Stinger will be in the hands of troops by the late 1970s.[25]

Equipment Integration Programs

Currently, several major joint programs are under study to improve the integration of the air defense system. Three projects designed to better integrate the command and control informational flow are Tactical Air Control System/Tactical Air Defense System (TACS/TADS), Joint Tactical Information-Distribution-System (JTIDS), and Automated Tactical Air Control Center (TACC-Auto). These programs are briefly discussed to demonstrate that defense managers are not completely overlooking the air defense integration problem.

The TACS/TADS program was established in 1969 as an ongoing study to insure interservice integration of present and future command, control, and communication systems. The major hurdle for TACS/TADS managers was to integrate the command and control computers of the various services and force them to "talk" to each other. The Air Force computers in the AWACS and 407L Tactical Air Control System use the Tactical Digital Information Link-A (TADIL-A), while the Army's TSQ-73 uses TADIL-B language. The TACS/TADS project developed a message processing center to convert the TADIL computer language for interservice usage.[26]

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[25]DA, USAADS, pp. 7-1 & 7-2.

[26]Ronald Dean Koblitz, "The Tactical Air Control System, Tacti-

The JTIDS program is another information integration project. It is a new jam-resistant digital data-link system that is designed to pass real-time tactical information between target acquisition, command and control, and weapons systems.[27] The third program that will provide the IADS manager with a more rapid information flow is TACC-Auto. The TACC-Auto is designed to provide the TACC with computer-generated air battle situation displays to replace the manual displays in the present TACCs. Hopefully, this project will cut the long delays in battle situation updating (10 minutes or longer) and will provide instantaneous (real-time) readouts.[28]

Training

Despite the major studies being made in weapons modernization and information integration, some of the most significant problems with increasing IADS effectiveness remain in the training area. Effective IADS employment requires extensive joint service training. As one of General Dixon's deputies commented about the philosophy of the Tactical Air Command (TAC):

> . . . It's all in his [General Dixon's] approach to "train like you fight," and how can you do that unless you work with the Army in every step of what you do all the time, ... [I]t's a matter of us [Air Force personnel] forcing ourselves to understand how the

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cal Air Defense System: A Description and Analysis (U)" (student paper, Naval Postgraduate School, March 1974), pp. 2-8. (DDC Doc. 530692L.)

[27]"Battle Assessment Techniques Pressed," p. 243.

[28]"Battle Assessment Techniques Pressed," p. 243.

> Army does things, and to get them to understand how we do things, ...[29]

Generally, the Air Force and the Army are progressing rather rapidly in the joint training arena, especially with respect to close air support and the A-10 operation. In the field of air defense, however, joint training is relatively scarce. Readiness Command joint exercises such as Bold Eagle and Brave Shield are the closest to realistic IADS training in which most TAC fighter pilots participate. Even these exercises, however, are so severely limited by range restrictions and scripted scenarios that effective IADS training is questionable.

The innovation and success of TAC's Red Flag combat exercises in November 1975 opened "Pandora's box" to realistic training. Blue Flag, Green Flag, and Black Flag are among the training programs that followed. For tactical aircrews, however, Red Flag remains the leader in realistic combat training despite a noticeable deficiency in its joint IADS training. It was not until November 1977 that IADS training was attempted with the integration of an Army Hawk unit in Red Flag exercises. This is typical of the low priority given joint IADS training, especially in the Continental United States. The following discussion highlights the IADS training problem.

Joint Training Exercises

Annual joint Army/Air Force exercises where the IADS is employed are few in number. Typical of the larger Readiness Command exercises

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[29]"Dual Challenges Confront TAC," p. 52.

are Brave Shield XVI (14-20 July 1977) and Bold Eagle 78 (22-30 October 1977). In these exercises, Army air defense units and Air Force interceptors were formed into an IADS. The training they received, however, was limited and, in some cases, unrealistic.

In most large exercises, range area, airspace control, and safety considerations constrain planners so that unrealistic IADS rules of engagement and procedures are employed. For example, in Bold Eagle 78, which took place at Eglin Air Force Base, Florida, all aircraft were restricted to subsonic flight within 30 nautical miles of the coastline and all air-to-air intercepts had to be under positive control of the TACS facilities. In addition, all air-to-air activity took place over the water ranges, while surface-to-air forces were employed over land ranges. This fact alone prevented integration of air defense weapons in the same area. Over land, all fighters were restricted to altitudes higher than 700 feet above ground level.[30] Rules and restrictions such as the ones that governed Bold Eagle make IADS training in most large exercises unrealistic.

Despite the restrictive training environment, however, these exercises provide units an opportunity to experience many of the integration problems discussed in previous chapters. For example, the frustration of a C/V battalion trying to integrate into the early

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[30]Department of the Air Force, Director of Operational Plans, Ninth Air Force (TAC), "AFFOR/OPP-AIR/EXORD 702" (Shaw Air Force Base, S. C., 12 August 1977), pp. C-17-1 through C-17-C-1.

warning nets can be felt in the following excerpt from the afteraction report on Brave Shield XVI by the 1st Battalion, 51st Air Defense Artillery:

> Early warning from any source was virtually nonexistent. The 1st Bn, 51st ADA [Air Defense Artillery], has no FAAR. Out of our own hide, we placed people and commo gear with the Air Force command reporting center [CRC] and with an assault fire unit from Marine Hawk battalion. The personnel with the CRC were equipped with the AN/GRC 106 [HFSSB capability]. When the radio did work, we found that the CRC would pass no data to the Army Liaison Officer. He was moved to the command reporting post, a multichannel shot was put in to battalion, and early warning was finally available to the battalion tactical operations center. From there, it went by AN/GRC 106 to the battery. This system is cumbersome and unworkable in a moving situation. . . . Without FAAR, C/V has no effective early warning.[31]

The preceding excerpt is just one example of the problems experienced in joint exercises. A study of Army afteraction reports from joint exercises found that a number of recurring problems plague these exercises. Among the most common are communication troubles, interruption of early warning nets, lack of hostile aircraft markings, and unrealistic kill assessment.[32] These problems, plus the previously mentioned restrictions, illustrate the present unrealistic approach to joint IADS training.

Red Flag

The most realistic and beneficial combat exercise for tactical

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[31]John D. Crandall, "Brave Shield XVI," Air Defense Magazine, October-December 1977, p. 5.

[32]James F. Bell, "Research Report," Air Defense Magazine, April-June 1977, pp. 4-5.

aircrews training is Red Flag. The unique features that make Red Flag superior to joint exercises for aircrew training are the range area, rules of engagement, and realistic threat simulators. Despite Red Flag's outstanding capability and results, Red Flag is grossly lacking in IADS training. Of particular concern is the void of IADS employment and the almost totally offensive orientated scenarios.

The Red Flag exercise area is one of the largest combined ground and air ranges in the Continental United States. It extends 140 miles north of Nellis Air Force Base, Nevada, and is about 170 miles wide.[33] The Government owns most of the land, so unrestricted supersonic low altitude operations are permitted. This is essential for realistic training since General Dixon and TAC have acknowledged that the next war will probably be fought at low altitude.[34] Unlike Readiness Command exercises, Red Flag's minimum altitude restrictions are compatible with current fighter tactics and aircrew proficiency (below 200 feet above ground level).

Rules of engagement for opposing forces are more realistic. Positive radar control is not a mandatory prerequisite for intercepts or engagements. Airspeed and altitude restrictions in Red Flag are minimal, and pilots are encouraged to try innovative tactics. The opposing

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[33]"Red Flag Stresses Realism in Training," Aviation Week & Space Technology, 6 February 1978, p. 188.

[34]"Requirements Concepts Keyed to Mission Area Analysis," Aviation Week & Space Technology, 6 February 1978, p. 62.

forces in Red Flag are made up of the most realistic Soviet simulated weapons found outside the Iron Curtain. Everything from 23mm and 57mm gun platforms to surface-to-air missiles to F-5Es simulating MIG-21s are found on the Red Force side.[35]

Red Flag is an excellent facility for realistic training, but improvement in some areas would make Red Flag even more effective. Scenario development in Red Flag is stagnant and outdated, especially for IADS training. Most scenarios harken back to the composite strike forces of the Vietnam era. Offensive air base attack, deep interdiction, and close air support scenarios comprise the majority of the missions. The Red Forces in Red Flag exercises (Aggressor Squadrons) are given the task of designing an enemy IADS and conducting a defensive counterair campaign. Currently sophisticated SAM simulators are integrated into a Soviet air defense system with elaborate East German airfields reconstructed on the target ranges.[36] Blue Force air defense scenarios occur intermittently, while air defense integration with Army units is practically nonexistent. Unfortunately, given the current Soviet tactical air doctrine, Soviet numerical superiority, and the distinct possibility the United States will be engaged in a defensive counterair battle in Europe, Red Flag forces are fighting the wrong war. Aggressor forces are becoming proficient in IADS employment, yet they

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[35]"Red Flag Stresses Realism in Training," p. 186.

[36]"Red Flag Stresses Realism in Training," p. 188.

should be simulating air base attack. F-15 pilots are training in offensive fighter sweeps and interdiction escort, yet they should be practicing air defense integration.

As stated earlier, Army air defense units are just beginning to become involved in Red Flag exercises. Units from the 11th Air Defense Artillery Group from Fort Bliss, Texas, joined units from the 727th Tactical Control Squadron from Bergstrom Air Force Base, Texas, in November 1977 to participate in Army maneuvers (Devil Strike) and Red Flag 78-1 and 78-2. This was the first time Army air defense units participated in Red Flag. The IADS was established at the Fort Irwin, California, range, a small Army range adjacent to the large Red Flag Nellis complex. It consisted of a mini-CRC (one cell of the AN/TSQ-91 (V)), an AN/TPS-43E radar, and a Hawk unit. Major Jim Burns, Operations Officer, 727th Tactical Control Squadron, explains the benefits realized by the initial attempt at Red Flag IADS training in the following excerpt from his afteraction report:

> . . . The major benefit experienced in Red Flag 78 1&2 was that the combined talents and experience of individual members were applied to realize the potential of the mini-CRC. Red Flag exercises provide a forum where contemporary concepts, tactics, and techniques can be tried within the bounds of generalized guidance. Personnel and equipment were adapted to a conception of what a realistic combat environment would be. The lack of scripted scenarios with scripted outcomes provided an unusual opportunity to experiment with new concepts, tactics, and techniques. That is not to say that tried and proven procedures were abandoned. However, the latitude to recognize and react to the tactical situation, to innovate where necessary was a welcomed opportunity. Interaction of all the TACS elements and aircrews was dynamic and not necessarily bound by the constraints normally experienced in a somewhat

artificial exercise environment. . . .[37]

Despite the major benefit of an unrestricted training environment, the Red Flag IADS had to contend with many problems. For example, the Red Flag TACC was inadequately staffed and poorly prepared to monitor and support the CRC at Fort Irwin. Communications between the CRC, TACC, and tactical unit operations centers were inadequate. The FACP personnel and the ADALO who manned the CRC were not familiar with the AN/TSQ-91 (V) equipment and procedures. The Fort Irwin range complex was too small to conduct realistic and effective operations. Communication problems existed between the CRC and Hawk unit, as the TSQ-73 was not used and target information had to be passed manually between the CRC and the BCC.[38]

Due to these and other problems, bastardized procedures were employed out of operational necessity. In discussing this fact, Major Burns states:

> The manual mode of operations required that substantial chances [changes] be made in the coordination and execution of integrated counter air operations. The need to rapidly recognize and react to the tactical situation in a high density/high threat environment resulted in extensive modification of classic TACS procedures. For example, the ADALO was delegated authority to identify, initiate tactical action, and engage non-friendly aircraft within the improved HAWK's area of coverage using information and equipment capabilities available in the Operations Central. Coordination was effected with the Weapons Assignment Officer-WAO. Concurrent operations were carefully orchestrated between defensive air weapons

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[37]DAF, 727th Tac Con Sq (TAC), p. 7.

[38]DAF, 727th Tac Con Sq (TAC), pp. B-1 through B-6.

controllers and the ADALO.[39]

Another IADS procedure modified in Red Flag was the method in which the ADALO passed early warning information to the Hawk units. In the words of Major Burns:

> Initially the ADALO passed engagement information to the BCC in GEOREF. This system is cumbersome, inaccurate because of cumulative errors, and lacks the flexibility necessary to react in a time compression situation. After some investigation it was determined that the BCC had an electronic cursor which was capable of providing azimuth in mils and range in kilometers. The TACS equipment can provide cursor azimuth in degrees and range in nautical miles. The TACS cursor also was [has] a feature where by [sic] a track can also be integrated and its modes/codes determined simultaneously. By placing the TACS cursor over the known site location of the BCC the ADALO was capable of rapidly providing timely and accurate information on the position, identification, and number of targets to the BCC. A simple conversion system from degrees to mils and nautical miles to kilometers was used which significantly improved the timely acquisition and engagement of non-friendly tracks. After experience was gained with this procedure it was adopted as the primary mode of operation for the remainder of the exercise. This procedure also facilitated the engagement of aircraft when the HAWK acquisition radar was inoperative. In addition, the clarity of the TPS-43E information also facilitated the engagement of specific aircraft in a flight or air-to-air engagement. This capability has not been available with other systems.[40]

The Red Flag environment can thus be seen as providing an excellent opportunity for concentrated and expanded IADS training. The report by Major Burns concludes with the following recommendation:

> It was evident during the course of exercise conduct that a closer working relationship is required between TACS/ADA units. Joint training should be improved and expanded both in preparation for the exercise and during exercise execution. The increasing complexity of TACS/ADA capabilities and limitations be developed to

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[39] DAF, 727th Tac Con Sq (TAC), p. B-1-3.

[40] DAF, 727th Tac Con Sq (TAC), pp. B-1-3 & B-1-4.

> ensure that these units can work effectively toward attainment of common goals. Recommend that a TACS Orientation Course be developed for ADA Liaison Teams and that an ADA Orientation Course be developed for TACS Weapons Teams. This approach would provide the requisite experience base to facilitate closer team work in the anticipated combat environments of the future.[41]

Conclusions

In examining the major IADS command and control facilities, it was discovered that the equipment has many limitations which hinder the integration process. Many of the IADS operational centers are still basic manual systems with time-consuming manual plotting and unreliable voice communication networks. The joint services are attempting to rectify this situation with new automated data-link systems such as TSQ-73 and JTIDS.

The IADS weapons inventory is undergoing a similar major modification program. All Air Force and Army current air defense weapons are being replaced by systems that will sustain the IADS through the 1980s. As the F-15, F-16, Patriot, Roland, and Stinger become incorporated into operational units, their greatly improved capabilities call for a reevaluation of the present employment doctrine and procedures. Although these new weapons have superior capabilities, the same integration problems remain unresolved.

Finally, in the IADS training discussion, it was concluded that current joint service IADS training is conducted too infrequently and is

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[41] DAF, 727th Tac Con Sq (TAC), pp. B-1-4 & B-1-5.

unrealistic in most exercises. Joint exercises such as Readiness Command exercises do not provide adequate realistic IADS training. Their scenarios are extremely stereotyped to the offensively oriented tactical employment doctrine, while rules of engagement are unrealistic and highly restrictive due to range area, airspace control, and safety constraints. The recent use of Red Flag exercises for IADS training has solved some of these problems. Rules of engagement are more realistic, and innovative tactical employment is encouraged. Some problems with Red Flag IADS training must be remedied, however. The scenarios are too offensively oriented toward air base attack. The range area at Fort Irwin is too small to conduct proper IADS training. These and other training problems are not insurmountable, especially if the proper emphasis is placed on tactical air defense integration.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Several significant events of the past decade have required the United States to reassess its integrated air defense doctrine and capabilities. These events include the Vietnam War, the 1973 Middle East War, and the change in Soviet tactical air doctrine and capabilities. The North Vietnamese air war over Hanoi demonstrated that an integration of jet aircraft, surface-to-air missiles, and conventional antiaircraft guns can be highly effective in defeating or harassing a superior enemy.

The experience by the Arab Forces in the 1973 Middle East War reinforced many of the outcomes found in Vietnam. Integrated air defense proved once again to be a decisive factor in air battles. Although the Israelis were eventually considered victorious, the effectiveness of the Arab air defenses surprised even the Israelis. These two wars demonstrated that a well-integrated air defense can degrade a strong offense or can at least make offensive tactical air operations extremely expensive.

The two wars also provided insights into the different techniques used for integrating air and ground defensive weapons in combat. Although the Soviet Union trained and supplied all three defenders--the

North Vietnamese, the Syrians, and the Egyptians--each defender's integration tactics differed. The North Vietnamese used a highly centralized and integrated command and control system in which they employed interceptors sparingly and only on the fringes of the SA-2 and antiaircraft artillery envelopes. The system was so well integrated after eight years of war that interceptors could be used as bait and decoys to lure the enemy into the missile and antiaircraft artillery belts.

The Egyptians and Syrians, using more sophisticated weapons, were not able to integrate their interceptors as effectively as the North Vietnamese. The Egyptians attempted to rely primarily on their surface-to-air weapons. They used their interceptors outside the missile belts only when it was absolutely necessary. This strategy worked initially; however, once the Egyptians were forced to commit their interceptors inside the missile belts, the number of aircraft lost to friendly fire rose sharply. On the basis of sketchy reports, the Syrians attempted to solve the fratricide problem through identification, friend or foe (radar) (IFF) procedures. They permitted friendly aircraft operations inside the Golan missile belt, but they, too, experienced a significant friendly loss rate.

In the past decade, tactical air defense has come into its own as a state of warfare. Obviously, air defense alone cannot win a war. If the enemy is powerful enough and is willing to absorb high loss rates, air defenders will find it difficult to hold out indefinitely in the absence of superior offensive combat power. Regardless of whether

offense or defense dominates, the integration of air and surface defensive weapons is extremely important to the overall outcome of the air battle.

Historical lessons of the employment of a modern integrated air defense system (IADS) in combat become even more significant when one considers the Soviet buildup of tactical air forces and the changing Soviet doctrine. Technological advances in Soviet offensive tactical air capability during the past decade have been astonishing. Deployment of the Fencer-A, Flogger-D, and Fitter-C has given Soviet Frontal Aviation forces the capability to strike deeper targets with larger payloads. This threat will probably ingress at low altitudes and high speeds in mass wave attack tactics. The Soviet tactical air power, always strong defensively, is now challenging United States rear-basing areas with a new offensive tactical air arm of unquestionable sophistication.

Even more threatening is the Soviet doctrinal metamorphosis from a defensive posture toward an offensive tactical air strategy. In the past decade, Frontal Aviation forces have been given increasing responsibility in all phases of offensive operations. Offensive targets such as enemy nuclear delivery systems and air bases, which in the past were reserved for Soviet rocket troops, are now primary targets for Frontal Aviation aircraft. This places the United States Air Force in a position where it must be able to conduct an offensive counterair campaign and also coordinate an effective IADS against a determined enemy.

Conclusions

The change in Soviet offensive capability and the recent historical reemergence of air defense potency have necessitated an examination of the United States tactical IADS. This research effort has revealed six major conclusions concerning the present IADS status. The first and perhaps most important conclusion is that tactical air defense is not given proper emphasis in current Air Force doctrine. Although the Air Force has primary responsibility for developing integrated air defense doctrine, it has been remiss in fulfilling this responsibility. Events of the past decade plus the Army's change to the "Active Defense" doctrine have placed the Air Force in the awkward position of being challenged on its doctrinal development.

The second major conclusion is that the present IADS organizational lines of control and communication are extremely centralized. Although the North Vietnamese demonstrated that a well-organized IADS with centralized control can be highly effective, an overriding disadvantage to centralization is that lines of weapons control and communication become complex and cumbersome. The integration of United States air defense weapons employment is highly centralized in the control and reporting centers (CRCs). With present equipment, the CRCs can effectively integrate interceptors and Hawk units only if the TSQ-73 is available. In cases where positive control is not assured, such as in manual Hawk employment (without TSQ-73) and in all short-range air defense (SHORAD) employment, the Air Force Component Commander (AFCC)

and his staff establish extremely restrictive rules of engagement. This centralized organization reduces flexibility of IADS weapons integration and prohibits autonomous bilateral operations, that is, operations such as the F-15/Hawk or the F-15/SHORAD employment without CRC control.

The third conclusion is that restrictive IADS rules of engagement and standard operating procedures restrain integration flexibility. Reliance on these rules and procedures is necessary to accommodate integration deficiencies, but some rules and procedures are grossly unrealistic and would be disastrous in a high threat environment. Employment procedures such as weapon engagement zones and safe passage corridors, which place friendly fighters at medium altitude over the forward edge of the battle area, are unrealistic in today's environment. Weapon engagement zones would also inhibit air defense battle managers who were employing the concept of mix and mass of air defense weapons. Additionally, universal weapons tight status for SHORAD weapons severely limits their employment throughout the theater of operations. These rules and procedures are designed to control the fratricide problem; however, their enforcement severely restricts integrated employment flexibility in the system.

The fourth conclusion is that the IADS command and control equipment is inadequate to support a totally integrated air defense system. The most important integration breakthrough to date is the development of the TSQ-73, which allows Air Force/Hawk real-time integration. The SHORAD units, however, are still completely on their own

as far as target early warning, acquisition, and identification. Interceptors are at the mercy of the CRCs, because at present no direct communication capability exists between the F-15 and Army air defense artillery units.

The IADS weapons themselves are also inadequate to support a totally integrated system. Fortunately, an extensive modernization program is correcting this fifth conclusion. Until the new weapons are deployed, however, present weapons, although capable, do not lend themselves to effective integration tactics. There is no capability to operate an integrated system in a totally all-weather environment. All of the present SHORAD weapons--Chaparral, Redeye, and Vulcan--are strictly visual target acquisition and identification weapons. Even the F-15 and the Hawk, which have IFF capability, still rely on visual identification as one of their primary means of target verification. Another problem associated with the F-15 modernization is that the Air Force must come to grips with the quantity versus quality matter in F-15 employment. Further, the Air Force must consider the impact of replacing the F-4E with the F-16, an aircraft that does not have an all-weather intercept capability.

The sixth and final conclusion is that IADS joint training is presently too scarce and unrealistic. The annual joint exercises, such as Bold Eagle and Brave Shield, do not incorporate realistic rules of engagement due to range area, airspace, and safety constraints. The joint exercise scenarios and training environment are too inflexible to

allow tactics innovation and experimentation. While Red Flag exercises have eliminated some of these problems, major problems remain. For instance, the emphasis in Red Flag is still on offensive air base attack and composite force deep interdiction scenarios. IADS employment is rarely played in Red Flag, and only then at the smaller adjacent Fort Irwin range. While offensive counterair and interdiction operations still warrant exercising in the joint environment, the overwhelming numerical superiority and doctrinal change in Soviet Frontal Aviation demand that a greater emphasis be placed on defensive counterair scenarios. The meager attempts to date to employ a fully integrated IADS in the joint environment have shown that the United States is ill-prepared to fight an intensive defensive counterair battle with today's equipment and training.

Recommendations

This thesis has dealt with the general topic of integrated air defense. The conclusions lead to one major recommendation: The Air Force and the Army should place more emphasis on integrated tactical air defense. Given the significant events that have occurred within the past decade, the Air Force, especially, should recognize the future importance of tactical air defense. The processes of air defense integration are complex and will require extensive future cooperation, development, and training.

Beyond this general recommendation, several more specific recommendations follow. In particular, this writer recommends that:

1. The Air Force and the Army publish a joint tactical air defense operational doctrine manual.

2. The Air Force examine present doctrine to determine if increased emphasis needs to be placed on defensive capabilities and air strategy in the light of the threat.

3. The Army revise sections in its air defense artillery employment manuals (44 series) that deal with integration doctrine and interceptor employment to align them with present capabilities.

4. Both services reevaluate the IADS rules of engagement and procedures to provide more flexibility in integration employment.

5. Both services procure additional control equipment such as UHF radios for Army air defense artillery, FM radios in aircraft, and better SHORAD early warning equipment to provide increased decentralized integration capabilities.

6. Both services accelerate their weapons modernization programs.

7. The Air Force consider modifying a portion of the F-16 swing-force with an all-weather intercept capability.

8. The Readiness Command change its joint exercise procedures to provide more realistic IADS training.

9. Red Flag managers revise their scenarios and deployments to incorporate more IADS training. A permanent IADS facility with operational tactical air control center (Air Force), control and reporting center, Hawk, and short-range air defense units should be set up on the

Nellis range complex.

10. Both services should initiate a joint IADS training school for weapons controllers, Army air defense artillery officers, and fighter pilots.

11. Brief (one-week) interservice exchanges should be arranged for weapons controllers, Army air defense artillery officers, and fighter pilots.

APPENDIX

APPENDIX: GLOSSARY OF ACRONYMS SHOWN IN FIGURES

AADCP: Army Air Defense Command Post

AD: air defense

ADA: air defense artillery

ADALO: Air Defense Artillery Liaison Officer

ALCC: airlift control center

AM: amplitude modulated

ASRT: air support radar team

BCC: battery control central (Army)

BOC: battalion operations center (Army)

CP: command post

CRC: control and reporting center

CRP: control and reporting post

C/V: Chaparral/Vulcan

CWAR: continuous wave acquisition radar

DASC: direct air support center

DEFCON: defense readiness condition

DTOC: division tactical operations center

ECM: electronic countermeasures

EW: early warning

FAAR: forward area alerting radar (Army)

FACP: forward air control post (Air Force)

FCC: flight coordination center

FEBA: forward edge of the battle area

FEZ: fighter aircraft engagement zone

FM: frequency modulated

GEOREF: World Geographic Reference System

HIMEZ: high-missile engagement zone

HIPAR: high power acquisition radar

LCG: launching control group

LOMEZ: low-missile engagement zone

LOPAR: lower power acquisition radar

MSL: mean sea level

MTR: missile tracking radar

PAR: pulse acquisition radar

PCP: platoon command post

RATT: radio teletypewriter

RTO: radio telephone operator

TAC: Tactical Air Command

TAC(A): tactical air coordinator (airborne)

TACC: tactical air control center (Air Force)

TCO: Tactical Control Officer

TOC: tactical operations center

TRR: target ranging radar

TTR: target tracking radar

TUOC: tactical unit operations center (fighter operations)

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VITA

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Michael C. Press was born in Los Angeles. In 1965 he graduated from the University of Oregon as a distinguished ROTC graduate and received a Bachelor of Science degree. He was commissioned into the United States Air Force as a regular officer in 1965. Lieutenant Press graduated pilot training number one in his class and received the Air Training Command Commander's Trophy. Following graduation, Lieutenant Press spent two years in Germany flying the F-4D. In 1969 Captain Press flew a combat tour in the OV-10 in Southeast Asia, accumulating 480 combat missions.

In 1970 Captain Press was assigned to the Tactical Air Command at MacDill Air Force Base, Florida, as an F-4E instructor. From there, in 1972, he was assigned to the 57th Fighter Weapons Wing, Nellis Air Force Base, Nevada, where he was an original member of the first Aggressor Squadron. At Nellis, while flying the F-5E he participated in numerous Tactical Fighter Weapons Center tactics development and evaluation (TD&E) tests for fighter aircraft. He also participated in many Red Flag exercises plus the F-15, F-16, A-10, and AWACS initial operational tests and evaluations (IOT&E).

In 1977, Major Press was selected to attend the United States Army Command and General Staff College, Fort Leavenworth, Kansas.

Following his graduation, Major Press was assigned to the Military Assistance Advisory Group (MAAG), Teheran, Iran, as the United States advisor to the Imperial Iranian Air Force for F-5E operations.