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PROJECT CHECO
Contemporary
Historical
Evaluation of
Combat
Operations
REPORT

THE EC-47 IN SOUTHEAST ASIA

20 SEPTEMBER 1968

HQ PACAF

Directorate, Tactical Evaluation
CHECO Division

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Prepared by:

Colonel
Alfred F. Hurley

Project CHECO 7th AF, DOAC

K717.0413-37
1968

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS PACIFIC AIR FORCES
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REPLY TO ATTN OF: DOTEC

20 September 1968

SUBJECT: Project CHECO Report, "The EC-47 in Southeast Asia" (U)

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FOR THE COMMANDER IN CHIEF

Warren H. Peterson

WARREN H. PETERSON, Colonel, USAF
Chief, CHECO Division
Directorate, Tactical Evaluation
DCS/Operations

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TAC (DPL) ..... 2 Cys
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MAC (MAFOI) ..... 1 Cy
MAC (MAOID) ..... 1 Cy
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AFSC (SCL) ..... 8 Cys
AFSC (SCO) ..... 2 Cys
AFLC (MCO) ..... 1 Cy
AFLC (MCF) ..... 1 Cy
ATC (ATXDC) ..... 1 Cy
SAC (DO) ..... 1 Cy
SAC (DPL) ..... 1 Cy
SAC (DXI) ..... 1 Cy
SAC (DIX) ..... 1 Cy
SAC (OA) ..... 1 Cy
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USAFA (DFH) ..... 1 Cy
USAFE (OPL) ..... 2 Cys
USAFSO (BIOH) .... 1 Cy
USAFSS (ODC) ..... 1 Cy
USAFSS (COI-5) ... 1 Cy

OTHERS

9AF (DO) ..... 1 Cy

12AF (DI) ..... 1 Cy
19AF (DA-C) ..... 1 Cy
USAFAGOS ..... 1 Cy
USAFSAWC (DO) .... 1 Cy
USAFTAWC (DA) .... 1 Cy
USAFTARC (DI) .... 1 Cy
USAFTALC (DA) .... 1 Cy
USAFTFWC (CRCD) .. 1 Cy
FTD (TDPI) ..... 1 Cy

PACAF

DP ..... 1 Cy
DI ..... 1 Cy
DO ..... 1 Cy
DPL ..... 1 Cy
DXIH ..... 1 Cy
5AF (DOP) ..... 1 Cy
7AF (DOAC) ..... 9 Cys
13AF (DOP) ..... 1 Cy
13AF (DXI) ..... 1 Cy
834AIRDIV ..... 1 Cy
3TFW ..... 1 Cy
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460TRW ..... 1 Cy
483TAW ..... 1 Cy
553RECON WG ..... 1 Cy
6400 TEST SQ ..... 1 Cy
DOTEC ..... 6 Cys

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FOREWORD

Air Force doctrine emphasizes that the most important aspect of tactical air reconnaissance is tactical responsiveness. To achieve this responsiveness, "the time goal of tactical reconnaissance" ideally must be "near instantaneous data sensing, processing, and dissemination to permit rapid command actions whenever necessary".[1/]

"The EC-47 in SEA" explores the potential of a prototype tactical air reconnaissance effort which, since its inception in May 1966, has repeatedly attained the real-time goal of Air Force doctrine. Three EC-47 Tactical Electronic Warfare Squadrons (TEWS) are conducting a project now called COMBAT COUGAR whose objective is:[2/]

> *"...day/night, all weather ARDF (Airborne Radio Direction Finding) operations against low-powered enemy operated transmitters in the RVN, and other permissive areas of Southeast Asia in support of requirements established by COMUSMACV and the Commander, 7AF."*

The TEWS collection, both of fixes locating enemy transmitters and related intelligence information, is the core of the real-time intelligence available to COMUSMACV and his subordinate commanders. Their prompt reactions to this information by ground maneuver, artillery fire, tactical air, and ARC LIGHT (B-52) strikes, frequently have foiled the enemy's plans and severely hurt his forces.[3/]

In this account, Airborne Radio Direction Finding (ARDF), has the preponderant role in the sphere of intelligence available to the ground

[redacted]

commander in Southeast Asia (SEA). Within the limitations required to protect highly sensitive information, this CHECO report surveys the background, operations, and achievements of the TEWS from the arrival of the first RC-47 (now EC-47) at Tan Son Nhut Air Base, Saigon, in May 1966, until 30 April 1968.

The EC-47 Tactical Electronic Warfare Squadrons are an important "first" in Air Force history. This is the first time that the Air Force has ever organized, equipped, and, for the most part, trained personnel for such operations in a combat zone. There has been, and still is, no comparable activity in the Continental United States.

Along with the U.S. Air Force, U.S. Army aviation has the same share of ARDF mission time in support of COMUSMACV. Army aviation conducted ARDF tests in RVN in 1961, a year before the first Air Force test in RVN. By 1965, fifteen Army aircraft exclusively conducted the ARDF operation.[4/] The Air Force did not begin to share the operation in any large measure until the end of 1966. An agreement between the Chiefs of Staff of the Air Force and the Army divides the ARDF mission between the two services for the duration of the war in SEA. Because the long term ARDF role of the services will not be decided until after the war,[5/] the performance record of the EC-47 in SEA undoubtedly will have a bearing on that decision.

[redacted]

CHAPTER I

USAF ARDF: EVOLUTION

Tactical Reconnaissance Problem in SEA

The combat arena for USAF tactical reconnaissance in RVN and Laos has few parallels in Air Force history. Perhaps only the arena in which the Air Force's first tactical unit, the First Aero Squadron (Aviation Section, USA Signal Corps) supported Gen. John J. Pershing's pursuit of Pancho Villa in 1916 offers some parallels. As in Mexico, the operational environment in RVN, and, to a lessening degree, in Laos is permissive; there is no enemy air and little ground-to-air opposition. There were no fixed battle lines in Mexico and, except for such "set piece" actions as at Khe Sanh, there were no fixed battle lines in the Southeast Asia conflict. Villa and his followers generally were indistinguishable from the local populace; so is the enemy now. The difficult terrain and heat in much of Mexico probably are surpassed in difficulty by the swamps, or the three-layer jungle, and the volatile weather in much of RVN and Laos. The combat arena in Mexico and in this war impedes the accomplishment of tactical reconnaissance objectives. The First Aero Squadron largely failed in its task in Mexico, but did enough to convince General Pershing that an army without tactical air reconnaissance "is doomed to failure against one with it". This experience also marks the point in history from which the U.S. Army can date its interest in controlling its own aerial reconnaissance.[1/] In this war, technology appears to have produced a solution to the tactical air reconnaissance problem. The control of that technology remains in doubt.

[redacted]

Early ARDF: German and French Efforts

The dependence of the Viet Cong and the North Vietnamese Army upon radio communications offered the opening which technology could exploit in behalf of tactical air reconnaissance. During World War II, the Germans used both airborne and ground radio direction finding equipment to track down partisan forces in occupied areas such as Norway.[2/] The French apparently used some form of this technique during their struggle in Vietnam. A recently captured VC document calls for radio discipline to counter detection techniques such as the French had used against them.[3/]

USA ARDF

The long-time interest of the Signal Corps of the U.S. Army in ground radio direction finding appears to have led to the Army's early work in the airborne field. In 1961, the Army experimented with ARDF in RVN.[4/] By 1 January 1966, it had 15 aircraft in Vietnam to satisfy a weekly COMUSMACV ARDF requirement for 240 hours of coverage of enemy operations.[5/]

Ever since its experiments in 1961, Army ARDF has depended upon the so-called "aural null" technique. When one of its ARDF crews picks up an enemy signal, the pilot maneuvers his aircraft until he obtains an aural null (i.e., he hears nothing on that aircraft heading). The aural null means that the aircraft is heading directly toward or away from the enemy transmitter. The aircraft's heading can be plotted as a line of position (LOP), if the exact position of the aircraft is known, and

[redacted]

the ambiguity of its heading toward or away from the transmitter is resolved. The Army crew repeats this aural null procedure until several widely spread LOPs are obtained. The LOPs should cross at a common point, or fix, which is the location of the enemy transmitter.[6] (See Chapter VI.)

USAF Enters the Field

A new approach to ARDF, sponsored by Gen. Curtis E. LeMay, when he was USAF Chief of Staff, brought the U.S. Air Force into the field. In April 1962, General LeMay noted that existing radio devices, such as the OMNI system, gave instant, unambiguous bearings to a station or transmitter. Why, he asked, might not the station be located by a reverse application of the electronic principles involved?[7]

The first of two Air Force attempts to develop a new ARDF system quickly followed. Known as HILO HATTIE, this first project in 1962 was unsuccessful. Its Vietnam test occurred in a C-54 flying out of Tan Son Nhut Air Base, Saigon. The lack of maneuverability of the C-54, problems with the new ARDF system, and difficulties with the U.S. Army agency supporting HILO HATTIE were key factors in the failure.[8]

The second, and ultimately successful, project began as a joint effort with the U.S. Navy, under the title MONA HI. In August 1962, the Air Force assumed entire responsibility for the project, under the nickname HAWK EYE. Sanders Associates of Nashua, New Hampshire, developed

[redacted]

a new ARDF device, the AN/ARD-18, later the AN/ALR-34, which used Phase Angle Discrimination (PAD) to obtain, without human judgment, angle measurements on an incoming radio signal in one second. To aid the ARDF crew to pinpoint its location, the Air Force purchased a commercial version of a Bendix Doppler system.

Between February and July 1964, a C-47 deployed to RVN as the test vehicle for the new system. Results were unsatisfactory and the HAWK EYE aircraft was returned to CONUS for further modification.[9/] Another round of tests in Vietnam started on the last day of October 1965 and paid some dividends. The most notable HAWK EYE achievement in these tests came on 13 December 1965, when its crew fixed a VC battalion within a few hundred meters of its location near the Michelin Plantation. This, and other successes, prompted MACV and 7AF to keep the aircraft in RVN beyond its original 120-day testing period.[10/]

Air Force interest in the possibilities of ARDF was not confined only to the Chief of Staff level. In particular, an Air Force officer, Col. James S. Novy, on assignment to the National Security Agency (NSA), made vigorous efforts to arouse USAF interest in its potential.[11/] In January 1964, a month before the first HAWK EYE test in Vietnam, Hq PACAF had submitted a Qualitative Operational Requirement for seven HAWK EYE aircraft with an HF Direction Finding System. The Air Staff, however, delayed approval of the requirement, until the first HAWK EYE aircraft had proved its worth.[12/]

[redacted]

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COMUSMACV Spurs USAF Action

At about the same time that HAWK EYE was showing results, COMUSMACV was planning to expand his requirements for ARDF coverage by a factor of nine. In December 1965, the 2d Air Division Commander, Lt. Gen. Joseph H. Moore, alerted PACAF to MACV's interest and requested 34 additional HAWK EYE aircraft to satisfy it. He pointed out:[13]

> *"Limitations of short range Army aircraft and lack of all weather capability of aircraft and crews point up the need for USAF to enter this special area of aerial reconnaissance as a proper role for USAF."*

As General Moore had reported, COMUSMACV passed his request for additional ARDF coverage to PACOM in January 1966. He told PACOM:[14]

> *"The ARDF program has demonstrated without equivocation the capability to provide rapid determination of enemy locations and movement which is of paramount intelligence importance."*

COMUSMACV wanted to increase his ARDF capability from 272 to 2,424 hours of coverage per week. As indicated, the Army had the preponderant ARDF role at this time with 240 hours (15 aircraft) per week, as compared to the USAF contribution of 32 hours (the HAWK EYE aircraft). While COMUSMACV recognized that an additional 1,168 hours (56 additional Army aircraft) had been either programmed (15 Army aircraft) or scheduled (41 Army aircraft), he advised PACOM that he still would have "a deficit of 1,252 required hours of coverage". To solve this, COMUSMACV wanted:

[redacted]

"...a properly tested and operational system which can be provided in the shortest possible time frame, regardless of the type aircraft or the service providing it.

"It is imperative that the 41 aircraft previously requested be expedited and that highest priority be given to furnishing an additional 79 U-6/U-8 aircraft or equivalent equipment and crews to meet the requirement of this command."

Three factors appear to have brought the Air Force its larger role in the ARDF program. An Air Force briefing on the capability of the HAWK EYE, given to CINCPAC on 12 February 1966, led to his recommendation to the JCS that the USAF begin deploying 35 C-47 ARDF aircraft to RVN in April 1966.[16/] A consideration at Department of Defense level was that the Air Force already had the aircraft in its inventory to perform the mission; the Army did not.[17/] Finally, Gen. John P. McConnell, the Air Force Chief of Staff, gave full support to a "crash program" to meet the 35 C-47 aircraft requirement under the nickname PHYLLIS ANN. These aircraft (designated as RC-47s) were to be deployed to RVN between April and December 1966, after they had undergone IRAN and factory modification. At the same time, their crews were to be formed and then trained on basic C-47 equipment.[18/] A key Air Staff figure in generating this surge of activity was Maj. Gen. Robert N. Smith, Assistant DCS/Plans and Programs. After personally studying the Army ARDF operations in RVN, he realized the need for Air Force participation in ARDF as quickly as possible.[19/]

The PHYLLIS ANN aircraft were to have an important improvement in their ARDF capability beyond that in the HAWK EYE. This was side angle

calibration, which made it possible to fix enemy transmitters in any direction without turning the aircraft. Without this feature, the crew would have to point the aircraft toward or away from the transmitter, as is the case with the aural null technique. Therefore, side angle calibration reduced the possibility of compromise, and also enabled the crew to fix a radio transmitting in only short bursts.[20/]

A roles-and-missions discussion of the ARDF programs in April 1966, between the Chiefs of Staff of the Army and Air Force, led to an increase in the required number of PHYLLIS ANN aircraft from 35 to 47.[21/] Only a few aspects of that discussion are known. It is clear that in March 1966, the JCS approved CINCPAC's request for 35 C-47 aircraft, but also requested the Army to add 41 U-6/U-8 aircraft to the 30 which, by that time, were in RVN. A month later, and apparently after the roles-and-missions discussion", the JCS stated a mix of 57 Army U-6 and 47 USAF C-47 ARDF aircraft could meet the COMUSMACV requirement of 2,424 hours per week, and directed the Chiefs of Staff of the Army and Air Force to carry out the necessary deployments.[22/]

The net effect of the JCS decision was to split the ARDF responsibility between the Army and the Air Force. The joint USAF/USA force of 104 aircraft would give MACV a 16-hour per day ARDF coverage for all of RVN and the Laotian Panhandle.[23/] The basis for dividing the responsibility was the number of ARDF aircraft positions possessed by each service (one per aircraft). The slightly larger number of Army aircraft in the joint force compensated for the greater endurance of the RC-47.[24/]

USAF/USA New Focus Agreement

To handle questions as to responsibilities of each service in the ARDF mission, the Army and Air Force Chiefs of Staff established the New Focus Committee, in the Pentagon, composed of a general officer from each service. On 11 September 1967, these Chiefs of Staff signed a memorandum for the New Focus Committee on the ARDF program which stated: 25/

> *"We agreed that for the short term and the duration of the war in South Vietnam, we would continue to jointly support the MACV requirements with each of us furnishing equipment as may be jointly agreed upon between the Chief of Staff of the Army and the Chief of Staff of the Air Force in accordance with our respective capabilities recognizing the time frames in which the equipment is required by MACV."*

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CHAPTER II

COMMAND AND CONTROL

Organizational Framework

As the RC-47 fleet was being readied in CONUS, an USAF ARDF organization was emerging in RVN. The USAF concept of the ARDF mission required separate agencies to operate the aircraft and its special equipment, as compared to the Army's concentration of its entire operation under one organization, the 509th Radio Research Group (RRG).[1/]

Hq PACAF, through 7AF, progressively established three Reconnaissance Squadrons for the "front end" crews and placed them under the 460th Tactical Reconnaissance Wing (TRW), Tan Son Nhut Air Base, Saigon. The 360th Reconnaissance Squadron began operations at Tan Son Nhut on 8 April 1966, some five weeks before the first PHYLLIS ANN aircraft arrived on 14 May 1966.[2/] As additional aircraft arrived, other organizations were established, first as detachments and then as squadrons, at Nha Trang and Pleiku Air Bases. The 361st Reconnaissance Squadron came into being at Nha Trang on 1 October 1966; the 362d Reconnaissance Squadron, at Pleiku, followed on 1 February 1967.[3/] Two months later, on 15 March 1967, all three squadrons were more precisely retitled Tactical Electronic Warfare Squadrons (TEWS).[4/] Their RC-47 aircraft became EC-47 aircraft in May of that year.[5/] The nickname of the entire project was changed from PHYLLIS ANN to COMPASS DART in 1967, and then became COMBAT COUGAR in 1968. (For the sake of clarity, the squadrons, their aircraft,

and the project nickname will be referred to as TEWS, the EC-47, and COMBAT COUGAR, respectively, for the remainder of this report.)

In the meantime, Hq USAF Security Service organized three units for ARDF equipment and special intelligence personnel, to be collocated with the TEWS: the 6994th Security Squadron (SS) at Tan Son Nhut, Detachment 1 of that squadron at Nha Trang, and Detachment 2 at Pleiku.[6/] The Security Service retained command and administrative control of its units, while the Commander, 7AF, had operational control of the SS units.[7/]

COMUSMACV and ARDF

From the outset of the USAF ARDF operation in RVN, COMUSMACV made it clear that USAF and USA ARDF resources would be used only in response to his "approved requirements".[8/]

On 12 April 1966, COMUSMACV published his concept of operations for the control of ARDF resources. This concept included a description of the ARDF organization he desired, the tasking of the USAF and USA ARDF resources, and the processing of mission results.[9/]

He designated his J-2 as point of contact on ARDF matters. The MACV J-2 responsibilities included acting as intelligence requirements control authority for MACV, designating consumers for ARDF results, passing those results to consumers, and establishing the necessary procedures to accomplish the foregoing.[10/]

[redacted]

TASKING CYCLE

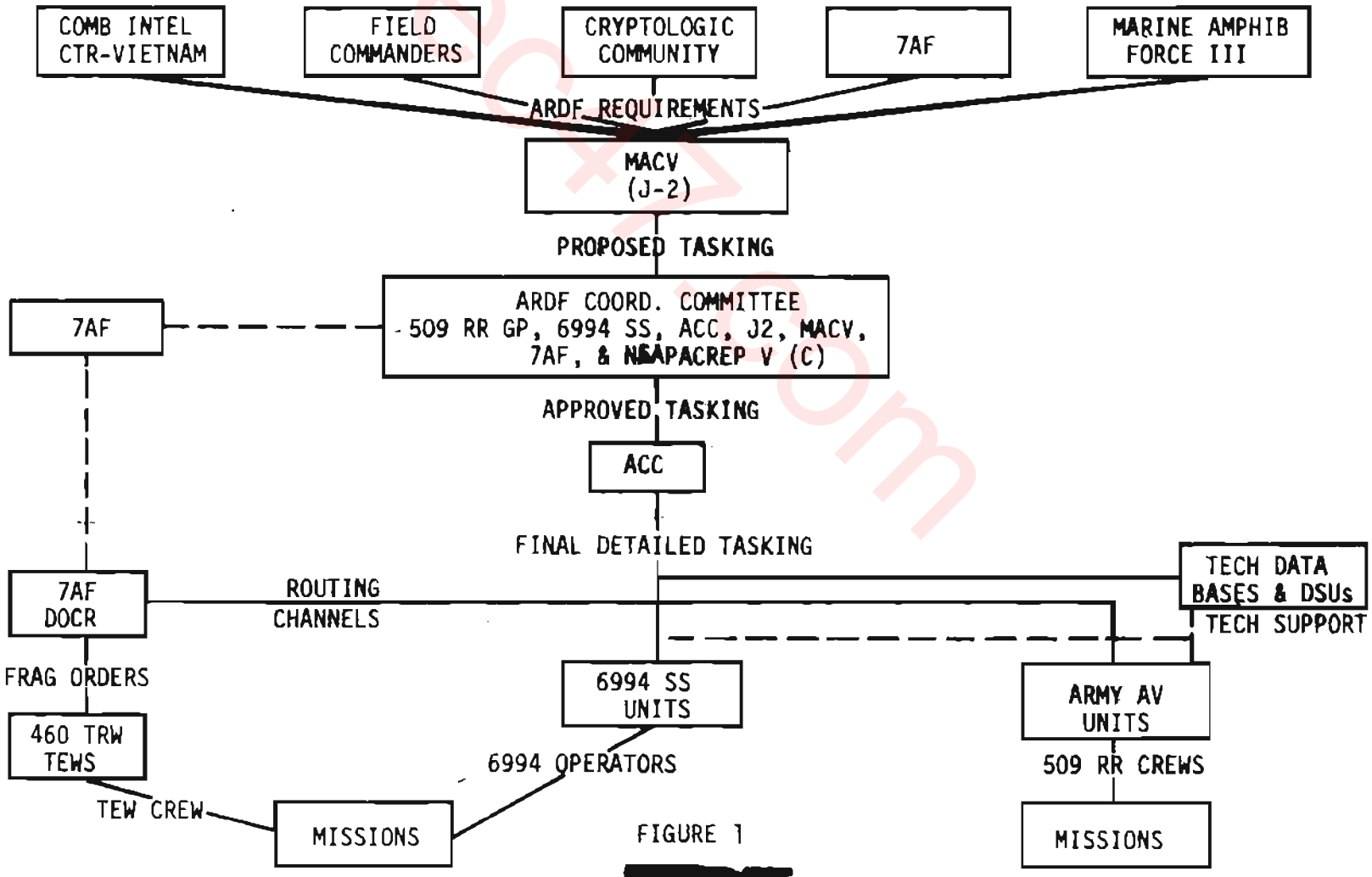

FIGURE 1

[redacted]

A key procedural step to be developed by MACV J-2 was the creation of a coordinating committee made up of MACV, 7AF, 6994th SS, and 509th RRG representatives. Under the MACV concept of operations, this committee would meet weekly to "receive, validate, and approve requirements" from the consumers such as the field commanders and 7AF. In practice, the committee meets weekly only to receive and approve a proposed allocation of aircraft sorties to satisfy the requirements of the consumers.[11/]

ARDF Tasking

As shown in Figure 1, the requirements approved by the coordinating committee are sent in order of priority to the Air Force and Army ARDF agencies through an ARDF Coordination Center (ACC). This center, manned jointly by 6994th SS and 509th RRG representatives, standardizes, where possible, all ARDF activities, establishes specific times over the target, and designates priority targets among those to be covered by mission aircraft. The ACC, in effect, translates the general requirements approved by the coordination committee at MACV level into tasking for each service, based on a weekly capability report submitted by the services. The detailed tasking is passed, in the case of the USAF, through the Reconnaissance Division, 7AF (DOCR), to the TEWS, and directly to the 6994th SS units. In the case of the Army, such requirements are passed directly through the 509th RRG.[12/]

Air Force and Army aircraft are tasked by ACC to operate in a total of 39 MACV ARDF areas. On the basis of experience as to target availability

and priority, MACV has set up these areas, as shown in Figure 2. The boundaries of these areas are not fixed; they are adjusted to meet the current tactical situation. Areas 1 through 4 in Laos are known to the tactical fighter forces as the STEEL TIGER and TIGER HOUND areas. The area off the coast of North Vietnam (Area 5) begins six miles off the coast at the DMZ and extends north to 20 miles south of Dong Hoi, NVN. Because of the greater endurance of the EC-47, only the Air Force operates in Areas 1 through 5. For the same reason, Air Force aircraft cover three areas in the western part of South Vietnam: 10, 14, and 16. Army, as well as Air Force, aircraft can be tasked to cover the remaining 31 MACV areas.

ARDF Results

ARDF aircraft pass results as soon as possible, and while still airborne, to Direct Support Units (DSUs) serving the field commanders. (The DSUs belong to the 509th RRG.) Upon landing, the crews report accomplishments through their respective intelligence organizations (either the SS units or the 509th RRG). The 6994th SS units report results to the 509th RRG, which maintains an ARDF data base. Its analysis of these results, as well as those of the Army mission aircraft, are then submitted to MACVJ-2 for dissemination to consumers.[13/]

COMUSMACV has charged the field commanders with promptly responding to ARDF information:[14/]

[redacted]

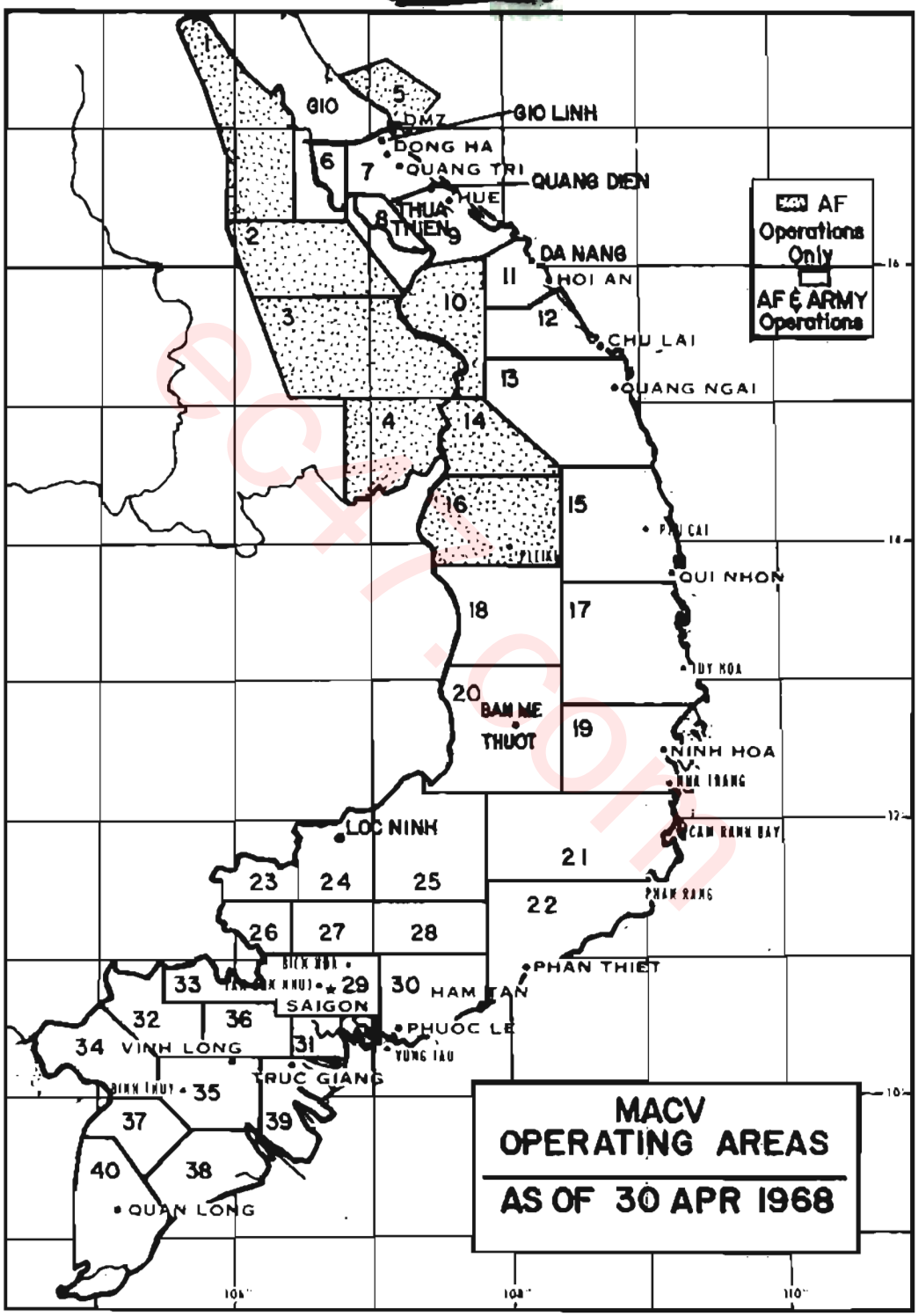

FIGURE 2

[redacted]

"Except for those targets designated as 'Off Limits' by this headquarters, commanders are directed to take timely advantage of this valid intelligence to direct appropriate airstrikes, naval gunfire, artillery, ground maneuvers, visual reconnaissance, FACs, or other activities in the vicinity to destroy the enemy. ARDF targets should be involved in day and night H and I (Harassment and Interdiction) fires...."

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CHAPTER III

PERSONNEL AND EQUIPMENT

USAF ARDF Personnel

The "front end" crews (two pilots, a navigator, and a flight mechanic) for the EC-47 are assigned to each TEWS on a 2.0 crew/aircraft ratio in support of an 150-hour-per-month utilization rate/aircraft. Prior to assignment to RVN, the crews receive Phase I training from Tactical Air Command at England AFB, Louisiana. Since all operational EC-47 aircraft are in SEA, crews can receive only familiarization training in the basic C-47 at England. Phase II training or actual work in the EC-47 occurs on combat missions at the assigned TEWS. The training covers some 13 hours of ground school, plus a minimum of five Phase II missions with a qualified instructor.[1/]

The 6994th SS units are responsible for training "back end" crews whose first experience with the EC-47 necessarily is also "in-theater". Their Phase II training includes up to 57 hours ground training and eight missions with an instructor.[2/]

This training in RVN has been under way for more than two years. The 6994th personnel have been told that USAF Security Service and Tactical Air Command soon will institute integrated Phase II combat-crew training in CONUS. The 7AF and 460th TRW oppose this requirement because crews integrated in CONUS will not necessarily be assigned to the same unit, and also Phase II training there cannot approach combat conditions in-theater.[3/]

All personnel assigned to the TEWS require SECRET clearances. "Front end" crew members must be cleared for access to at least TOP SECRET information. Because each navigator must work very closely with "back end" Security Service personnel, he, as they, must have a Special Security Investigations Required (SSIR) clearance.[4/]

The formal training and clearance requirements do not reveal all the intangible aspects of turning the TEWS into combat organizations. The history of their immediate headquarters, the 460th TRW, describes the situation:[5/]

> *"As could be expected, the activation and buildup of a flying combat organization presented an enormous combat readiness training situation. This is especially true (in this case)...with prototype ARDF electronics equipment...."*

The high experience level and maturity of the crew members undoubtedly helped to surmount problems implicit in such an operation. The initial complement of crew members in the 360th TEWS was 80 percent field grade officers drawn from a variety of Air Force assignments, including command of SAC units and aircraft, supervisory roles in research and development activities, and staff positions in the Pentagon. Their average age was 40, and the educational backgrounds of the initial assignees included one law degree, 18 master degrees, and 36 bachelor degrees.[6/]

This maturity and experience level has continued in all three TEWS. By the close of this reporting period, there were 4 PhD's, 43 master

degree holders, and 171 officers with at least a bachelor's degree participating throughout the three TEWS. More than 50 percent of the assigned crew members were in the field grades, the majority of whom were lieutenant colonels and colonels. Recently, however, a large number of pilot training graduates have begun to come into each of the TEWS. These lieutenants had won their wings almost entirely in jet trainers. Adjusting well to the EC-47, they log up to 1,000 combat hours in one year.[7/]

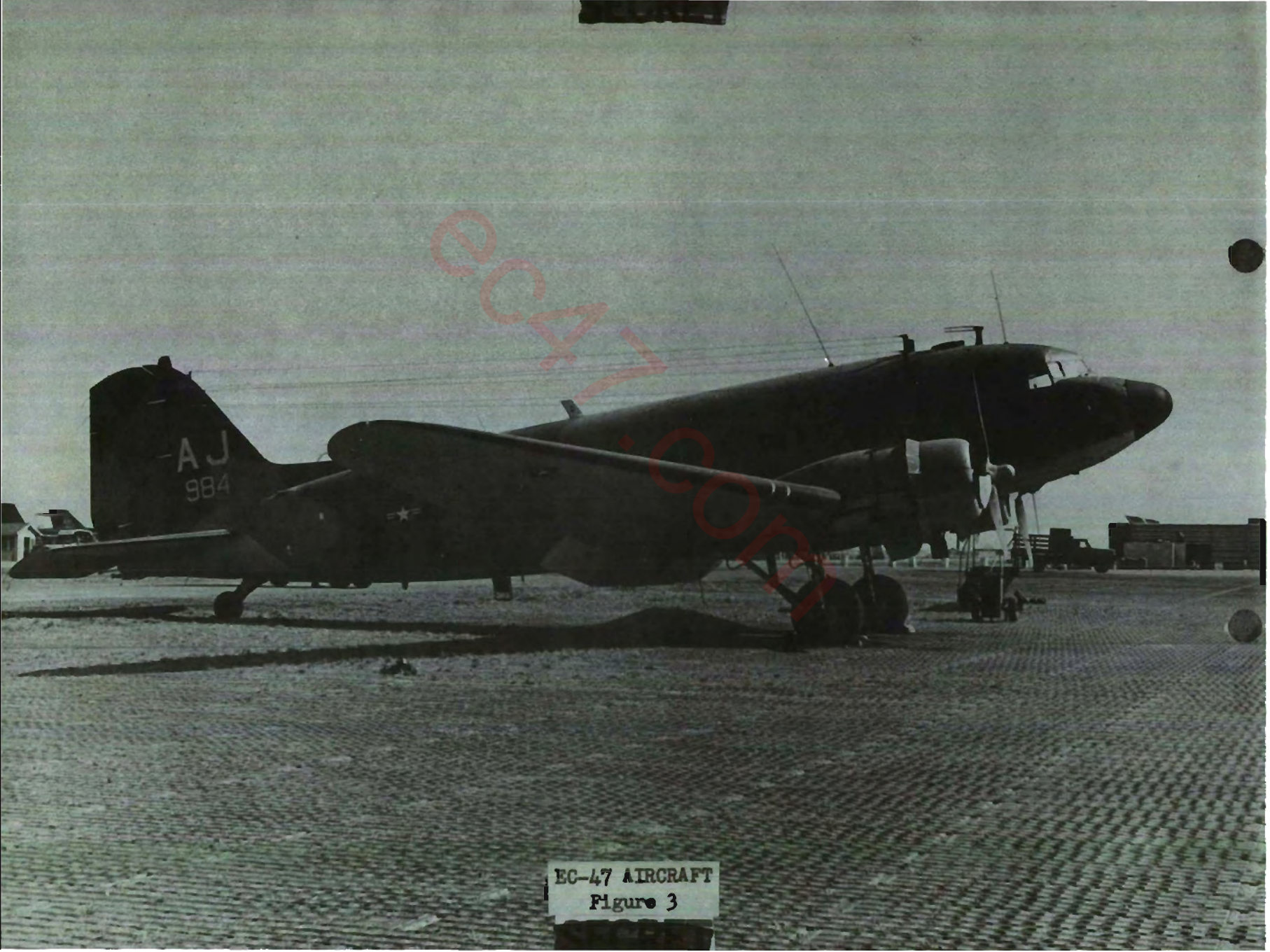
The impact of the overall maturity and experience level may be seen in the safety record of the EC-47 operation. For the two-year period of this study, the EC-47 crews have flown 109,339 hours without an accident (excluding the two combat losses discussed in Chapter IV).[8/]

USAF ARDF Equipment

With the exception of an antenna on each wing and the nose, the EC-47 aircraft is to all external appearances, a standard C-47 (Fig. 3). Several items of internal equipment, which are central to the effective accomplishment of the mission, make the aircraft system unique.

The "back end" crew operates the equipment shown in Figure 4:

. AN/ALR-34 ARDF: An electronic Airborne Radio Direction Finding unit (known as the "X" console) employs a "phase measurement" technique to determine the relative bearing of a signal to the EC-47 aircraft (i.e. the angle formed by the direction of the radio signal and the aircraft heading). The AN/ALR-34 establishes the direction of



EC-47 AIRCRAFT
Figure 3

the enemy signal, as a result of computing through a complex process, the time of arrival of the target signal at the three antennas on the aircraft wings and nose.

· A target-acquisition position (the "Y" console): Permits its operators, as the title implies, to search various frequencies for an enemy signal.

· KY-8 radio: Permits secure communications between the "back end" crew and ground contacts (located near "Y" console in Fig. 4).[9]

Seventeen of the forty-seven EC-47 aircraft assigned to the TEWS have additional special equipment. Twelve aircraft have two additional search/acquisition "Z" positions, and five other aircraft have two additional acquisition and jamming "Q" positions.[10] (Fig. 5.)

The navigator uses several distinctive items of equipment:

· Bendix Doppler Computer CPA-24 (AN/APN-179): Enables him to fix his aircraft's position within a tolerance of 0.6 percent of the distance traveled and 1 - 7 percent of cross track distance. At 120 knots, this means that the maximum allowable error is 1.8 nautical miles per hour. To insure the accuracy of the computer, the navigator must check the position shown by the Doppler against a known position at frequent intervals. With this technique, he can predict the accumulation of error and also establish a proportionate part of measured error. His main resource for checking the Doppler is the relatively

old-fashioned B-3 driftmeter, through which he can direct the EC-47 over a known position.

C-12 Compass System: One of the most advanced compass systems available, which gives an instant readout of aircraft heading within a tenth of a degree. It is accurate within 0.25 degrees root-mean-square (RMS) at mid-latitudes and 500 knots (a far greater speed than the EC-47 can attain.) [11]

The pilots have one non-standard piece of equipment, a Bendix Weather Radar, AN/APS-113, mounted on their instrument panels. [12]

USAF ARDF Equipment: Operation

The 460th Tactical Reconnaissance Wing Manual 55-1, March 1968, has a full description of ARDF operational procedures. For the purposes of this study, it should be pointed out that two problems are involved in locating an enemy transmitter. The position of the aircraft must be known precisely, and at least two relative bearings taken on the transmitter, as shown in Figure 6. [13]

Once the AN/ALR-34 has "locked on" to a target, its relative bearing, the Doppler data on the position of the aircraft, and the C-12 Compass heading are integrated and dispalyed on demand by the navigator on a paper tape. This process can take place less than one second after a lock-on to a target. The navigator must then make several computations before plotting a line of position (LOP). This entire procedure is repeated for at least one more bearing and, ideally, several widely

[redacted]

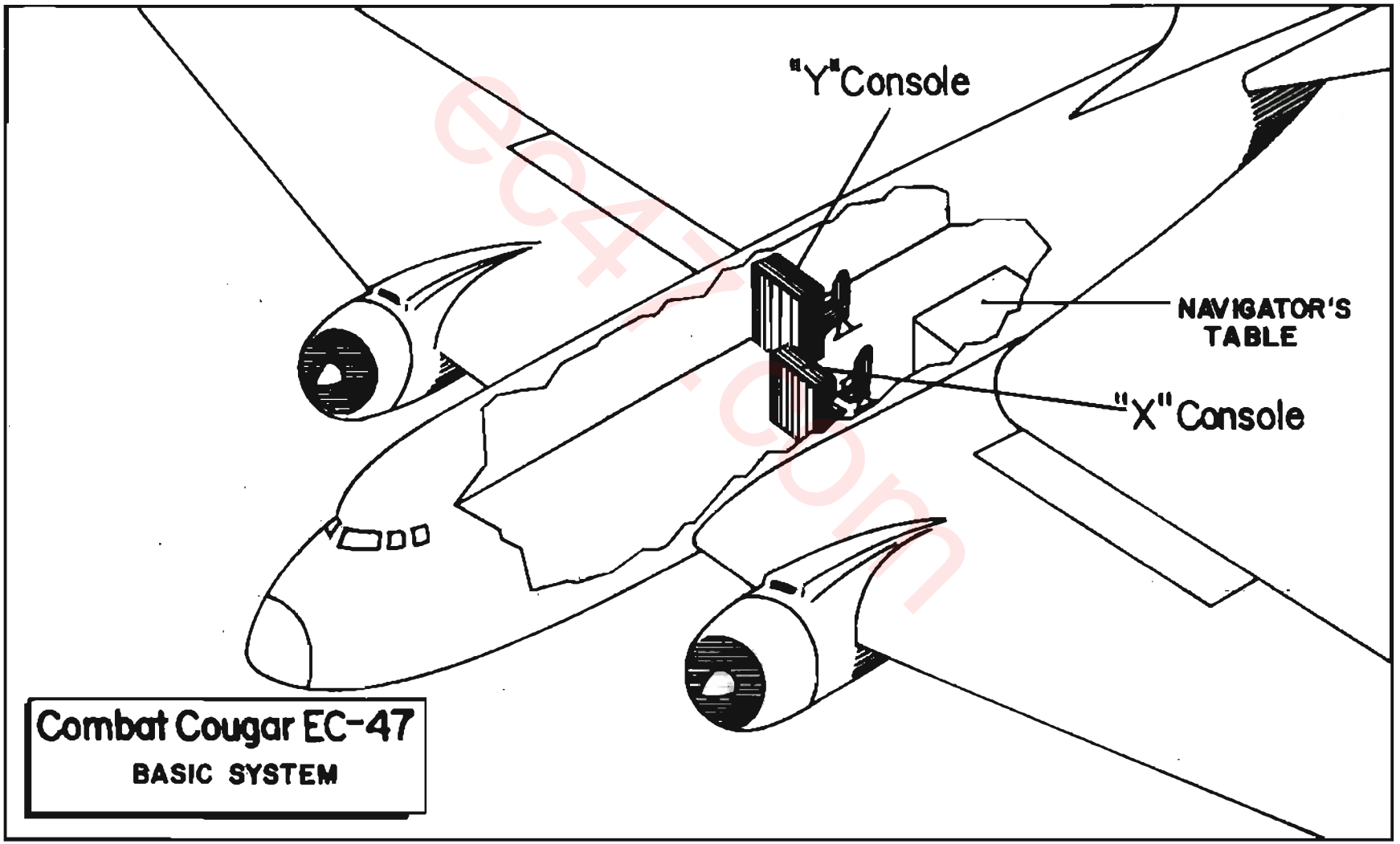


FIGURE 4

[redacted]

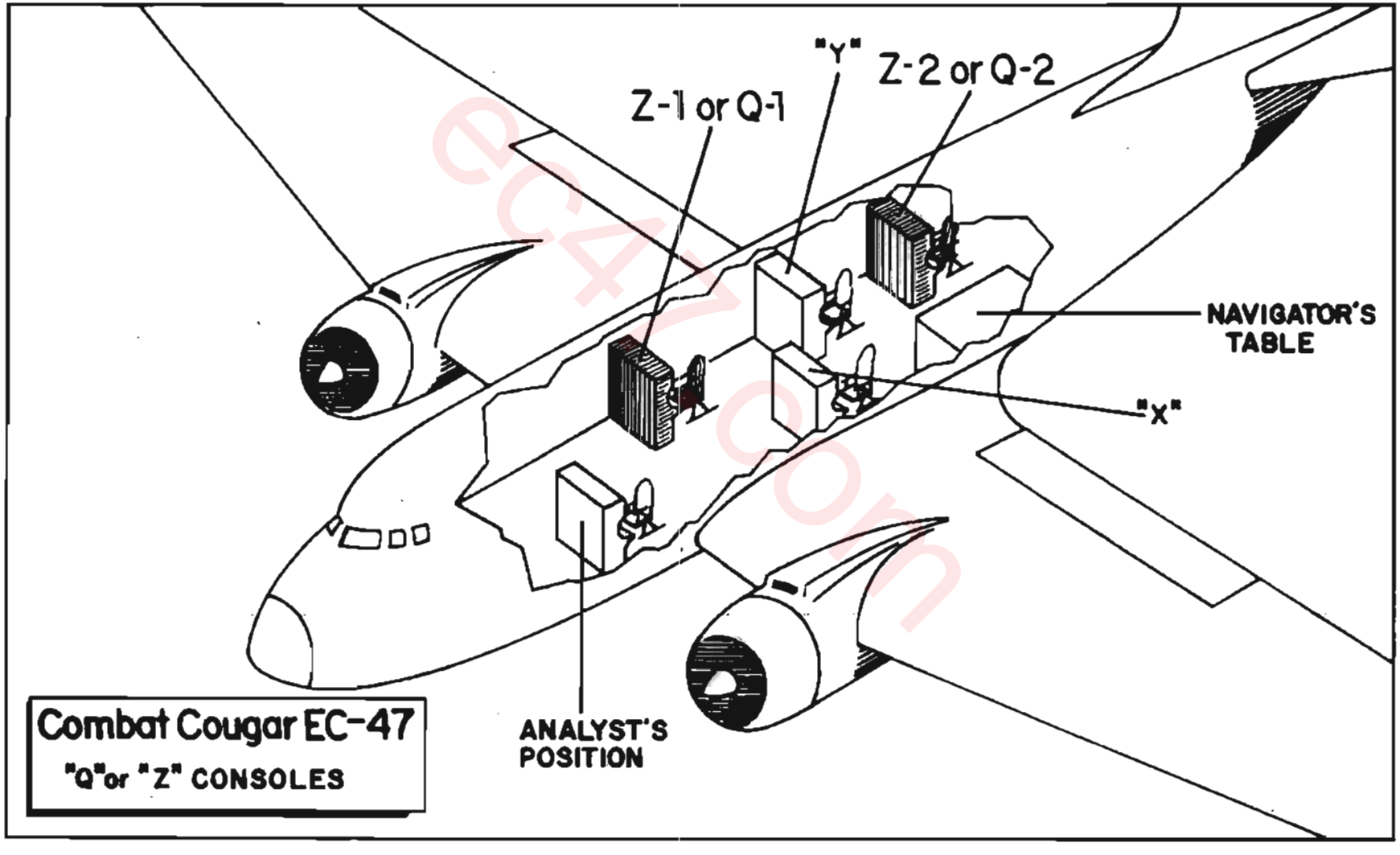

Z-1 or Q-1
"Y"
Z-2 or Q-2
NAVIGATOR'S TABLE
"X"
ANALYST'S POSITION
Combat Cougar EC-47
"Q" or "Z" CONSOLES

FIGURE 5

[redacted]

ARDF OPERATIONAL PROCEDURES

(Pinpointing Targets)

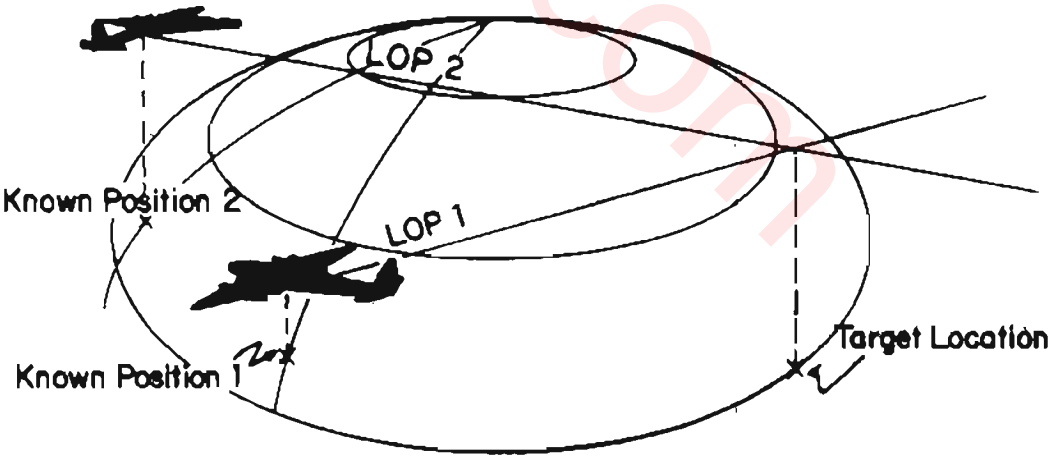


FIGURE 6

[redacted]

spread bearings, to get the best fix. While a target can be fixed on a single aircraft heading, the navigator usually directs a heading change either to secure better bearings on the target or to stay close to it.[14/]

A proficient navigator can compute his data, plot between six and twelve LOPs, fix a target, and pass his information for KY-8 transmission to a Direct Support Unit in seven minutes.[15/] He uses a 1:250,000 scale chart and is capable of measuring within 1/10 degree and 1/10 mile. His judgment must come into play in deciding which lines of position form his fix. Considerations such as terrain, weather, and an unreliable Doppler affect individual bearings. Also, the present state of his equipment makes less than a 250-meter radius fix unlikely. Indeed, up to a 10,000-meter radius fix is reportable. The fix radius is measured from the center of the fix (determined by bisecting the exterior angles) to the farthest intersection. The radius tells an evaluator that the enemy transmitter lies within a circle whose radius is the fix radius.[16/]

As indicated, the navigator passes his fix data to the special equipment operator at the "Y" console, who immediately transmits it on the KY-8 to the closest Direct Support Unit. The fix information also becomes part of a log, which the equipment operator forwards through his SS unit to the 509th RRG.[17/]

USAF ARDF Equipment: Maintenance

The Air Force's decision to split the ARDF operation between the TEWS and SS units, and its general maintenance philosophy, have fragmented

the maintenance of USAF ARDF aircraft and special equipment. The TEWS have control of aircraft maintenance only up through the organizational maintenance level. Full field maintenance is the responsibility of other organizations. An exception to this is the 360th TEWS, because the parent 460th TRW happens to have full maintenance responsibility for all aircraft at Tan Son Nhut Air Base, Saigon. The other TEWS depend upon the 14th Air Commando Wing at Nha Trang and the 633d Combat Support Group at Pleiku for full field maintenance. The maintenance of the AN/ALR-34 and associated equipment is the responsibility of the SS units.[18/]

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CHAPTER IV

OPERATING CONTEXT AND LIMITATIONS

The capability of the EC-47 in SEA cannot be accurately gauged unless the context in which it operates, the limitation experienced, and measures taken to overcome these limitations are considered.

Operating Context: The Enemy

The TEWS conduct Airborne Radio Direction Finding operations over RVN, Laos, and in one area six miles from the coast of North Vietnam. Only the generally permissive environment created by U.S. and allied air supremacy makes the EC-47 a suitable aircraft for the operation. The word "generally" must be used because the groundfire threat in Laos makes that area increasingly less permissive than the other two areas.

Beyond the permissive environment, three protective measures are in force for the EC-47 operation. The aircraft itself, except for the three antennas on the nose and wings, resembles the powerfully armed AC-47. Initially, the minimum operating altitude was 1,500 feet above ground level (AGL). This was raised to 2,000 feet AGL in March 1967, after nine EC-47 aircraft had received hits at the lower altitude. Also, in high threat areas, the crews were to fly at the altitude recommended in their pre-flight intelligence briefing.[1/]

Finally, as a "cover" for the operation, EC-47 aircraft drop psychological warfare leaflets, when they are available. The expenditure of leaflets was scheduled to reach 80,000,000 each quarter after 1 July

1968.[2] The massive transportation requirement to move leaflets to the TEWS at Nha Trang and Pleiku appeared difficult to meet. At the end of this reporting period, aircraft of those units were flying missions with only one token box of leaflets as a cover in the event the aircraft came down in enemy-held territory.[3]

Combat losses for the EC-47 have been minimal. The first, with seven crew members, was lost probably to groundfire on 10 March 1967 in RVN. VC troops searched the wreckage before a USAF ground party could reach the site. Apparently, the large number of leaflets scattered around the crash site deceived them as to the mission of the EC-47.[4] Enemy groundfire in Laos knocked out one engine and damaged the other on the second EC-47 on 11 March 1968. The aircraft commander managed to steer the disabled aircraft for 60 miles to a friendly airstrip and crashland it. His action saved the crew; the special equipment was salvaged, but the airplane had to be abandoned.[5] The skill of the crew also saved a third EC-47 on 24 April 1968, after groundfire in Laos punched a two-foot by four-foot hole in its vertical stabilizer at the point where the vertical and horizontal elements join together, along with other damage. The crew brought the airplane to Nakhon Phanom Air Base, where it was repaired and eventually returned to service.[6]

A Combat Tactics Panel comprised of representatives of the 460th TRW, 6994th SS, and the TEWS meet monthly to review their experiences, tactics, and ideas for improvement. After the second EC-47 was hit in Laos in

April 1968, the 460th TRW commander effected a fourth protective measure recommended by the panel, whereby no aircraft would operate closer than three miles ground distance to known enemy antiaircraft positions.[7]

Another aspect of the enemy's role in determining the operating context are his countermeasures against detection by ARDF. It is uncertain as to how much the enemy knows about the EC-47 and its purpose. As indicated earlier, he has been practicing communications discipline based on his experience in fighting the French.

Insofar as enemy communications are concerned, SS unit personnel know that he uses mobile transmitters (carried on various vehicles), which are extremely difficult to fix. The enemy transmits in short bursts which reduces the chances of a "lock-on" by ARDF equipment. He changes either his frequency or power output frequently to hamper detection. By sending and receiving on the same frequency from two transmitters at different locations or by changing antennas, he might escape detection. Finally, if an U.S. or allied aircraft approaches too closely to his position, he may stop transmitting.[8]

The period before the TET Offensive in early 1968 offers an example in this regard of what may be either an enemy tactic or a limitation of ARDF. U.S. intelligence analysts used ARDF information to fix the location of a NVA division not far from the Cambodian border. However, the division actually was east of the fix and near Bien Hoa. Apparently, that division had left its transmitters at the border site.[9]

Operating Context: Natural Phenomena

Among natural phenomena, the weather in SEA presents obvious problems for a non-pressurized, altitude-limited aircraft such as the EC-47. The TEWS attributed to weather, either the loss of some time in the operating areas, or the loss of the mission entirely in 532 sorties out of a total of 11,632 flown during FY 1968.[10/] Thunderstorms, as well as terrain, and the coastline of Vietnam (through shoreline effect), interfere with effectiveness of ARDF equipment. Weather also affects the Doppler navigational system, because the B-3 driftmeter, by which it is normally reset, requires clear visibility.

The time of day has its effect on the Doppler system as well, because the B-3 driftmeter also requires daylight. The TEWS are using other devices at night (and in weather) for resetting the Doppler. The RBS Skyspot radar device is used to obtain fixes. Also, on occasion, ceilometer lights at certain Special Forces camps are used at night to set the Doppler through the B-3 driftmeter.[11/] Wiring deficiencies in the aircraft have delayed a full test of LORAN C for navigation and for setting the Doppler. As of this writing, a modification to correct those deficiencies is in progress.[12/]

Operating Context: Man-made Limitations

The beddown problems affecting 7AF activities in general have had their impact on the TEWS. Ideally, the squadrons at Pleiku and Nha Trang would be based farther north in RVN, so as to be closer to their operating

areas. The 361st TEWS at Nha Trang, for example, must fly as much as 1:50 to reach its farthest operating area near Hue, in the northern portion of RVN. This handicap is diminished somewhat by conducting the search for enemy transmitters, while proceeding to and from operating areas.[13/]

Other man-made phenomena are the artillery fire and ARC LIGHT areas which dot RVN. They add a limitation to free operations by EC-47 (and other) aircraft. To keep this problem at a minimum, the EC-47 navigator closely coordinates his aircraft position with the artillery fire directors and, in the case of ARC LIGHT, with ground monitors.

Equipment and Personnel Limitations

ARDF and its associated equipment are the elements in the TEWS effort, which make it a prototype operation at the end of a long supply line to CONUS. The TEWS have had a continuing supply problem with their non-standard equipment (Doppler, C-12 compass, and radar). The Doppler system was a completely new item in the Air Force inventory. At the outset, there were no maintenance personnel with experience in repairing the Doppler; there was no test equipment or technical data file, and few spare parts. Civilian field engineers plus a local "self-help" program have been the main resource in meeting these limitations.[15/]

In any event, Aircraft Not Operationally Ready - Supply (NORS) rates for all types of equipment in the TEWS during FY 1968 have exceeded the Air Force standard of five percent for six months in the separate cases of the 360th and 362d TEWS.[16/] The 361st TEWS remained well within the

Air Force standard, allegedly because Nha Trang is "geared to a C-47 operation".[17] To meet their commitments as they have, each of the three TEWS has turned to cannibalization as a short-term answer. The 360th TEWS has effected as many as 72 cannibalization actions in one month (December 1967); the 361st TEWS had a high of 61 of these actions in January 1968; the 362d TEWS reached a total of 151 in April 1968.[18] The SS units are exempt from NORS reporting, but they have had comparable difficulties with their equipment.[19]

The AN/ALR-34 ARDF equipment has an inherent limitation, as it is extremely sensitive to steep turns. These turns cause errors in transmitter bearings and distort signal strength as shown on the target acquisition console. Thus, the aircraft must be level before usable data can be obtained.[20]

The Doppler, as already indicated, is limited in usefulness unless reset periodically. Also, Doppler "dropout" may occur, causing the computer function to receive information from the Doppler memory mode. These data would affect the accuracy of locating the position of the aircraft.[21]

The general maturity and experience level of assigned personnel has been shown. However, the one year DEROS concept and other personnel actions lead to an almost complete turnover of TEWS personnel in the period of August to March each year.[22]

[redacted]

All crew members have a definite role to play in the TEWS mission, but the navigator has an especially critical and extremely busy function. His grasp of the mission, proficiency in plotting, judging lines of position, and determining fix radii are fundamental to mission success. His plotting problem is apparent when one considers that 500 meters are only slightly more than 1/16 inch and are equal to three pencil lines on a 1:250,000 chart. [23/] The lack of standardization among the navigators in the three TEWs in determining fix radii has been a persistent problem. As will be shown in Chapter V, the ground commander's reactions to fix reports are more prompt when fixes of 500 meters or less radii are passed to them. Supervisory personnel have set 250 meters as the minimum reportable fix radius because of equipment and chart limitations. The individual navigator has to judge the effect of driftmeter error, Doppler errors, standoff range, altitude, weather, and terrain on the fix. One 460th TRW study in February 1968, showed that the navigators of the 362d TEWS reported 48 percent of their fixes with radii of 2,000 meters or over. The 360th TEWS and 361st TEWS navigators reported only 10 percent and 17 percent of their fixes at 2,000 meters. This problem had been alleviated somewhat through a renewed standardization emphasis. In the last analysis, as standardization representatives pointed out, the individual navigator still would have to make his own best judgment of the meaning of his fix data.

[redacted]

CHAPTER V

ACCOMPLISHMENTS

Security Restrictions

Security requirements will not allow the inclusion of the full record of the accomplishments of the USAF ARDF program in this study. Airborne Radio Direction Finding has the preponderant role in the intelligence picture used by the ground commander, but ARDF, in itself, is not the full picture.

Even the "front end" personnel in the TEWS are only generally aware of the effectiveness of their mission. Maj. Gen. Gordon Blood, Deputy Chief of Staff/Operations, 7AF, advised the TEWS parent unit, the 460 TRW, on 28 September 1967: 1/

> *"...The monthly feedback report provided by the 6994 Security Squadron, oral feedback of information obtained at weekly scheduling meetings, and congratulatory messages from MACV, although not completely satisfying, must suffice."*

This account is similarly limited to the sources mentioned by General Blood. As such, it must be a "mixed bag".

Reactions of Consumer

The ground war in Vietnam is largely one of small, but bitter actions. The major contribution of ARDF has been in its assistance to the ground commander in anticipating enemy movements before such actions begin. On those rare occasions when battles on a larger scale have occurred, such as during the 1968 TET Offensive, ARDF has played a correspondingly large role.

COMUSMACV has directed his ground commanders to take prompt advantage of ARDF information. There is no question that they do so, either by ground maneuver, artillery fire, tactical air, or ARC LIGHT strikes. At the very least, they use fix information as part of their overall intelligence picture to plan future operations.

One Army source advised the TEWS in March 1967, that in reacting to a fix passed to a ground force by the DSU, the ground commander operated with definite criteria. For his purposes, the best fix was one with radii of less than 500 meters, received in time to react, positively identified, and collaborated by other intelligence. The Army source's experience has been: 2/

> *"Twenty-five to forty percent of fixes (received) were used for immediate harassment and interdiction (H and I) of the enemy, by artillery, naval gunfire, and tactical air. Targets of major suspected importance receive all types of fire or a combination thereof depending on the forces and means available."*

Fixes not acted on immediately usually did not meet the best criteria (timely reception, small radii), or fell too close to a friendly populated area. In any event, these fixes at least added to the commander's intelligence picture. 3/

Another Army source, whose experience had been in the open country near Dak To in central RVN, advised the 361st TEWS on 2 April 1968, that every priority target reported with a fix radius of 1,000 meters was immediately hit by artillery fire. Unidentified targets with a radius of 500 meters or less also were immediately hit. 4/

The use of ARC LIGHT (B-52) strikes against targets produced by ARDF and other intelligence is not entirely within the local commander's jurisdiction. COMUSMACV must plan their use in the light of his total picture. Precise data are not available, but SS personnel understand that 90 percent of all ARC LIGHT strikes were based at least in part on ARDF information.[5/]

Some indications of this important role of ARDF in ARC LIGHT planning may be seen in the following detailed accounts of operations:

Initial Accomplishments: 1966

As mentioned, the success of the HAWK EYE aircraft during the second test in RVN prompted COMUSMACV to keep it in theater beyond its scheduled time. On 11 April 1966, the HAWK EYE acquired 13 fixes in the Tay Ninh area, the largest number to date. That mark fell when the first EC-47 showed its superiority by acquiring 19 fixes on 7 June 1966, and kept up the pace with another 13 the next day.[6/]

The Air Force had deployed 26 aircraft to RVN by 31 December 1966. Their effectiveness on 1,526 sorties in the May-December period was not lost on CINCPAC or the field commanders.[7/]

On 29 September 1966, Maj. Gen. Grover C. Brown, Director of Intelligence, PACOM, called to the attention of CINCPAC and his staff the early work of the EC-47 in the DMZ. Without its work and that of more sensitive intelligence, "we would be completely in the dark about the enemy situation in the DMZ".[8/]

On 31 October 1966, the First Infantry Division told the 460th TRW:[9/]

[redacted]

"On 28 October, the 1st Infantry Division sent two battalions into the Cam Xe Jungle, vicinity XT6855, exclusively on the basis of intelligence provided by ARDF. The battalions made immediate contact. When the battlefield was policed, 70 bodies were found and evidence indicated numerous others had been carried away. Please pass to those responsible the compliments of the CG, 1st Infantry Division for a job well done. We need your continued support."

Evidence of real-time reaction to ARDF fixes also came from the G-2, 1st Infantry Division, who, within eight minutes after a Direct Support Unit received and passed him a fix, "immediately ordered 200 to 300 rounds of artillery on the fix". 10/

Another early, but continuing dimension to the role of the EC-47 in ARDF appeared on 21 November 1967, when one of its fixes prevented an ambush in real-time. A Direct Support Unit reported: 11/

"Reference message received 21/0136Z and fix passed immediately to Regt S-2. Forward Air Control aircraft sent into the air approximately 21/0205Z to recon the area. Air strike requested in area by FAC. Convoy was notified of possible ambush. Four each UH-1D gunships sent to area due to approach of 11th Cavalry convoy along Route 1. As convoy reached area of fix location, helicopters began recon by fire. Fire was returned by VC and firefight began---Important point, this ARDF prevented serious ambush...."

USAF ARDF Program Matures: 1967-1968

The USAF ARDF program reached its full proportions in 1967, as the programmed 47 EC-47 aircraft became available. They flew 10,891 sorties during 1967, of which 2,574 were flown over Laos and 478 in the area off North Vietnam. 12/ By August 1967, the crews could point to a record of

[redacted]

25,000 ARDF fixes and 10,000 missions, since the program had begun in May 1966.[13]

One report on the effectiveness of the EC-47 came during a conversation between Gen. William W. Momyer, Commander, 7AF, and Col. Robert G. Williams, Commander 460th TRW, in May 1967. Colonel Williams quoted General Momyer to the TEWS personnel:[14]

> *"...I want all personnel in this mission to know that the primary and basic source of intelligence in this country comes from COMPASS DART (now COMBAT COUGAR), and I want the people in these squadrons to know it."*

Recurring reports from the ground commanders supported General Momyer's statement. Not all of the reports are used in this study. Only those which give an insight into ARDF in one of its dimensions are considered at length; other typical operations which repeat points already made are summarized.

One of the war's major operations in 1967 was the two-phase Operation JUNCTION CITY in Tay Ninh Province. Several divisions, supported by 5,002 tactical air and 126 ARC LIGHT strikes, hit the enemy in an area reported to be the center of important Viet Cong activities. U.S. and Allied Forces claimed 2,728 Viet Cong and NVA dead, 99 prisoners, and 137 returnees, plus a considerable amount of enemy material destroyed or captured.[15]

During the first phase of JUNCTION CITY, USAF and Army aircraft contributed 903 "immediate interest" fixes in an 1,558 ARDF total. The II Field Force planners used the fixes to plan their operations. On 5 March, an ARC LIGHT strike hit "the center of a mass of ARDF fixes". As many as

476 rounds of various types of artillery fire hit six fixes over a ten-day period.[16] In the second phase of JUNCTION CITY, there were 1,869 "immediate interest" fixes in a total of 2,850. The ARDF information alerted the ground forces to an enemy move culminating in "human wave" attacks on 17 March and on 1 April. The alerted ground forces killed 777 of the enemy.[17]

Another major effort, Operation SHENANDOAH II, in September-November 1967, had significant EC-47 support. "ARDF was the primary basis for targeting...airstrikes against the 271 NVA Regiment." An ARC LIGHT strike hit an ARDF fix on the 273 NVA Regiment; "the radio station serving the unit was not heard again". The results of another nine ARC LIGHT strikes between 14 - 30 October 1967, during SHENANDOAH II helped to highlight the accuracy of the ARDF fixes (and the proficiency of the SAC crews). The B-52 effort placed 90 percent of their ordnance squarely on target in two cases, 70-80 percent in three, 60-65 percent in two, and 50 percent in one. In the ninth case, the B-52 aircraft knocked out "100 meters of tunnel, three fighting positions, three bunkers, and one foxhole". The enemy lost 1,331 (confirmed), 385 (probable), and 15 as prisoners during the course of the operations.[18]

As already noted, not all ARDF fixes supported major operations or necessarily brought "immediate interest" reactions by the ground commanders. Nevertheless, in Operation SANTA FE (3 November through 2 December 1967), the TEWS were told:[19]

> *"ARDF...continued to be the most important intelligence product provided to the tactical commander. Although there was no action taken directly against ARDF fixes, it kept the commanders up to date on enemy locations*

in his tactical area of responsibility and interest."

A summary of other operations for the year 1967 in which the EC-47 figured, shows, in each case, feedback was limited:

OPERATION CODENAME OR LOCATION	DATES	FIXES	FEEDBACK
THAYER I and II, IRVING 20/	13 Sep 66-11 Feb 67	778	Two B-52 strikes; used ARDF "extensively in planning and execution"
FAIRFAX 21/	12 Jan-14 Dec 67	13,028	327 "immediate interest"; too close to friendly area (Gia Dinh, near Saigon) to take action in majority of cases.
GADSEN 22/	Jan-Feb	480	295 "immediate interest"; one B-52 strike.
CEDAR FALLS 23/	Jan	574	362 "immediate interest"; entire operation prompted by ARDF.
FARRAGUT and GATLING 24/	26 Jan-23 Mar	UNK	"Several" B-52 strikes.
SUMMERALL 25/	Apr 67	134	"ARDF once again proved the most valuable source of intelligence"
Saigon River 26/	1 Apr	1	Waterborne fix followed by VR sighting of four vessels. All destroyed.
FRANCIS MARION 27/	23 Apr	2	102 enemy KIA
25th Division Monsoon Campaign 28/	1 Jun-7 Dec	UNK	2,609 artillery rounds fired; 14 airstrikes; 2 B-52 strikes.

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OPERATION CODENAME OR LOCATION	DATES	FIXES	FEEDBACK
Various Coordinates 29/	2 Jul-30 Jul	52	696 Harassment and Interdiction Rounds.
	3 Aug-31 Aug	43	483 H&I rounds.
III Marine Amphibious Force 30/	1-31 Oct	1,095	325 "immediate interest"; 250 fixes hit by H&I fire; 6 fixes by ARVN artillery; 77 fixes by tactical air; all fixes with radii of 750 meters or less passed to local area commander for action.
YELLOWSTONE 31/	8 Dec 67-24 Feb 68	UNK	2 B-52 strikes; 703 H&I rounds; 1,170 enemy KIA.

The year 1967 closed with a message from the Commander, III Marine Amphibious Force, thanking the TEWS for their support of Marine Operations with EC-47 aircraft missions in Laos and the DMZ: 32/

> *"Have noted with pleasure results of COMPASS DART (COMBAT COUGAR) "ZULU" aircraft since its resumption of flights in MACV Area Seven.*
>
> *"Today's effort cited as an example of a superb performance wherein (aircraft) fixed six targets of vital concern to me. Well done. LGen Cushman sends."*

Accomplishments: Jan-Feb 1968

By 1 Jan 1968, the EC-47 aircraft were consistently flying more than 900 sorties each month. 33/ The ground commanders continued to take positive action in response to the ARDF results, especially as the enemy mounted the TET Offensive.

The intelligence community in RVN had been aware through ARDF and other sources that a TET attack might take place, but did not know its precise nature. On the evening of 31 January 1968, the VC and NVA made their most daring attack in the war, a massive raid against Saigon and Tan Son Nhut Air Base. From 31 January through 3 February, the 360th TEWS was able to launch only four aircraft. The remainder were grounded by battle damage. Nevertheless, these four aircraft fixed 453 enemy targets, 70 percent within 20 miles of Tan Son Nhut and Saigon. The complete record of the reaction to these fixes is not available, but it is known that, on 4 February, artillery and airstrikes hit 14 fixes. A FAC aircraft made a post-strike reconnaissance and "reported numerous enemy bodies throughout the strike zone". Similar action was taken against 33 fixes on 5 February 1968. The 199th Light Infantry Brigade enjoyed major success against the enemy on the basis of fixes reported on 4 February and used as the basis for planning, the unit's deployment on 6 February. 34/

A few days earlier, on 3 February, the EC-47 made its "most significant accomplishment...in II Corps". The Commanding General, I FFV, "personally took information" based on 20 fixes sent under FLASH precedence to his headquarters, to Ban Me Thuot, to redeploy his forces successfully against the enemy. 35/

In another area, at Nha Trang, during the TET Offensive, the 361st TEWS flew eight "base support" missions and supplied 40 fixes to be hit by air and naval fire. On 31 January, a 361st TEWS crew produced 11 fixes, which established that the enemy was closer to Nha Trang than other intelligence

had indicated. The Assistant Chief of Staff, G-2 I Field Force, commented:[36]

> *"There is no question but that this added support in the Nha Trang area contributed to the ultimate local military and political victory."*

In the Delta area, the Mobile Riverine Force found itself almost completely dependent on ARDF fixes during TET, when "other sources of information became extremely limited".[37]

Other typical operations supported by ARDF, often through the TET period, are summarized below:

OPERATION CODENAME OR LOCATION	DATES	FIXES	FEEDBACK
FARGO[38]	22 Dec-20 Jan	63	Gave commander check on infiltration from Cambodia; basis for B-52 planning.
My Tho[39]	15 Jan	2	2 "immediate interest"; 64 enemy KIA; 4 captured; 28 bunkers destroyed.
ATTALA[40]	21-27 Jan	717	9 "immediate interest"; planned on basis of ARDF; 7 airstrikes; destroyed 65 bunkers.
MANCHESTER[41]	12 Jan-18 Feb	1,496	391 "immediate interest"; 4-5 rounds artillery against each one.
SAN ANGELO[42]	15 Jan-10 Feb	310	35 "immediate interest"; 103 enemy KIA.
Phuoc Vinh[43]	20-27 Feb	UNK	6 B-52 strikes.
Bien Hoa[44]	20-27 Feb	UNK	9 B-52 strikes.

[redacted]

CHAPTER VI

U.S. ARMY ARDF: PROGRAM

USA Sensor Reconnaissance

During the period of this study, U.S. Army aviation made a consistently substantial use of sensors in tactical reconnaissance in RVN. This effort is compared in total Photo, IR, SLAR, and ARDF sorties with that of the Air Force in-country record:

	ARMY	AIR FORCE
April 1966	2,080	698
April 1968	2,065	1,757

This comparison does not consider total flying hours, visual reconnaissance, or the almost exclusive Air Force effort, both in ECM/ELINT and in all categories of out-country sorties. The reason for the comparison is to highlight the size of the Army sensor effort. The tripling of the Air Force effort is largely due to the USAF ARDF sortie increase over the time period. 1/

USA ARDF: Organization

As described, the history of the early USA ARDF effort, as in the case of the Air Force, had an organizational structure which kept pace with the overall program. Initially, the 3d Radio Research Unit controlled all ARDF activities for the Army. Its successor is the 509th RRG, whose aviation is operated by a subordinate unit, 224th Aviation Battalion. The Commander of the 224th Avn Bn serves in effect as Aviation Officer for the 509th RRG. Battalion headquarters are located at Tan Son Nhut Air Base, Saigon, but its

[redacted]

activities are decentralized into five companies and four detachments distributed throughout the four Corps areas in RVN:

UNIT	LOCATION
138th Aviation Company	Da Nang
144th Aviation Company	Nha Trang
146th Aviation Company	Saigon
156th Aviation Company	Can Tho
1 Radio Research Company	Cam Ranh Bay

There are four detachments (Phu Bai, Pleiku, An Khe, and Lai Khe) providing direct support to Army divisions. 2/

Tasking of Army ARDF resources follows essentially the same process as that shown for the Air Force (Fig. 1). The ARDF Coordination Center (ACC) also tasks the 509th RRG on the basis of its weekly capability report to the ACC. A major difference is that the Army allocates some ARDF sorties by detachment aircraft to divisional commanders. 3/

To accomplish their tasks, USA ARDF aircraft log some 5,000 hours each month, with a "fragged" mission time of four hours (as compared to the Air Force time of seven hours). Army aviation operates its equipment in 31 of the 34 MACV areas in RVN. 4/

USA ARDF: Personnel and Equipment

Each aviation company has a total of 160 military personnel, including 30 officers (about one-half of the latter are warrant officers). As compared to the Air Force practice, each company has its own field maintenance capability. About 20 civilians supplement the military maintenance personnel in the individual companies. 5/

[redacted]

The ARDF crew has three members (pilot, copilot, and equipment operator), each having full security clearances for the mission. The individual crew members take a ten-day ARDF familiarization course in the U-8D aircraft at Fort Devens, Massachusetts, prior to their RVN assignment. As in the case of TEWS flying personnel, the Army pilots receive most of their training "in-theater". Each pilot requires some three to six weeks' training on combat missions to become proficient. The "typical" pilot flies four combat missions as a copilot, takes an instrument check, and then spends the remainder of his training period learning the mission. 6/

By the end of this reporting period, the 509th RRG had the following 67 assigned aircraft:

42 U-8 (SEMINOLE)
15 U-6 (BEAVER)
3 U-1 (OTTER)
2 JU-8D (Experimental)
5 P-2V (NEPTUNE)

The primary USA ARDF aircraft are the 57 U-6/U-8 mix. Each of these carries one "aural null" AN/ARD-15 position. The U-8 is a multi-engine, all-weather aircraft equipped with a Doppler. The U-6 is a single engine aircraft with no precision navigation equipment, and is suitable for only daylight "visual" ARDF. 7/

The key to USA ARDF is its AN/ARD-15 "aural null" system. Basically, this equipment is a radio receiver using an Adcock dipole antenna to determine an aural null, and thus, the direction of the enemy transmitter. Under the Adcock principle, dipole antennas on each wing of the aircraft form a loop between them when a signal is received. Whenever the aircraft

[redacted]

is heading directly toward or away from the transmitter, there is an aural null (i.e., no signal is received).

When the aural null occurs, the copilot determines the position of the aircraft through either visual means in the U-6 or the Doppler in the U-8. If he knows the position of the transmitter, he can plot a LOP. If he does not, he must wait for a second bearing to determine that direction. After the first null, the pilot sharply turns the aircraft and flies ahead long enough to obtain a spread in radio bearings. Then, the crew repeats the aural null procedure for another LOP.[8] Army personnel prefer to get three LOPs, some 45° apart, to fix the location of the transmitter.[9] This, apparently, is quite difficult, if the enemy is using a short burst technique. Estimates vary as to how long this procedure takes. TEWS personnel who work closely with USA ARDF personnel say that a three-LOP fix would take at least five minutes.[10] The Commanding Officer, 224th Avn Bn, claims it could be done at the rate of 1.3 minutes for each LOP. The fix results are passed to the Direct Support Unit through a secure radio (KY-25).[11]

USA ARDF: Capabilities and Limitations

The decentralized base system for the USA ARDF permits considerable flexibility. For example, when operating in close tactical support, their detachment personnel can closely integrate their efforts with the ground forces. Also, their operational philosophy permits an informal schedule, so that if an aircraft is unable to complete a mission due to weather, the crew can land and relaunch as soon as the weather improves to complete their mission. Finally, with centralized maintenance, the company commander has

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the advantage of full control of that situation.[12]

The effectiveness of the USA ARDF total effort appears to be at least satisfactory. The limited "feedback" on ARDF missions received by USAF personnel occasionally mentions that Army aircraft contributed to the effectiveness of an operation.[13] Army ARDF personnel believe that "95 percent of the ground commander's intelligence" is based on ARDF information. Their relationship with the individual ground commanders is supposed to be such that crews are told "if you say the enemy is out there, we will go after them".[14]

The limitations of the U-6 aircraft confine it to the Delta portion of RVN (IV Corps), where it normally works targets at 2,000 feet AGL. The U-8 aircraft, which bear the brunt of the USA ARDF load, work their targets at 3,500 to 4,500 feet AGL. Overall, the U-6/U-8 aircraft move in a more permissive environment than the EC-47. One U-6, however, was lost in action, probably the result of enemy groundfire.[15]

USAF Security Service personnel point to several disadvantages in the present "aural null" technique:[16]

- The aural null is subjective. Some operators may detect it at slightly different points.
- Extensive maneuvering and time consumed in the aural null technique seriously hamper the fixing of short burst transmissions.
- Pointing the aircraft toward the transmitter can alert the enemy and cause him to stop his transmission.
- The U-6 can operate only under VR conditions.

[redacted]

A joint test in Puerto Rico, of the relative capabilities of Army and Air Force ARDF, provided the following data:[17/]

	USAF	ARMY
· Percentage of targets fixed out of 126 available	98.4	79.3
· Accuracy against signals of 1 min duration	800 m	Unable to fix
· Accuracy 50% of the time fixes made	600 m	1,500 m
· Percentage of times fix fell within 1NM of target location	75	57

USA ARDF: Related Activities

Reportedly, the Army is conducting other activities under the general heading of ARDF.

It is using five former Navy P-2V (NEPTUNE) aircraft in a passive ECM role. The aircraft, based at Cam Ranh Bay (1st Radio Research Company), have missions in Laos, as well as in RVN. Groundfire in Laos has brought down one of these 15-man aircraft, since the activity began in July 1967.[18/]

The Army has trained VNAF crews to operate two U-6 aircraft equipped with the AN/ARD-15 in one of the MACV areas. Because the full ARDF program has a NOFORN classification, the VNAF personnel are denied a full picture of ARDF.[19/]

Finally, the Army is assisting an Australian experiment in RVN with a makeshift ARDF system in a Cessna 182. There is a plan to test the Australian equipment in an Army aircraft.[20/]

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CHAPTER VII

FUTURE OF THE ARDF PROGRAM

ARDF in the Short Term: Pending Actions

With COMUSMACV's Airborne Radio Direction Finding program continuing to expand, additional Air Force and Army mission aircraft will be deployed to RVN during the last half of 1968. In keeping with the NEW FOCUS agreement, these aircraft will permit an equal increase in coverage responsibility for each.

Ten additional EC-47 aircraft are to have more powerful engines--R-2000-4 as compared to the present R-1830. Their "third generation" special equipment, which presently is undergoing Category III tests in the United States, includes a new ARDF set (the AN/ALR-35), and a computer system to give the navigator the location of the enemy transmitter in displacement distances from the aircraft. The computer should lighten the workload of the navigator, but his judgment as to the accuracy of the computer will be a new, vital factor in mission effectiveness. 1/

Army personnel in the 224th Aviation Battalion expect the deployment of 18 U-21 (Beechcraft twin-turboprop) aircraft in October 1968. A Litton inertial navigation system and the planned addition of the AN/ALR-35 to the 18 U-21 aircraft, should give USA ARDF a qualitative boost. A proposal within the 509th RRG, to organize a second aviation battalion after the new aircraft arrive, may become a reality. 2/

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ARDF: Immediate Lessons

Two USAF general officers have suggested some immediate lessons from their experiences with the ARDF program.

The former Commander of the 460th TRW, Brig. Gen. Robert J. Holbury, has suggested that ARDF data might be used as inputs for armed FAC and fighter reconnaissance. This suggestion has a deeper significance than might be thought at first, because it depends on a fundamental point: the control of intelligence exploitation. As already noted, the Air Force collects intelligence data, including ARDF, for the Army which controls its analysis and exploitation through its 509th RRG and related activities leading to MACV itself. This control in turn is the key to levying requirements on the tactical air forces, ARC LIGHT operations, and (if General Holbury's suggestion were adopted) on the armed reconnaissance forces.

In reviewing the fundamental question of control, the present 7AF, DCS/Intelligence, Brig. Gen. George J. Keegan, has pointed out advantages to be accrued, if the Air Force had an intelligence analysis and exploitation capability. Certain immediate Air Force interests would be served, such as improved protection of air bases and their lines of communication. With such a capability, the Air Force could make a greater contribution to the total war effort.

General Keegan cites the successful defense of Khe Sanh, in early 1968, as evidence for benefits achieved in the total war effort, when the Air Force briefly had an intelligence analysis and exploitation capability. After 21 January 1968, when COMUSMACV had greatly increased General Momyer's

responsibility for the defense of Khe Sanh, General Keegan formed an "ad-hoc" intelligence exploitation effort. To do so, he temporarily had to cut into regular 7AF intelligence activities by drawing personnel from those areas. In time, some 65 personnel from worldwide resources augmented the intelligence exploitation team. Its efforts led to the development of some 2,000 targets, whose successful attack by air was in his view the key to the Khe Sanh success. The ad hoc effort was demobilized, but not before it also had developed 170 targets around Camp Carroll, near Khe Sanh, whose identification and attack were indispensable to its successful defense.

ARDF: Future Equipment

Planning to improve the Air Force Airborne Radio Direction Finding capability is underway. On 7 August 1967, Hq PACAF submitted a Required Operational Capability (ROC) request entitled "Follow-on Airborne Radio Direction Finding Capability". The author of the ROC recognized the EC-47 ARDF system "was assembled and deployed on a crash basis, as a near-time response to a Southeast Asia Operational Requirement (SEAOR)". The EC-47 lacked "adequate serviceability, endurance, precision navigation, and growth potential" and "was not designed for crew comfort". The special equipment in the aircraft lacked "a capability for automatic target fixing", was "not optimized for handling RF emissions having other than vertical polarization", and did not have "a means for data transmission via high speed, secure digital data lines". Other system deficiencies were the absence of "capability for radio fingerprinting" to pinpoint specific transmitters; "the direction finding system itself must be operated at low altitudes at a short

stand-off range".[5]

The forthcoming "third generation" of ARDF, with its AN/ALR-35 and computer, will correct some of the deficiencies listed in the ROC. The author of the ROC, however, envisaged something more than short-term advances. He advocated "a follow-on tactical ARDF system, with a jamming capability, to be employed through the 1970-1985 time frame", which would have a 3,000-mile range, speed up to 350 knots, and the ability "to loiter" for up to eight-hour periods. A force of such new aircraft would be organized under Tactical Air Command, with an organic "total mission capability".[6] At the end of this reporting period (and during the first quarter, FY 1969), no substantive action had been taken on the total ROC.[7]

ARDF: Doctrinal Lessons

Planners in all aspects of Air Force activities might profitably consider the facts and implications to be derived from a study of USAF and USA ARDF experience in SEA. Although facts about the Army's experience are not easily obtained, their relevance toward improvement of Air Force support of ground commanders makes a continuing effort to learn them worthwhile.

The present statement of basic Air Force doctrine (AFM 1-1, August 1964) does not address either the question of a permissive environment in warfare, or the question of tactical air reconnaissance as an Air Force mission.[8] The planners for the next revision of AFM 1-1 might look at these questions in the light of the ARDF program.

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Two USAF general officers have made especially pertinent remarks about the war in SEA, which doctrinal planners might consider. As former Deputy Commander of 2d Air Division, Maj. Gen. Gilbert Meyers, pointed out in his End of Tour report:[9/]

> *"The experience the Air Force has been afforded by the war in Vietnam should be of inestimable value if we capitalize on the lessons learned. First and foremost, we must relate those lessons to the environment under which they occurred. Many false conclusions can be reached on future capabilities, if we fail to appreciate and understand the many peculiarities associated with this war."*

A comment by the Chief of Staff, Gen. John P. McConnell, also seems as pertinent in the case of ARDF, as it was to an earlier discussion in late 1964, about the wisdom of using the FC-47 (now AC-47) as an offensive weapon. The late Gen. Walter Sweeney, then Commander of Tactical Air Command, opposed the concept of the FC-47 because it violated Air Force doctrine, and it gave the Army an opening to use helicopters in an offensive role. Looking to the future, General Sweeney warned:[10/]

> *"The end result (of using the C-47 in this role) could be an entirely new concept for utilization of cargo-type aircraft which might be disastrous in some future conflict."*

General McConnell overruled the objections and added the comment, which could be applied to the EC-47, and considered by those formulating future Air Force doctrine:[11/]

> *"...it certainly is in the Air Force interest to run the program rather than to sit on the sideline commenting."*

[redacted]

With the admonitions of Generals McConnell and Meyer in mind, doctrinal planners might then wish to consider the basic issue raised by General Keegan in his "on the scene" comments. Has the Air Force's traditional focus on the flying operations in which it excels led it to emphasize only the collection aspects of the roles-and-missions problem? Would Air Force emphasis on intelligence exploitation and analysis, as well, lead to a greater voice in the command and control, planning and execution of joint or unified operations?

The experience of Army ARDF may have material of interest. The alleged effectiveness of its centralized organization and maintenance; its decentralized support of the ground commanders; its heavy use of warrant officer pilots; and its relatively informal operational philosophy offer material for study by Air Force planners. Above all, the expanding role of Army aviation in tactical reconnaissance is a subject for study by the entire Air Force community.

Air Force operations, maintenance, logistics, personnel, and manpower planners might also find material for their areas of interest in the Airborne Radio Direction Finding operation. Among the important facets of the USAF ARDF program are:

- Demonstrated ability of the Air Force to establish a prototype operation on a crash basis in a combat theater.
- The organizational question of splitting responsibilities in an airborne intelligence activity between the "operators" and "collectors".

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- The long-standing problem of centralized versus decentralized maintenance.

- The advisability of clearing only certain members of a crew for the entire mission.

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GLOSSARY

ACC	ARDF Coordination Center
AGL	Above Ground Level
ARDF	Airborne Radio Direction Finding
CHECO	Contemporary Historical Evaluation of Combat Operations
CINCPAC	Commander in Chief, Pacific
COMUSMACV	Commander, U.S. Military Assistance Command, Vietnam
DMZ	Demilitarized Zone
DSU	Direct Support Unit
ECM	Electronic Countermeasures
FAC	Forward Air Controller
FEB	Flying Evaluation Board
FFV	Field Force, Vietnam
FOB	Forward Operating Base
FW	Free World
H&I	Harassment and Interdiction
IR	Infrared
KIA	Killed in Action
km	kilometer
LOP	Line of Position
MACV	Military Assistance Command, Vietnam
NORS	Aircraft Not Operationally Ready - Supply
NSA	National Security Agency
NVA	North Vietnamese Army
PACOM	Pacific Command
PAD	Phase Angle Discrimination
RMS	Root-mean-square
ROC	Required Operational Capability
RRC	Radio Research Company
RRG	Radio Research Group
RVN	Republic of Vietnam

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SAC	Strategic Air Command
SEA	Southeast Asia
SEAOR	Southeast Asia Operational Requirement
SLAR	Side Looking Airborne Radar
SS	Security Squadron
SSIR	Special Security Investigations Required
TEWS	Tactical Electronic Warfare Squadron
TRW	Tactical Reconnaissance Wing
VC	Viet Cong
VNAF	Vietnamese Air Force
WIA	Wounded in Action

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