SECRET

HISTORICAL RESUME

USAF AIRBORNE RADIO DIRECTION FINDING

ITS DEVELOPMENT AND USE

April 1962 - 31 May 1968

27 June 1968

SPECIAL HANDLING REQUIRED
NOT RELEASABLE TO
FOREIGN NATIONALS

6994TH SECURITY SQUADRON, TAN SON NHUT AIR BASE, VIETNAM

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Chapter 1

THE DEVELOPMENT OF ARDF

U.S. Army Pioneers Effort

The U.S. Army has been conducting Airborne Radio Direction Finding (ARDF) operations for an unknown period. It is known that they were operating ARDF equipped U-3 aircraft as early as 1961. This effort was referred to as "Project Wine Bottle". During 1966 they conducted experimental operations with an ARDF equipped Caribou aircraft. This aircraft, which was equipped with additional target acquisition/collection equipment, was referred to as "Project Pacesetter". The U.S. Army ARDF operations are under the control of the 509th Radio Research Group, Tan Son Nhut AB, Vietnam. Their ARDF fleet consists of 25 U-6/U-8 aircraft in February 1966. However, this number had increased to 58 by 31 May 1968.

USAF Directed to Develop ARDF System

During April 1962, General Curtis E. LeMay called for the USAF to develop an ARDF system. This desired system would be all-electronic and would give instant bearings. After all, OMNI and TACAN navigational aids gave instant bearings, and through electronic phase measuring these systems eliminated the 180 degree ambiguity inherent in the U.S. Army ARDF system (see Chapter 2). Two projects evolved from this request.

USAF's First Attempt - "Hilo Hattie"

The first USAF attempt at ARDF, designated "Project Farm Gate" and "Project Hilo Hattie", consisted of a C-54 aircraft equipped with photographic, infra-red reconnaissance and a homing type radio direction finding system. This aircraft was deployed to Tan Son Nhut AB, Vietnam during (?) 1962. The project was under the operational control of the 2nd Air Division. The ARDF activities were integrated into the 3rd

Radio Research Unit's (now 509th Radio Research Group) radio direction finding activities. The project met with little success and was subsequently abandoned. Little is known of the ARDF system employed or the ensuing results. Some items cited as major reasons for the lack of success of the endeavor were the size and maneuverability of the C-54, unspecified technical problems within the system and control problems with the U.S. Army agencies.

"Mona Hi" Becomes USAF "Project Hawkeye"

During August 1962, Project Mona Hi was transferred to the USAF and redesignated "Project Hawkeye". Sanders Associates of Nashua, New Hampshire designed and developed a prototype system and installed a "breadboard" version in a C-47 aircraft for feasibility demonstration purposes.

Hawkeye Tested in South Vietnam

The Hawkeye aircraft was deployed to Tan San Nhut AB, Vietnam during (early) 1964 to undergo testing in its intended operational environment. The project was placed under the operational control of the 2nd Air Division. Tasking was accomplished and mission results evaluated through coordination with the U.S. Army's 3rd Radio Research Unit, Tan Son Nhut AB, Vietnam. Initial testing of the system met with limited success. During July 1964, the aircraft was returned to CONUS after the aircraft navigational system failed completely.

Improved Hawkeye Returns to South Vietnam

During early 1965, emphasis was placed on getting the "Hawkeye" ARDF system operational by the Military Assistance Command, Vietnam (MACV) increasing demands for more and better ARDF support of the Vietnam conflict. The system had been undergoing continued design/capability

improvements since its return from South Vietnam. I t was operationally tested in Florida during June 1965 and plans called for its immediate deployment to South Vietnam. However, extended testing at the Florida test site forestalled its intended deployment until December 1965. This deployment was originally intended to be a 120 day test operation. However, it met with such success that the 7th Air Force (formerly the 2nd Air Division) and MACV retained the aircraft in-country until the "Phyllis Ann" aircraft (which were being developed after early results from "Hawkeye" proved the system capable) started arriving. The first "Phyllis Ann" aircraft arrived in-country on 26 May 1966. The Hawkeye aircraft flew its last operational mission on 9 July 1966. The equipment was subsequently removed from the airframe and the aircraft returned to CONUS for installation of the much improved "Phyllis Ann" ARDF system. It rejoined the USAF ARDF fleet in South Vietnam on 6 March 1967.

"Project Phyllis Ann" Evolves

Two factors actually caused the culmination of the USAF ARDF project. The first, and most important, was the obvious superiority of the USAF ARDF system (A N/ALR-34, formerly AN/ARD-18) over the U.S. Army's AN/ARD-15 system. The second factor was that when the Department of Defense presented a MACV requirement for increased ARDF resources during 1965, the U.S. Army could not meet the requirement without a significant increase in funding. Since the USAF had the aircraft in inventory the cost of increasing the ARDF resources was reduced significantly by giving the responsibility to the USAF. The USAF did not, however, receive the entire commitment; the U.S. Army was directed to increase its ARDF fleet from 25 to 57 aircraft during the time frame allocated to the USAF to develop its ARDF fleet (April - November 1966). The USAF was initially

programmed to meet a requirement for 35 ARDF aircraft. This was later increased to 47 (plus six not operationally assigned "NOA" aircraft.) This joint force was to provide the capability for 16 hour per-day ARDF coverage for all of South Vietnam and the Laotian panhandle. The USAF portion of the expanded ARDF program was designated "Project Phyllis Ann". During April 1967, it was redesignated "Compass Dart", and in April 1968 as "Combat Cougar".

Units Designated and Organized to House Phyllis Ann

USAFSS

The USAF Security Service designated and organized the 6994th Security Squadron at Tan Son Nhut AB, Vietnam to accomplish the USAFSS portion of the ARDF program. The unit was activated 15 April 1966. Two detachments of the squadron, Detachment 1, Nha Trang AB, Vietnam, and Detachment 2, Pleiku AB, Vietnam were activated on 1 July 1966 and 1 October 1966, respectively.

USAF

Simultaneously with the activation of the USAFSS units, three Tactical Electronic Warfare Squadrons (TEWS) were designated and organized by the USAF. These squadrons were collocated with the USAFSS units and were subordinate to the 460th Tactical Reconnaissance Wing, Tan Son Nhut AB, Vietnam. The 360th TEWS was at Tan Son Nhut AB, the 361st TEWS at Nha Trang AB, and the 362nd TEWS at Pleiku AB, Vietnam.

Chapter 2

SYSTEM DESIGN AND CAPABILITY

U.S. Army and USAF Systems Differ

Considerable differences exists in the design, capability and operational techniques of the two ARDF systems in use in South Vietnam. The U.S. Army system, designated AN/ARD-15, employs an "Aural Null" technique and the USAF system, designated the AN/ALR-34, (formerly AN/ARD-18), employs a "Phase Measure" technique to determine the line of position (LOP) of a target.

U.S. Army (AN/ARD-15) System

The AN/ARD-15 "Aural Null" ARDF system is basically a radio receiver which employs the aural null characteristic of an Adcock type antenna to determine the direction from which a radio signal is emanating. The Adcock effect is created by dipole antennas installed on each wing of the aircraft. When a radio signal is picked up on the antenna, a loop is formed between them. Therefore, when the aircraft is positioned directly toward or away from the signal source (transmitter) an aural null occurs in the incoming signal. To obtain an LOP, it is necessary for the pilot to monitor the target signal and maneuver the aircraft until this null occurs. At that point the transmitter is located either directly ahead or behind the aircraft. The exact position of the aircraft must then be manually computed and the LOP plotted.

U.S. Army Aircraft Configuration

The AN/ARD-15 system is installed in comparatively small U-6 (single engine) and U-8 (twin engine) aircraft. The basic [illegible] of the aircraft consists of only a target search/acquisition position and air/ground communications equipment (including secure voice).

U.S. Army Aircraft Navigational System

With the exception of three doppler [sic] equipped U-8's, the Army aircraft contain no special navigational equipment. The position of the aircraft must be determined by visual references to known ground points. The navigational duties are performed by the co-pilot.

U.S. Army Fix Technique

When a target signal is acquired by the ARDF operator, the pilot monitors the signal and maneuvers the aircraft until the aural null occurs. At this time the co-pilot will determine and plot the position of the aircraft. (At this point the target could be located in either of two directions.) The aircraft then turns abruptly at a right angle to the LOP and flies for several minutes. The signal is then nulled, as before, and another LOP is obtained. A minimum of three LOP's must be obtained to establish (fix) a target's location. A spread of 30 degrees is desired between each LOP or a minimum spread of 30 degrees between all LOP's utilized to compute the fix.

U.S. Army System Has Disadvantages

Several disadvantages are inherent in the AN/ARD-15 system.

1. The aural null is quite subjective, since some operators may detect the null at slightly different points.

2. Visually and manually establishing the location of the aircraft is slow and generally less accurate than the Doppler method.

3. Considerable time is involved in executing the [necessary?] air maneuvers required to position the aircraft into or away from the signal source.

4. Extensive stress is placed on both the aircraft and crew in executing the "High G" turns while working a target.

5. The maneuvers of the aircraft often alert the target to the fact that activity is directed toward it.

6. The system is suited for daytime VFR conditions, only.

USAF (AN/ALR-34) System

The AN/ALR-34 is an all electronic Airborne Radio Direction [Finding] unit that employs a "phase measure" technique to determine the direction from which a radio signal is emanating in relation to the heading of the aircraft. The system has the capability to determine the direction of the signal source regardless of its point of arrival at the aircraft. The unit is part of a system in stalled in EC-47 type aircraft that are equipped for day/night, all-weather operation.

Basically, the AN/AL-34 couples three antennas to a phase angle discriminator. Through computing the time of arrival of the target signal at the antenna located on the aircraft wing and nose, the system (through a complex trigonometric process) establishes the direction of the source of the signal. This information plus the aircraft position data from the Doppler and the heading from the C-12 compass is combined to produce the line of position of the target and the aircraft position. This information is presented, on demand from the operator, on a paper tape. The tape also contains a [illegible] of the strength of the target signal. The time lapse for obtaining a print-out on a signal is less than one second after the operator has successfully "locked on" a target.

USAF ARDF Aircraft Configuration

The basic configuration of the ARDF equipped EC-47 consists of the ALR-34 console (commonly referred to as "X"), a target search/acquisition console (commonly referred to as "Y") and a navigator's position which

consists of the printer, the driftmeter and all other associated navigational equipment (see chart).

The aircraft is equipped with a KY-8 secure voice air/ground, air/air communications equipment to support the ARDF mission.

The basic ARDF equipped EC-47 has been modified to include the installation of two additional search/acquisition positions commonly referred to as "Z") on some aircraft. Also, the inventory includes six aircraft* that are equipped with the basic AN/ALR-34 system and two communications jamming positions (commonly referred to as "Q"). (see chart.)ǂ

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* Only 5 aircraft were actually converted. See EC-47 serial number list elsewhere on the site.

ǂ No chart was found in the AFHRA archives.

Note: Chapters 3 and 4 were missing from the document when copied at AFHRA.

Chapter 5

COMMAND, CONTROL AND [TASKING ?]

Control

A controversy has existed over who should exercise ultimate control over the USAF ARDF platforms since the USAF entered the program. The USAF position was that the total ARDF role was an Air Force mission and, therefore, full operational control should be exercised by the USAF. Certain cryptologic agencies felt that they should control the ARDF mission regardless of who flew the aircraft or how the collection data was used. JCS supported the USAF position, the Army did not. The USAF position was enhanced by the fact that during early 1966 the USAF Security Service (USAFSS) was given the Electromagnetic Warfare (EW) mission. ARDF clearly falls within the difines [sic] of this mission, which states in part:

> "... To support the development, planning and conduct of electronic warfare operations, and to operate specified intelligence collection systems as directed by the Chief of Staff, USAF."

This controversy still exists. However, it has had little or no effect on the actual deployment of USAF ARDF aircraft, due largely to the control and tasking procedures established by MACV.

Command

MACV Concept Outlined

On 12 April 1966, MACV published a concept of operations for control of ARDF resources. This directive, which outlined the responsibilities of the two services concerned, placed command of the U.S. Army resources with the Commanding Officer, 509th Radio Research Group and the command of the USAF resources with the Commander, 7th Air Force.

Although operational control of the USAF and USA resources was exercised by the respective commanders, the composite fleet was used in response to MACV requirements.

The Commander, 7th Air Force designated the Commander, 6994th Security Squadron as his executive agent for operational control of the USAFSS operation of the aircraft, and the Tactical Electronic Warfare Squadrons as executive agent for operational control of the "front end" crews.

MACV Delineates Responsibilities

Responsibilities were delegated to the various activities involved in the ARDF effort as follows:

1. MACV-J2 was responsible for:

a. Acting for MACV as the intelligence requirements control authority.

b. Designating consumers for ARDF results.

c. Establishing procedures for supported commands to submit requirements for ARDF support.

d. Establishing procedures for allocating resources to meet commitments for ARDF support.

e. Disseminating ARDF results to supported commands.

2. The two commanders involved - - 7th Air Force (with 6994th Security Squadron as agent) and the 509th Radio Research Group - - were responsible for:

a. Planning and coordinating a program for the ARDF effort.

b. Reporting ARDF results to the consumers assigned by MACV-J2.

c. Disseminating results and technical feedback [?]

d. Establishing and maintaining close liaison with each other in planning and employing ARDF resources.

3. The U.S. Army commander had the additional responsibility for:

a. Insuring appropriate cryptologic tasking in support of technical requirements.

b. Providing technical support for the ARDF resources.

MACV Establishes Tasking Procedures

In conjunction with the delegating of responsibilities, MACV established the procedures to accomplish the necessary tasks. The activities involved and their tasks were:

1. MACV-J2

a. Receive, validate, and approve requirements submitted by the various elements engaged in the war effort. The validation and approval was to be accomplished by a coordinating committee composed of representatives of NRV, MACV, 7th Air Force, the 6994th Security Squadron and the 509th Radio Research Group.

b. Issue the approved requirements to the Army and Air Force ARDF elements.

c. Establish a list of requirements in order of priority.

d. Indicate specific pre-emptive requirements by designating specific targets or areas of interest in support of current operations.

e. Issue specific instructions on handling reports. (Subordinate units would be required to submit requests for support through channels for validation and levy at least 72 hours prior to the anticipated requirement.)

2. 7th Air Force (6994th Security Squadron)

a. Forward results of Air Force missions to the 509th RRG for analysis and reporting to MACV-J2.

b. Provide ARDF reports to local tactical commanders during close support operations.

c. Report any visual sightings of targets of opportunity to local tactical commanders.

3. 509th RRG

a. Analyze and forward ARDF mission results to MACV-J2.

b. Provide MACV J-2 with a daily activity report to include the following day's planned activity.

c. Provide reports on results of ARDF missions.

d. Provide indicative reports to local tactical commanders during the close support operations.

This concept was given final approval by JCS with only minor changes.

ARDF Management/Coordinating Group [illegible]

The MACV concept of operations placed certain [illegible] responsibilities with the Commander, 6994th Security Squadron and the Commander, 509th Radio Research Group that were to be accomplished as a joint effort. The units subsequently formed a joint operations center to accomplish these responsibilities. The unit was initially formed on 1 July 1966. However, it was not approved by MACV until October 1966. The unit was initially designated the Joint Platform Management Group, but was later redesignated the ARDF Coordination Center (ACC). The mission of the ACC ultimately became:

"to provide for the coordinated management of the ARDF program in South Vietnam and other areas as directed by the Commander, USMACV."

To accomplish this mission, the ACC promulgated and issued directives that governed all phases of the ARDF operation that included both services and were suited for coordination.

The ACC was manned jointly by the two services. The command duties were shared by an Officer-in-Charge from both services.

Tasking

The procedures for tasking the ARDF aircraft were: The requirements for ARDF support are submitted to MACV by the various field commanders. Each Tuesday MACV-J2 consolidates the requests, assigns the priorities to the tasks and allocates sorties (by service) to satisfy the requirement. (MACV-J2 specifies the area, by coordinates, in which the sorties are allocated.) Each Wednesday a delegation consisting of representatives from the 6994th Security Squadron; 460th TRW; 509th RRG; [illegible]; 7th AF and [illegible] MACV J-2 to discuss and finalize the tasking. The [illegible] approved and forwarded to the ACC. The ACC develops the [tasking?] into specific tasking for each service (see below.) A less highly classified [one character blank space in original] is also prepared for forwarding to 7th AF [illegible] for developing the USAF frag schedule. (See chart for graphic display of tasking cycle.)

ACC Role in Tasking

The ACC Received general tasking from MACV-J2 (see tasking) and translated it into specific ARDF tasking. The MACV tasking was, in actuality, an outline of ARDF requirements that was formulated based on

the consumers requirements and the ARDF resources available. The ACC was responsible for insuring that the resources were utilized to the maximum effectiveness in fulfilling these requirements. To achieve this they:

a. Established specific time over target.

b. Selected specific targets for designated priority [targets ?]

c. Arranged for proper distribution of technical data.

d. Monitored and managed the distribution of encryption pads to the subscribers of the ARDF air/ground communication nets.

e. Distributed specific tasking to the U.S. Army aviation units and the 7th Air Force.

Chapter 6

ARDF SUPPORT OF TACTICAL OPERATIONS

General Use of ARDF

ARDF results are passed from the aircraft to Direct Support Units (DSU's). These DSU's are located near the combat elements and are in direct contact with the tactical commanders. When the DSU receives the information from the aircraft, it is passed immediately to the tactical commanders. The tactical commanders react to the information differently, depending on the known significance of the target, the immediate tactical situation and the proximity of the targets to friendly military forces.

Some commanders have ordered that a minimum of three rounds of heavy artillery be placed on each location. If the target is of known tactical significance, the commander may order an immediate tactical air strike against the location. It is also common practice to direct a forward air controller (FAC) into the area for reconnaissance purposes.

Information provided by the 3rd Marine Amphibious Force credited ARDF data with providing the basis for targeting numerous B-52 strikes in the DMZ area. In fact, 50 percent of the total B-52 strikes executed are purported to be targeted through ARDF data.

ARDF support is provided for all major operations. This close tactical support (CTS) is largely incidental since ARDF operations are conducted in daily in most [illegible.] When no major operations are being conducted in [illegible] ARDF flights are referred to as continuity and development (C&D) flights.

In some cases a study of ARDF fixes obtained in a given area has been the basis for conducting an operation. The planned area of operations has

often been altered during the operation based on ARDF information. Tactical commanders rely heavily on ARDF data for planning troop maneuvers and fire support. Also, it is possible, to a large degree, for the commanders to measure the effectiveness of their actions through ARDF.

Effectiveness

The following chronological brief represents some applications of ARDF to combat activities and the comments from the consumers relating o its effectiveness.

2 September 1966. The Commanding General, 1st Cavalry Division (Airmobile) cited 7th Air Force activities for their outstanding air support to tactical forces during Operation Paul Revere. Although ARDF was not specifically cited, it played a highly significant role in the operation.

29 September 1966. Major General Grover C. Brown, Director Intelligence, PACAF interrupted a briefing being presented [to] Admiral Sharp and staff concerning the nature of enemy forces in the DMZ and to laud ARDF. General Brown stated:

> "Without COMINT and the attendant ARDF support, we would be completely in the dark about the enemy situation in the DMZ."

31 October 1966. A message from the 1st Infantry Division stated, in part:

> "On 26 October the 1st Infantry Division sent two battalions into the Cam Me Jungle, vicinity [partly illegible; believed to be WV6655], 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."

13 November 1966. A message from the 1st Infantry Division in reference to a fix, of unknown significance, obtained by a Phyllis Ann aircraft stated, in part:

> "Fix was received directly from the aircraft at 0917Z and passed to the 1st Infantry Division G2 at 0925Z. The G-2 immediately ordered 200-300 rounds of 155mm artillery on the fix location."
>
> "The above incident is representative of the importance and reliance that the 1st Infantry Division places on COMINT material."

21 November 1966. A message from a U.S. Army 3rd Support Platoon in reference by a Phyllis Ann aircraft stated, in part:

> "Reference message received 21/0136Z and fix passed immediately to Regt S-2. Forward Air Controller 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 gun ships sent to area due to approach of 11th Calvary [sic] convoy along route 1. As convoy reached area of fix location, helicopters began recon by fire. Fire was returned and fire-fight began ---- Important point, this ARDF prevented serious ambush for which supported command is indebted to the COMINT community."

Note: All but a few words of the next paragraph are too indistinct to read. The gist of the quotations seems to be that ARDF was used to develop a preemptive "fire plan" which saved " . . . base from a possible mortar attack."

At this point an uneven line appears in the original, approximately as shown above. It not clear that it indicates the end of the paper; indeed its appearance may not have been intentional. The remainder of the document consists of various feedback reports on ARDF results. These may be viewed as separate files.