UNITED STATES ARMY
AIRBORNE RADIO DIRECTION FINDING
OPERATIONS

BACKGROUND[1]

Following World War II, little was done in the Army's airborne signal intelligence arena. Through the 1950s, ASA operators flew electronic reconnaissance missions in Navy EA-3B Sky Warriors. In the early 1960s, ASA crews again flew on board the EA-3Bs within a project called FARM TEAM. It was at this point that the Army had made a decision to invest both manpower and funds in order to have its own ability to expand its intelligence coverage of enemy forces within a theatre of operations which appeared to be increasing in both size and complexity.

The early days of Vietnam truly marked the beginnings of Army airborne signals intelligence. The Army's U-6 Beaver was one of the first platforms converted from a utility mission to take on intelligence collection efforts from the air. As a result, it was officially redesignated as the RU-6. This, in effect, initiated the process wherein most of the remaining Army aircraft which eventually became incorporated within this emerging fleet of signals intelligence platforms, were also redesignated with a reconnaissance or "R" prefix designator.

The RU-6A aircraft was a relatively simple and basis platform equipped with on-board mission receiver equipment for homing in on signals emitted by enemy forces. The data returned were only as accurate as the pilots' navigational skills. With no doppler/inertial navigation system (INS) or global positioning system, the pilots relied on landmarks and dead reckoning to determine their known location from which to calculate the intercepts.

One veteran recalls his early days in Vietnam flying in a Caribou with an experimental system. The operators hung a long wire out the back of the aircraft for a crude direction finding antenna. Crews flew in hot, humid conditions in very loud aircraft. Missions were often four hours long, but could be longer depending on the operational tempo of the forces in contact. It has been said that air missions produced as much as one third of the intelligence known to ground forces.

The single-engine companion Army platform, the RU-1 Otter, was similarly configured with personnel and equipment, but it was an expanded platform. But it wasn't until the introduction of the Army's RU-8D Seminole that a significant advance was made in the SEMA fleet and in the contribution these intelligence platforms were providing the theatre tactical commanders. In addition to having on-board mission equipment similar to that found initially on both the RU-6A and the RU-1A, the RU-8D aircraft were equipped with the Marconi doppler navigation system. This required the co-pilot to manually plot the ARDF fixes (locations) to large pads of graph paper on his lap. (Masking tape was applied to the

[1] Extract from : http://www.nsa.gov/about/cryptologic_heritage/vigilance_park/origins_of_asa.shtml

aircraft doors to prevent the plotting sheets from being sucked out of the aircraft.) Also, the RU-8Ds were equipped with blade antennas in the wings, which gave them the capability to home in on a transmitter and fly a standard flight pattern to achieve the geometry necessary to obtain several lines of bearing (LOB).

Although overflight of the actual target sometimes occurred, the procedure for flying the pattern for triangulating the target tried to prevent overflight whenever possible. Additionally, some of the aircraft were configured with radio fingerprinting to further enhance signal identification. The mission gear on board these RU-8D aircraft were known by the nicknames WINEBOTTLE, CEFISH PERSON, and CHECKMATE. These aircraft, with the on-board systems and crews, truly became the new workhorse of the Army's SEMA fleet primarily due to a combination of the improved mission gear and a newly introduced multi-engine capability, each contributing to expanding and improving the unit's mission coverage in several dimensions.

In 1968, a project known as LAFFIN EAGLE entered service with the Army and within Vietnam. It used the Army RU-21 aircraft with additionally improved mission gear to include an automated direction finding capability as a result of the use of an on-board inertial navigation system.

With the follow-on introduction of three JU-21 LEFT JAB into Vietnam, the Army now had the first airborne collection system to give 360-degree direction finding coverage. It was also the first system to use a digital computer to store calibration tables for the DF system and to calculate emitter locations from the LOBs generated by the "Spaced Loop" DF antenna and aircraft position data furnished by the on-board INS. In essence, what the RU-6A, the RU-1A, and, most importantly, the RU-8D had provided and accomplished as the Army's initial trio of signals intelligence platforms was now resident in the proliferating fleet of RU-21s in both Vietnam and CONUS.

Finally, a truly special unit was formed and deployed to Vietnam using Army pilots, Army ASA mission operators on board a Navy P-2V Neptune four-engine aircraft. This Army project was a significant leap in both mission coverage and overall mission capability. As with most of the other platforms, these aircraft were redesignated specifically as RP-2E aircraft with an associated mission project name of CEFLIEN LION or CRAZY CAT.

The remaining platforms which also contributed to the Army's airborne signal intelligence capability were six specially configured UH-1 helicopters. These aircraft were redesignated as EH-1 LEFT BANK aircraft and were assigned directly to the tactical war-fighting divisions in Vietnam. These LEFT BANK assets were manned and maintained by ASA operators, also found with the same divisions. Their flight profiles included both high- and extremely low-altitude operating envelopes necessary to locate and target tactically oriented enemy threats of immediate and times-sensitive value.

Often, the ultimate customers for the information did not understand the capabilities of the systems. They expected to be able to go to a given location and find the enemy at that location speaking on the radio. There were some constraints with the systems, in that the

location of the target could be depicted as an elliptical core - not a pinpoint target. Therefore, the emitter was not always exactly where the report indicated.

AIRCRAFT

The US Army Airborne Radio Direction Finding (ARDF) operations and aircraft were situated at all of the major airfields in SVN. They flew a variety of aircraft:

De Havilland UA-1 Otter

De Havilland UA-6 Beaver

De Havilland "Beaver[2]

> *The brown, high-winged, tail-dragging airplane that would fly the mission was a De Havilland "Beaver," what the Army then called the L-20 and later designated the U-6A. This was a venerable bird. It had been serving the Army for nearly 20 years by that time. There was nothing fast or fancy about it, but it was reliable. A big radial engine with a two bladed prop would pull it along at 160 mph, top speed in a crisis.*

[2] Extract from: http://www.asalives.org/ASAONLINE/uwarriors.htm

The fat fuselage was shaded by a thick, wide wing, and the wing tips were pierced by vertical rods. These were the directional antennae that would give the intelligence analyst aboard the azimuth to any radio transmitter his receiver could pick up.

In the cargo space, bent over a steel desk backed by an instrument panel, and virtually surrounded by grey steel cabinets, was a soldier wearing earphones, testing his equipment and going over the collection plan for the day. The pilot settled into his seat and began his pre-flight routine. He fastened a map and the collection plan to a clipboard mounted above instruments in front of him, shouted "clear"—to no one in particular—out the window, and turned the switch.

The pilot kept a constant check on his position by reference to the map in front and the ground below. Abruptly, he kicked the right rudder and the plane swung around to the north like a weathervane in a strong gust. The soldier-technician had picked up one of the wanted call-signs and the pilot had turned the airplane's nose around until the instruments told them that he was flying directly toward the transmitter. Checking his position with reference to the terrain below, he marked a dot on the map, noted the airplane's heading with a glance at the compass and, with a protractor, drew the azimuth to the transmitter. He worked fast, flying the Beaver with his feet.

That accomplished, the next task was to fly as fast as the old bird would take him to another part of the sky to get another bearing before the transmitter fell silent. With the throttle to the firewall, he banked in a tight turn and headed southeast. They were lucky that morning, for this transmitter had a long message to send. Through the combined skills of the pilot and the technician, they managed three bearings. Where the bearings intersected was a "fix' the location of an enemy transmitter belonging to a known enemy unit.

Unfortunately, the equipment then in the hands of the RRU denied them the capability to "fix" with precision. Error was built into the system and the size of the error depended on the relative skills and experience of the pilots, operators and analysts, and the accuracy to which the equipment was calibrated. Nevertheless, correlated with intelligence gained from prisoners-of-war, captured documents, and agents, ARDF intelligence became the best means for following enemy movement. From his movements, intelligence officers and commanders could estimate the enemy's intentions and plan fire and manoeuvres against him with telling effect.

Beachcraft Seminole RU-8
(early model)

Beachcraft Seminole RU-8
(later model)

Beachcraft Seminole RU-8
In Flight

Beachcraft Kingair RU-21
Post 1969

All of the US Army ARDF were very distinguishable due to the array of antennas on the aircraft.

US ARMY ARDF PROCEDURE

Crew

The crew of each aircraft consisted of a command pilot, a co-pilot and an ARDF operator in the rear compartment

Pre Mission Brief

Before flying a mission the crew were issued with a 'Frag Point'[3], a target list that contained target identities, schedule times, frequencies, callsigns, last location (if known) and the relevant Direct Support Unit (DSU)[4] contact frequencies.

Aircraft Operation

Most of the US Army ARDF aircraft would normally fly between 2000 and 5000 feet above ground level and for best results operate approximately three to ten kilometres from a target. Depending on the type of aircraft, a mission would last approximately three hours.

DF Operation

During a mission the following procedures were taken:

- **Arrival at Target Area**. When the aircraft arrived in the specified area, the ARDF operator would immediately commence searching for targets and make contact with the DSU.
- **Acquisition of a Target**. When the operator acquired a target, he patched the audio from the DF receiver to the pilot's headphones.

- **Rotation of Aircraft**. When the pilot heard the signal in his headphones, he turned the aircraft towards the suspected location of the transmitter until such time as he received an audio null in his headphones.

- **Confirmation of Signal.** After getting the first null, the pilot put the aircraft into a flat left-right-left "skid" to confirm the null. When the null was confirmed, the pilot would call "Mark".

- **Aircraft Position**. When the co-pilot heard 'mark' he would note the aircraft heading and Doppler[5] reading and record both on a plotting chart.

[3] **Frag Point** in ARDF context is the central location of where an aircraft is to operate
[4] **Direct Support Unit (DSU**). The term DSU was given to the Sigint unit that was on the ground in the aircraft's tasking area. The DSU passed additional technical information up to the aircraft when required and received all Fix reports from the aircraft for action and on-forwarding.
[5] **Doppler**.(*navigation*) Dead reckoning performed automatically by a device which gives a continuous indication of position by integrating the speed and the crab angle of the aircraft as derived from measurement of the Doppler effect of echoes from directed beams of radiant energy transmitted from the craft.

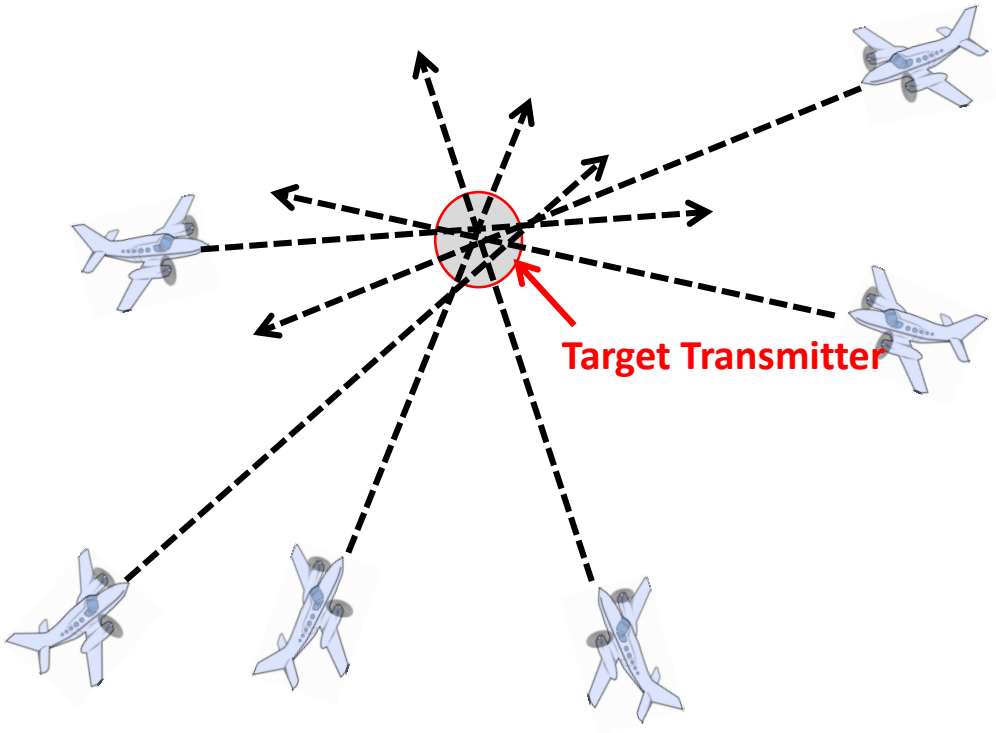
- **LOB.** The plot would show a LOB from the aircraft.

- **Additional LOBs.** After the co-pilot has computed the first LOB**,** the pilot would then turn at right angles to the target, fly for an unspecified period, then repeat the exercise. Normally, about six LOBs would be taken on each target. The number of LOBs taken would depend on how long the target was active.

- **FIX.** When the co-pilot plotted all the LOBs he would be able to determine a Fix with a circular area of probability (accuracy)[6].

- **Reporting.** The result would be transmitted to the DSU via one time pad and later secure radio.

Example of a US Army ARDF Plot



US ARMY FIX

[6] **CEP**. A Circular error of probability is an intuitive measure of a system's precision. In DF terms it is the approximate average distance between a centre point and the intersecting lines (LOBs).

Target Activity

The VC/NVA were well aware that the US Army flew ARDF aircraft and over time became used to the noise of the ARDF aircraft as they seemed to always appear when they were transmitting. As a consequence, whenever they heard the aircraft, they would stop transmitting. To keep the target transmitting the aircraft would normally attempt to stand off at greater distances from the target. This in turn increased the circle of error.

547 Sig Tp Support

Throughout its deployment, 547 Sig Tp was supported by the 146th Aviation Company.

Originally the Company was located at Tan Son Nhut Airport, Saigon, and later moved to Long Than just to the north of Phuoc Tuy Province.

A close relationship was established between the 146th and the Troop, and this continued throughout the deployment.