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PROJECT
Contemporary
Historical
Examination of
Current
Operations
REPORT

IGLOO WHITE

JULY 1968 - DECEMBER 1969 (U)

10 JANUARY 1970

HQ PACAF

Directorate, Tactical Evaluation
CHECO Division

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Prepared by:

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Project CHECO 7th AF, DOAC

ASSIFIED [redacted]

DOTEC-70-16

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS PACIFIC AIR FORCES
APO SAN FRANCISCO 96553

OFFICE OF THE CHIEF OF STAFF

PROJECT CHECO REPORTS

The counterinsurgency and unconventional warfare environment of Southeast Asia has resulted in the employment of USAF airpower to meet a multitude of requirements. The varied applications of airpower have involved the full spectrum of USAF aerospace vehicles, support equipment, and manpower. As a result, there has been an accumulation of operational data and experiences that, as a priority, must be collected, documented, and analyzed as to current and future impact upon USAF policies, concepts, and doctrine.

Fortunately, the value of collecting and documenting our SEA experiences was recognized at an early date. In 1962, Hq USAF directed CINCPACAF to establish an activity that would be primarily responsive to Air Staff requirements and direction, and would provide timely and analytical studies of USAF combat operations in SEA.

Project CHECO, an acronym for Contemporary Historical Examination of Current Operations, was established to meet this Air Staff requirement. Managed by Hq PACAF, with elements at Hq 7AF and 7AF/13AF, Project CHECO provides a scholarly, "on-going" historical examination, documentation, and reporting on USAF policies, concepts, and doctrine in PACOM. This CHECO report is part of the overall documentation and examination which is being accomplished. Along with the other CHECO publications, this is an authentic source for an assessment of the effectiveness of USAF airpower in PACOM.

ROLAND A. CAMPBELL, Major General, USAF
Chief of Staff

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS PACIFIC AIR FORCES
APO SAN FRANCISCO 96553

REPLY TO ATTN OF: DOVD

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SUBJECT: Project CHECO Report, "IGLOO WHITE, July 1968-December 1969" (U)

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FOR THE COMMANDER IN CHIEF

Maurice L. Griffith

MAURICE L. GRIFFITH, Colonel, USAF
Chief, CHECO Division
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      (2) IGS 1

   f. AFSG. 1

   g. AFNIATC 5

   h. AFAAC 1
      (1) AFACMI. 1

   i. AFODC

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      (5) AFSSS. 1
      (6) AFSTP. 1

   m. AFTAC. 1

   n. AFXO 1
      (1) AFXOD. 1
      (2) AFXODC 1
      (3) AFXODD 1
      (4) AFXODL 1
      (5) AFXOOAB. 1
      (6) AFXOSL 1
      (7) AFXOOSN. 1
      (8) AFXOOSO. 1
      (9) AFXOOSS. 1
      (10) AFXOOSV. 1
      (11) AFXOOTR. 1
      (12) AFXOOTW. 1
      (13) AFXOOTZ. 1
      (14) AFXOOCY. 1
      (15) AF/XOX 6
      (16) AFXOXXG. 3

3. MAJOR COMMAND

a. TAC

(1) HEADQUARTERS
- (a) DO. 1
- (b) DPL 2
- (c) DOCC. 1
- (d) DREA. 1
- (e) DIO 1

(2) AIR FORCES
- (a) 12AF
  - 1. DORF 1
  - 2. DI 1
- (b) 19AF(DI). 1
- (c) USAFSOF(DO) 1

(3) WINGS
- (a) 1SOW(DOI) 1
- (b) 23TFW(DOI). 1
- (c) 27TRW(DOI). 1
- (d) 33TFW(DOI). 1
- (e) 64TAW(DOI). 1
- (f) 67TRW(C). 1
- (g) 75TRW(DOI). 1
- (h) 316TAW(DOP) 1
- (i) 317TAW(EX). 1
- (j) 363TRW(DOI) 1
- (k) 464TFW(DOIN). 1
- (l) 474TFW(TFOW). 1
- (m) 479TFW(DOF) 1
- (n) 516TAW(DOPL). 1
- (o) 4410CCTW(DOTR). . . . 1
- (p) 58TAC FTR TNG WG. . . 1
- (q) 4554CCTW(DOI) 1

(4) TAC CENTERS, SCHOOLS
- (a) USAFTAWC(DA). 2
- (b) USAFTARC(DID) 2
- (c) USAFTALC(CAL) 1
- (d) USAFTFWC(CRC) 1
- (e) USAFAGOS(DAB-C) . . . 1

b. SAC

(1) HEADQUARTERS
- (a) DOPL. 1
- (b) XPX 1
- (c) DM. 1
- (d) DI. 1
- (e) OA. 1
- (f) HO. 1

(2) AIR FORCES
- (a) 2AF(DICS) 1
- (b) 8AF(DO) 2
- (c) 15AF(DI). 1

c. MAC

(1) HEADQUARTERS
- (a) DOI 1
- (b) DOO 1
- (c) MACHO 1
- (d) MACOA 1

(2) AIR FORCES
- (a) 22AF(OCXI). 1

(3) WINGS
- (a) 61MAWg(OIN) 1
- (b) 62MAWg(OCXP). 1
- (c) 436MAWg(OCXC) 1
- (d) 437MAWg(OCXI) 1
- (e) 438MAWg(OCXC) 1

(4) MAC SERVICES
- (a) AWS(AWCHO). 1
- (b) ARRS(XO). 1
- (c) ACGS(CGO) 1

d. ADC

(1) HEADQUARTERS
(a) DO. 1
(b) DOT 1
(c) XPC 1

(2) AIR DIVISIONS
(a) 25AD(OIN) 1
(b) 29AD(ODC) 1
(c) 20AD(OIN) 1

e. ATC
(1) ATXPP-X 1

f. AFLC

(1) HEADQUARTERS
(a) XOX 1

g. AFSC

(1) HEADQUARTERS
(a) XRSG. 3
(b) SDA 1
(c) CSH 2
(d) DLXP. 1
(e) ASD(ADJT) 1
(f) ESD(ESO). 1
(g) RADC(EMOEL) 2
(h) ADTC(ADGT). 1
(i) ADTC(ADBRL-2) 1

h. USAFSS

(1) HEADQUARTERS
(a) ODC 1
(b) CHO 1

(2) SUBORDINATE UNITS
(a) Eur Scty Rgn(OPD-P) . 1
(b) 6940 Scty Wg(OOD) . . 1

i. AAC

(1) HEADQUARTERS
(a) ALDOC-A 1

j. USAFSO

(1) HEADQUARTERS
(a) CSH. 1

k. PACAF

(1) HEADQUARTERS
(a) DP 1
(b) IN 1
(c) XP 2
(d) CSH. 1
(e) DOVD 5
(f) DC 1
(g) DM 1
(h) DOVH 1

(2) AIR FORCES
(a) 5AF
1. CSH 1
2. DPL 1
(b) Det 8, ASD(DOASD). . 1
(c) 7AF
1. DO. 1
2. DIP 1
3. DPL 1
4. TACC. 1
5. DOAC. 2
(d) 13AF
1. CSH 1
2. DI. 1
(e) 7/13AF(CHECO). . . . 1

(3) AIR DIVISIONS
(a) 313AD(DOI) 1
(b) 314AD(DPL) 2
(c) 327AD
1. DO. 1
2. DI. 1
(d) 834AD(DO). 2

(4) WINGS
(a) 8TFW(DCOA) 1
(b) 12TFW(DCOI). 1
(c) 35TFW(DCOI). 1
(d) 56SOW(WHD) 1
(e) 347TFW(DCOOT). 1
(f) 355TFW(DCOI) 1
(g) 366TFW(DCO). 1
(h) 388TFW(DCO). 1
(i) 405FW(DCOI). 1
(j) 432TRW(DCOI) 1
(k) 460TRW(DCOI) 1
(l) 475TFW(DCO). 1
(m) 1st Test Sq(A) 1

(5) OTHER UNITS
(a) Task Force ALPHA(DXI). . 1
(b) 504TASG(DO). 1
(c) Air Force Advisory Gp. . 1

1. USAFE
(1) HEADQUARTERS
(a) DOA. 1
(b) DOLO 1
(c) DOO. 1
(d) XDC. 1

(2) AIR FORCES
(a) 3AF(ODC) 2
(b) 16AF(ODC). 2
(c) 17AF(OID). 1

(3) WINGS
(a) 36TFW(DCOID) 1
(b) 50TFW(DCO) 1
(c) 66TRW(DCOIN-T) 1
(d) 81TRW(DCOI). 1
(e) 401TFW(DCOI) 1
(f) 513TAW(OID). 1

(4) GROUPS
(a) 497RTG(TRCOD). 5

4. SEPARATE OPERATING AGENCIES
a. ACIC(DOP). 2
b. AFRES(XP). 2
c. USAFA
(1) CMT. 1
(2) DFH. 1
d. AU
(1) ACSC-SA. 1
(2) AUL(SE)-69-108 . . . 2
(3) ASI(ASD-1) 1
(4) ASI(HOA) 2
e. AFAFC(CEH) 1
f. ANALYTIC SERVICES, INC . 1

5. MILITARY DEPARTMENTS, UNIFIED AND SPECIFIED COMMANDS, AND JOINT STAFFS

6. SCHOOLS

7. SPECIAL

TABLE OF CONTENTS

FIGURES

FOREWORD

This CHECO report updates "IGLOO WHITE (Initial Phase)," which traced the beginnings of IGLOO WHITE (MUSCLE SHOALS) from the September 1966 decision of Secretary of Defense, Robert S. McNamara, to develop the system to its initial operation on 1 December 1967.

Covering the period mid-1968 through December 1969, this report notes achievements and problem areas of the IGLOO WHITE system, its technological advancement, and changes in hardware. Testing of the accuracy and effectiveness of the IGLOO WHITE system proved it to be satisfactory in monitoring enemy lines of communications. It was operated effectively as a real time intelligence source for target development and added a new dimension to interdiction operations.

CHAPTER I

ESTABLISHMENT OF IGLOO WHITE

The MUSCLE SHOALS (IGLOO WHITE) program was initiated on 16 September 1966, with a decision by Secretary of Defense, Robert S. McNamara, to develop a system to interdict North Vietnamese infiltration into South Vietnam. The program, as envisioned, included two closely related systems: (1) a strong point/obstacle subsystem to be deployed in a line across Vietnam, just below the DMZ, extending inland from the coast; and (2) an air-supported anti-infiltration subsystem extending westward from the strong point/obstacle subsystem into central Laos to include the area of the Ho Chi Minh Trail from North Vietnam through central and eastern Laos into South Vietnam (Fig. 1). By the end of 1966, a plan had been prepared and funds for the program were budgeted.[1/]

The initial sensor program was called PRACTICE NINE until 14 June 1967, ILLINOIS CITY until 15 July 1967, and DYE MARKER until 8 September 1967, when MUSCLE SHOALS was adopted to indicate the air-supported subsystem in eastern and central Laos. In June 1968, the program was renamed IGLOO WHITE[2/] and consisted of three components: (1) munitions and sensing devices which were placed across and along suspected routes of infiltration to detect and impede enemy foot or vehicular movement; (2) orbiting aircraft which received signals from these sensors, amplified them, and retransmitted them; and (3) an Infiltration Surveillance Center (ISC) which received the transmitted signals from the aircraft and analyzed them to produce reliable tactical information for planning and interdiction operations. The IGLOO WHITE system was originally expected to impede enemy infiltration through use of mine fields and aid in determining when mine reseeding was necessary. Sensors were also to be used along trails and roads to provide real time target information for tactical airstrikes. By July 1968, the munitions had proved to be relatively ineffective, and the use of sensors to obtain reconnaissance information was rapidly becoming the principal objective of the IGLOO WHITE system.[3/]

The hub of the operation was the Infiltration Surveillance Center nicknamed DUTCH MILL. This facility and other components of IGLOO WHITE were placed under a 13th Air Force organization known as Task Force Alpha (TFA) located at Nakhon Phanom Air Base, Thailand. It was there that the computer, intelligence, operations personnel, and highly-trained technicians compiled and analyzed the sensor data and passed them on to the strike forces. The latter were fragged and controlled by the Seventh Air Force at Tan Son Nhut AB, Vietnam.[4/]

The initial concept of operation, which was still basically valid at the end of 1969, was to implant the sensors, either in the ground or in overhead foliage, by airdrop. When activated by movement or sound, the sensor would transmit its basic identity code to an EC-121 aircraft which flew a specified orbit above the sensor field. This aircraft would automatically relay these transmissions to the ISC for analysis.[5/]

ANTIINFILTRATION SUBSYSTEMS

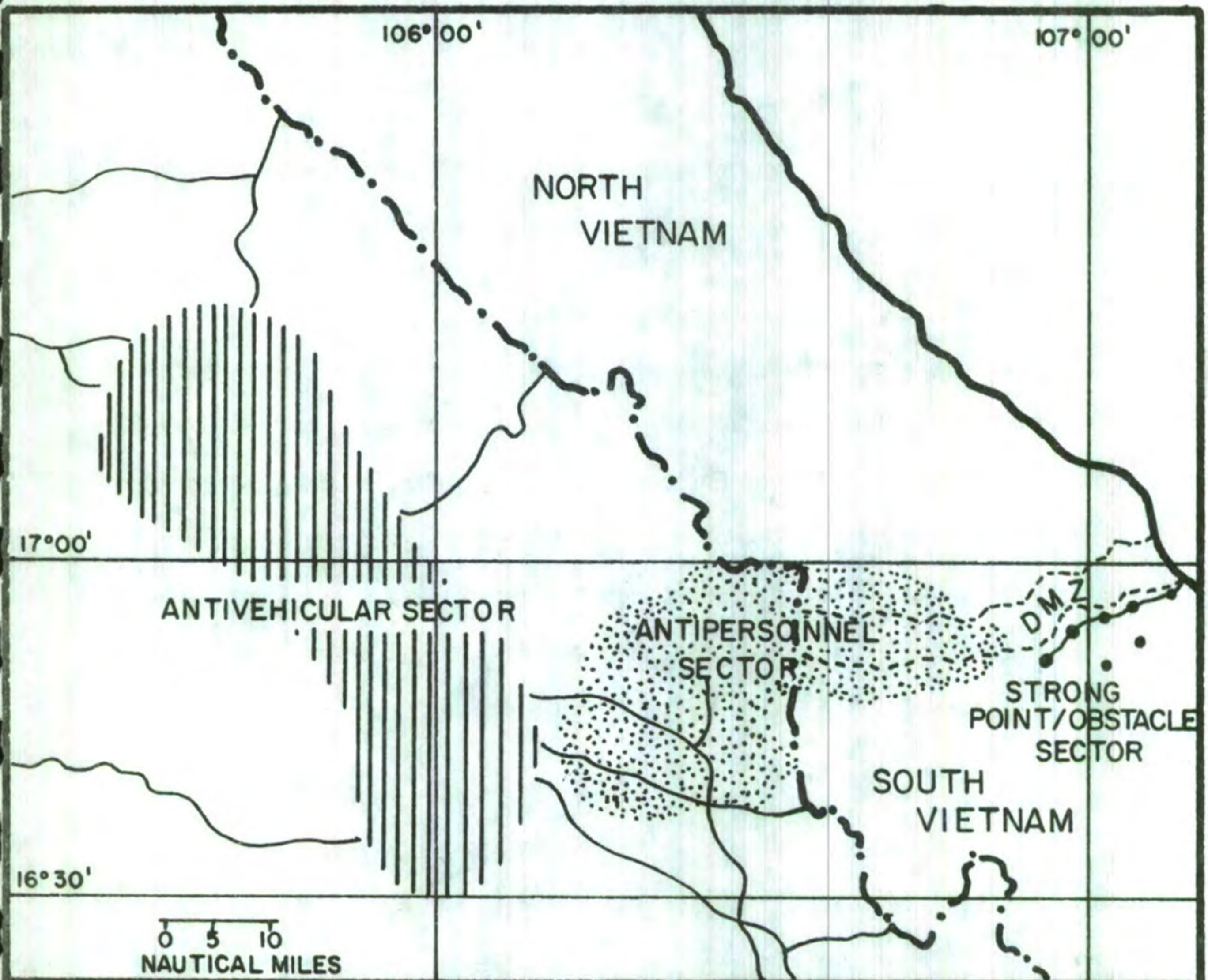


FIGURE 1

The initial deployment of the system produced a number of challenging requirements. Sensors had to be electronically reliable detectors and sturdy enough to survive the implanting process. A Wing of EC-121 aircraft had to be deployed to Korat Royal Thai Air Force Base (RTAFB); and while maintaining the strictest secrecy, the Infiltration Surveillance Center had to be constructed and equipped. Each sensor string implanted in Laos had to be approved by the U.S. Ambassador in Vientiane, Laos. The operation was begun on 1 December 1967, only one month behind schedule. The first test of the system in combat came less than two months later with the battle of Khe Sanh.[6/]

The first CHECO Report on IGLOO WHITE identified several problems that affected the early operation. Chief among these was the accuracy of sensor emplacement. The primary sensor seeding aircraft until March 1968 was the Navy OP-2, which was vulnerable to ground fire. Its lack of accuracy in placing sensors resulted in irregular sensor patterns and less-than-optimum sensor coverage.[7/]

Another problem was the failure of the sensors to function according to specification. The implant loss was high, signals were often unreliable, and battery life was generally less than expected.[8/]

A third problem was that of data loop loss within the relay system. This was caused by radio interference with the VHF signal, equipment problems on the relay aircraft, and occasional overloading of the equipment at the ISC.[9/] Data loss in the deployed system was 40-60 percent, but by early 1969, it had been reduced to about 17 percent.[10/]

"IGLOO WHITE (Initial Phase)" indicated accuracy of the Target Assessment Officer (TAO) readout was less than optimum. A recent 7AF study, however, pointed out that accuracy of sensor interpretation, in terms of truck movement and counting, was amazingly close to actual visual sightings by FACs, therefore allegations that TAOs tend to over- or under-count movements can be disputed.[11/]

The IGLOO WHITE system made creditable contributions to the intelligence picture in Laos during the early months of its operation. The system demonstrated that sensors could be successfully implanted in a hostile area, their output relayed by an orbit aircraft, and read with meaningful results at the ISC. At the end of March 1968, new procedures were implemented whereby only significant groups of trucks would be reported, not individual movements as before. This was expected to give the TAOs more time to analyze terrain, weather conditions, and overall truck activity to make their target evaluations more accurate. New, more sophisticated equipment was also planned in early 1968, which would sharply increase the capability and value of the IGLOO WHITE system.

CHAPTER II

IGLOO WHITE AND TASK FORCE ALPHA

IGLOO WHITE and TFA Before COMMANDO HUNT I

The battle of Khe Sanh, which began in January 1968, was a watershed and proving ground for IGLOO WHITE. Prior to that time, the concept had been one of infiltration monitoring and operational testing. At Khe Sanh, the system became operational as a battlefield surveillance system; the antipersonnel subsystem was suspended due to lack of resources. The successful application of air-delivered sensors at Khe Sanh attracted wide interest in their use and served to strengthen the acceptance of their reliability.[1/]

Gen. William W. Momyer, Commander, Seventh Air Force, stated: "I consider your effort at Khe Sanh to be highly successful...."[2/] The USMACV MUSCLE SHOALS Six-Month Summary Evaluation Report noted:[3/]

> *"...this use of the system for battlefield surveillance and real time intelligence gathering was instrumental in directing the massive air and artillery strikes that broke the siege and destroyed the besieging forces....The fundamental premise underlying the system was proven--that it was feasible, in a combat environment to air emplace and monitor a large sensor field, and to relay the sensor outputs in real time to a remote center for analysis and exploitation."*

Internal developments at Task Force Alpha were also stimulated by the enemy's intent to overrun Khe Sanh. The number of sensor activations was so large that the TAOs were unable to log all of them, primarily because of signals generated by friendly airstrikes and artillery reports.

Further refinement of techniques and procedures, however, provided a means of partially screening those directly related to artillery and airstrikes.[4/]

The battle at Khe Sanh marked the beginning of the lengthy employment of sensors in the DYE MARKER/DUEL BLADE area in cooperation with both the Army and Marines. (The name DYE MARKER was changed to DUEL BLADE and MUSCLE SHOALS to IGLOO WHITE on 31 May 1968.)[5/] This involved the extensive use of sensors in the DMZ and I Corps Tactical Zone (CTZ) areas and included both airborne and ground monitoring stations and sensor emplacement. This operation is documented in the CHECO Report, "Air War in the DMZ, September 1967-June 1969."[6/]

The use of sensors to detect enemy truck traffic was also being perfected. The aircraft used to implant sensors was changed from the Navy OP-2E to the F-4, and the sensor field was expanded.[7/] From 1 April through 30 September, for example, 633 ACOUBUOYs, 1,068 SPIKEBUOYs, and 1,696 Air-Delivered Seismic Intrusion Detectors (ADSIDs) were emplaced. In late May, sensors were first emplaced in Route Package I and approaches to the A Shau Valley in conjunction with the Southwest Monsoon Plan.[8/]

During the Southwest Monsoon Campaign, Task Force Alpha maintained a 24-hour Combat Operations Center (COC) and continually monitored sensor activations.[9/] The most promising detections were passed to Airborne Battlefield Command and Control Center (ABCCC) as SPOTLIGHT reports for possible strike. During the period 27 April - 20 May, these reports were sent to 7AF on a daily cumulative basis, but transmissions to ABCCC were resumed on 20 May because of the time delay in sending targets to 7AF and from there to ABCCC. Sensor reported activity around Khe Sanh was also sent to the Marines until 7 July. In addition, the COC had a backup function as an alternate ABCCC; it was equipped with direct secure lines to ABCCC, 7AF, 7AF/13AF, Tactical Unit Operations Center (TUOC), and the Air Attache at Savannakhet.[10/]

The interpretation of sensor activations also produced the "Zulu Truck Park" concept. (By definition, Zulu targets were semi-perishable and remained valid from dawn to dusk.)[11/] A Truck Park Working Group was established on 8 April 1968 to keep records of sensor activations and plot traffic movements to determine the suspected locations of enemy truck parks during the day. This information was then corroborated with other available sources, and probable targets were forwarded to ABCCC for possible COMBAT SKYSPOT attack.[12/] These data were also incorporated in the Operation TURNPIKE input.[13/] (Operation TURNPIKE was a COMUSMACV-directed intensive interdiction effort conducted in STEEL TIGER during April and May 1968, using large numbers of ARC LIGHT sorties.)[14/]

On several occasions during 1968, there appeared to be periods of inactivity when the number of sensor signals relayed through the orbit aircraft was significantly reduced. This was eventually traced to EB-66 electronic countermeasure (ECM) activities in connection with ARC LIGHT strikes. Other sensor problems also became evident as Phase II sensor emplacement was begun. Moving target detection and tracking with the ACOUBUOY II were difficult because of poor audio quality. Shipments of this sensor were halted until a fix could be instituted. The Fighter Air-Delivered Seismic Intrusion Detector (FADSID) was also unsatisfactory due to initial implant problems and later because of unreliability.[15/] Incidents of abrupt sensor failures indicated the enemy was probably tampering with sensors. To discourage enemy sensor deactivation, as well as to stop or funnel traffic, active sensor strings were seeded with Gravel munitions, Dragon Tooth Mines, and Wide Area Antipersonnel Mines (WAAPM).[16/]

For some time, preparations had been under way for a large scale sensor placement effort in North Vietnam should a bombing halt occur. On 23 October 1968, 12 strings of Long Life ADSIDs, 69 sensors in all, were placed in Route Package I. On 1 November, within a few hours of the bombing halt, ten more of these sensors were implanted. The Pink Orbit EC-121, flown over the Gulf of Tonkin, was reestablished on 3 November 1968, and was flown until 26 November 1968, when the decaying number of active sensors no longer warranted the orbit. Most of the Long Life ADSIDs had lasted less than one month.[17/]

Planning efforts for the Northeast Monsoon Campaign, COMMANDO HUNT, were begun in July 1968, with numerous conferences and meetings held through October. Coincidental with the planning process, TFA completed the conversion from IBM 360 Model 40 computers to Model 65s, which greatly increased the data processing capability of TFA.[18] Preparations were also made to give TFA control of the strike force operating in the COMMANDO HUNT area on 15 October 1968. To facilitate control of these aircraft, a balcony was built in the TFA control room, and TFA controllers, experienced and newly assigned, were given two flights in the ABCCC to become better oriented with current traffic control operations. Slippage in the 15 October date was caused by communications difficulties, but on 22 October 1968, SYCAMORE Control (the TFA COC) assumed direction of two sectors of the COMMANDO HUNT area. This area was enlarged on 7 November, and on 15 November, COMMANDO HUNT and its associated evaluation of IGLOO WHITE officially began.[19]

COMMANDO HUNT I

The COMMANDO HUNT operation and the role of IGLOO WHITE have been analyzed in great detail in the CHECO report titled "COMMANDO HUNT", published on 20 May 1969.

The most significant chapter in the development, operation, and analysis of the IGLOO WHITE system was written during the period of 1 November 1968 through 12 April 1969. During these five and one-half months, Task Force Alpha was the focal point for the COMMANDO HUNT interdiction campaign in Laos. Integration of the IGLOO WHITE system into COMMANDO HUNT was a special feature of the campaign.

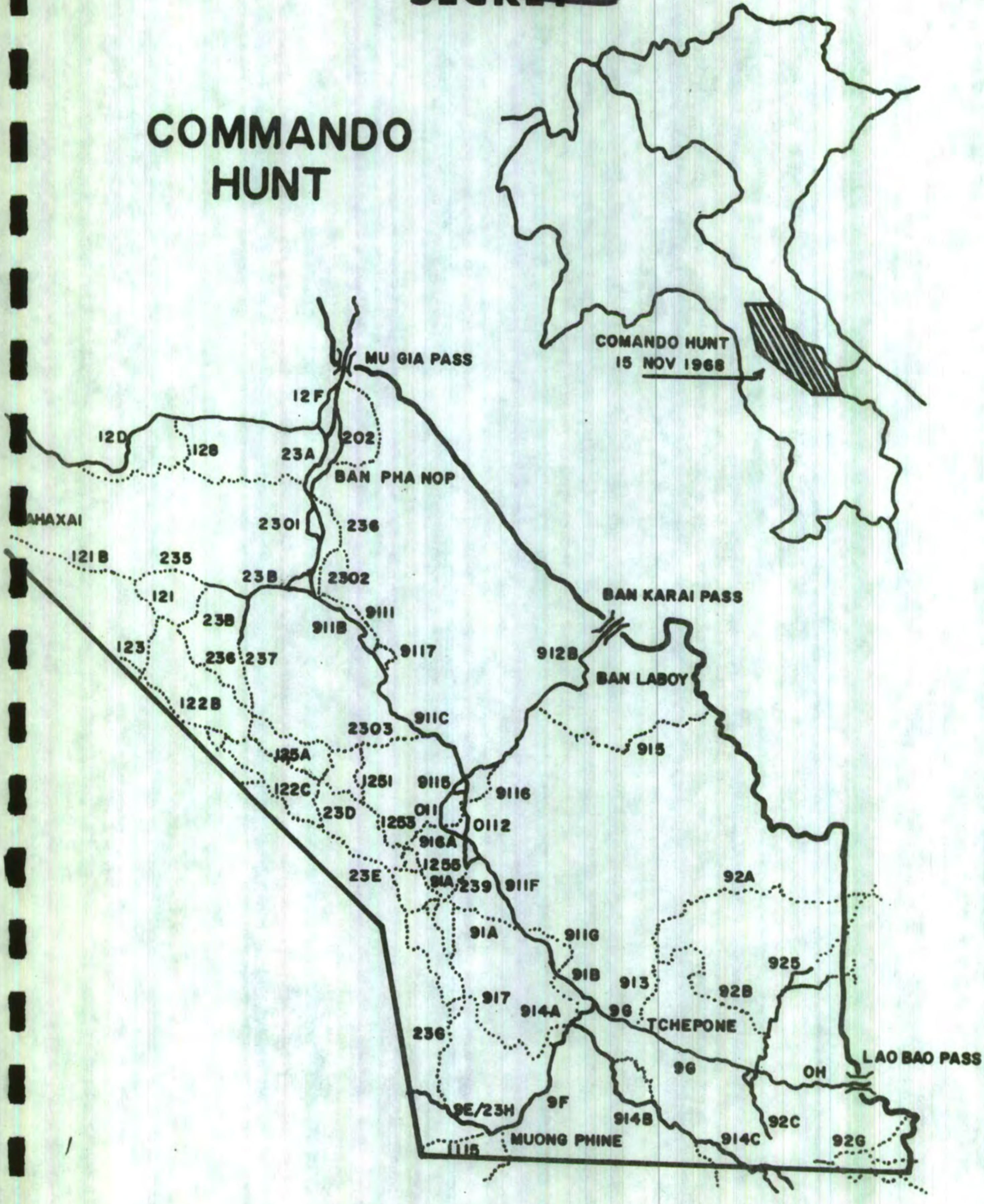
The primary objectives of COMMANDO HUNT were to: (1) reduce the logistical flow by substantially increasing the time required for the enemy to transmit supplies into South Vietnam; and (2) destroy enemy trucks and caches of military supplies along the routes leading into South Vietnam.[20/]

Throughout the campaign, the strategy was to vary force allocations and targeting in dynamic interaction with the enemy to inflict maximum destruction on his logistics pipeline through Laos.[21/] IGLOO WHITE was employed as an integrated part of the Tactical Air Control System (TACS) to aid in the development of general intelligence on specific targets and to provide real time tactical information for battlefield management.

It is important to realize the number of trucks which were moving through the Laos road system to grasp the significance of COMMANDO HUNT I. The total truck inventory in Laos was approximately 1,300, of which about 275 were on the road at any given time during the hours of darkness. In December 1968, the number of trucks observed to have been damaged/destroyed per day was 27; during April 1969, the number had risen to 44.[22/]

At the outset, the difference between Task Force Alpha and IGLOO WHITE must be clarified. TFA was a 13th Air Force organization under operational control of Seventh Air Force. It operated the Infiltration Surveillance Center and was assigned operational responsibility for the IGLOO WHITE system. During COMMANDO HUNT I, TFA also exercised operational direction over strike aircraft in the COMMANDO HUNT area of STEEL TIGER. (Fig. 2)

COMMANDO HUNT



To accomplish the latter, a Combat Operations Center (COC) known as SYCAMORE Control was established at TFA in October 1968 to provide control over the interdiction effort.[23/] In actual operation, a certain number of aircraft were fragged to the COMMANDO HUNT area each day. Some of these were fragged with specific ordnance to strike certain kinds of targets. Lists of alternate targets were drawn up in case the primary was not available, but aside from primary and specified alternate targets, these aircraft were not divertible. Others were fragged to TFA to use as it saw fit to exploit the sensor information developed by the IGLOO WHITE system. TFA determined the targets and their priority; it also provided other intelligence information and exercised operational direction through SYCAMORE Control. A number of FACs were also fragged to TFA to control the strikes.[24/]

Integral parts of TFA were monitoring, interpreting, and maintaining the IGLOO WHITE sensors. The sensors--seismic and acoustic--were planted in strings of three to six sensors along lines of communications (LOCs), suspected truck parks, and other areas of personnel or equipment concentration. They were to monitor moving traffic and confirm the location of suspected logistic areas. The data derived from the sensors were used as real time tactical information to intercept truck convoys and as non-real time intelligence to improve storage area targeting, locate bypasses, and measure traffic through-put. Sensor-derived information also aided in locating troop concentrations and in checking efficiency of air tactics.[25/]

The establishment of Task Force Alpha as a Combat Operations Center and the intelligence derived from the IGLOO WHITE system were milestones. For the first time, observing truck movement by sensor interpretation was possible, and an airstrike could be directed on the convoy on a near-real time basis. This real time information was available to FACs, strike aircraft, and gunships to use as circumstances warranted. IGLOO WHITE directly assisted in the real time location of slightly more than 20 percent of the targets attacked. Nearly all the targeting of LOCs, about 38 percent of the truck parks, and 15 percent of the trucks struck were located by using IGLOO WHITE inputs. Sensor readouts were also used to evaluate the success of interdiction efforts.[26/]

This interdiction campaign also demonstrated that it was not essential to have the aircraft control function collocated with the sensor readout function.[27/] Direct operational control of interdiction resources through normal Seventh Air Force channels and the ABCCC appeared to be more satisfactory, and the decision was made to withdraw the control function from TFA at the end of COMMANDO HUNT.[28/]

COMMANDO HUNT II - April-November 1969

Operational direction of aircraft in the COMMANDO HUNT area was transferred from Task Force Alpha (SYCAMORE Control) to the Airborne Battlefield Command and Control Center on 13 April 1969. The next week, the control team continued to monitor air operations in COMMANDO HUNT in the event the ABCCC was unable to handle the traffic. The COC function at TFA ceased on 26 April 1969. 29/

During this same period, plans were made to expand and modify the existing sensor field at the conclusion of COMMANDO HUNT I to cover a larger area: from BARREL ROLL through STEEL TIGER South, but with fewer sensors. The objectives were to: (1) monitor input through the major LOCs from North Vietnam; (2) measure through-put along the South Vietnamese Border; and (3) monitor vehicular traffic at selected key points. 30/ LORAN/Sensor strike missions were also flown nightly and procedures were developed to exploit real time sensor information to execute LORAN-equipped F-4 strikes on moving truck convoys. These tactics were further refined to include sensor-detected stationary targets such as active truck parks. This operation was suspended on 23 June 1969 due to a lack of targets. 31/

This dearth of targets was indicative of a general late spring and early summer lag in activity caused primarily by weather conditions, and the Air Force interdiction effort, a combination which made most roads impassable. Sensor implants, however, continued at about 350 to 400 per month. The primary functions of the IGLOO WHITE system were to maintain critical sensor fields and monitor them for possible wet season movement efforts.

The summer of 1969 was also a period of testing new procedures and developing new sensor applications. For example, experiments were conducted on ADSIDs to determine which gain setting gave the most sensitivity compatible with reliability.[32/] The ground system installations, associated operational procedures, and training programs for Phase III were also completed, including instruction on the use of the IBM 2250 display. A joint Sensor Spectrum Analyzer working group was organized to incorporate several different sensor studies.[33/]

The "reserve field" capability of the commandable Phase II system was also evaluated for the first time. One string of sensors was set in the active mode and the other in reserve on implant. The mode of the two could then be switched back and forth to use more sensors on the same frequency and tone code.[34/] During this time, the sensor buildup facility was moved from Nakhon Phanom to Ubon RTAFB, allowing location of the completed sensors at the same base as the 25th Tactical Fighter Squadron (TFS).[35/]

The center of action in the out-country war shifted to BARREL ROLL during the summer of 1969. There, in Operation ABOUT FACE, tactical airpower was effectively used in the offensive against the Pathet Lao and North Vietnamese. Although no sensor implantations had been made in the BARREL ROLL area, it appeared that not only could surveillance of certain outlying portions of entry and exit routes to the Plaine des Jarres be improved from their limited usage,[36/] but results of the interdiction program might be measured.[37/] Accordingly, the first three strings of sensors were implanted in BARREL ROLL on 21 and 22 August, and the Rose

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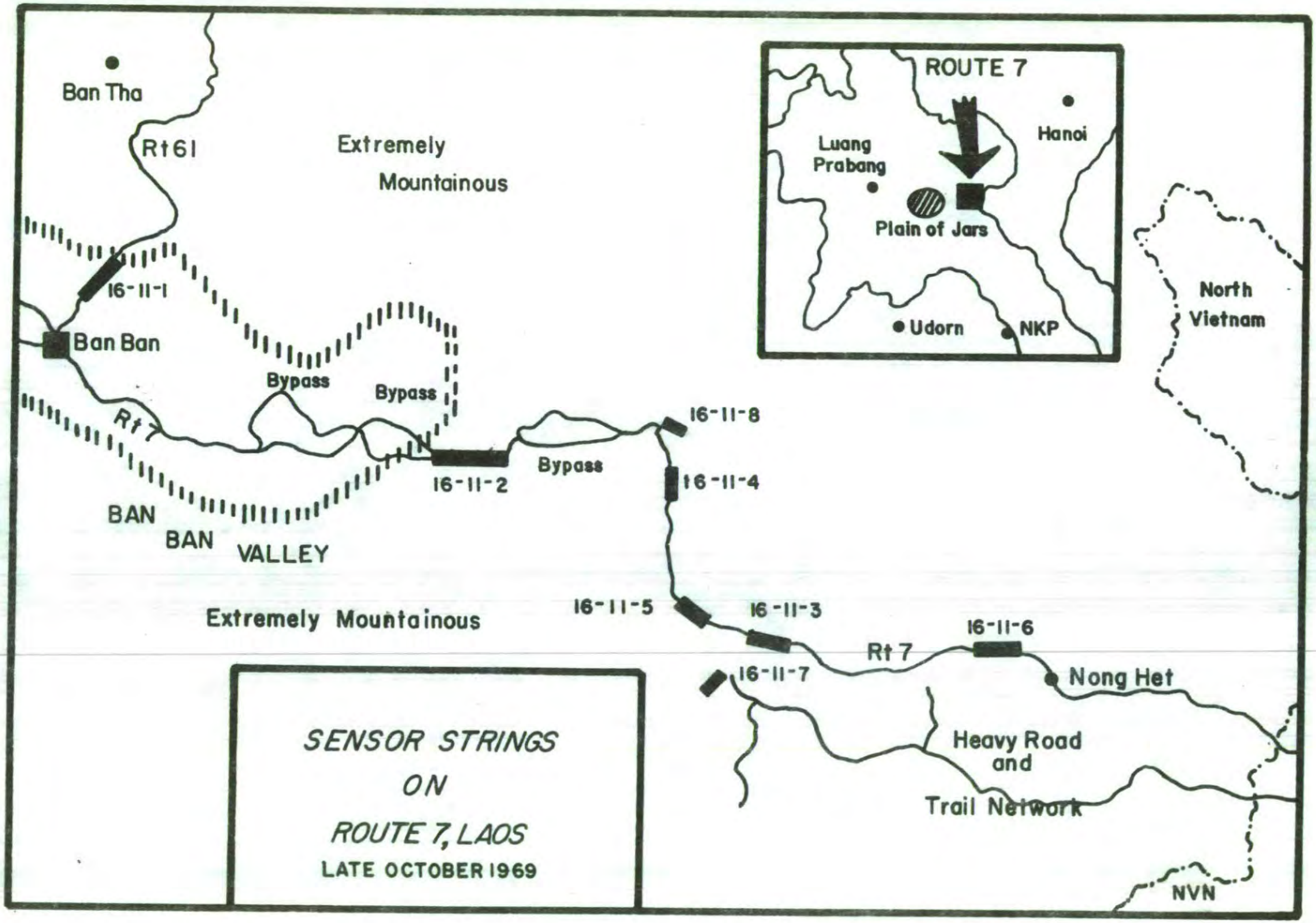

FIGURE 3

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orbit EC-121 was established with manual readout. 38/ The activity detected by these sensors was disappointing, however, and on 20 September, the Rose orbit was discontinued. 39/

In late September, intelligence sources again indicated sensors could be profitably used in BARREL ROLL to determine three specific facts: first, how much truck traffic existed on Route 7; second, to confirm the existence of transshipment points; and third, to determine if trucks were offloading to supply the trail system in Laos or continuing on to forward positions. 40/ This outcome led to implantation of a second group of sensors on 9 October and resumption of the Rose orbit, 41/ with gratifying results. Additional sensor fields were laid and reseeded in October and November 1967 as activity in BARREL ROLL remained high. (Fig. 3.) As in COMMANDO HUNT I, the results were significant, even demonstrating an improvement in effectiveness of the system. They proved conclusively that sensor operations and control of forces were independent functions. 42/

COMMANDO HUNT III

At the time of this writing, COMMANDO HUNT III was in progress. The role IGLOO WHITE assumed in the operation was a reflection of the lessons learned in COMMANDO HUNT I and II. The Seventh Air Force OPlan for COMMANDO HUNT III pictured IGLOO WHITE as an integral part of the interdiction campaign on a real time basis. Emphasis was placed on the system's improved detection and analysis capability, reliability, and confidence in tracking trucks. This was coupled with the ISC's capability to provide real time tactical information, integrate intelligence, and furnish real time direction against moving targets.[43/] Sensor by sensor analysis of a string was the key to much of the increased capability of IGLOO WHITE.

Also included in COMMANDO HUNT III was the concept of using sensor information to vector aircraft for LORAN strikes. Sensorized strike zones, made up of long strings of sensors (8 to 12), were established to provide real time data on truck movements for FACs and strike aircraft. Special sensor emplacements were also made at entry and exit points and interior LOCs. Sensors were programmed for use in interdiction package monitoring and "reconnaissance by acoustics," which was the emplacement of acoustic sensors in specified areas of enemy activity in an effort to determine the type of activity taking place.[44/] It appeared that COMMANDO HUNT III took its form primarily because sensors proved their ability.

As previously noted, during the COMMANDO HUNT I campaign, TFA had been a Combat Operations Center. Rather than diversify operational direction in COMMANDO HUNT III, the control of all air resources in BARREL ROLL and STEEL TIGER was retained by the two ABCCCs.[45/] In addition, a new operation called COMMANDO BOLT, was established in November 1969.[46/] This was a combined operation using the sensor detection capability of TFA with certain FAC and strike aircraft to intercept enemy movers at predetermined interception points, Desired Mean Points of Impact (DMPI). One of the features of COMMANDO BOLT was SPARKY FAC, with the call sign Copperhead, which basically detected and calculated the arrival time of trucks at a

SPARKY FAC

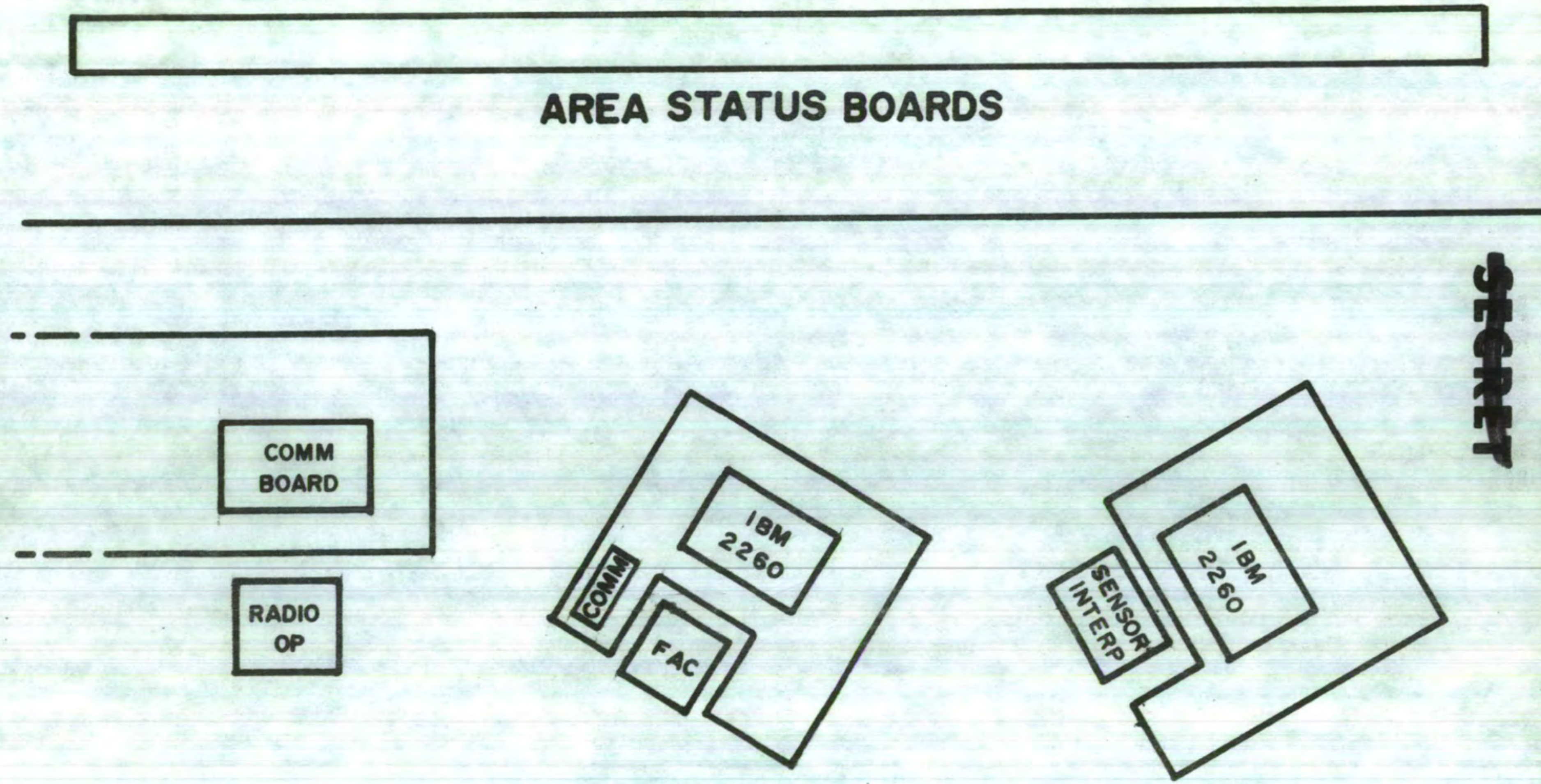

FIGURE 4

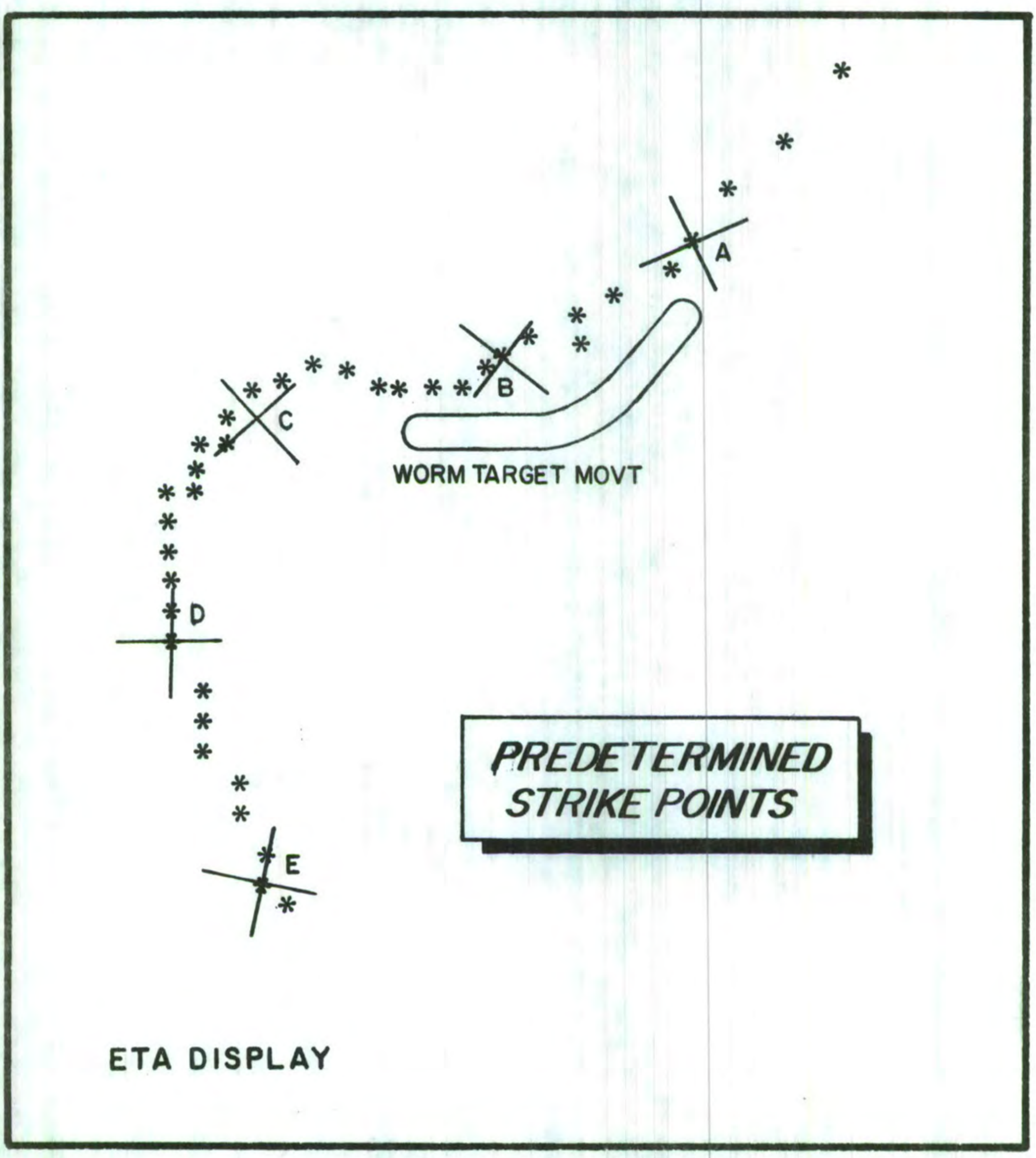
A
B
C
D
E
WORM TARGET MOVT
PREDETERMINED STRIKE POINTS
ETA DISPLAY

FIGURE 5

DMPI.[47/]

The heart of the SPARKY operation was the balcony of the TFA control room where a three-man team handled the LORAN strikes. The two team officers, the FAC and the sensor interpreter, actually conducted the operation. The former was a field grade fighter pilot, while the latter was a company-grade intelligence officer. In front of each man was an IBM 2250 display unit on which several displays could be selected. (Fig. 4.) The primary ones were a minute-by-minute update of the Coincidence Filtering Intelligence Reporting Medium (CONFIRM), or a geographical display of the road and sensor locations of strings in the COMMANDO BOLT area. As sensor activations were displayed on the 2250, the interpreter and FAC conferred to determine the validity of an activation. They might cross-check it with other sensors or have one of the sensor audio monitors listen to the sensor for further information. If they determined the activations were a valid target, they changed the presentation on either or both of the tubes to the map presentation of the sensor string in question. DMPIs were displayed on the map, which featured a "worm" which moved down the map at a rate equal to the computed target speed. ETAs for various DMPIs were also visually displayed and constantly updated. (Fig. 5.) The sensor interpreter and FAC were thus able to "see" the movement of the truck and determine the time for a strike on one of the DMPIs. An example might be the conclusion that a truck would be at LORAN point ECHO at 36 after the hour. The strike would be called for ECHO at

36 and variations in the predicted impact point would be given to the strike aircraft, so it could drop long or short, depending upon aircraft speed and changes in speed of the target.[48/] CBU weapons which would cover an area approximately 3,000 feet long and 1,100 feet on either side of the target were generally used. The wingman on these flights was generally armed with 12 MK-82s.[49/]

Aircraft were fragged for COMMANDO BOLT missions over a four-to-six hour period each night, during which time the COMMANDO BOLT area adjacent to Ban Karai Pass was sterilized below 12,000 feet for strikes only by those fighters.[50/]

Two strike teams were used in COMMANDO BOLT: PANTHER and FLASHER. PANTHERs were the slow-movers, two A-1s with an OV-10 or O-2 FAC, working only VFR and being held in orbit outside the route structure until SPARKY FAC directed them to strike. From 26 December 1969 through 9 January 1970, when their operation was discontinued, PANTHER aircraft had destroyed or damaged 21 percent of the targets they attacked. The greatest limiting factors to the slow-movers were weather conditions and AAA which necessitated a change in their operating area on 26 December, to a newly created COMMANDO BOLT II area.[51/]

FLASHER teams were fast movers (LORAN-equipped F-4s or Navy/Marine A-6s with Airborne Moving Target Indicator [AMTI] equipment) and were not restricted to VFR operations. The LORAN-equipped F-4s usually led one or two non-LORAN-equipped wingmen. The Navy A-6 usually led two A-7s while the Marine A-6 led one Marine F-4. The Marine F-4 and Navy

A-7s were usually flak suppression aircraft, but could also strike targets by releasing on signal from the A-6 or dropping VFR. The FLASHER teams could be used outside the sterilized COMMANDO BOLT area, and thus remained under control of the ABCCC to attack targets at the request of the SPARKY FAC. 52/

The primary problem with the operation was weather conditions which made positive BDA very difficult to obtain. Results of 64 percent of the FLASHER strikes had not been observed through 14 January 1970. It was therefore difficult to appraise effectiveness of FLASHER operations by using reported strike results. For example, on the night of 11 January 1970, reported results of 23 attacks were four fires and one AAA silenced. Weather conditions had precluded observation and subsequent photo reconnaissance indicated 19 trucks had been destroyed. No confirmation, however, credited the FLASHER strike with this success. 53/

Another problem was the seeming difficulty of mating aircraft and targets. 54/ On several occasions, there were trucks moving and no aircraft available, while at other times, there were several aircraft in holding orbit and no targets in the sensor string. 55/

Task Force Alpha also represented a great intelligence potential for all of Southeast Asia. It collected intelligence data from all sources and also had target validation capability. During COMMANDO HUNT III, TFA was developing visual reconnaissance (VR) targets for sectors one through five of STEEL TIGER, as well as all ARC LIGHT strikes for STEEL TIGER.[56/]

Sensors which did not die on time continued to produce a problem for the IGLOO WHITE operation. These sensors tied up a channel or tone code for as long as they were alive, whether or not their transmissions were being monitored. Although a Phase II sensor could be put into the non-real time mode so it would not broadcast its activations, this was not possible with the Phase I sensors which were still being used.[57/]

Because of the short operation span of COMMANDO HUNT III at the time this report was written, its results could not be compared with COMMANDO HUNT I with any validity. These factors, however, indicated its relative success: (1) visual truck sightings for November 1968 were 3,602 as compared with 4,218 for November 1969; (2) sensor activations for the same periods were 7,072 and 10,060, respectively; (3) through-put for November 1968 was estimated at 29 tons per day, while 12 tons per day were determined for the same period in 1969; (4) November 1968 statistics for trucks damaged/destroyed per sortie were .4 versus .6 for November 1969, and .48 for November 1968 truck parks/storage areas struck as compared with 1.1 for November 1969; and (5) effectiveness of airstrikes had also increased. These clearcut improvements indicated the IGLOO WHITE system was continuing to operate more effectively as a detection and targeting tool in 1969 as compared to 1968.[58/]

CHAPTER III

THE IGLOO WHITE SYSTEM

IGLOO WHITE incorporated the Infiltration Surveillance Center (ISC) at Nakhon Phanom RTAFB, Thailand, the remote sensor field, and the airborne relay stations.[1/]

Seismic or audio signals detected by sensors in the field were picked up by orbiting EC-121 or PAVE EAGLE aircraft and relayed to the ground facility at Nakhon Phanom before information derived from them was sent in two directions. The computer received seismic information directly, whereas audio signals involved an assessment process by an audio monitoring specialist and a spectrum analyst before reaching it. Sensor information fed into the computer was displayed in two ways: on a cathode ray tube presenting updated data each minute, and a hard-copy printout (CONFIRM) which was produced every five minutes. These displays were analyzed by a Ground Surveillance Monitor (GSM) before the resulting real time tactical information was passed to the appropriate recipient (SPARKY FAC, ABCCC, or 7AF) for use in strike and intelligence preparation.[2/]

Sensors

The heart of the IGLOO WHITE system was the extensive strings of sensors located along LOCs, in truck parks, and along trails in BARREL ROLL, STEEL TIGER, and DUEL BLADE. These sensors picked up and transmitted the audio and seismic indications to the orbiting EC-121 or PAVE EAGLE aircraft for ultimate relay to the ISC.

The early sensors were basically "off the shelf" acquisitions because of the press of time between Secretary McNamara's order of 15 September 1966 to develop the system and the 1 December 1967 activation date.[3/] The mainstays of the Phase I effort were the Navy SONABUOY and the Sandia ADSID.[4/] The former was modified to become the CANOPY ACOUBUOY acoustic detector, designed to hang up in the jungle canopy, and the SPIKE ACOUBUOY (SPIKEBUOY), modified to implant in the ground where proper canopy was not available. The ADSID was air delivered and implanted itself in the ground to receive seismic indications.[5/] These sensors transmitted on 31 channels in 27 tone codes to make a maximum possible sensor field of 837, although this number was never active at any one time.[6/] Phase I sensors were not commandable. (Figures 6-11.)

Two other Phase I sensors were used, although not in large numbers.[7/] These were the Hand Emplaced Seismic Intrusion Detector (HANDSID), which was primarily used by the Army in Vietnam, and the Helicopter Emplaced Seismic Intrusion Detector (HELOSID), which was launched from the CH-3 helicopter.[8/]

Phase II sensors differed primarily from Phase I devices in their commandable feature,[9/] the greatest advantage of which proved to be an ability to command audio.[10/] This improved family of sensors responded

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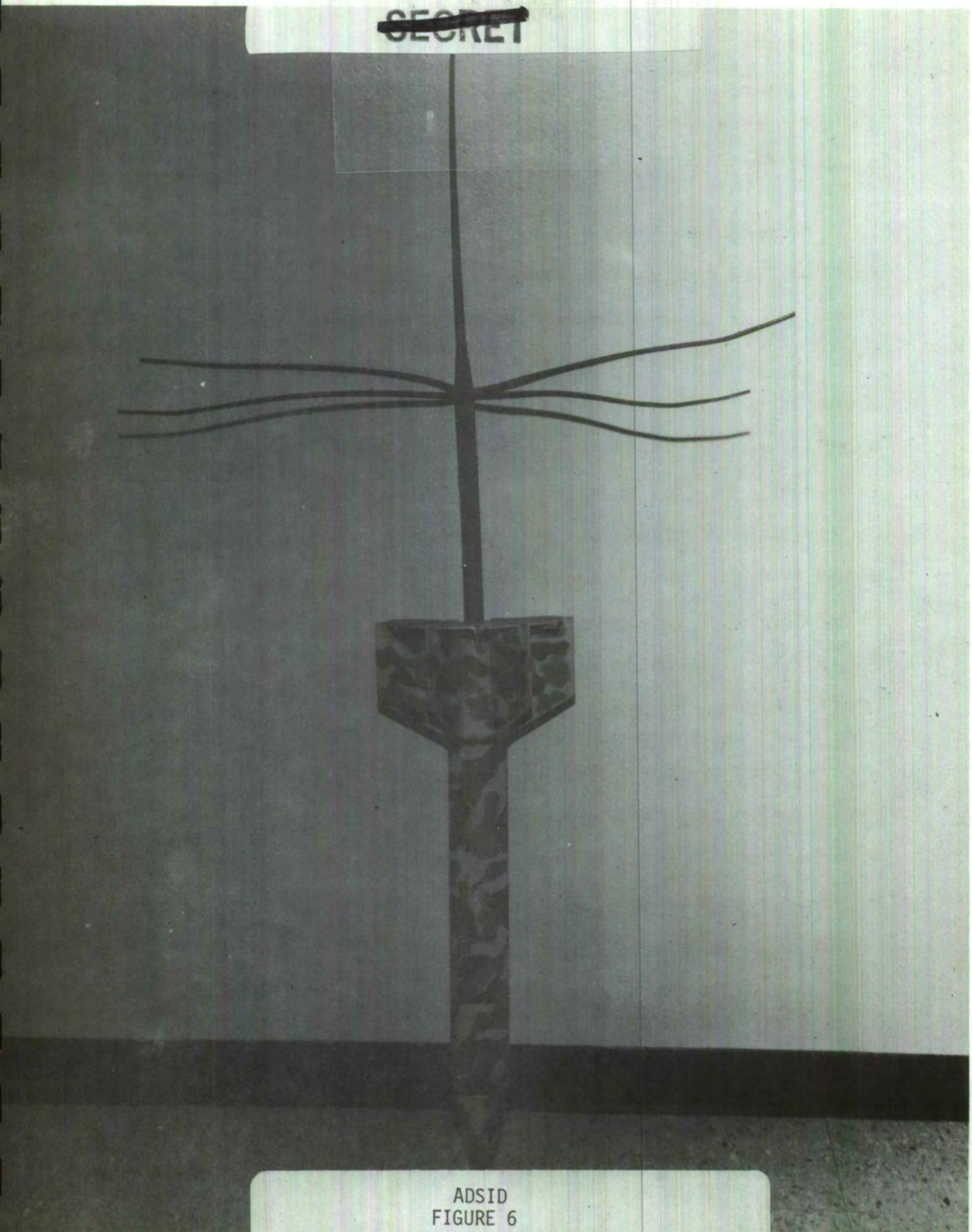

ADSID
FIGURE 6

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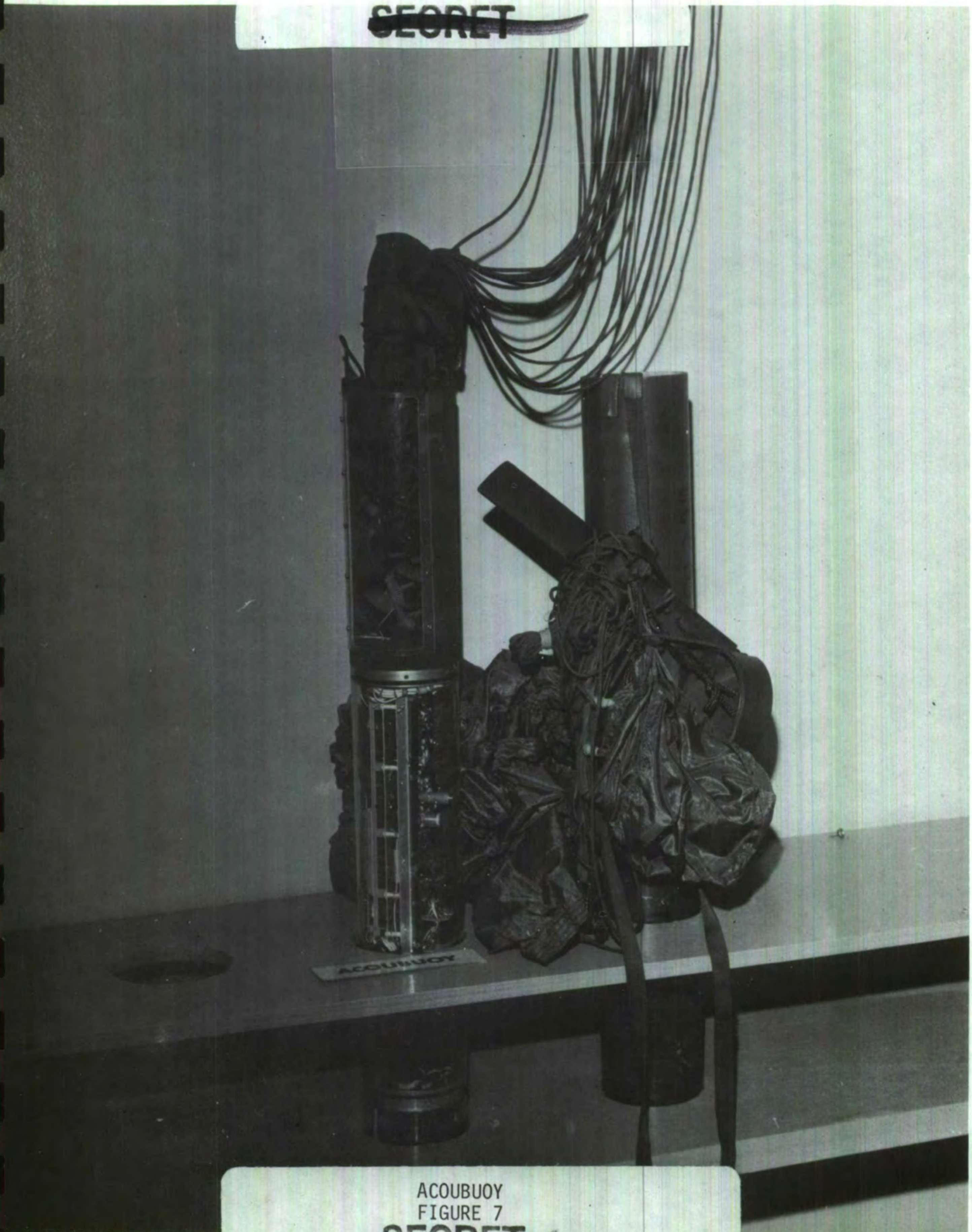

ACOUBUOY
FIGURE 7

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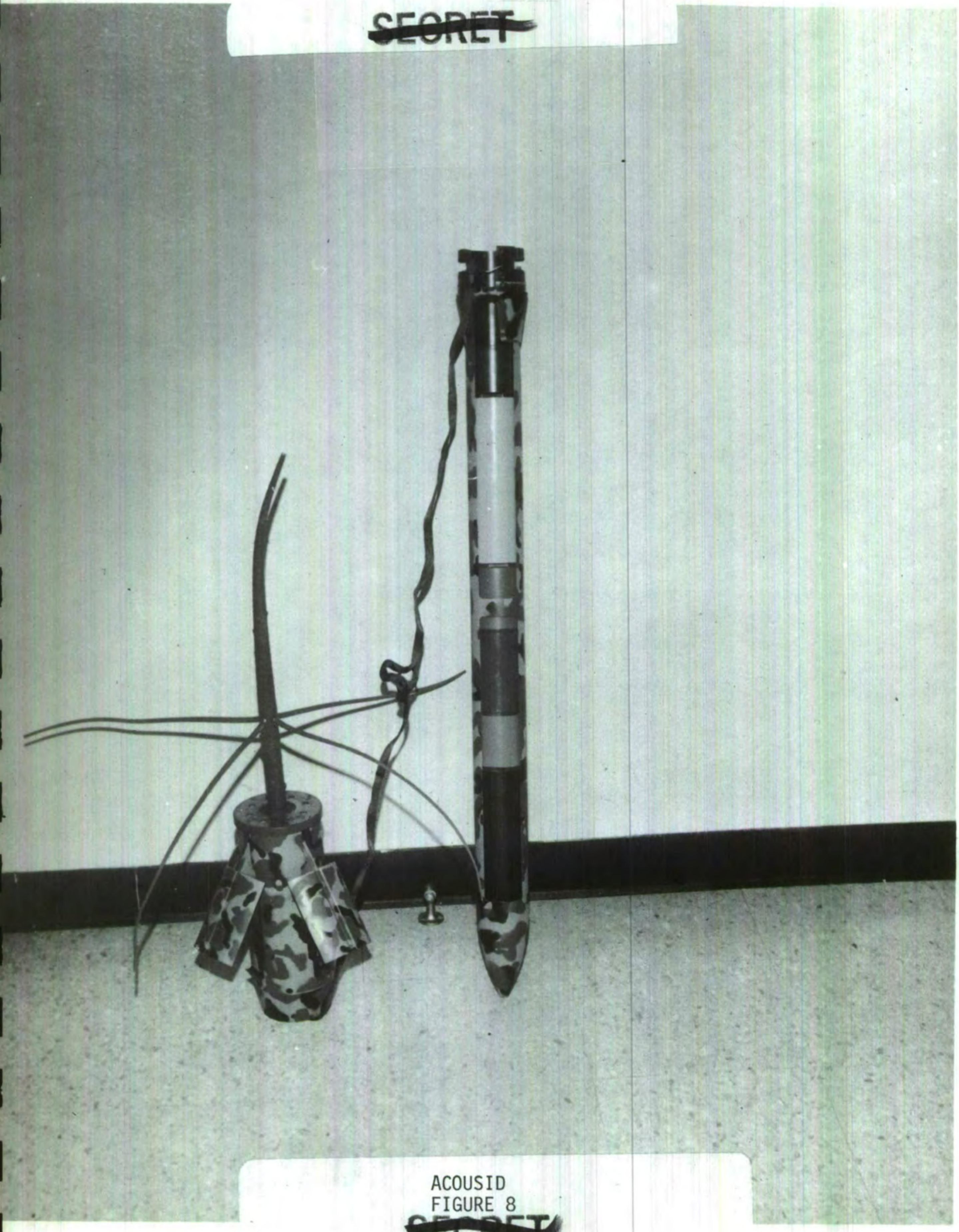

ACOUSID
FIGURE 8

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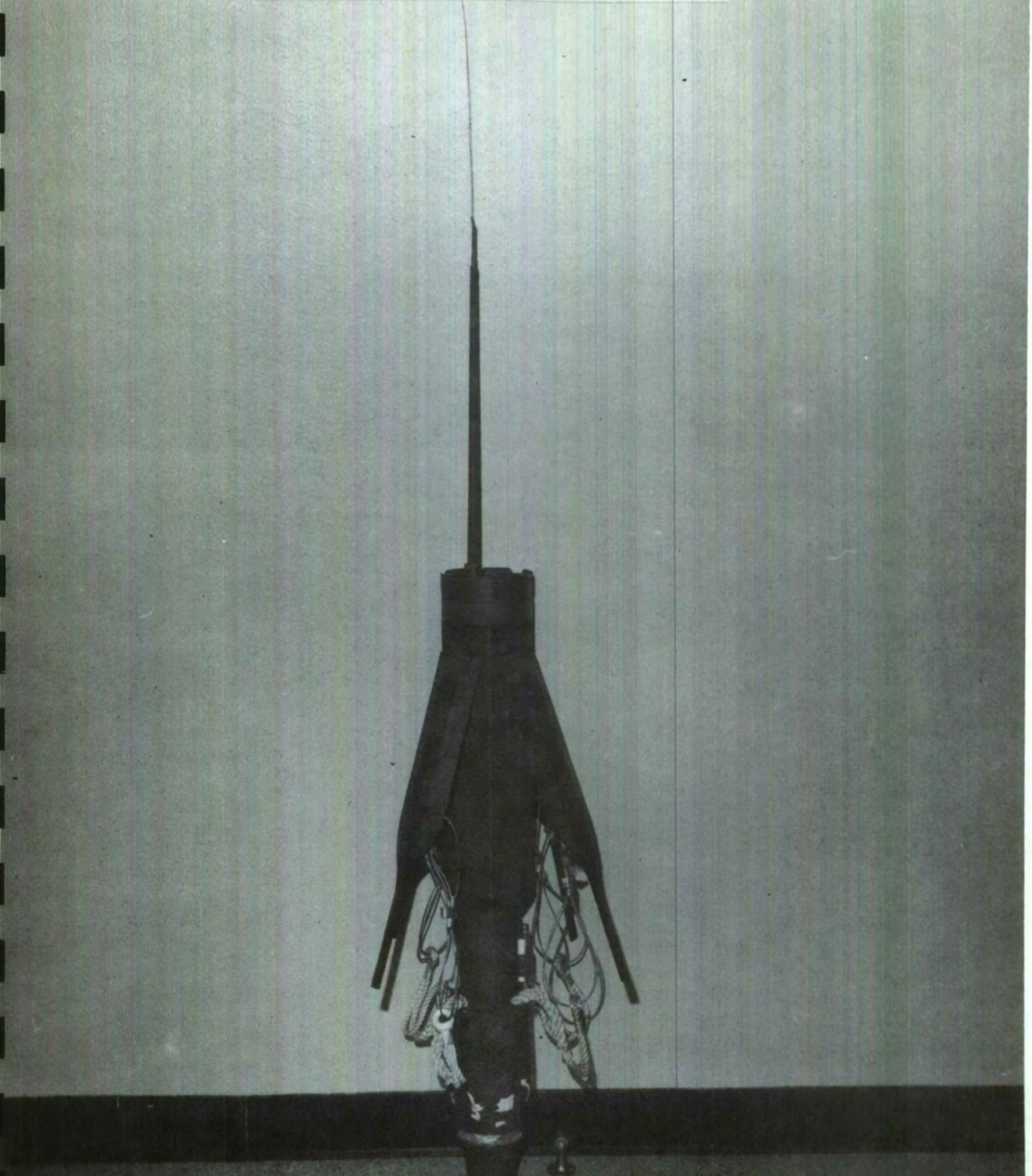

FADSID
FIGURE 9

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HELOSID
FIGURE 10

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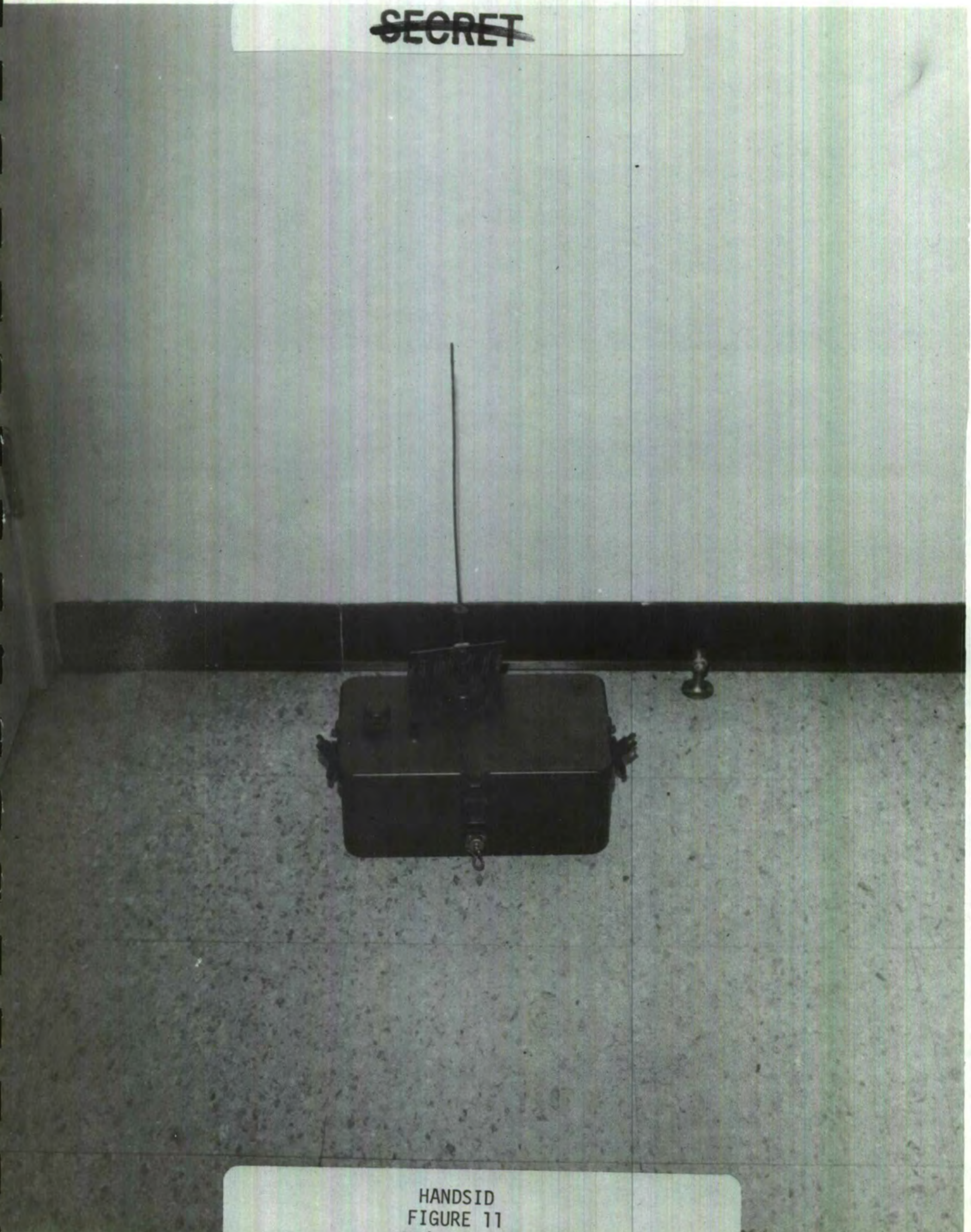

HANDSID
FIGURE 11

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to several commands, primarily: send audio, go non-real time (count impulses and store this information for later transmission on command), go real time (transmit impulses as they occur), and readout (transmit accumulated non-real time impulses). The first of these Phase II sensors was implanted on 22 October 1968.[11/]

Three primary types of sensors were featured in the Phase II program: the ACOUBUOY and SPIKEBUOY, the FADSID, and the Acoustic Seismic Intrusion Detector (ACOUSID). With the exception of sending audio only on command, ACOUBUOYs and SPIKEBUOYs were basically the same as their Phase I predecessors. The FADSID was the replacement seismic sensor for the Phase I ADSID, featuring an ability to be commanded to non-real time.[12/] From its inception, this sensor posed problems, proved to be quite unreliable, and had an abnormally high mortality rate on implant.[13/] Although subsequently improved to a degree, usage of the Phase I ADSID rather than the FADSID predominated.[14/]

The most versatile of the Phase II sensors was the ACOUSID. It was essentially a seismic sensor with an added audio capability on command, which enabled either TFA or EC-121 sensor monitors to command audio to determine the cause of seismic indications when they were present. The use of this sensor was becoming more widespread as supplies became available.[15/]

Although great improvements were evident with the Phase II feature of commandable sensors, additional features were still desirable. Among them were: (1) additional sensor transmission channels; (2) modular design which would permit the use of common modules or components in the fabrication of nearly all sensors; and (3) improved flexibility to respond to various electronic commands.

To incorporate these advances into the system, three main Phase III sensors were designed and included in this program: the ADSID, ACOUSID, and ACOUBUOY.[16/] With the exception of the ADSID, these sensors were physically very similar to their Phase I/II counterparts and were to be used simultaneously with them. Implanting procedures were also basically the same as in Phases I and II.

In terms of actual differences, the number of separate sensor identifiers on a channel in Phase III was increased from 27 to 64 by using digital identification code rather than a tone code. Making the sensor transmission band narrower also increased the number of channels from 32 to 640. Thus, the theoretical maximum sensor field was expanded from 837 in Phase II to 20,480 in Phase III. Computer capabilities, however, limited this number to slightly more than 2,000 sensors. Modular construction reduced costs, logistics complexities, and provided ability to tailor sensors to the situation presented.[17/]

To support the Phase III program, 18 EC-121 aircraft were to be modified with Phase III receivers, and PAVE EAGLE II would be an exclusive Phase III aircraft.[18/] A new computer program, also needed at the ISC, neared completion by December 1969, with sensors anticipated to be in the field by mid-1970.[19/]

Sensor Emplacement

The Sensor Placement Planning Committee at Task Force Alpha made the decision to plant sensor strings. This group, which included representatives from Operations (DO), Intelligence (DI), and Technical Operations (DIO), met daily to weigh various proposals for placing new strings or reseeding old ones. Studies were made to determine their feasibility, taking into account such factors as terrain, jungle canopy, tone codes and frequencies available, and the type of information desired from the string.[20/] This information was sent to Seventh Air Force which fragged the sensor mission to the 25th Tactical Fighter Squadron at Ubon RTAFB.[21/] After intelligence at TFA prepared the needed placement information and mosaics, these essentials were forwarded to the 8th TFW (DI) at Ubon, which prepared the flight maps and additional information.[22/]

Although the task of implanting sensors had been filled originally by the Navy OP-2E and the CH-3 helicopter, the environment soon became too hostile for these aircraft. As a result, the F-4 began implanting sensors in March 1968, and on 25 June the use of the OP-2E was discontinued.[23/] The 25th TFS, which had long-range navigation (LORAN) equipped F-4s, became the unit dedicated to sensor emplacement.[24/] In addition to being the only Air Force sensor emplacing unit, the 25th TFS was also the mainstay of the LORAN/Sensor strike force.[25/]

All sensor drops were accomplished during daylight when weather conditions made ground photography possible.[26/] This was necessary since a KB-18 camera took horizon-to-horizon photos at the instant of sensor release. Using this photo coverage and established ballistics statistics, the TFA personnel were able to compute, within about 40-60 meters, the exact location of each sensor.[27/] Experiments were conducted on making drops at night, but no operational night drops had been made at the time of this writing. However, night drops, using a laser camera on an RF-4 flying formation with the sensor aircraft, appeared feasible.[28/]

There were several reliable methods of sensor emplacement--the primary one--use of LORAN coordinates in combination with a FAC to determine the initial drop point. Other variations included FAC smoke to identify the starting point for a string or a visual drop in certain areas, when no other method was available. It was important to realize that the techniques of sensor emplacement were quite unique to the fighter pilot. All drops were made from straight and level flight, at a pre-computed altitude, from 500 to 2,000 feet above the terrain, and 550 knots airspeed. The pilot had to be established on his run-in heading and altitude at least 16 NM prior to the initial release point, because the LORAN required at least 30 seconds of straight and level flight prior to weapon release for accurate output.[29/] At the release point, the first sensor was triggered by the pilot and the others sequenced by the use of an intervalometer. The ADSID was carried on external racks and simply blown off, like a bomb, at release point. The FADSID, ACOUSID, or ACOUBUOY sensors were carried in an SUU-42 external pod and blown out by a small charge at release time. 30/

The length of most sensor strings allowed one aircraft to implant them, however, exceptionally long strings of 18 to 20 sensors required a second aircraft. Sensor emplacement aircraft were escorted by another F-4 loaded with ordnance for use as a decoy, as a flak suppressor, or a strike aircraft. Serving as a motivational device, the 25th TFS received reports stating which sensor did or did not operate after being implanted. 31/

BAT CATs

The second essential component of the IGLOO WHITE system was the airborne relay platform, which became the responsibility of the 553d Reconnaissance Wing located at Korat RTAFB, Thailand. Primarily using former Navy aircraft control and warning EC-121s, this unit had been activated at Otis AFB, Mass. The aircraft were reconfigured for the IGLOO WHITE mission and flew their first combat sortie on 25 November 1967. 32/ By 6 December 1969, the unit had 24 aircraft and was manning four orbits, two on a night-only basis and two 24 hours a day. The time-on-station was 10 hours per aircraft at an altitude of 16,000 to 18,000 feet. At that altitude, sensor transmissions could be picked up within 43 NM with about 90 percent accuracy. 33/

Equipped to automatically relay sensor data to the ISC, 34/ the EC-121 also had four manned sensor display stations, a supervisor station, and supporting Ultra High Frequency (UHF) secure voice communications to the ISC for a manual backup mode of operation. The EC-121 also had the capability to issue commands to sensors and monitor responses during manual operation. For sensors that transmitted audio, the operator was able to listen to the associated audio data.[35/] The aircraft were all equipped to operate with Phase I and II sensors. With the approach of Phase III sensors and operations, nine aircraft had been modified to receive all three phases by December 1969; the others were to be modified in future months.[36/] (Figs. 12, 13.)

Operationally, the aircraft served in a much more diversified manner than originally anticipated.[37/] For example, in December 1969, Rose orbit, in BARREL ROLL, was operating in both manual and automatic modes because of the orbit distance from TFA. Green orbit, in Northern STEEL TIGER, was an all-automatic operation, but the primary strings were monitored so manual operation could be assumed if necessary. Blue orbit, in the tri-border area, was unique in several ways. It monitored a number of STEEL TIGER sensor strings and relayed the information to TFA automatically. It also monitored a number of strings in the DUEL BLADE (I CTZ) area and relayed this real time tactical information to the Marines and the Army for possible artillery response. To assist the EC-121 sensor monitors, an X-T Plotter was installed on a test basis in the aircraft flying the Blue orbit. Producing a sheet similar to the ISC CONFIRM, this equipment provided them with an automatic printout system, and the airborne analyst

ANTENNA ARRANGEMENT

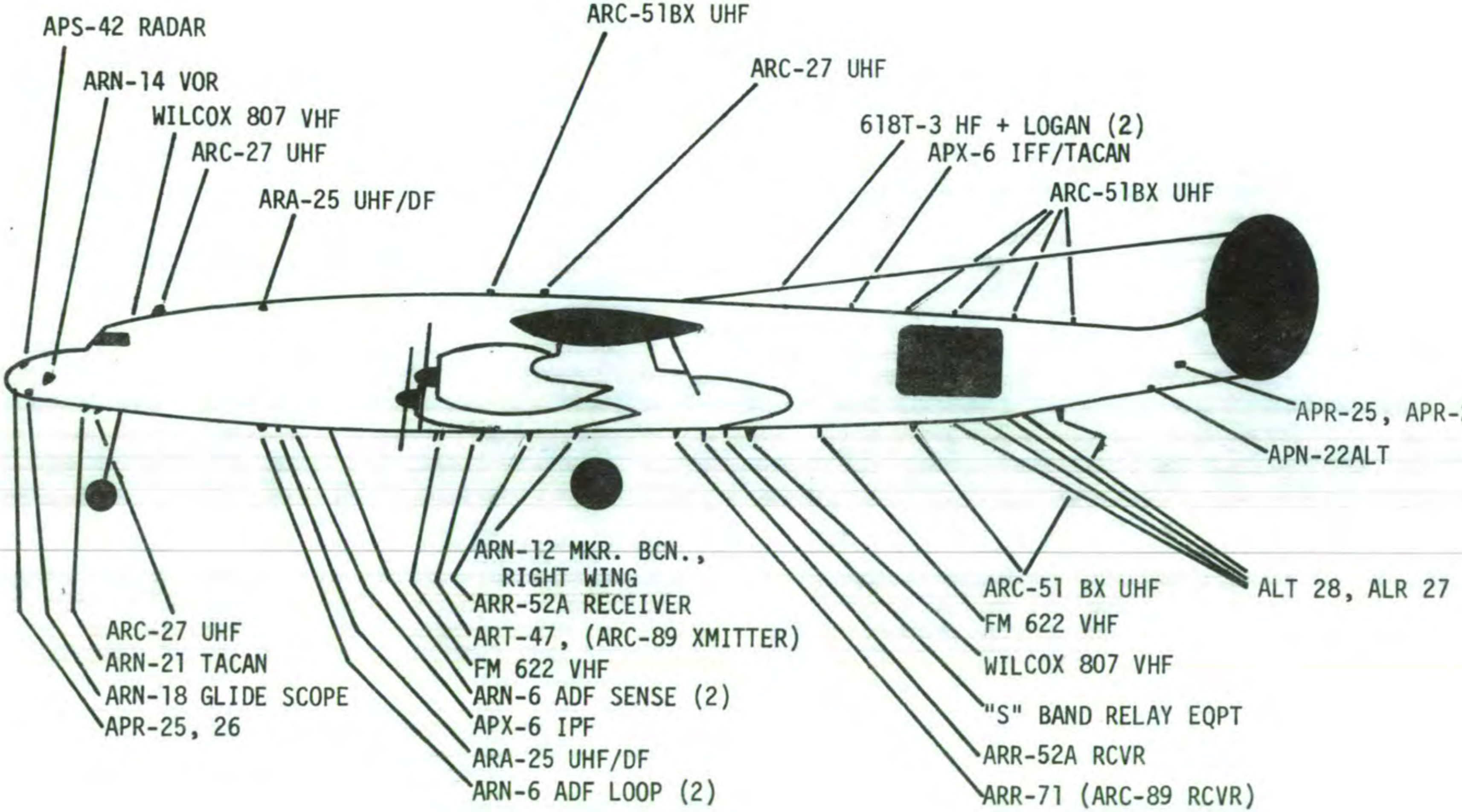

FIGURE 12

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INTERIOR ARRANGEMENT

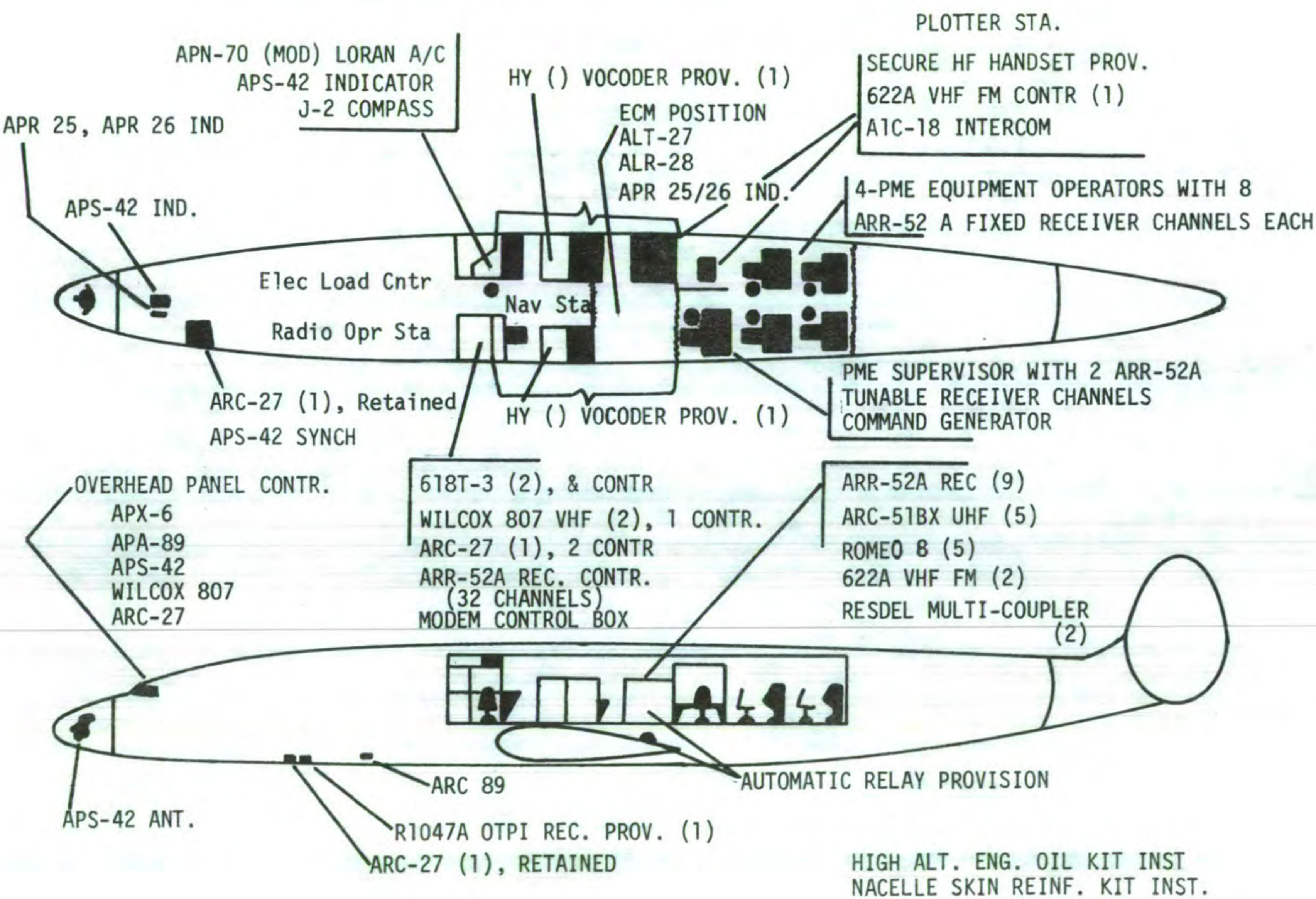

FIGURE 13

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received a near-real time evaluation of up to 100 sensors. When used in support of the Army, for example, which normally used four sensors in a string, up to 25 strings could be automatically monitored and interpreted. This development greatly enhanced the ability of the EC-121 crew to detect targets.[38/] The plan called for availability of six X-T Plotters with racks installed in nine aircraft for their use.[39/] Envisioned in 1969, this capability also helped bring about realization of the concept of the EC-121 as an airborne and alternate Infiltration Surveillance Center.[40/]

The fourth orbit, Orange, was operating in purely manual mode because it was located too far from the ISC at NKP. Any significant movements monitored by it were radioed to ABCCC, TFA, and 7AF. It also served as the relay platform for DART II. In addition, the 553d had an Amber orbit which could be flown as a backup for DART I, if needed. The Blue orbit could also be divided into two, if sensor saturation made it necessary.[41/]

At the close of 1969, the 553d Reconnaissance Wing had not lost any aircraft to enemy fire. Due to the basic vulnerability of the EC-121 and its large crew, 15 to 22 men, the orbits were adjusted if high threat AAA areas were encountered. Ten of the BAT CATs were also equipped with at least rudimentary electronic countermeasure (ECM) gear, and were used on missions that flew into the areas where SAMs and radar-aimed AAA were a possibility.[42/]

The EC-121 operation had to be considered in light of one overriding problem: the age of the aircraft. All of the EC-121s had been in continual service for a number of years. An ever increasing amount of time was being spent on maintenance, and parts were becoming more difficult to obtain. The number of orbits required was also due, in large part, to the limited altitude capabilities of the EC-121. It seemed reasonable that a follow-on aircraft with greater reliability, higher altitude capabilities, and a more economic crew configuration was essential for realistic continuation of the sensor relay function over the long term.[43/]

PAVE EAGLE

In early 1968, Hq TAC visualized conditions might arise in certain EC-121 orbit areas, in which it would be impractical to risk the airplane and its large crew to enemy AAA fire.[44/] The solution was the YQU-22A, a Beechcraft Debonair (PAVE EAGLE), modified with a turbocharged engine, additional fuel capacity, and data relay equipment, designed as a radio controlled drone. (Figs. 12, 13.) It was to be used for a period of from one to five days, while the threat to the EC-121 was eliminated.[45/] It was envisioned that this aircraft could maintain an orbit for six hours manned and 12 hours unmanned at altitudes in excess of 20,000 feet.[46/] By March 1969, five of these aircraft were operationally ready and began flying one orbit from Nakhon Phanom RTAFB, Thailand.

The PAVE EAGLE, a relay platform used in receiving signals from the sensors and sending them to TFA, had none of the manual capabilities of the EC-121. Tests determined this aircraft at 22,000 feet was approximately 80 percent as effective as the EC-121 at 16,000 feet.[47/] Although

UNCLASSIFIED

PAVE EAGLE Drone
FIGURE 14

UNCLASSIFIED

control in orbit was in the drone mode, all flights were manned, due primarily to: (1) high probability of losing an aircraft in the drone mode; (2) permissive environment for manned operation; and (3) an incompatibility of the drone transmitter with radio frequency interference at NKP.[48/]

As early as February 1969, it had been recognized that PAVE EAGLE had several deficiencies, such as, no deicing gear, insufficient power, and no pressurization. This was further stressed by two accidents (one of them resulting in a fatality) which were attributed to engine failure.[49/]

The problems with the aircraft were further underlined by a 73 percent sortie rate effectiveness and a 63 percent on station effectiveness in late May and early June 1969.[50/] Effective 1 July 1969, the aircraft was restricted from flight over hostile territory and an EC-121 assumed its orbit.[51/] The PAVE EAGLE operation in Southeast Asia was suspended on 4 September 1969, and the three remaining aircraft were returned to the United States.[52/]

Although PAVE EAGLE I had been unsatisfactory, work had long been in progress to produce PAVE EAGLE II. Many recommendations had been made, including cabin pressurization, more adequate deicing gear, and a turboprop engine. As work progressed, the decision was made to use a Beech Model 36, about the same aircraft as PAVE EAGLE I. It would not be modified to include pressurization or a turboprop engine, due to cost, but a larger reciprocating engine was to be installed. In addition, PAVE EAGLE II was to have the capability to respond only to Phase III sensor activations. By limiting it to Phase III, use of the aircraft was limited to readout of Phase III sensors.[53/] These sensors were expected to be actively employed in the field by mid-1970.[54/] PAVE EAGLE II was undergoing extensive testing at the end of 1969, and it was not to be deployed to Southeast Asia until it had fulfilled all the necessary operational requirements.[55/]

Infiltration Surveillance Center

Three S-band tracking antennae completed the link between the orbiting relay aircraft and the ground element of the system. Sensor activations transmitted through the link provided the data for meaningful assessments of enemy activity in the sensor field. The ISC performed several major functions: (1) data processing; (2) target identification; and (3) system performance monitoring.[56/]

The digital data picked up from the relay aircraft were fed into the Ground Terminal System Segment. Audio information was separated from the data train, converted into analog form, and sent to audio monitoring specialists who would make both an audio and spectrum analysis of chosen audio input. Any selected audio information could be entered into the computer using a 2260 video display-typewriter.[57/] Tone code information was fed directly into the IBM 360/65 computer. There it was combined with the audio assessment and printed every five minutes in the form of a hard copy printout. This record covered the minute-by-minute activations of each sensor for the previous 40 minutes, providing a visual history of activations. In addition to the hard-copy printout, each one minute update of the CONFIRM was displayed on a 2250 cathode ray tube which provided near-real time tactical information.[58/]

The hard-copy printout was the composite of all sensor generated information and the main tool with which the Ground Surveillance Monitor worked. (As of 1 November 1969, the TAO became a GSM.)[59/] Sensor activations were noted by a number opposite a time frame on the sheet. The higher the number, the more activity had been picked up by the particular sensor in that one minute period (the maximum number of activations per minute was six).[60/] A code letter, such as, A-aircraft, T-truck, V-voices, printed in place of the number, indicated an audio assessment of the activation. The hard-copy printout also included the area and string location of the sensor, its frequency and tone code, and the distance between sensors.[61/] The number of activations, their strength and duration, as well as their movement from sensor to sensor, were the tools used by the GSM to assess amount of traffic, size, speed, and direction. Added GSM validity was obtained by his intimate knowledge of the area, the location of the sensor strings, and the individual characteristics of the various sensors.[62/]

Information derived from the hard-copy printout was sent to several sources. It was available to the COC at TFA (SPARKY FAC), although its primary source of information was the minute by minute sensor activation display on the 2250 cathode ray tube. Significant activations were called to the ABCCC as SPOTLIGHT reports for possible strikes. In addition, the information was used to build up data banks on truck parks, traffic density, and direction of traffic flow. It was also passed to 7AF for use in intelligence and future targeting.63/

Two other functions within the IGLOO WHITE system were important. The first was the computerized "keyword" file. This was an automated data file which served as a central depository for multiple source intelligence data sorted by route segment and geographic coordinates.64/ This file enabled the user to obtain relevant information on cumulative sensor inputs in particular locations or particular times of the day over a prolonged period.65/

The second, a program directed by 7AF, DOA, was Traffic Analysis and Prediction (TRAP). The purpose of this program was to identify potential stockpile locations, including storage areas and truck parks, locate bypasses in the LOC system and, by eliminating duplicate truck counts, determine the approximate number of trucks moving at any given time. The information obtained by TRAP was used for target development, both for tactical air and ARC LIGHT, LOC status analysis, and as intelligence information on possible new route construction, supply transfer locations, and LOC interdiction effectiveness.66/

Accuracy and Effectiveness of IGLOO WHITE

The primary test of IGLOO WHITE effectiveness was conducted during the COMMANDO HUNT I campaign and was reported in detail in the "COMMANDO HUNT" CHECO Report previously cited. In summary, it found that 82 percent of the data generated by the sensors was received, processed, and interpreted. The biggest contribution was in terms of truck park and storage area target nomination. Approximately 39 percent of the targets attacked were IGLOO WHITE nominees. In the area of truck kills, approximately 25 percent of the total trucks destroyed or damaged had IGLOO WHITE inputs. Sensor inputs were also vital in the compilation of cumulative intelligence, through-put estimates, and force allocation.[67/] The effectiveness of sensor data appeared to be increased in COMMANDO HUNT III, but conclusive evidence will not be available until the completion of that campaign.[68/]

The question of the accuracy of TAO performance was addressed in detail in a report by the Directorate of Tactical Analysis, Headquarters, Seventh Air Force, on 15 November 1969. Its thorough analysis concluded the number of trucks called by the TAO was very close to the actual number visually confirmed by the FACs. In cases of differences, the tendency for the TAO was to overcall slightly the number of trucks in large convoys.[69/]

Overall, it seemed the IGLOO WHITE system was both effective and accurate in its analysis of traffic. It was also very useful in the area of non-real time intelligence and efforts were under way to use sensor data as one source of establishing BDA.

CHAPTER IV

FUTURE APPLICATIONS OF SENSORS

With the advent of the Phase III sensor program, IGLOO WHITE itself had reached a plateau.[1/] Its future application and evolution remained undetermined.

At least one study had been completed that addressed specifically the application of IGLOO WHITE technology to border surveillance in Southeast Asia. The implications for employment of sensors in other parts of the world in roles such as border surveillance and interdiction monitoring seemed evident. Beyond this was the possibility of using stationary orbit satellites as sensor data relay platforms rather than orbiting aircraft. The relay could then be made from a much larger sensor field to readout stations as far away as line of sight would permit (Hawaii for Southeast Asia sensors).[2/]

While it was generally conceded that a facility such as DUTCH MILL at NKP would not be reproduced, the use of DART in South Vietnam and the possible use of the Sensor Reporting Post (SRP) made more mobility for the entire system possible. These facilities also made the application of sensor technology on a temporary basis in a given area more feasible in terms of cost. The experience of IGLOO WHITE had served as a learning curve and developmental test to bring the whole field of sensor technology to a relatively refined level.

In the conclusion of CHECO Report, "IGLOO WHITE (Initial Phase)," dated 31 July 1968, a number of questions were raised pertaining to the future of IGLOO WHITE. Several of these questions have been answered in this report, and for further clarification, a summary of the questions and pertinent facts bearing upon them is provided:[3/]

To what extent should the system in isolation, have control over its own aircraft resources for implanting sensor fields and verifying detected target sequences?

During COMMANDO HUNT I, TFA had operational direction over an allocated number of aircraft and no major problems were encountered. Operational direction was not given to TFA during COMMANDO HUNT III for the sake of unity of command within Seventh Air Force, since it was determined during COMMANDO HUNT I that the aircraft control function and the sensor readout function need not be collocated.[4/] Although TFA had no control over the sensor implanting aircraft, the 25th TFS was dedicated to sensor emplacement as its primary mission and thus was responsible to TFA through 7AF. The operation was satisfactory to all parties.[5/]

The extent to which TFA should control aircraft to verify detected target sequences requires the consideration of four factors. First, since the number of target sequences varied nightly, a continual shift in the number of aircraft required to verify movements would be necessary. This could result in less than optimum aircraft utilization. Second, air traffic control in the interdiction area, already a problem, would be compounded by a continually changing number of aircraft going to continually changing areas to verify targets. Third, a large amount of this function was being done by gunships with no apparent problems. Fourth, a large number of sensor sequences did not need visual verification given the state of the art by 1970. Overall, it appeared a dedicated force for verifying detected target sequences was unnecessary.[6/]

To what extent should the system have direct control over strike aircraft and ordnance in its zone of operations?

The question of command and operational direction was subjected to a critical test during COMMANDO HUNT I. Although the operational direction at TFA was generally satisfactory, it was determined unnecessary to have aircraft control and sensor readout at the same location. Optimum control integrity also dictated that operational direction be retained at 7AF, through the ABCCC, if possible.[7/] The ordnance control function was satisfactory under 7AF and there appeared to be no need for TFA to have direct control over either strike aircraft or over ordnance.

Can the system operate effectively as a real time intelligence source for predicting future positions of moving targets?

The ability of the system to provide real time intelligence on moving targets was demonstrated during COMMANDO HUNT I and by use of LORAN/Sensor strikes in the months immediately following. The OPlan for COMMANDO HUNT III spelled out this application of IGLOO WHITE data and the SPARKY FAC operation was firm evidence that it would work.[8/] It must be recognized, however, that sensor technology cannot be used to predict movement several hours in advance or to project movement several miles ahead.

Can the system be used as the basis for a fully organized Tactical Air Control System (TACS) (including radar) to monitor and strike enemy traffic and targets both on the surface and in the air within its zone of operations?

There would seem little question that it could be used as a TACS but not as the exclusive agent for monitoring and striking enemy traffic and targets. More information than that provided by sensors was needed for the complete operation of such a system. The physical facilities at TFA, including INVERT radar at Nakhon Phanom, seemed adequate as the base for a TACS and could provide an alternate site for the one at Tan Son Nhut. The primary issues in this question were again the duplication of effort, operational direction versus command control, and the inadequacy of sensors as the sole intelligence source for tactical air.

Can the system be used effectively as a basis for defending battlefield strongpoints? Ground installations? Airfields?

The sensor system has already proved itself to be one valuable link in the perimeter defense mechanism, witness Khe Sanh and the use in the DUEL BLADE area.[9/] Again, however, there was some question as to the use of sensors as the sole detection system for defensive actions. In the present state of the art, at least, other factors, such as dogs, rocket watch teams, Starlight Scopes, and associated techniques were needed for a complete defense detection system.

Can the system provide accurate guidance for the effective direction of ground or offshore naval fire on ground targets?

The present applications by the Army and Marines effectively exploit sensor data to direct artillery fire. The key to this system is pre-aimed artillery which can be fired when sensors detect activity in certain areas.[10/] Presently, sensors are not used to correct fire coordinates or evaluate fire effectiveness. Naval application would be possible by firing on predesignated coordinates in the case of sensor activation but again, fire correction by sensor is not presently utilized.

Can the system be used to monitor such areas as demilitarized zones or truce lines?

The increasing use of sensors to monitor the movement of ground troops in Vietnam indicates the system might have future application in such areas as demilitarized zones or truce lines. Such possible use has been projected by the Directorate of Plans, Headquarters, USAF. Any such application would be of a burglar alarm nature and would require further backup facilities to ascertain exactly which kind of activity was taking place.[11/]

Can the functions of sensor monitoring be performed by drone aircraft? By satellites in a stably positioned orbit relative to the movement of the earth?

The PAVE EAGLE has been operational long enough to demonstrate the concept of sensor monitoring by drone is possible. Its weaknesses are the airframe and engine, not the electronic ability of sensor monitoring.[12/]

The use of satellites remains an area for future planning and consideration. At least one study has been made on the use of sensors and satellites in several future applications for large area coverage and distant monitoring.[13/]

Can the collection and analytic equipment needed to identify targets be installed in movable surface vans or aircraft, so that the system will not be dependent upon a fixed ground installation?

The X-T Plotter capability of the EC-121 allows bypassing of the ISC, as automatic monitoring and analysis of sensor data can be directed from the aircraft.[14/] DART, a surface van contained collection and analysis facility, is capable of being moved as needed.[15/] DCPG considers DUTCH MILL a one of a kind facility which will not be reproduced.[16/]

Although all of the questions raised about the future application of IGLOO WHITE in early 1967 could not be answered by the end of 1969, it was significant that several had been considered in application experiences during such campaigns as COMMANDO HUNT I or in studies on the subject of sensor applications. Advancements had been made in case of system operations with more refined systems at the ISC. New sensors had been developed and proved in application. New tactics such as COMMANDO BOLT had been initiated, and the entire system had proved itself as an established part of the overall interdiction campaign in SEA.

Epilogue

Several issues were addressed by Brig. Gen. Chester J. Butcher, Commander of Task Force Alpha, in January 1970, reflecting his proposals for the future of TFA. These primarily concern future manpower, operations and maintenance funding, and the future concept of the sensor system itself:17/

In late January, it was decided to implement the first of three possible options for future operations. Without compromising the mission, one of the two IBM 360/65 computers was to be eliminated by 1 July 1970 with modifications incorporated to program SPARKY FAC into the one remaining computer. The EC-121 was to perform as a daylight ISC during the wet season, SPARKY FAC was to be manned by TDY personnel, and nearly all of the FY 71 operations and maintenance would be assumed by PACAF. These measures would reduce needed manpower--some 136 military and 51 civilian spaces--and, along with equipment modifications, would save approximately $4 million per year in TFA operating costs.

A second option, still under consideration in January 1970, was to replace the ISC with a Sensor Reporting Post (essentially a mobile ISC). Such a unit was in operation at Eglin AFB, Florida, awaiting a decision as to its future. In addition, such residual functions of TFA as intelligence would be transferred to in being units of 7AF/13AF.

The third option, also under consideration, would eliminate the EC-121 and replace it with the PAVE EAGLE II. This would necessitate modifying both DART I and II for Phase III sensors and using all Phase III sensors in STEEL TIGER and I and II CTZ in Vietnam. Options 2 and 3 represented potential savings of about $12 million.

Although a number of critical questions remained in the application of various options for TFA and the sensors, it was apparent that dramatic changes were destined for IGLOO WHITE.

CHAPTER V

DART I AND II

DART I

The success of IGLOO WHITE sensors at Khe Sanh was so gratifying that in April 1968, COMUSMACV was directed to coordinate with DCPG and formulate a plan for the use of these assets in-country. The project was given the nickname of DUFFEL BAG.[1/] As the plan evolved, it became obvious that sensors could be used throughout South Vietnam in support of ground operations, in anti-infiltration technology, and in target acquisition to provide near-real time (less than one minute) intelligence information on personnel and vehicular position and movements.[2/] One part of this system was the Deployable Automatic Relay Terminal (DART), which was designed to serve the same basic functions of sensor readout, interpretation, and transmission of data to the necessary operating agencies that the ISC served for the IGLOO WHITE system.[3/]

The DART was actually tested and manned during the fall of 1968 at Eglin AFB, Florida, where the prime contractor, Radiation, Inc., assembled the system and Tactical Air Command trained the personnel. Several ideas were advanced for DART application, including LOC, border, and base surveillance, or possibly an alternate ISC. Deployment was decided upon to implement COMMANDO SHACKLE, a plan centering on sensor surveillance of infiltration from Cambodia into South Vietnam. DART I was deployed to Bien Hoa on 18-19 February 1969 and became operational on 1 March 1969.[4/]

The DART installation consisted of a Transportable Acquisition and Assessment Ground Station, a Communications and Power Subsystem, an Operations Shelter housed in several vans, as well as a directional S-Band Antenna atop a 60-foot tower.[5/] The DART was the readout portion of a sensor application system; the sensors and relay of sensor signals were similar to that discussed in IGLOO WHITE. Sensors and a relay platform of the DART were replacing the Infiltration Surveillance Center.

The initial period of operation of the system, 1-31 March 1969, was a shakedown and learning time. Relay was provided by an EC-121 BAT CAT flying the Amber orbit with automatic relay to the DART. Because of the flat terrain which characterized the Delta region of South Vietnam, it was possible to replace the orbiting EC-121 with a permanent ground relay station located atop the 3,235-foot high Nui Ba Den mountain. This facility was installed on 19 April 1969 and became operational on 1 May 1969, replacing the orbiting EC-121.[6/] On 16 June, the Nui Ba Den facility was extensively damaged by a sapper attack. The EC-121 again took up the Amber orbit, which it maintained until 11 July, when the mountaintop relay facility resumed operation.[7/]

Although the DART, the relay aircraft, and the Nui Ba Den facility were operated by the Air Force, the sensors were hand implaced by the Army. Sensor reactions were relayed to the Army for artillery fire support. The 25th Infantry Division, the 1st Infantry Division, and the 1st Air Cavalry Division all responded to DART I reports. For example, the 25th fired on an average of approximately 68 percent of the DART target sequences it received during the 1 March-30 June 1969 period. It expended about 2,000 rounds per week or 13 rounds per sensor target. The BDA from U.S. Army reactions against DART targets produced the first significant results from the use of sensors in RVN. During May, DART targets were credited with a body count of more than 100 KIA.[8/] It was significant that the DART was reading only 20 to 30 percent of the sensors in use during that period, but these produced about 75 percent of the targets fired upon. DART target sequences were also forwarded to III DASC for tactical air reactions if the assets were available. A majority of this response was by AC-47 gunships.[9/]

The number of sensors in the field and artillery response to their activations almost doubled after 11 May 1969, with the inauguration of Operation TIGHT JAW. This was a MACV plan to increase border surveillance in Vietnam. A significant increase in the application of tac air was also evident after the start of that operation.[10/]

Sensors used with DART I were different from those of IGLOO WHITE origin. The primary sensor used was the Phase I HANDSID.[11/] This type of sensor was placed in the ground with only the antenna showing. It could be used alone as a seismic sensor or have a Magnetic Intrusion Detector (MAGID) or a Passive Infrared Intrusion Detector (PIRID) hard-wired to it to transmit magnetic/infrared/seismic activations as desired.[12/]

At the end of 1969, the future of DART I was uncertain. A new system called Battle Area Surveillance System (BASS) was developed by

DART II

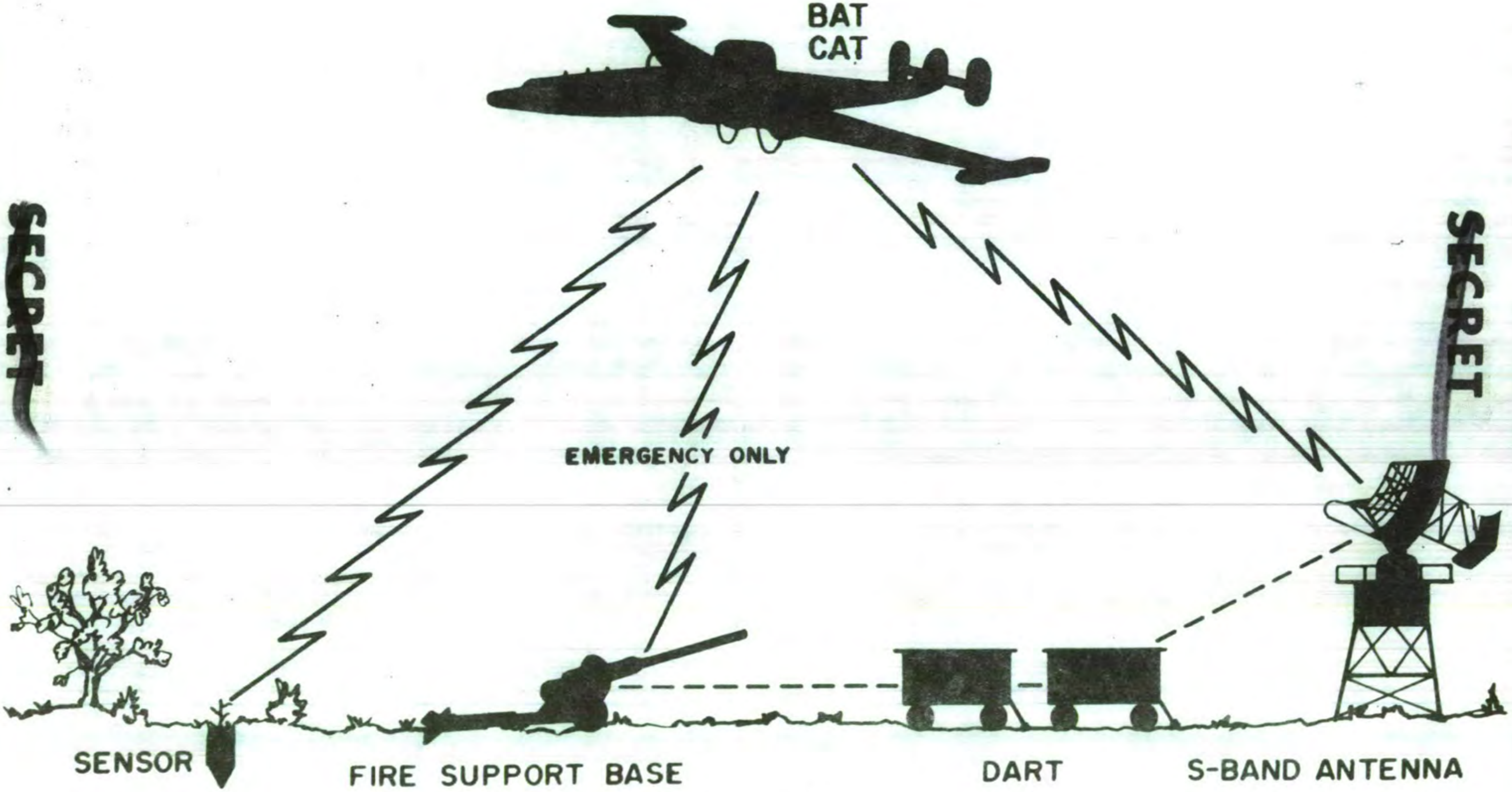

FIGURE 15

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DCPG for use by the Army. It was simpler than the DART and would place the system completely under Army operation.[13/] Neither BASS nor DART was compatible with Phase II sensors and the problem of modification also remained to be solved.[14/]

DART II

DART II was built as a backup unit for either DART I or the ISC, and as a training facility within the CONUS. The success of DART I during the spring and summer of 1969, and the desire to increase sensor surveillance along the Cambodian Border, precipitated the decision to deploy DART II. Operation TIGHT JAW also envisioned integration of the VNAF into the sensor surveillance system, and DART II was applicable to that objective as well.[15/] Thus, on 15-17 September 1969, DART II was deployed to Pleiku with all of the equipment of DART I, with the exception of the communications vans. DART II was to use the communications equipment already at Pleiku in the Control and Reporting Post (CRP). Becoming operational on 28 September 1969, its initial employment was in support of Operation TIGHT JAW.[16/]

During TIGHT JAW, DART II primarily supported I Field Force Vietnam (FFV) and worked with the 52d Artillery Group. The sensor readout that was received at DART was relayed to the Fire Support Bases of the 52d (Fig. 15) in near-real time (less than one minute). The Army then made the decision on whether to react and how much to fire on a sensor impulse. It also was responsible for obtaining the necessary fire zone clearance.

The data gathered from sensor impulses were sent in non-real time to Seventh Air Force and to Special Forces units for intelligence buildup.

There were three significant differences between DART I and II operations. First, DART II used an EC-121 BAT CAT aircraft as an automatic relay to the DART. Manual readout of sensor impulses was also possible on this aircraft and it was equipped to relay information directly to the Fire Support Bases if communications with the DART were to break down. No ground relay facility was envisioned for the DART II because of the terrain. Second, the sensors used were all Phase I or II ADSIDs, HELOSIDs, and ACOUBUOYs implanted from Army helicopters. These sensors functioned as they did in the IGLOO WHITE operation with the exception that the DART was not able to command the Phase II sensors into non-real time mode. No hand-implanted sensors were used because of the terrain and enemy activity. The decision on where to place sensor strings was made through MACV by the Army at I FFV, although the Air Force did participate in the process in terms of sensor readout possibility, terrain masking, and other associated terms. Third, the VNAF was integrated to a limited degree in both operations and intelligence aspects of the DART.[17/]

As part of Operation TIGHT JAW, integration of the VNAF was programmed for limited participation, but there was no program to integrate the VNAF into systems maintenance.[18/] The first contingent of 7 officers and 15 NCOs was graduated from training on 12 December 1969, and was fully integrated into the operation by the end of the year. There were no firm plans on future VNAF control at the time of this writing.[19]

DART II was the last of the DARTs to be built. It was actually envisioned as an interim measure awaiting a simpler system, such as BASS or the SRP, which was undergoing operational test and evaluation at Eglin AFB, with an operational ready date of April 1970.[20] It should be stressed that DART was not the only sensor application in the Republic of Vietnam. The U.S. Army, USMC, and ARVN had significant numbers of sensors throughout the region, but these sensor operations were basically read out by a hand-carried portable unit. Using no USAF assets, with the exception of certain implant operations, they were considered outside the scope of this report.

FOOTNOTES*

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7. Ibid, pp 26-27.

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12. (TS) "IGLOO WHITE," pp 36-37.

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(S) CHECO Rprt, Hq PACAF, DOTEC, "Khe Sanh (Operation NIAGARA)," 13 Sep 68.

2. (S/NF) Ltr of Transmittal, 7AF/13AF, VC, subj: Recommendation of Award of Unit Decoration (TFA, 1 Oct 67-1 Jun 68), 29 Aug 68. (Hereafter cited: Unit Decoration Recommendation.)

* Extracts from TOP SECRET documents are classified SECRET.

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7. (S) Hist Rprt, TFA, 1 Apr-30 Sep 68.

8. (S) Ltr, DITS to DOSM, subj: Historical DATA Record, 1 Apr-30 Sep 68, pg 1.

9. (TS/NF) OPlan 530-68, 7AF, "Southwest Monsoon Campaign," 1 May 68, pg B14.

10. (S) Hist Rprt, TFA, 1 Apr-30 Sep 68.

11. (S/NF) Ltr, DITA to DIT Historian, subj: Historical Data Record, 1 Apr-30 Sep 68, undated.

12. (S) Rprt, MACV, MUSCLE SHOALS, Six-Month Evaluation, 31 May 68, pp 11-12.

13. (S/NF) Unit Decoration Recommendation;
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16. (S/NF) Hist Rprt, Directorate of Operations, TFA, 1 Oct-31 Dec 68.

17. Ibid, pg 2.

18. (S/NF) Ltr, TOA to TFA (DXI).

19. (S/NF) Hist Rprt, Directorate of Operations, TFA, 1 Oct-31 Dec 68, pp 2-5.

20. (TS) OPlan 544-69, 7AF, 29 Aug 68, pp 1-2.

21. (S) Rprt, 7AF, COMMANDO HUNT, 20 May 69. (Hereafter cited: COMMANDO HUNT.)

22. (TS) OPlan 544-69, 7AF, 29 Aug 68, pg EE-III-2;
(S) COMMANDO HUNT, pp xvii-xviii.

23. (S) COMMANDO HUNT, pp 28-29.

24. (S) Interview, Col James Hall, Deputy DO, TFA, NKP RTAFB, Thailand, with Maj Philip Caine, 26 Nov 69.

25. (S) COMMANDO HUNT, pp xxii-xxix.

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33. (S/NF) Ltr to TFA (DIX), 24 Nov 69.

34. (S) Ltr, DOSM to DOPA, subj: "ISC Operations 9 Jul-15 Jul 69," 16 Jul 69, pg 2.

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36. (S) Talking Paper, subj: "Use of Sensors in BARREL ROLL," undated. (CHECO Microfilm TS-46, Frame 184 1/2.)

37. (S) Memo, Maj Gen J. F. Kirkendall to Gen G. S. Brown, 16 Aug 69. (CHECO Microfilm TS-46, Frame 189.)

38. (S) Memo, Maj Gen J. F. Kirkendall to Gen G. S. Brown, 16 Sep 69. (CHECO Microfilm TS-46, Frame 189.)

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52. Ibid.

53. Ibid.
(S) Ltr, DIP to DOTE, CHECO Rprt - IGLOO WHITE, Jul 68-Dec 69 (U), 20 Mar 70.

54. (S) Internal Memo, TFA, undated.

55. (U) Special Research Project, Maj Philip Caine.

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3. (S/NF) TFA Briefing;
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14. (S/NF) Hist Rprt, Directorate of Operations, 1 Oct 68-31 Dec 68;
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GLOSSARY

AAA	Antiaircraft Artillery
ABCCC	Airborne Battlefield Command and Control Center
ACOUSID	Acoustic Seismic Intrusion Detector
ACW	Aircraft Control and Warning
ADSID	Air-Delivered Seismic Intrusion Detector
AMTI	Airborne Moving Target Indicator
ARVN	Army of Republic of Vietnam
BASS	Battle Area Surveillance System
BDA	Battle Damage Assessment
CBU	Cluster Bomb Unit
COC	Combat Operations Center
COMUSMACV	Commander, United States Military Assistance Command, Vietnam
CONFIRM	Coincidence Filtering Intelligence Reporting Medium
CONUS	Continental United States
CRP	Control and Reporting Post
CTZ	Corps Tactical Zone
DART	Deployable Automatic Relay Terminal
DCPG	Defense Communications Planning Group
DMPI	Desired Mean Point of Impact
DMZ	Demilitarized Zone
ECM	Electronic Countermeasure
ETA	Estimated Time of Arrival
FAC	Forward Air Controller
FADSID	Fighter Air-Delivered Seismic Intrusion Detector
FFV	Field Force, Vietnam
GSM	Ground Surveillance Monitor
HANDSID	Hand Emplaced Seismic Intrusion Detector
HELOSID	Helicopter Emplaced Seismic Intrusion Detector
ISC	Infiltration Surveillance Center
LOC	Line of Communications
LORAN	Long-Range Navigation
MAGID	Magnetic Intrusion Detector
NKP	Nakhon Phanom
NM	Nautical Mile

PIRID	Passive Infrared Intrusion Detector
RTAFB	Royal Thailand Air Force Base
SRP	Sensor Reporting Post
TACC	Tactical Air Control Center
TACS	Tactical Air Control System
TAO	Target Assessment Officer
TFA	Task Force Alpha
TFS	Tactical Fighter Squadron
TRAP	Traffic Analysis and Prediction
TUOC	Technical Unit Operations Center
UHF	Ultra High Frequency
USMACV	United States Military Assistance Command, Vietnam
USMC	United States Marine Corps
VHF	Very High Frequency
VNAF	Vietnamese Air Force
VR	Visual Reconnaissance
WAAP	Wide Area Antipersonnel Mine