UNCLASSIFIED

History of
the Warner Robins Air Materiel Area
1 July 1970 – 30 June 1971

Part III: WRAMA's Role in Southeast Asia

EC-47 Aircraft, 1962-1970
A Summary of the Modifications

Historical Study No. 24

by

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Office of History
Robbins AFB Georgia, 31093
July 1971

HISTORY OF THE WARNER ROBINS AIR MATERIEL AREA, 1 July 1970 - 30 June 1971.

PART III: WRAMA's ROLE IN SOUTHEAST ASIA

EC-47 Aircraft, 1962 - 1970
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AIR FORCE LOGISTICS COMMAND RCS: HAF - D148

CLASSIFICATION

[redacted] Each paragraph in the narrative of this study has been marked with the security classification of the source of information in that paragraph. A classification guide has been included in Section A of the documents. A point that the reader should bear in mind about the security classification of the EC-47 is that the mission of that aircraft and all association of that aircraft with the term "Airborne Radio Direction Finding (ARDF)" is classified SECRET.

(Unclassified) Many pages in the list of documents have been classified; for although the subjects and titles of the documents are unclassified, their association in a list reveals classified information.

Personal views or opinions expressed or implied in this publication are not to be construed as carrying official sanction of the Department of the Air Force, Headquarters Air Force Logistics Command, or Headquarters Warner Robins Air Materiel Area.

Like other WRAMA studies, this commentary is subject to revision, and additional information or suggested corrections will be welcomed.

Comments and questions concerning this study may be addressed to the WRAMA Office of History (WRAMA/HO), Robins AFB, Georgia, 31093.

HISTORY OF THE WARNER ROBINS AIR MATERIEL AREA,
1 July 1970 - 30 June 1971.

The "History of the Warner Robins Air Materiel Area, 1 July 1970 - 30 June 1971," consists of the following parts as of 30 June 1971:

PART I: WRAMA's WEAPON SYSTEMS

The H-3 Helicopter Manifold Problem, 27 Aug - 22 Sep 1970.
(Hist Study No. 22)

PART II: WRAMA's ROLE IN SOUTHEAST ASIA

The B-57G Canberra, 1968 - 1971, Project Tropic Moon III.
(Hist Study No. 23)

PART III: WRAMA's ROLE IN SOUTHEAST ASIA

EC-47 Aircraft, 1962 - 1970.
(A Summary of the Modifications)
(Hist Study No. 24)

WRAMA's ROLE IN SOUTHEAST ASIA SERIES

The following historical studies have been published in this series as of 30 June 1971:

Project RED HORSE, 17 Oct 65 - 31 Dec 66.
(Hist Study No. 7)

Project BITTER WINE, 1 May 65 - 31 Dec 66.
(Hist Study No. 8)

A General Examination, 1 Jan 61 - 31 Dec 66.
(Hist Study No. 9)

Project COMBAT FOX, 22 Jan - 22 Mar 68.
(A Chronology)

Project COMBAT FOX, 22 Jan - 22 Mar 68.
(Hist Study No. 11)

Management Aspects, 1 Jan 67 - 31 Dec 67.
(Hist Study No. 12)

Armor Plating Flare Box, 1967 - 1968.
(C-47 Aircraft)
(Hist Study No. 16)

AC-47 Gunship, 1960-1968, Project BIG SHOOT.
(An Interim Report)

AC-47 Gunship, 1 Jan 60 - 1 Apr 70.
(Hist Study No. 17)

AC-119G/K Gunship Program, 1967 - 1970.
(Hist Study No. 18)

AC-119G/K Gunship Program, 1967 - 1970.
(A Summary Report)

The Impact of Social, Political, and Economic Forces on the Armed Services.
(Hist Study No. 19)

Preface

When first planned, this study was to have been merely an introduction to a particular set of documents which the author had compiled from the files of the Technical Services Branch of the Cargo Aircraft Systems Management Division. This division was the component of the Directorate of Materiel Management having system management responsibilities for the C-47 aircraft. The details of logistics support are difficult to put in the form of historical narrative, and the author's idea was to make the compilation, with its introductory guide, a documentary history illustrating the technical services phases of system management.

As the writing progressed, however, the author realized that it would be more feasible to change the intended introduction into a separate study and to place the documents in the series of bound documents compiled by WRAMA Historians under the title "WRAMA Southeast Asia Document Collection." The volumes and their contents are as follows:

VOLUME	SECTION AND TITLE
XXXV	A. General B. Project Hawk Eye C. Project Red Chief
XXXVI	D. Modification 1876
XXXVII	E. Modification 2000

The WRAMA Office of History made an earlier compilation on the EC-47 aircraft, and these documents are in Volumes V and VI of the "WRAMA Southeast Asia Document Collection." The author used the earlier compilation extensively, for it contained key documents not found in the files of the Technical Services Branch, notably correspondence and planning documents of operational organizations. On the other hand, the Technical Services Branch's files contained modification requirements, feasibility studies, purchase requests, specifications, and correspondence with other WRAMA components, notably the Service Engineering Division and the Directorate of Procurement and Production.

The author regrets that he was not able to complete the study as planned. His retirement at the end of May 1971 made it necessary for him to cover the later modifications very briefly.

The author acknowledges with appreciation the assistance rendered by personnel of the Cargo Aircraft Systems Management Division in making records available and in explaining the EC-47

program. Especially helpful and considerate were Mr. James C. Prince, Mr C.H. Hartley, Mr C.C. Moore, Mr W.J. Murphy, and Mrs Louise Smith, all of whom are in the Technical Services Branch, and Mr Paul J. Barrett of the Operations Branch.

Likewise, the author wishes to place on record his thanks to Mr James F. Jones of the Commander's Mail Room for providing legible reproductions of the documents, and to Sergeant Jerry D. Lewis of the WRAMA Office of History for his concientious work in listing the documents and in typing.

Robert W. Barnwell
May 1971

NOTE OF EXPLANATION

Dr Robert W. Barnwell retired before this study was completed. His draft manuscript was turned over to me for completion, i.e., indexing and final format. No changes were made in his narrative account for to do so would have required retracing his detailed research. It will be noted that he heavily stressed documentation throughout this study. A further examination of these documents will reveal considerable detailed information which he purposely omitted.

Richard E. Maltais
Historian
WRAMA Office of History

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Chapter I
Background

(Secret - N.F.) The EC-47 aircraft had a special mission of locating the source of radio transmissions, and for that purpose carried equipment known as ARDF, the initial letters of "Airborne Radio Direction Finding."* Use of aircraft in searching for the location of hostile radio transmitters has a history dating back to World War II at least. The United States Army began experimenting with ARDF in Southeast Asia in 1961, and by the end of 1965 had 15 aircraft equipped for this work.[1]

(Secret - N.F.) The Air Force also experimented with ARDF in Southeast Asia, starting in 1962, a year later than the Army. The Air Force, however, sought a more advanced system than that used by the Army, which had the disadvantage of requiring the nose of the aircraft to be pointed directly towards or away from the source of transmission several times before a "fix" could be obtained, thereby possibly warning the enemy. Also, the enemy might reduce chance of detection by transmitting in short bursts.[2]

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* The association of ARDF with the EC-47 is classified SECRET. See classification guide in Doc Nr A-1.

I

(Secret - N.F.) In the first Air Force ARDF experiment, Project Hilo Hattie, a C-54 aircraft was used as a test bed for the equipment. This project was not successful, one reason for the failure being that the C-54 was not sufficiently maneuverable for the task. Also, the ARDF equipment gave trouble.[3]

(Secret - N.F.) The Air Force next teamed up with the Navy in an ARDF project named Mona Hi. When the Navy dropped out in August 1962, the Air Force renamed the project Hawk Eye. Sanders Associates of Nashua, New Hampshire, developed for this project special ARDF equipment based on a principle termed "phase angle discrimination." The aircraft selected as the test bed was the old but dependable C-47.[4]

Chapter II
Project Hawk Eye

(Unclassified) In the preparation of the C-47 for the Hawk Eye experiments, WRAMA had an important part. The earliest record of WRAMA's connection with Project Hawk Eye to be found in the documents assembled for this study was of a telephone call, on 24 September 1962, from a Mr Kimball of Headquarters AFLC to Colonel D.G. Bussey, Chief of WRAMA's Aerospace Systems Support Management Division. This call was in effect an informal directive for the modification of a C-47 aircraft (S/N 45-00925) assigned to the 1st Air Commando Group, Eglin AFB, Florida. The formal directive, or authorization message, was sent the next day.[1] The WRAMA shops were to accomplish part of the modification work, but Sanders Associates was to install its highly classified equipment at L.G. Hanscom Field, Massachusetts.

(Unclassified) The work to be performed at Robins AFB included engineering, fabrication of kits, and installation of equipment. Personnel of the Aerospace Systems Support Management Division, the Airframe Inventory Management Division,[2] and the Service Engineering Division, the three divisions of the Directorate of Materiel Management most heavily involved in the project, held a planning meeting on 26 September and assigned

tasks for making the installation drawings, determining kit requirements, requisitioning equipment, and negotiating with the Directorate of Maintenance for work in the shops. Two of the important items of equipment to be installed, a compass and a camera, had to be obtained through other air materiel areas (AMAs).[3]

(Unclassified) A configuration conference for Project Hawk Eye was held at the Special Air Warfare Center, Eglin AFB, Florida, on 1 October 1962. In attendance were representatives of the 1st Air Commando Group (ACG) and the 1st Combat Applications Group (CAG), the 319th Troop Carrier Squadron, the 3245th Operations Group of L.G. Hanscom Field, Massachusetts, the USAF Security Service, WRAMA, SMAMA, the Bureau of Naval Weapons, Bendix Radio Corporation, and Sanders Associates, Inc. of Nashua, New Hampshire.[4] The list of equipment to be installed, exclusive of the special equipment of Sanders Associates, was as follows:

ARN-21 TACAN (1C-1-151)

N-1 Compass

T-11 Camera

Two 300-AMP Generators

ARC-27 UHF

APX-6 and APX-25 IFF

ARC-44 (1C-47 (S) -515)

Doppler (Bendix)

Decca Navigation System

Nickel Cadmium Batteries

Two-place hot cup provisions

(Unclassified) WRAMA was committed to the installation of most of this equipment. The Sacramento Air Materiel Area (SMAMA), however, was responsible for the location and schedule of installation of the Decca System. Likewise, SMAMA was to furnish that system. Eglin AFB was to provide the generators and Bendix the Doppler. The remaining equipment in the list above was to be obtained by WRAMA from Air Force stock. Fast Coin procedures were authorized in obtaining the equipment required.[5] Fast Coin was a project for the support of the Coin Test[6] program at Eglin AFB.

(Unclassified) The target date for completion of the work in the WRAMA shops was 12 October 1962. The 1st Commando Group set this date, considering it necessary in order for them to meet the deployment date of 2 January 1963 set by the Department of Defense.[7] Originally, overtime was not authorized;

but the short time allowed for the engineering and shop work caused the Director of Materiel Management to request the WRAMA Commander for overtime funds, as follows:

$4,100	for Directorate of Maintenance
1,300	for Engineering (NEW)
600	for Airframe IM Division (NT)
$6,000	Total

In response to this request, the Directorate of Materiel Management received an overtime allowance of $1,200, of which NEW was allocated $600 and NT $200, the remaining $400 being held in reserve. The Directorate of Maintenance was directed to take overtime out of its quarterly allotment.[8]

(Unclassified) The WRAMA phase of the Hawk Eye modification bore the Management Improvement Project (MIP) Number WR62-3974RK.[9] The Director of Materiel Management was informed of the progress of the work through daily reports.[10] The Maintenance shops worked two shifts a day on the project, but did not use overtime, at least in the early stages.[11] Much of the work consisted of wiring, and the engineers had to prepare diagrams before this could be accomplished.[12] Progress of installation was slowed at times by delay in arrival of parts. The report for 5 October stated "requisitioned items being received very slowly from supply."[13]

(Unclassified) The camera gave some trouble. A hole had to be cut in the aircraft floor and this was done incorrectly, an error which made a new panel necessary. Also, a work stoppage occurred because the camera mount was late in arriving. Finally, the camera mount when received was found to be damaged, and although accepted temporarily, had to be replaced with a serviceable mount after the aircraft had departed from Robins AFB.[14]

(Unclassified) On 9[62] October, only three days before the aircraft was to depart from Robins AFB, the 1st Commando Group requested a feasibility study for the installation of a periscopic sextant, an AIC-10 Interphone System, and two ME-1 Amplifiers. The study was made, but since the equipment was not immediately available, the installation work had to be scheduled at L.G. Hanscom Field.[15] Installing the Group "B" components of the ARC-44 also was scheduled for L.G. Hanscom Field, as these components did not arrive in time for being installed at Robins. The Electronics Systems Division agreed to install this equipment provided WRAMA sent an aeronautical engineer and an electronics engineer to Hanscom to design and approve the installation.[16]

(Unclassified) The schedule called for the completion of the work at Robins on 12 October 1962, after which the aircraft was to go to Eglin AFB and from there to L.G. Hanscom Field, arriving at the latter installation on the 17th. The WRAMA shops met the 12 October target and the aircraft departed the next day. It was back at Robins on the 16 October, however, for "repairs were too extensive for the 1ACG" to perform. These descrepancies were "cleared to the pilot's satisfaction" in a day, and the Hawk Eye aircraft left for Hanscom on the 18th October, one day late.[17]

(Unclassified) Much work had to be done at Hanscom before the aircraft was ready for Sanders Associates to install its equipment, for in addition to the work that WRAMA had had to postpone until the aircraft reached Hanscom, Bendix had its doppler and SMAMA the Decca System to install there. Also, additional airframe modifications had to be made to accommodate the Hawk Eye equipment. WRAMA sent to Hanscom two electrical and two sheet metal workers in addition to the two engineers mentioned above. The WRAMA team and the personnel of the Electronics Systems Division worked 12 hours a day and seven days a week; and by 29 October the following tasks had been completed:[18]

a. A1C-10 Interphone System installed

b. DPA-12/CPA-24 Bendix Doppler Navigation System installed

c. ARC-44 Radio Set installed

d. Decca Navigation System installed by SMAMA team

e. 400-Cycle, 1500 VA Single Phase Inverter installed to prevent AC power overload

f. All wiring for Sanders Equipment installed

g. Periscopic Sextant Mount installed

h. Navigator's Chair installed to replace a wooden stool

i. Pitot-Static System relocated to reduce radio beam reflection on the Sanders antenna installation

j. Broken Mount for T-11 Camera replaced

k. All structural Components for Sanders Equipment installed

l. Verbal instructions given for wiring of Hot Cup installation

(Unclassified) When it was learned, on 30 November, that the Group "B" components of the Sanders equipment would not be ready until 2 December, the aircraft was made ready for a test flight, which took place the next day. Discrepancies were noted and corrected. A second flight was made on 1 December and

showed all installed equipment working properly except the ARC-44 and the Bendix Doppler. The doppler was repaired, but test equipment for the ARC-44 was not on hand.[19]

(Unclassified) At this point the WRAMA records on the modification work in 1962 run out. Presumably, Sanders Associates, Inc. was successful in its phase of the work. The historian has one observation to make, which may or may not be of importance. The work at Hanscom took place at the time of the Cuban Missile Crisis of 1962.

(Unclassified) The Hawk Eye aircraft, with its special configuration, equipment, and mission, had to have special logistical support, and the WRAMA documents pick up the story in 1963 with records of a conference held on 11 January at the USAF Special Air Warfare Center, Eglin AFB, Florida. In attendance were representatives of Headquarters USAF, the Special Air Warfare Center, the AFLC Liaison Office (SAWC), WRAMA, the 1st Combat Applications Group, the Navy's Bureau of Weapons, and Sanders Associates, Inc. WRAMA was designated as "Office of Primary Responsibility" for furnishing the overall logistics support, including the writing of the plan. Of course, this plan was subject to the concurrence of the AFLC Commander prior to initiation.[20]

(Unclassified) For the special Sanders' equipment, both installed and AGE, WRAMA was to provide supply of spares for one year. More specifically, WRAMA was to provide this supply by establishing coordination with Sanders through the Department of the Navy by use of a funded Military Inter-Departmental Purchase Request (MIPR). Soon after this conference, WRAMA requested AFLC for $25,000 for these spares, of which amount $15,000 was for the installed equipment and $10,000 was for the AGE. This request was made before firm requirements had been established, and WRAMA stated that additional funds might be needed. Another task in connection with the peculiar Sanders equipment that was assigned to WRAMA at this conference was to investigate, through Headquarters AFLC, the action necessary to provide 12 months of technical support at the final destination.[21]

(Unclassified) The Bendix Doppler had not been bought and was merely under consignment to the Air Force at the time of this conference. The 1st Combat Applications Group had the responsibility of negotiating with the company to provide spares support for the doppler system. In the event that the Air Force purchased the doppler, however, the 1st CAG was to coordinate with WRAMA for follow-on spares support.[22]

(Unclassified) For the Decca equipment, WRAMA was to contact SMAMA for a year's support. For other items peculiar to the project, WRAMA was to establish Air Force Supply Directives (AFSDs) covering six month support. For all other follow-on supply action, the gaining command was to use Speed Through Air Supply (STAR) procedures; and the Special Air Warfare Center was to provide the kit for support of the aircraft en route.[23]

(Unclassified) The Hawk Eye folder on which this study was largely based contained only two documents on the aircraft for the period between 1 February and September 1963. One of these documents, tells of a trip to Eglin AFB, Florida, by a WRAMA engineer. This trip, which began on 31 January and lasted through 6 February, resulted in the resolution of problems with the C-1 Compass.[24] B-43

(Unclassified) More important was the second of these documents, for it gave a clue as to the whereabouts of the aircraft, other than at Eglin, during the months of March through August 1963. The document was a message from the Fifth Air Force, Fuschu Air Station, Japan, to the Air Procurement Region, Far East, Tachikawa Air Base, Japan, requesting the

AFPRE to dispatch Mr Wong, a structural engineer, to Osan, Korea, to assist the 314th Air Division's personnel in determining "structural limits and repairs required for making camera installation in Hawkeye C-47." This message explained further that the camera installation was a high priority project that had been delayed by factors beyond local control.[25]

(Unclassified) The WRAMA records picked up the Hawk Eye story with the minutes of a meeting at Robins AFB on 24 September 1963, at which preliminary plans were made for "two forthcoming classified projects on C-47 aircraft." The directive message, MCMP 2528 dated 20 September 1963, was classified and was no longer available at WRAMA. One of the projects was essentially just the updating of the Decca equipment on the Hawk Eye aircraft, SN 45-00925; the other project, known as Red Chief, involved prototype preparations and installation of equipment on C-47 SN 42-92916.[26]

(Unclassified) The plans for the work on the Hawk Eye aircraft were completed by 30 September. WRAMA's Directorate of Maintenance had accepted the workload and the Special Air Warfare Center at Eglin AFB had provided drawings and given assurance that the Group "B" components were available.[27] The

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work to be accomplished and the schedule were as follows:

a. Input HC-47-00925 into WRAMA Maintenance shops on 7 October 1963 from SAWC, Eglin AFB, Florida.

b. Modify Group "A" components of the Mark VII Decca System to be compatible with the Mark VIII A Decca (TAPS) System.

c. Install and functionally test the Group "B" components.

d. Complete modification on or before 11 October 1963 and release aircraft to SAWC, Eglin AFB, Florida.

(Unclassified) The modification work was on a "prototype basis without benefit of" time compliance technical orders (TCTO's). The Service Engineering Division (WRNEW) developed the Group "A" kits and provided guidance in the installation work. SMAMA furnished engineering prints, but these had to be verified by WRAMA's engineers. SMAMA also arranged for Decca representatives to come to the WRAMA shops and assist in testing
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the equipment.

(Unclassified) The modification was completed on 10 October, and the aircraft departed for Eglin AFB on the same day. The Chief of the Airframe IM Division, in announcing the completion of the project, stated that "coordinated efforts and accurate preplanning by System Managers, Inventory Managers, Engineering and Maintenance personnel enabled output of aircraft one day

ahead of schedule," while the Maintenance personnel who performed the work were commended for their "concerted team efforts, individual conscientious enthusiam, and practical application of knowledge" by the Director of Materiel Management.[30]

(Unclassified) WRAMA's Service Engineering Division still had the task of developing detailed drawings of the electrical wiring, and this phase of the project was not closed out until 27 January 1964.[31]

(Unclassified) Only one other document for the year 1964 was in the folder of WRAMA's records on Hawk Eye. This document was a letter written in March from the Plans and Programs Division (WRVP) of WRAMA's Plans and Management Office to several components of the Directorate of Materiel Management with reference to a letter to WRAMA from the Special Air Warfare Center at Eglin AFB. The principal points in the WRAMA letter were as follows:[32]

a. that certain requested support had been provided;

b. that test equipment and spares "definitized subsequent to the arrival of an assigned tech representative" would be provided as agreed to at the conference on 11 January 1963;

c. that Headquarters AFLC had advised that Project Coin funds would be approved upon request for Project Hawk Eye;

d. that Project Hawk Eye would be supported through "STAR" procedures unless further directed.

While these points seem vague at first, they take on more meaning when it is known that the Hawk Eye aircraft was in Vietnam at the time the letter was written.

(Secret - N.F.) The Hawk Eye aircraft was in Vietnam between February and July 1964, accordng to a CHECO report on "The EC-47 in Southeast Asia." The aircraft then returned to the United States for some changes but was back in Vietnam for the last two months of 1965, and the tests during this second tour were sufficiently successful for the aircraft to be retained in Southeast Asia for a longer period and for many more C-47's to be equipped with Sanders' ARDF systems.[33]

(Secret - N.F.) Headquarters PACAF had asked for additional Hawk Eye aircraft in January 1964, but the request was not approved at the time. Very different was the situation two years later, however, for not only had the Hawk Eye equipment achieved significant success but Sanders Associates had greatly improved its ARDF system and the build-up of United States forces in Southeast Asia was in progress. In February 1966, Project Phyllis Ann was established for modifying 35 C-47's with Sanders' improved ARDF equipment and deploying them to

Southeast Asia.[34]

(Secret - N.F.) Project Hawk Eye was undoubtedly a success, but its equipment had serious limitations. In Southeast Asia Operational Requirement (SEAOR) 32, dated 11 January 1966, the Air Forces ARDF capabilities in Vietnam were described as follows:[35]

> No sustainable Air Force capability exists, either qualitatively or in suitable quantity. One C-47 aircraft (Hawkeye) is currently performing a minimal ARDF task using bread-board equipment designed and made in 1963 by Sanders Associates, Nashua, N.H.

(Secret - N.F.) An important quality limitation of the Hawk Eye equipment was that the aircraft had to be pointed towards or away from the hostile transmitters in order for a fix to be obtained, just as was the case with the system used by the Army. The Phyllis Ann ARDF equipment featured "side angle calibration," an improvement which obviated the necessity of changing the direction of the aircraft.[36]

(Secret -N.F.) The Hawk Eye aircraft remained in Southeast Asia for a while in 1966 but later returned to the United States to be fitted with Sanders' improved system and to become a member of the Phyllis Ann fleet. As of November 1970, EC-47P SN 45-00925 was still operational in Southeast Asia.

Chapter III
Project Red Chief

(Unclassified) The Air Force equipped a second C-47 for electronics tests in Southeast Asia prior to 1966. The project was named Red Chief and the aircraft had the serial number 42-92916. Apparently Red Chief was a companion project, or perhaps more correctly a competitive project, to Hawk Eye, with the Martin Company of Baltimore providing the classified equipment instead of Sanders Associates.[1] c-1/c-3

(Unclassified) Preparation of the Red Chief aircraft for its mission followed the pattern of the Hawk Eye modification. The WRAMA shops installed certain systems, after which the aircraft went to the Martin plant for the highly classified test equipment. Headquarters AFLC assigned the project to WRAMA on 20 September 1963, with a tentative schedule of input on 24 October and output not later than 30 December.[2] Red Chief was a Fast Coin[3] aircraft, and had a precedence rating of two and a supply priority of 1-22.[4] Technicians of the Aerospace SSM Division considered the flow time for the modification marginal, but with the precedence and priority ratings assigned, they though the work might be accomplished provided the Group "A" hardware, cordage, and Group "B" components were available.[5]

(Unclassified) WRAMA's Directorate of Maintenance was

reluctant to accept the Red Chief modification project. That directorate first accepted the workload and then reversed its position and rejected it on technical grounds as follows:

a. The aircraft was non-vital in nature.

b. The requirement was not valid because it came from the wrong component at Headquarters AFLC. The letter about the project had come from MCMX and all requirements for work had to be levied by MCMP.

c. The letter from MCMX did not actually constitute a requirement but merely called for a study as to capability and funds requirements.[6]

(Unclassified) In the end Maintenance had to give in, but acceptance of the workload was based on two provisos. First, all Group "B" components desired must be made available prior to in-put date to allow time for prototype engineering, determination of material requirements, and manufacture of Group "A" components. The second provisio was that definite work statements relative to specific components to be installed must be available prior to any engineering action and should be available ten to fifteen days prior to the desired in-put date. These provisos should be kept in mind, for neither was carried out, a point that WRAMA emphasized when the scheduled

completion date was not met and when complaints about the work arose.[7]

(Unclassified) The original list of systems to be installed on the Red Chief aircraft in the WRAMA phase of the modification was as follows:

AN/ARC-44

AN/ARA-31

AN/ARN-21 (TACAN)

AN/APN-102

N-1 Compass System

K-A-52 Camera System

Decca Mark VIII TAPS System

Investigations by WRAMA showed that of these seven systems the components of only two, the ARN-21 and the C-1 Compass, were readily available from Air Force stock.

(Unclassified) The ARA-131 was available through Army channels but required a priority one. The ARC-44 could be obtained only by withdrawal from a using command. At the time, the Air Force was negotiating with the Army to improve the delivery schedule for the ARC-44, but the estimated lead time was 10 to 12 months after contract.[9] These two items were dropped

from the Robins AFB phase of the Red Chief modification.

(Unclassified) To obtain the APN-102 required a lead time of eight to 10 months or else authority to withdraw it from a using command. A substitute was available in the APN-144 Doppler, however, and this system was used on the project. A substitute also was used for the K-A-52 Camera, which could be obtained as contractor furnished equipment at a cost of $63,000 and had a lead time of from 30 to 60 days. The Air Force Logistics Command supplied a K-A-56 Camera in its place.[10]

(Unclassified) The availability of the Group "B" components for the Decca Mark VIII TAPS System were unknown, but WRAMA was assigned the work of installing the Group "A" components.[11] At this time, the WRAMA shops were updating the Decca Mark VII System to a Mark VIII configuration on the Hawk Eye aircraft.[12] The Group "A" components to be installed by the WRAMA shops were the Antenna, the Fan, the Mount, cable, and connector installations. When these components were requisitioned, the Item Manager, SMAMA, replied that all assets for the Mark VIII System had been sent to the Ogden Air Materiel Area (OOAMA) for use on a B-26 project. Headquarters AFLC directed OOAMA to send the required equipment to WRAMA, but rescinded this order when the decision was made to delete the Decca system

from the modification because of the difficulty in securing components. The Group "A" components would not have arrived at Robins in time to be installed there.[13]

(Unclassified) The deletion of the Decca system reduced the number of systems to be installed by WRAMA to four, namely, the ARN-21 (TACAN), the APN-14 Doppler, the N-1 Compass, and the K-A-56 Camera. WRAMA also was to install additional power supply as Engineering specified. In the early stages of planning, the WRAMA Engineering Division had stated that a 500VA, three-phase inverter must be installed to furnish power for the N-1 Compass and that generators (300 AMP DC) would probably be required because the systems to be installed at Robins AFB plus the Martin Company's equipment might require more DC power than a standard HC-47 aircraft could supply.[14] The available records do not indicate what was actually done at Robins about additional power producing equipment.

(Unclassified) The work at Robins was complicated by the problem of space utilization within the aircraft. One effect of this problem was that much of the Group "A" bracketry had to be manufactured locally in order to fit the locations selected for the black boxes.[15] Also, to make room for the camera and doppler systems, the oxygen and JATO systems were rendered

inoperative by the removal of components; and the homing antennas of the ARA-8 were removed because their location was to be used for the antennas of Martin Company equipment. The coaxial cables for these antennas were left intact, however, for they would fit the new equipment.[16]

(Unclassified) Headquarters AFLC gave the authorization for WRAMA to proceed with the Red Chief modification on 30 October 1963.[17] This was a week late and reduced the time available for planning and engineering, as the Directorate of Maintenance pointed out subsequently.[18] Nevertheless, engineering and system-support-management personnel were optimistic about meeting the completion date of 31 December set by Headquarters AFLC. In contrast, personnel of the Airframe IM Division (WRNT) were pessimistic. The minutes of a meeting held on 5 November record these opposite attitudes as follows:[19]

> Comments: WRNT has a pessimistic attitude. They (as a group) feel if the program slips they will be the fall guys. WRNF/NE and NPCA are confident work can be completed in flow schedule indicated.

(Unclassified) Two weeks later, the Directorate of Maintenance gave warning that the target completion date would not be met. This prediction was based on the computation of projected manhours divided by the number of personnel capable

of working on the C-47 aircraft at one time. Maintenance also had other projects with a higher priority. The engineers complained that the camera and doppler had not been received and that they could not complete the installation drawings without those components.[20] The camera and the doppler did not arrive until 8 December.[21] There was also complaint about the lack of Group "A" equipment, some items which had been "known requirements for thirty days" had not been delivered, and as of 5 December none of the parts to be locally manufactured had been received.[22]

(Unclassified) The difficulties with Group "A" items brings up the subject of the criticism and defense of the Technical Services Branch of the Airframe IM Division, which had the assignment of determining "all Group "A" hardware requirements including harnesses, structural brackets, and common bits and pieces."[23] This assignment was interpreted to include the research work of furnishing the identifications of such items as plugs and connectors, work which NTSB contended was a supply rather than a technical services type of function and which NTSB was not staffed to perform. NTSB thought the assignment should have been made to the Cataloging Branch of the Directorate of Materiel Management (NSC) or to the Quality

Inspection Branch of the Directorate of Supply and Distribution (SQI). When the Technical Services Branch of the Aerospace SSM Division (NFTA) wrote an exhortatory letter to all components of the Directorate of Materiel Management urging aggressive follow-up action to prevent further slippage of the Red Chief Project, NTSB answered that its actions had been aggressive and positive and pointed to the fact that equipment requirements had been hand-carried first and verified by letter immediately thereafter.[24]

(Unclassified) The work in the WRAMA shops was completed on 6 January, a week late, and the Red Chief aircraft departed from Robins AFB on the following day.[25] The Service Engineering Division still had to complete the drawings and that work continued until 26 February 1964.[26]

(Unclassified) The final phase of the work in the WRAMA shops seems to have been hurried. Headquarters AFLC, having a contractual commitment on delivery of the aircraft to the Martin Company, had insisted that the work be completed around 6 January 1964. There was no time left for checking out some of the equipment. The representative of the Special Air Warfare Center complained that the APN-144 Doppler was inoperative and that there was also a malfunction in the Camera or its controls.

WRAMA offered to correct these problems by having the aircraft return to Robins after the Martin Company had finished its work.[27]

(Unclassified) The SAWC representative, Captain Finan, also complained that there was no means by which the crew could cover the camera glass or to clean the inside of the glass without removing the camera. He explained that the aircraft would have to operate from unpaved airstrips and that the glass would become obstructed unless it could be covered and uncovered as needed.[28] The following quotation gives WRAMA's reply:

> ...Capt Finan was told that these requirements illustrated very clearly some of the reasons why WRAMA had expressed in WRNF-77388 (dated 1 Oct 1963) the need for definitive work statements plus being allowed at least 10 to 15 days engineering time prior to having to start work upon the aircraft. That we were not made aware of the conditions, etc., under which the aircraft would operate and our time for installation was cut to less than half of what had been required with no allowance for engineering time and the camera glass was installed in accordance with data furnished me.

(Unclassified) This complaint, however, was referred to the Technical Services Branch with a suggestion that they discuss with the Service Engineers the installation of a cover, removeable in flight, for the camera glass and an arrangement whereby the glass itself might be hinged to permit cleaning of

the inside without removal of the camera.[29]

(Unclassified) The SAWC representative further complained that there was no means of in-flight processing of film. He was told that no mention of such a requirement had ever been expressed, that it would probably require engineering involving structural portions of the aircraft, and that action would have to be directed by Headquarters AFLC.[30]

(Unclassified) No further information on any of Captain Finan's complaints and their solution is to be found in the Red Chief documents available at WRAMA. The aircraft was scheduled to remain at the Martin Company's plant until about 1 March and then return to Eglin AFB for a period of system evaluation.[31]

(Unclassified) In June 1964, WRAMA received a request from Eglin AFB to assist in the installation of a Doppler Computer AN/ASN-7 on the Red Chief aircraft. WRAMA first sent an engineer to Eglin to plan the work and subsequently sent a sheet metal worker and a radio installer. It was a prototype installation, and some incompatibilities between doppler and computer had to be solved. The major end items were on hand at Eglin, but WRAMA had to assemble a kit of cables, connectors, and related hardware. The WRAMA shops had to manufacture some

parts. The aircraft could not come to Robins because important tests had been scheduled.[32]

(Unclassified) The Red Chief aircraft eventually went to Southeast Asia and was flown on a number of missions there in 1965.[33] That part of the Red Chief story, however, must be obtained from the Special Air Warfare Center, to which the aircraft was assigned. The aircraft's career came to an end in the latter part of 1965 following a ground accident which damaged the left wing, the engine nacelle, and part of the center wing section.[34] The manhours required for repair in the "theatre" were considered excessive, and the operational requirement for the aircraft and its special equipment no longer existed. The Red Chief aircraft, therefore, went to reclamation. The special equipment was sent to Eglin AFB, and WRAMA prepared a list of other equipment to be saved.[35]

(Unclassified) The importance of Project Red Chief in the development of the EC-47 cannot be evaluated from the records available. From the standpoint of WRAMA, however, the documents on Red Chief illustrate very vividly the difficulties and frustrations confronting technicians, engineers, and shops in accomplishing a prototype modification on a crash basis.

Chapter IV
The Operational Modifications

Establishment of Project Phyllis Ann

(Unclassified) Hawk Eye had been merely an experimental project, but the establishment of Project Phyllis Ann in 1966 gave the C-47 an operational role, and an important one, in the Southeast Asia conflict.

(Secret -N.F.) In December 1965, the situation with respect to ARDF in Southeast Asia was as follows: (1) the Army had a number of ARDF aircraft in operation and had scheduled more but still could not provide all of the anticipated coverage requirement; (2) the success of Project Hawk Eye had demonstrated the feasibility of the Air Force's ARDF equipment, and the Commander of the 2nd Air Division was requesting additional Hawk Eye aircraft. It was not until the middle of February 1966 that the Commander-in-Chief, Pacific, recommended to the Joint Chiefs of Staff the deployment of additional C-47 aircraft for ARDF missions,[1] but in the meantime the Air Force had gone ahead with preparations for the modification of the aircraft.

(Secret) The 2nd Air Division's requirement for additional ARDF aircraft was expressed formally in SEAOR 32-FY 66 QOR, dated 11 January 1966.[2] This SEAOR was forwarded through

channels to WRAMA's Directorate of Materiel Management for evaluation, reaching that directorate about 31 January.[3] Three days earlier, however, technical services personnel of WRAMA's SM division having responsibilities for the C-47 aircraft had received notice by a telephone call from Headquarters USAF that a conference on SEAOR 32 was to be held at Wright-Patterson AFB on 1 February 1966. The importance and urgency of the matters pending were indicated by an inquiry from the Headquarters USAF end of the line as to whether WRAMA could get a contract within ten days if given "say $100,000 in QRC funds."[4]

(Unclassified) The WRAMA technicians immediately telephoned Headquarters AFLC to report the inquiry about the contract. In return they learned from Headquarters AFLC that they were to attend the conference and that there were tentative plans for a modification involving 35 C-47 aircraft and a full range of avionics equipment.[5] An AFLC message to WRAMA, dated 31 January, gave further details of the project. AFLC was to manage it, but the Systems Command was to provide the engineering on new equipment. Twenty aircraft were to be "pulled from storage, IRANed and modified," and 15 other aircraft were to be "recruited from ZI users."[6]

IV

(Secret) The conference at Wright-Patterson AFB was attended by representatives of the Aeronautical Systems Division, Headquarters AFLC, and WRAMA, and its purpose was the preparation of a BPE (best preliminary estimate) for SEAOR 32. Three industrial contractors gave presentations at this conference, and the proposal of Sanders Associates was chosen as offering the most promise of meeting the requirements of SEAOR 32. In addition to ARDF equipment, the modification required a long list of communications, navigation, photographic, and other avionics equipment. Also, generators and inverters had to be installed to furnish the electrical power for this equipment.[7]

(Secret) Phyllis Ann was the first nickname assigned to the program for accomplishing SEAOR 32. WRAMA received notice of this nickname in an AFLC message dated 10 February 1966.[8] As used in the documents, the term Project Phyllis Ann seems to have been applied to the modification, deployment, and operation of EC-47 aircraft. For security reasons, the nickname was changed to Project Compass Dart in 1967,[9] next to Project Combat Cougar in 1968,[10] and again in 1970 to Project Combat Cross.[11]

Modification 1876

(Secret) On 4 February 1966, Headquarters USAF requested a formal cost and feasibility study for SEAOR 32. Headquarters AFLC assigned the number 1876 to this study and the resulting modification. WRAMA had the task of preparing this study in conjunction with the Aeronautical Systems Division of AFSC. The deadline for arrival of this study at Headquarters USAF was first set at 14 February but later was changed to 1 March.[12]

(Secret -N.F.) On 12 February 1966, the Air Force gave a briefing on Project Hawk Eye and ARDF equipment to the Commander-in-Chief, Pacific, who then recommended to the Joint Chiefs of Staff that the Air Force deploy more C-47 aircraft with ARDF capability to Southeast Asia.[13] On 17 February, Headquarters USAF notified AFLC that Project Phyllis Ann had been approved.[14] Also on 17 February, Headquarters USAF published a modification requirement entitled "Installation of Airborne Radio High Frequency Direction-Finding Equipment,"[15] which was the official authorization for the modification of C-47 aircraft in response to SEAOR 32 and Project Phyllis Ann.

(Unclassified) The modification requirement number was 1526 (FS-1876/C-47), but within the Air Force Logistics Command the "FS" or feasibility study number was considered the

modification number. Therefore, Modification 1876 was the term that WRAMA's technical services personnel used in referring to the first EC-47 modification and under which documents relating to that modification were filed.[16]

(Secret) The preparation of Phyllis Ann aircraft for deployment was a joint effort by AFLC and AFSC, with the former acting as "overall project manager."[17] WRAMA, as the system manager for the C-47 aircraft, did much of the detailed work on AFLC's share of the project. The physical modification work was divided into two stages. WRAMA monitored the first stage in which the aircraft were IRANed and most of the equipment was installed. The second stage was the installation of the ARDF and other special equipment by Sanders Associates under the monitorship of AFSC. WRAMA personnel prepared the cost estimates and the purchase requests, even for the Sanders equipment; but AFSC personnel assisted in obtaining data for these documents. WRAMA's service engineers wrote specifications, but AFSC personnel handled the more difficult phases of the engineering.[18]

(Confidential) The modification of C-47 aircraft in response to SEAOR 32 was essentially the installation of equipment. The modification requirement document of 17 February

1966 contained a list of equipment to be installed, but this list underwent many changes: additions, deletions, substitutions, and postponements. The list, with asterisks added to mark items undergoing change, was as follows:[19]

* Sanders Associates Inc. ARD-4

* APN-153 Doppler Navigation System

* ASN-25 Navigation Computer

ASN-62 (C-12) Compass

ARN-14 VOR

ARN-18 Glide Slope Indicator

BC-1333 Marker Beacon

ARN-21 TACAN

Wilcox 807, UHF Receiver

* ARC-44 VHF-FM Receiver

ARC-27 UHF Receiver

AIC-10A Interphone

HF 103 (618T3) SSB Receiver

ARA-25 Homing Adapter

ARN-7 ADF

* LORAN C/D UHF Secure Speech Encryption

* Mapping Camera

* Auxiliary Camera, Graphflex with Polaroid Back

Generators, 300 Amp and 2500VA Inverters

(Secret) The cameras were soon dropped from the list, but Red Eyebrow Lighting on the instrument panel and the RDR-100 Weather Radar were added. These two items were on the revised list in the amendment to M. R. 1526 (FS-1826/C-47) dated 20 April 1966. That modification requirement was not amended, however, to include every added item, for Phyllis Ann aircraft were equipped with driftmeters, periscopic sextants, auxiliary fuel tanks, and typewriters, none of which are listed in amendments to M. R. 1526 (FS-1876/C-47). Another unlisted requirement, though not in the nature of equipment, was camouflage painting.[20]

(Secret) The equipment for Phyllis Ann aircraft was discussed at a conference held at Robins AFB on 2 March 1966. One of the important decisions made at that conference was to change the doppler and computer because the number of APN-153/ASN-25 sets available was insufficient for Project Phyllis Ann. The choice for a substitute lay between the Bendix DRA-12/CPA-124 and the Canadian Marconi Company's APN-147/ASN-35. The Bendix doppler/computer sets were available as off-the-shelf commercial equipment that was not in the Air Force inventory. In contrast the Marconi Company's product was standard Air Force equipment that was already in use on C-130, C-133, and C-141

aircraft. But some personnel of the Special Air Warfare Center objected to the APN-147/ASN-35 on the grounds of maintainability problems and lack of the high degree of accuracy required for Phyllis Ann missions. The representatives of Headquarters USAF who were present decided in favor of the Bendix equipment on the basis of the time schedule. The Marconi Company made another effort to have its equipment selected after the conference, and some personnel of the Aeronautical Systems Division testified that the APN-147/ASN-35 sets had the required accuracy. The final decision, however, was in favor of the Bendix DRA-12/CPA-124 sets.[21]

(Confidential) The equipment list for Project Phyllis Ann included a radio receiver for use with the LORAN C and D chain that the Army was establishing to provide accurate navigation in Southeast Asia. The ARN-78A, a Sperry product, was the set chosen. This radio receiver gave a great deal of trouble. In the first place, the ARN-78A was a new modification that would not be available until the latter part of 1966; in the second place, there was keen competition among the many projects for the modified sets when they became available; and in the third place, there were performance problems when the sets came into use.[22]

(Secret) Unmodified ARN-78 sets were provided for the first two Phyllis Ann aircraft, but PACAF objected to the older model, which could not be used with the LORAN chain in Southeast Asia, and so the remaining aircraft were fitted only with the wiring and connective equipment, which was the same for the ARN-78 and ARN-78A. The lack of the radio receiver caused no problem to deployed aircraft for the ground complex of the C and D chain in Southeast Asia was not scheduled to be completed until October 1966.[23]

(Confidential) Phyllis Ann had a priority precedence rating of 1-6, which was sufficiently high for this project to receive a share of the ARN-78A production, the sets being withdrawn from the HC-130 program. At a meeting held on 6 July 1966 at Wright-Patterson AFB, the C-130 System Program Office agreed to discontinue use of the ARN-78 and ARN-78A on HC-130 aircraft in order to supply Phyllis Ann and other high priority projects. Phyllis Ann received delivery rights to 18 sets of the ARN-78A and 42 sets of the ARN-78 which were already installed on HC-130 aircraft. The installed sets were removed and shipped to the factory for modification.[24] Later on Phyllis Ann had to give up six of its sets to Project Stray Goose.[25]

(Unclassified) Part of the agreement under which the C-130 requirements for ARN-78/78A were cancelled was that the costs for technical data and for the development of test and other ground equipment (AGE) be charged to Phyllis Ann and the other recipient projects. Subsequently, Headquarters USAF inquired as to the reasons for a large increase in the cost of Project Phyllis Ann, and WRAMA explained that the increase was due in part to the absorption of costs for the ARN-78/78A as follows: $152,000 for technical data for AGE; $140,000 for technical data for the systems; and since the quantity of AGE items had decreased considerably, the contractor had increased the cost for the remainder by $625,000.[26]

(Secret) Diversion through higher priority precedence was used to obtain other items on the Phyllis Ann equipment list, specifically, Wilcox 807, ARN-21, ARC-44, HF-103, and ARA-25. These electronic systems were available but had been allocated to other programs. Headquarters USAF issued the diversion authorization upon submission by WRAMA of a list showing equipment required and aircraft from which diversion to Phyllis Ann could be affected.[27]

(Confidential) Another problem item on the Phyllis Ann equipment list was the ARC-44 radio. Its purpose was air-to-ground communications, but its use was greatly reduced by a

change in the Army's communications system. The Army had been using AN/PRC-9 and -10 FM radios but in 1966 was changing to the AN/VRC-12 series, which had the advantage of a greater frequency range. For its airborne radio, the Army was changing to the ARC-54, a narrow-band radio that was compatible with the VRC-12 systems. The ARC-44 was a wide-band system, and an aircraft equipped with it would have difficulty communicating with Army ground units. As a remedy for this air-to-ground communications problem, the 2 Air Division issued Class V Mod SEAOR 17 to equip its aircraft with ARC-54 radios.[28]

(Confidential) But the demand for ARC-54's was great and the lead time lengthy, so the Air Force selected as a substitute the Magnavox FM-622A, a commercial off-the-shelf product that was compatible with the VRC-12 and other Army communications systems. Actually, the FM-622A was an airborne version of the VRC-12 and had been built to military specifications. Furthermore, the same cables, connectors, and mounts could be used for either the ARC-54 or the FM-622A.[29] But the lead time for the FM-622A was long also, and this radio was needed for many aircraft. Phyllis Ann was high on the priority sequence list, but installation was not made until 1967. The Phyllis Ann aircraft were equipped with ARC-44's until FM-622A's or ARC-54's became available.[30]

(Secret) Another delay in installation of equipment centered around the ARC-27. This UHF radio had to be modified before the KY-8 "secure voice" equipment could be used with it. The KY-8 sets were available in 1966, but the kits for modifying the ARC-27 were not. Installation took place in 1967, on some aircraft in connection with Modification 2000 and on others as a separate project. The KY-8 was an encryption device, managed by the USAF Security Service, by means of which sensitive information could be relayed to the ground. It worked through the FM-622A as well as through the modified ARC-27.[31]

(Secret) The ARDF equipment which Sanders Associates had at the time of the conference of 1 February 1966 did not meet fully the Air Force's requirements for Project Phyllis Ann although it was superior to the equipment offered by the other two competing companies.[32] But during the months of February and March 1966, Sanders greatly improved its ARDF system. Moreover, in March 1966, USAF decided that a second position was needed in Phyllis Ann aircraft to assure greater capability for search and acquisition of target signals. The letters "X" and "Y" were used to distinguish positions and the consoles in which the equipment was housed.[33]

(Secret - N. F.) At the X position was the Sanders ARDF equipment. Its purpose was to locate radio transmitters. The

equipment was very sensitive and featured a complicated process which indicated the direction from which a signal was coming regardless of the heading of the aircraft. Notable advantages of the Sanders equipment over other ARDF systems were greater speed in making "fixes" and avoidance of pointing the aircraft in the direction of the signal.[34]

(Secret) The Y position was also known as the "acquisition" position, and as this designation suggests, one of its main functions was the search for radio transmissions. The equipment at the Y position was not peculiar to the Sanders ARDF system. Its essential items were not standard Air Force equipment and were termed "G" equipment because their stock numbers were prefixed with that letter. The USAF Security Service managed "G" items. WRAMA's only responsibility for it was procurement, for Headquarters AFLC had arranged supply support, depot maintenance and preparation of technical manuals for "G" equipment under Project Big Safari. Some items of "G" equipment, but not all, were listed in the amendment to MR. 1526 (FS-1876/C-47) dated 20 April 1966.[35]

(Secret) A more detailed account of the workings of the Sanders ARDF system and associated equipment will not be made in this brief narrative. One of the supporting documents, however, contains the text of a briefing on the equipment at

the X and Y positions and also the equipment added in later modifications.[36] Also, the two CHECO Reports on the EC-47 Aircraft in SEA[37] give excellent accounts of the electronics package.

(Secret) The middle of May was the original target date for deploying the first Phyllis Ann aircraft to Southeast Asia;[38] but the 2nd Air Division, which was the Air Force organization that would operate the aircraft, urged an earlier date, the pertinent passage in its message on this subject reading as follows:[39]

> ... April first delivery of number one aircraft extremely important, with late March arrival considered of utmost advantage as demonstration of Air Force ability to deliver promised product on time. Extreme measures not only justified but necessary.

(Secret) In response to the 2nd Air Division's request, Headquarters USAF made efforts to speed up the preparation of the Phyllis Ann aircraft; and although 1 April was too early for a target date, hopes were expressed that an aircraft would be ready for operations in the latter part of that month.[40] To achieve an April deployment, Headquarters USAF authorized strong measures in a message to the major commands involved, namely, AFLC, AFSC, PACAF, and TAC.[41] An excerpt from that message is as follows:

> ... Present USAF commitment in SEA makes it imperative that the first C-47 aircraft be deployed to PACAF during April rather than mid May... This program is of the utmost importance to USAF and required extraordinary actions by all organizations and personnel concerned with the program to meet the deployment date.

(Secret) Recognizing that the Sanders subsystem was the "pacing item" of the Phyllis Ann modification, Headquarters USAF requested AFSC to have the contractor work "round the clock, 7 days a week" if necessary to improve the delivery schedule. Premium overtime was authorized. AFLC was requested to consider the feasibility of using two C-47's for prototyping the modification, with the final testing, calibration, and alignment of the first aircraft to be completed after arrival in Southeast Asia. On the second prototype aircraft, all testing would be completed before deployment.[42]

(Secret) The deployment date for Phyllis Ann aircraft was discussed at the conference held at WRAMA on 2 March 1966. The Sanders representatives pointed out that they could not accept the aircraft at their plant until about 1 May because the Group B components of their equipment would not be available earlier. The Headquarters USAF representatives promised to take action to improve the delivery schedule of equipment from the vendors to the Sanders plant.[43]

(Unclassified) The portion of the modification work that WRAMA managed was contracted to Air International Corporation of Miami, Florida. Sole source procurement was authorized; and as this company was already engaged in the IRAN of C-47 aircraft, its selection was considered the best means of meeting the delivery

schedule. The Phyllis Ann aircraft had to undergo IRAN before the project equipment was installed, and a head start was gained by selecting as the prototype aircraft two C-47's on which IRAN work was already in progress.[44]

(Unclassified) While the work on the prototype aircraft was in progress, WRAMA had three persons on temporary duty at the contractor's plant. One was an Equipment Specialist from the Technical Services Branch, another was an Aeronautical Engineer, and the third was an Electronics Engineer.[45]

(Secret) After completion of the first phase of the modification at Miami, the Phyllis Ann aircraft were flown to Grenier Field, New Hampshire, where the Sanders equipment was installed. The original target date for delivery of the first prototype aircraft at Grenier Field was 31 March.[46] The date was later changed to 4 April. The work schedule for this first aircraft at Grenier was as follows: Completion of installation of equipment and ground check by 16 April; completion of the flight check and of partial calibration by 20 April; then removal of the ARDF equipment, after which the aircraft would be ready for the ferry crew. The ARDF was to be shipped to arrive concurrently with the aircraft in Southeast Asia, where the calibration would be completed.[47]

(Secret - NF) Exact dates for the completion of work and for the departure of the aircraft are not available in the documents on

which this study is based; but apparently the schedule was not quite met, yet not missed too far. The first modified aircraft "deployed through the PACAF area" in early May 1966[48] and arrived at Tan Son Nhut on 14 May.[49] This aircraft demonstrated the effectiveness of its ARDF equipment on 6 June 1966 when it acquired 19 fixes, a new record. The Hawk Eye aircraft had set the previous record of 13 fixes in one day.[50]

(Secret) The first aircraft deployed to Southeast Asia by the Pacific route; but the second one took the eastern route, crossing the Atlantic by way of New Foundland and the Azores. The plan at that time was to use the Atlantic route for all of the remaining Phyllis Ann aircraft. The 250-gallon auxiliary fuel tank, which was part of the permanent equipment of the aircraft, being intended for operational use, provided sufficient additional fuel for the longest overwater leg of the flight. A change of plan in June, however, routed all of the remaining aircraft across the Pacific <u>via</u> Alaska, Midway, Wake, Guam, and the Philippines.[51] As adjustments to the aircraft for the Alaska-Pacific route, de-icer boots for the propeller and a second 250-gallon fuel tank were added to the equipment list. This second tank was installed temporarily for the deployment flight; but to make room for it, the Y console had to be moved and stored in the back of the aircraft.[52]

IV

(Unclassified) After the completion of the two prototype aircraft, the work at Miami progressed steadily. One of the expediting measures was to allow the contractor to obtain needed items by local purchase. The generators were obtained from second hand sources; but they proved to be serviceable, and some were still in use on the aircraft at the end of 1970. The work at Miami was not merely the installation of equipment, but the interfacing of that equipment, so that the many electronic subsystems didn't interface with each other.[53]

(Secret) Calibration of the doppler and the C-12 compass posed some difficulties. These were very important items of equipment, because they were used together to determine the position of the aircraft at the time a "fix" was being made. The C-12 was new in 1966; and having been designed for fast aircraft, it had to be adjusted for use with the slow C-47.[54] Another problem was that to swing the compass to the high degree of accuracy required, it was considered necessary for the aircraft to be in the attitude of flight. In other words, the tail of the C-47 had to be elevated to the position it would be in if the aircraft were flying. At Air International's plant, this was done by raising the tail of the aircraft on a lift truck. An inquiry was made as to whether the right type of truck would be available at all bases

in Southeast Asia where Phyllis Ann aircraft were to be located. The problem was solved on discovery that tilting some parts of the compass to a level position made unnecessary the elevation of the tail of the aircraft.[54]

(Secret -NF) In April 1966, the Joint Chiefs of Staff authorized an increase from 35 to 47 in the number of C-47 ARDF aircraft that the Air Force was to operate in Southeast Asia. Apparently, this increase of 12 aircraft was the result of a roles-and-missions agreement between the Army and the Air Force.[55] The Air Force also approved the modification of six additional aircraft to the Phyllis Ann configuration, justifying four of them for training purposes and two as reserves for contingencies that might arise in areas other than Southeast Asia.[56] The addition of these six aircraft raised the total for the Phyllis Ann fleet to 53 aircraft; and by November 1966 all 53 had been allocated to PACAF, although flying hours and manpower spaces were not authorized for six that were considered "non-operating active."[57]

(Secret) As originally planned, 20 of the Phyllis Ann aircraft were to be obtained from storage, but aircraft from operating units were preferred, and few if any of the Phyllis Ann aircraft were actually taken out of storage. Some of the aircraft obtained from operating units were about to be sent to storage, for in 1966

the C-47's were being phased out at many bases.[58] The Hawk Eye aircraft was one of those modified for Project Phyllis Ann. It rendered valuable service in the spring of 1966, but the manhours expended in maintaining it were considered "exhorbitant." It was delivered to the Air International facility at Miami around August 1966.[59]

Deployment

(Secret) The modification and deployment of the Phyllis Ann aircraft took considerably longer than scheduled at first. In January 1966 when the plans were first being made, the completion of 35 aircraft was expected in August.[60] This was too optimistic a schedule. The TAC programming plan dated 15 April set 25 October as the date for completion of the 35th Phyllis Ann aircraft.[61] This schedule also was too optimistic. There were two obvious reasons for the delays that necessitated extensions of the time schedule for the modification. One reason was the difficulty of interfacing and calibrating so much new and complicated equipment, and the other was the problem of obtaining items of equipment in 1966 when so many aircraft and electronic projects were in progress.

(Secret) The second prototype aircraft reached Tan Son Nhut on 26 June 1966, but two of the doppler items had not been installed.[62] A message dated 15 July reported that aircraft number

5 was having the final tests and should be ready for deployment by the 18th of July. The message stated further that aircrafts numbered 6,7, and 8 would be in the air by 15 August and "ready for ferry" by 23 August.[63] By 19 September, nine Phyllis Ann aircraft had arrived at Tan Son Nhut and two more were on the way.[64]

(Secret) A delay in the work at Grenier Field was explained as follows:[65]

> The first five AN/ARD-18's were fabricated from pre-production drawings, installed and calibrated in a minimum of time, and precluded through engineering and environmental testing. Initial funding of the Sanders contract would permit only a partial sub-contract procurement of "raw material" enough for 5 systems. The 2nd increment of funds allowed for the sub-contracting of parts for 35 systems. The break in placement of sub-contract orders created an interruption in parts-flow into Sanders. This in turn has created a portion of the delay that is now necessary.

(Secret) Further details on the intricacies of obtaining parts for Sanders' equipment is revealed in a message from the Aeronautical Systems Division to Headquarters USAF. This message was dated 19 September 1966; and at that time, Sanders Associates had electrical parts for complete fabrication of the ARD-18 through system number 20, but lack of connectors would halt further completions until deliveries from Cannon Electric. Another delaying item was the Franklin printer, which was an essential part of the "X" console, as it provided

print-outs of the data essential for locating signals. The Franklin company was dependent on one of its vendors, Globe Industries, for the motors that worked the printer. The anticipated chain of delays ran as follows: further deliveries of Globe motors was not expected until December, which in turn would delay deliveries of Franklin printers until January, which would mean delay of completed ARD-18's until February. The suggested remedy was for the Air Force to get the Department of Commerce to expedite the delivery of Globe motors to Franklin.[66]

(Secret) But in spite of the problems described above, Sanders Associates was expected to fabricate and test a total of 33 ARD-18 systems by the end of November 1966. Only 27 of these systems would be available for deploying aircraft, however, as one system was required for maintenance training, two systems for tests, and three systems for spares support to aircraft already deployed.[67]

(Secret) The delivery of unusuable printed circuit cards slowed down the fabrication of the "Y" modules, but the contractor protected himself against further difficulties on this score by having several sources of supply.[68]

(Secret) While difficulties in obtaining parts for Sanders' equipment slowed the work at Grenier Field, the work at Miami

proceeded at full pace once the prototyping was completed and some calibration problems were solved. At first, the C-47's were flown to Grenier immediately after Air International had completed its phase of the modification; but by the latter part of July, the storage of aircraft awaiting installation of Sanders' equipment was becoming a problem at Grenier. One cause for concern was security protection.[69] In October, arrangements were made with MOAMA for flyable storage at Brookley AFB of from 20 to 25 aircraft awaiting the second phase of the modification.[70]

(Secret) The deployment schedule called for 36 Phyllis Ann aircraft to be in Southeast Asia by the end of November 1966; but as that date approached, the 7th Air Force and Headquarters PACAF expressed great concern because the deployment count was only 17 aircraft in place and five more on the way. Failure in the deployment schedule meant a failure of the Air Force to meet its commitment in the data collection program. With the establishment of Project Phyllis Ann, the Air Force had agreed to accomplish a certain number of data collection hours; and although the assigned aircraft were overflying their schedule, they could not meet the number of data collection hours required of the Air Force.[71]

(Secret) Completion of modifications by Sanders Associates speeded up in December, and a total of 30 aircraft had been

calibrated and delivered to the ferrying crews by the end of 1966.[72] Status statistics for 31 January 1967 were as follows:[73]

29 aircraft in theatre
8 aircraft enroute
8 aircraft scheduled for deployment in February and March
2 aircraft scheduled for tests
6 aircraft (Q modification) to be deployed after 1 July 1967.

(Secret) As the Air Force was committed to have 47 aircraft in the theatre by the end of February, the schedule shown above indicated a slippage.[74] But this slippage was on paper, as production was ahead of the training program and crews were not available to operate 47 aircraft.[75] The six aircraft scheduled for deployment in July or August were having Modification 2027 in addition to Modification 1876. Deploying these aircraft in March and installing the equipment Modification 2027 in the field was considered but not adopted.[76]

(Unclassified) The Technical Services personnel who had an important share of WRAMA's responsibilities for Project Phyllis Ann considered the modification phase of that project a great success. In slightly over a year after the project was officially authorized, Sanders Associates had developed a new system; and in spite of the problems of obtaining prototyping, interfacing, and calibrating an extensive electronics package, 47 aircraft

had been modified and deployed. Within a year and a half, all 53 aircraft had been deployed. Six of these also had Modification 2027 and a number of others had the Group "A" equipment for Modification 2000.[77]

Redesignation of the Aircraft

(Unclassified) In June 1966, the designation of C-47 used on Project Phyllis Ann was changed. The C-47A's became RC-47N's and the C-47D's became RC-47P's.[78]

(Unclassified) A second redesignation was made in May 1967, with EC-47N and EC-47P replacing RC-47N and RC-47P, respectively. The reason for this change seems to have been the avoidance of confusing Phyllis Ann aircraft with photographic types of aircraft.[79]

Redesignation of Sanders' Equipment

(Secret) The direction finding system that Sanders Associates developed for Project Phyllis Ann was first called the ARD-18; but in August 1967, the nomenclature became AN/ALR-34 Receiving Set, Countermeasures. The computerized version of the ARD-18 that was an essential part of Modification 2042 was designated AN/ALR-35.[80] The reason for the change seems to have been the protection of the mission of EC-47 aircraft, as ALR was less revealing than ARD.[81]

(Secret) In connection with this change of nomenclature, the AN/ALR-34/35 equipment was transferred from FSC 5826, Airborne Radio Navigation Equipment, to FSC 5895, the class which included Electronic Countermeasure Equipment. This change caused a transfer in item management, for although WRAMA had IM responsibilities for both classes, the classes were in separate divisions, FSC 5826 being under the Airborne Radio and Radio Navigation IM Division and FSC 5895 being under the Airborne Radar and Electronics Warfare Division.[82]

Other Major Modifications*

(Unclassified) In addition to Modification 1876, there were five other major modifications to the Sanders' equipment on EC-47 aircraft. The numbers and dates of the modification requirements were as follows:[83]

M.R. Nr. 1690 (FS-2000/C-47), 27 Sep 66

M.R. Nr. 1719 (FS-2027/RC-47), 15 Dec 66

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* The author had planned to cover these modifications in the same way that he had covered Hawkeye, Red Chief, and Modification 1876; but he had time for only this very brief coverage before his retirement at the end of May 1971.

M.R. Nr. 1792 (FS-2042/RC-47), 27 Apr 67

M.R. Nr. 1816 (FS-2139/EC-47), 29 Jun 67

M.R. Nr. 1938 (FS-2235/EC-47), 16 Apr 68

Since the usage within the Air Force Logistics Command was to identify modification by the feasibility study number, WRAMA personnel used the numbers 2000, 2027, 2042, 2139, and 2235 for these modifications.

(Secret) Modification 2000 added additional positions and consoles known by the letter "Z" to some of the original 53 EC-47 aircraft. The "Z" equipment was for "search" purposes and was very similar to "Y" equipment. Modification 2000 applied to 30 of the original Phyllis Ann aircraft. On each of these 30 aircraft, the wiring and other Group "A" equipment for two "Z" consoles was installed, in some cases before and in other cases after deployment. Only about 24 "Z" consoles were procured, so that only 12 aircraft could operate with the "Z" capability at one time; but the "Z" consoles could be moved from one aircraft to another as needed.

(Secret) Modification 2027 applied to only six of the original 53 Phyllis Ann aircraft. It added a "Q" or jamming capability. This "Q" equipment was installed on the last six aircraft to deploy. These aircraft were not permitted to use the jamming function, however, but they were used as "Z" aircraft.

IV

(Secret) Modification 2042 updated and computerized the ALR-34, greatly speeding up the work thereby. The updated equipment was designated ALR-35. This modification applied to 15 of the aircraft that already had Modification 2000. The "X" consoles were shipped to the Sanders plant, modified, and then returned to Vietnam. To provide the power required for the additional equipment, R-2000-4 engines were installed in place of the R-1800 engines previously used. As R-2000-4 engines were not available from Air Force supply, used engines from commercial sources were procured and overhauled for Modification 2042.

(Secret) Modification 2139 added first an increment of 11 aircraft to the EC-47 fleet and later a follow-on increment of five more aircraft, bringing to 69 the total number of aircraft modified to EC-47 configurations. Equipment-wise, Modification 2139 combined Modifications 1876, 2000, and 2042.

(Secret) Modification 2235 applied to 10 of the aircraft that had Modification 2139. It was an Air Force move in the game of electronics hide-and-seek that went on in Southeast Asia. To avoid detection, the enemy were using higher frequencies than those the ALR-34 and ALR-35 could receive. The Air Force countered with the ALR-38 which could detect radio transmission in much higher frequencies. The updating was made in two stages. As an

interim measure, there was a "mini-mod" that provided a moderate increase in frequency to the equipment on three of the aircraft. The ALR-38 with a much higher frequency range was later installed on these three aircraft and seven others.

(Secret) An Electronics Operational Simulator for use in training personnel to operate Sanders equipment was proposed in 1968,[84] but it was not adopted.

Attrition

(Secret-NF) A total of 10 EC-47 aircraft had been attritted as of February 1971. In some cases the loss was due to hostile action, either while the aircraft was in flight or from rocket attack while on the ground.[85] In other cases loss was due to crashes. One aircraft was lost in Alaska during deployment.[86] The serial numbers of the attritted aircraft were as follows:

45-1133	43-49201
42-24304	43-48959
44-77016	43-48402
43-49679	43-49100 x
43-49547	43-15133