COMMANDO HUNT V

TRUCKS DESTROYED OR DAMAGED PER SORTIE OF COMMANDO BOLT OPERATIONS

76/

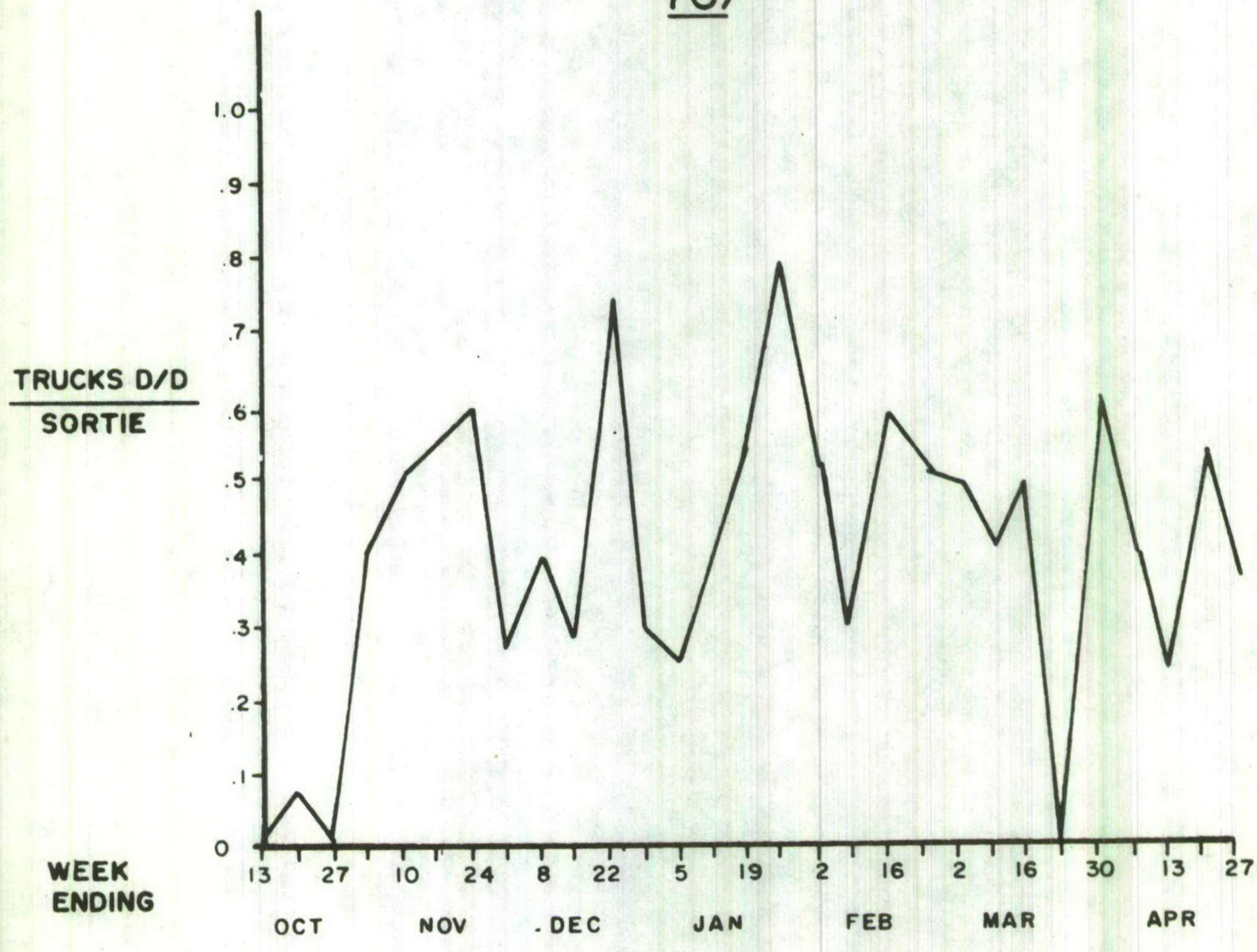


FIGURE 14

[redacted]

These circumstances definitely limited COMMANDO BOLT by reducing its number of strikes on movers, especially after gunship operations increased during January and March. COMMANDO BOLT aircraft occasionally were forced to expend on fixed targets when the presence of gunships prevented them from attacking targets passing through strike strings. At no time, however, were COMMANDO BOLT strike strings allowed to expire because gunships prevented their regular use.[78/]

Partly as a result of conflicts with gunships, COMMANDO BOLT regularly began to strike fixed targets in STEEL TIGER. Many of these targets were identified by TFA's target development branch (INTT) through the Night Fixed Targeting Program. These new COMMANDO BOLT tactics required that the precise LORAN coordinates for the targets be determined so that they could be attacked under non-visual conditions by either offset bombing (COMMANDO NAIL) or LORAN (PAVE PHANTOM) techniques. Strike pilots followed procedures similar to those employed against moving targets with the only differences being that no course or speed adjustments had to be made to insure a specific TOT. COMMANDO BOLT fixed targets also were struck when weather prevented daytime visual strikes, or when no sequences occurred through strike modules upon which pre-fragged strike aircraft could expend ordnance.[79/]

There were further indications during COMMANDO HUNT V that the enemy was monitoring US strike frequencies and using this information to adjust their truck movements. A 12 December 1970 message from TFA

[redacted]

reported that truck movement had been observed to increase at the end of aircraft on-station time and decrease as aircraft would check in with COPPERHEAD. TFA requested that in the future aircraft report their "playtime" by means of secure voice communications or use encyphering methods for those transmissions broadcast in the clear.[80/]

Traffic Advisory Service. A Traffic Advisory Service for FACs and gunships and the newly arrived B-57G was introduced during COMMANDO HUNT V. This service was developed in an effort to make better use of sensor information in acquiring real time targets and as a replacement for the EC-121Rs of the FERRET III program. The EC-121R was scheduled to be replaced during the campaign by QU-22B monitor/relay aircraft which had no capabilities for on-board sensor read out.

The advisory service became operational on 24 October 1970[81/] and was based on the COLOSSYS computer program (See Figure 15). By use of the light pen, the GSM instantaneously transferred developing sequences to the advisory service controller (call sign HEADSHED) where it was displayed on his IBM 2260 console. The display contained the following information:[82/]

a. Beginning time of sequence.

b. VR sector and sensor string number.

c. Size, type, direction and speed of mover(s).

d. Time when advisory was displayed.

e. Automatic Sequence Routing (ASR) number. (ASR was a computer process by which the above information was automatically relayed from TFA to ABCCC and 7th AF, and stored for eventual incorporation into the TFA data base).

[redacted]

HEADSHED Night Traffic Advisory
Station in TFA Control Room.

FIGURE 15

[redacted]

Upon receipt of this information, the HEADSHED controller was able to communicate directly with strike aircraft by radio and alert them to the target in near-real time. This was just an advisory, however, and unlike COMMANDO BOLT, the strike aircraft still retained the option of ignoring the reported target if engaged in other activities or attacks. This operation also differed from COMMANDO BOLT in that advisories were passed to gunships as well as fighters, and attacks were made on a visual basis rather than according to LORAN coordinates. It was the responsibility of the strike aircraft to locate a strikeable target once HEADSHED had informed him of an area in which sensors indicated activity. By late December, 17 additional sensor strings had been emplaced specifically to support the Target Advisory Service.[83/]

Prior to initiation of this advisory service, this information had been passed as a SPOTLIGHT report to ABCCC for relay to strike aircraft. ABCCC, however, was limited in the manner of advisories it could control at one time, and TFA had been allowed to pass only sequences which contained a specified minimum number of movers (usually five). The new procedure removed this limitation and greatly increased the number of advisories passed.[84/] The instantaneous, automatic data relay between the GSM and HEADSHED made possible by COLOSSYS was also a great improvement over the telephone procedures used in SPOTLIGHT, and significantly reduced the time between target identification and notification of strike aircraft.[85/] Table 7 reflects TFA Target Advisory Service activity during the most active truck-killing months of COMMANDO HUNT V.

[redacted]

TABLE 7

TFA NIGHT TRAFFIC ADVISORY SERVICE SUMMARY 86/

(HEADSHED)

JANUARY-APRIL 1971

SEQUENCES:

Number of Sequences Processed	69,723
Number of Sequences Passed	21,363

SEQUENCES PASSED TO:

COMMANDO BOLT	7,716
FACs	3,911
Gunships	4,863
Armed Recce	1,889
ABCCC	2,984
7AF Command Post	10

OPREP-4 REPORTED BDA RESULTED FROM ADVISORIES:

Trucks Destroyed	2,739
Trucks Damaged	586
Explosions	1,793
Fires	1,490

[redacted]

Phase III Sensors. Conversion of the IGLOO WHITE field to Phase III sensors was completed during COMMANDO HUNT V. Phase III sensors featured greater flexibility in assignment of monitoring frequencies and other advantages which are discussed in Chapter III. At the beginning of the campaign, 88 percent of the STEEL TIGER sensor field consisted of Phase III devices. The northernmost third of the field was entirely converted to Phase III by 1 October, the central by 1 November and the remainder by 17 February 1971.[87]

Sensor String "Band" Concept. During previous interdiction campaigns LOC-monitor sensor strings had been located in a linear fashion along the roads of STEEL TIGER. This method of emplacement accurately recorded enemy vehicle traffic through a particular area since no known alternative routes existed. By COMMANDO HUNT V, however, the Laotian route structure had expanded and the great number of bypasses and alternate routes as well as ever-growing numbers of truck parks and storage areas allowed enemy truck traffic to avoid (often unknowingly) sensor strings and consequently not be included in the overall picture of traffic patterns. TFA awareness of this problem led to the "band" concept of sensor emplacement by which strings were placed on all possible routes, bypasses, and alternates in lines cutting across strategically located choke points, areas where routes converged, and across exit gates (See Figures 16 and 17). Any vehicles passing through a band would be detected by one sensor string and

COMMANDO HUNT V

SENSOR STRING DEPLOYMENT CONCEPTS

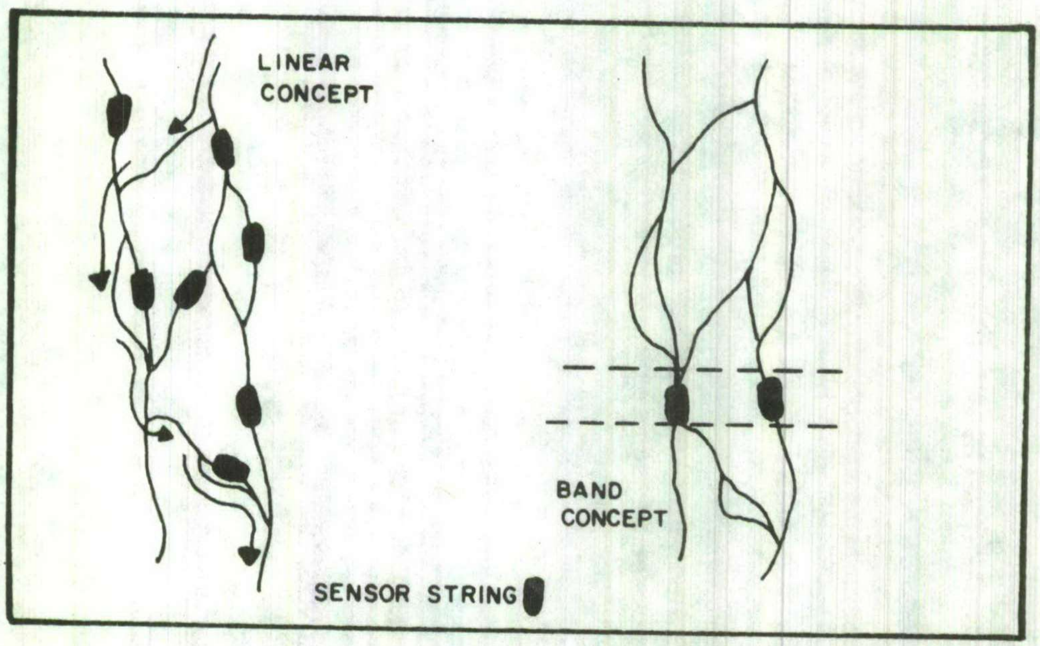
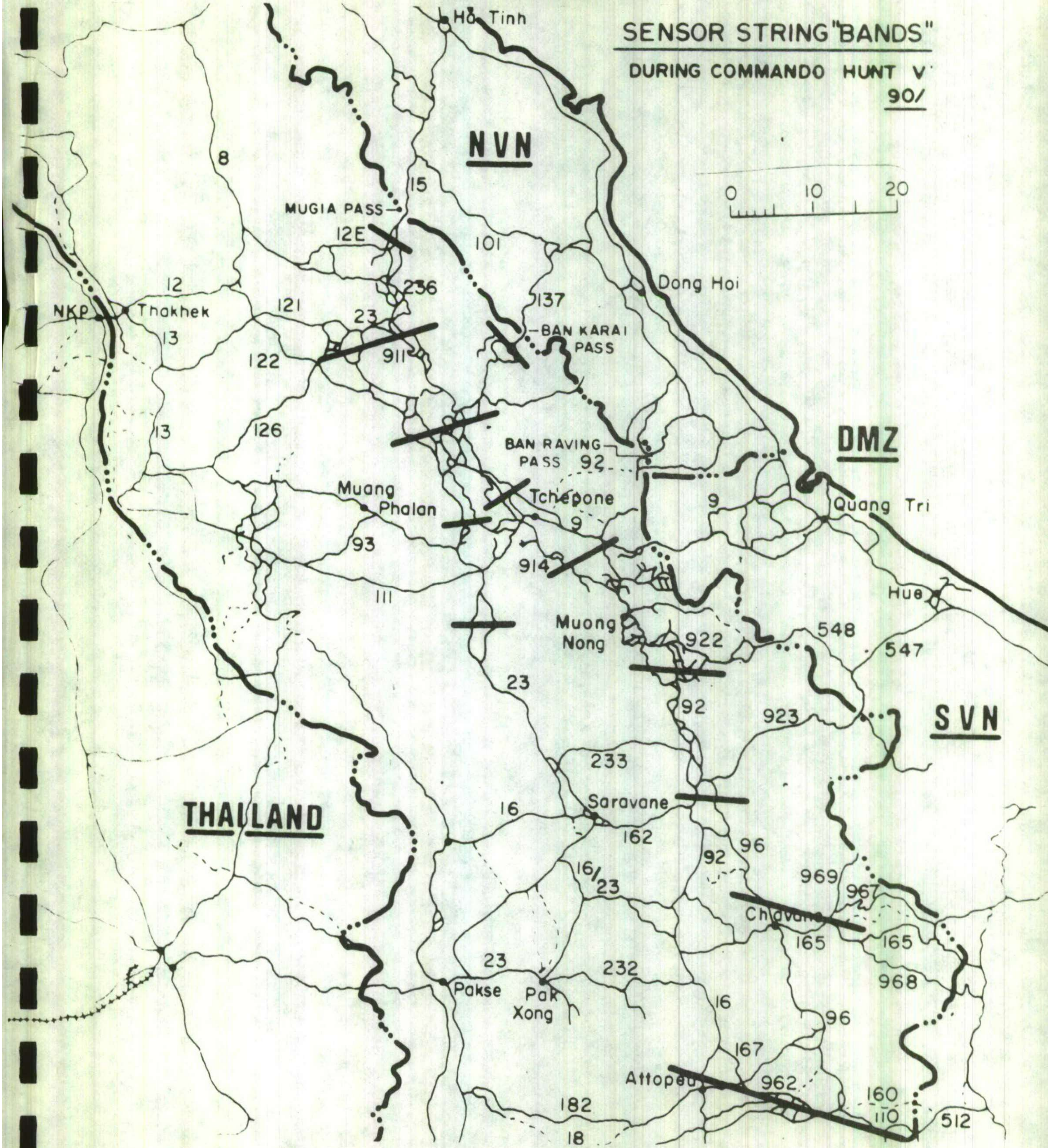


FIGURE 16


SENSOR STRING "BANDS"
DURING COMMANDO HUNT V
90/
NVN
DMZ
SVN
THAILAND
0 10 20
Ha Tinh
MUGIA PASS
BAN KARAI PASS
BAN RAVING PASS
Dong Hoi
Quang Tri
Hue
NKP
Thakhek
Muang Phalan
Tchepone
Muong Nong
Saravane
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16/23
969
967
165
165
23
232
968
16
96
167
962
160
110
512
182
18

FIGURE 17

counted only on that string, regardless of the road used.[88/] This configuration also sought to minimize double-counting of trucks.[89/]

Night Fixed Targeting Program. On 5 January 1971, TFA initiated a night fixed targeting effort utilizing sensor-derived information. By analyzing sensor patterns and enemy truck movements, areas were singled out as possible locations of currently active targets such as truck parks, storage areas, or transshipment points. Based on UTM coordinates, a print out was obtained from the KEYWORD File giving all activity noted in the area for the past 30 days. This recent history of the target area was correlated with the sensor lead, and the targets officer selected a target based upon his analysis of the collated data. In many cases, recent film coverage or Special Intelligence (SI) data would also support target selection. When this process was complete, the target coordinates were passed to TFA strike controllers, 7th AF COC, the ABCCC or FACs for strike and/or prompt visual reconnaissance. COMMANDO BOLT aircraft were frequently used to deliver ordnance the following night. If collateral intelligence supporting the sensor-derived lead was insufficient, the lead was referred to FACs, PIs and targets personnel for further development.[90/]

The night fixed targeting program differed from normal target development in that the leads were derived primarily from an analysis of sensor intelligence rather than from FAC, SI, or photographic information.

Lucrative leads from sensors could be quickly supported by other intelligence sources from the KEYWORD File and strike recommendations made the same night that the initial indication was received. Previous target development procedures required nominations to 7th AF by message and a lengthy process before the location was finally fragged and struck (normally three days for Tac Air and four days for Arc Light targets).[91/] This program supplemented rather than replaced the normal targeting process and was a further attempt to derive useful targets from IGLOO WHITE's ability to provide real time information on enemy activity.

Night-fixed targets were classed as "A" or "B" targets. "A" targets were those which were expected to be lucrative for less than 48 hours and required immediate strike action. Examples were certain truck parks and storage areas in use for only a short time. "B" targets were expected to remain lucrative for as long as 30 days. These latter were passed to the day targeters for further development, rather than immediate nomination and strike.[92/]

The night-fixed targeting program reported the following results for the period 5 January through 15 September 1971:[93/]

	NOMINATED	STRUCK	STRUCK WITH POSITIVE BDA
"A" Targets passed for strike within 48 hours	819	125	65
"B" Targets passed for further development	471	161	109

<u>X-T Plotter</u>. In late January 1971, the installation of an X-T Plotter was completed in the plot room at TFA. For the past year this device had been mounted in EC-121R sensor-monitor aircraft as the basis of the FERRET III program and had given these aircraft the ability to read out a selected set of up to 99 sensors per plotter. This capability allowed the EC-121Rs to send near-real time traffic advisories direct to FACs and gunships and performed many functions of an airborne ISC.[94/]

While this device greatly enhanced the EC-121R's capabilities, FERRET III experience had demonstrated that the computerized surveillance center at TFA was still superior to the X-T Plotter in detailed analysis:[95/]

> *Identification of sensor-detected movers by X-T Plotter readout is not as reliable as when accomplished by the computer-aided process used at TFA which includes greater audio and spectrum analysis validation capability. However, the X-T Plotter does provide read out in areas where relay of sensor data to TFA is not possible (extreme southern STEEL TIGER) and in other areas when the TFA computer is not on the line.*
>
> *. . .the X-T Plotter provides targets only in the sense that it identifies that movers are passing through a sensor string, and this information is used to provide traffic advisories to aircraft in near-real time. At very best it could pinpoint the location of a mover to within the detection range of a given sensor. Direction of movement is apparent, but speed of movement can be determined only approximately.*

TFA's X-T Plotter served as a backup when the computer was unavailable because of required maintenance or was engaged in data processing and analysis tasks. The X-T Plotter was also employed for periodic daylight monitoring of Green and Blue Orbits during March and April 1971, and for the round-the-clock monitoring of certain sensor strings in the Lam Son 719 area during that operation. Other roles for the plotter included an operator training function in conjunction with the computer in which comparisons of computer and plotter read-outs for the same sensor strings produced excellent results. TFA's X-T Plotter read out the deployable Automatic Relay Terminal (DART I) field in northern RVN from 7-24 March 1971 when this system's read out facility was down for maintenance and again during July when the DART facility at Quang Tri was dismantled for transfer to TFA. The presence of the X-T Plotter also served to partially compensate for the removal of one of TFA's two IBM 360/65 computers.[96]

Lam Son 719. The tight security precautions which characterized preparations for Lam Son 719 prevented the inclusion of a plan for the employment of IGLOO WHITE in the initial planning for the operation. Once the security hold was lifted, however, the Army implanted and read out sensor strings for security along Route 9 and around Khe Sanh.[97] Marine OV-10s also emplaced 41 strings in the same areas in support of ground forces. During the withdrawal phase of the operation an additional 12 strings were emplaced by F-4s along Routes 9 and 925 and again around Khe Sanh.[98] Sensors were credited with detecting 5232 targets,[99] 694 of which were engaged by artillery, 14 by mortars and three by remotely-triggered mines. No BDA was recorded since the majority of the responses occurred at night or during inclement weather. There are no records of USAF sorties directed against sensor-derived targets because the target source was not specified in the mission reports.[100/]

As the operation progressed, the ARVN commander was notified of the availability of F-4 implanted sensor strings. Two route-monitor strings subsequently were requested and implanted. Advisors also emphasized to ARVN forces the opportunity to implant stay-behind sensors as friendly forces withdrew. ARVN commanders, however, were reluctant to become involved in emplacing these devices since equipment and teams familiar with implant techniques were not readily available. ARVN approval was finally given during the withdrawal phase of the operation, but it was by then too late to implement the plan.[101/]

The major lesson learned concerning the use of sensors during Lam Son 719 was that sensors can be used in an effective and timely manner in large ground operations only if they are incorporated into the operational planning from the beginning.[102/] The utilization of stay-behind sensors also requires careful advance planning so that the necessary equipment, skills and relay/read out capabilities are available. Terrain masking problems should also be examined beforehand.[103/]

COMMANDO HUNT VI (Apr - Oct 1971)

The COMMANDO HUNT VI rainy season plan reduced the maximum number of active sensor strings in STEEL TIGER from COMMANDO HUNT V's high of 128[104/] to 96.[105/] After consultation with 7th Air Force, it was decided to begin the campaign with the maximum number of sensor strings and then eliminate strings as the enemy abandoned the routes they monitored.[106/] Towards the end of the campaign, the total number had fallen to approximately 50.[107/]

DART I Transfer. Of major importance to the future role of TFA was the transfer in early July of the Air Force-operated DART I sensor read out facility from Quang Tri, RVN, to TFA. The DART I system monitored sensor fields within northwestern RVN, including the Western Reconnaissance Zone (WRZ - western Quang Tri Province, RVN), the western Demilitarized Zone (DMA) and the A Shau Valley for the U.S. Army's XXIV Corps. The combination of DART I and IGLOO WHITE at one location was expected to provide a real time target correlation and strike capability against enemy forces infiltrating through the DMZ and along the Laos/RVN border. At the same time, the DART I data base was combined with TFA's.[108/]

Additional Sensor Channels. Early planning for the COMMANDO HUNT VII campaign envisioned a sensor field substantially larger than that for COMMANDO HUNT V because of the anticipated expansion of IGLOO WHITE to LOCs in western STEEL TIGER.[109/] With the 32 sensor channels then available for use, the maximum number of sensor strings possible consisted of approximately 150 strings. Requests by 7th AF in May resulted in eight additional channels being allocated to IGLOO WHITE, and a further eight being reserved for possible future use.[110] Seventh Air Force expressed hopes in July that new transmitters would be available for installation in sensors during September, so the new channels could be utilized. With 40 channels available for sensor operations (including three allocated to DART I/XXIV Corps), the maximum number of strings (with seven sensors apiece) technically feasible rose to approximately 200.[111] Plans to reduce the maximum number of sensors per string to four or five for COMMANDO HUNT VII would make a significantly larger number of strings possible.

COMPASS FLAG. Another important addition to TFA during COMMANDO HUNT VI was the COMPASS FLAG program. This was a Special Intelligence (SI) collection program which was expected to greatly improve TFA's effectiveness:[112]

> *COMPASS FLAG affords TFA the opportunity for more timely fusion of SI data with that from sensors and other sources of information. Proximity of the COMPASS FLAG ground terminal to the ISC means that results of preliminary analysis of the COMPASS FLAG product by USAF Security Service (USAFSS) personnel will be readily available for TFA use. Conversely, reports on enemy activity based on sensor activations may enable USAFSS analysts to produce a more complete product from COMPASS FLAG collection.*

It should be kept in mind that COMPASS FLAG was not part of IGLOO WHITE but was established at TFA so the two programs could mutually support each other.

As originally conceived, the QU-22B aircraft was to have provided air support for COMPASS FLAG activities by flying a special mission over STEEL TIGER designated Yellow Orbit.[113/] QU-22B difficulties in August 1971, however, resulted in an evaluation of the C-130 as an alternate platform.[114/] Although hopes were expressed that IGLOO WHITE and COMPASS FLAG functions could be combined in the same aircraft, the 6908th Security Squadron (SS) at TFA pointed out that both programs were designed around different orbits neither of which could be altered without degrading one or the other mission. Another potential problem was the desire to perform both functions by means of C-130s flying ABCCC missions. The 6908SS feared that communications transmissions necessary to the ABCCC would interfere seriously with COMPASS FLAG.[115/]

Reactivation of DO. Most significant of all for the future of TFA was the reactivation on 22 May 1971 of a Directorate for Operations (DO).[116/] This office had been deleted during COMMANDO HUNT II after SYCAMORE Control had been abolished and the direct control of strike aircraft operating over STEEL TIGER removed from TFA. The development and steady expansion of the COMMANDO BOLT system, the initiation of the Night Traffic Advisory Service and the move of DART I to the ISC resulted in TFA acquiring increased responsibilities in the operational sphere. Consequently, a central office was needed to effectively control and coordinate the efforts of these different functions.

A further indication of this increased operational orientation was the decision in late June to make TFA predominately a night operation. Instead of the former practice of operating the ISC on the basis of three roughly equal shifts daily, the majority of TFA's personnel were placed on a 1700 to 0500 work schedule to match the daily period of peak enemy activity. Skeleton crews remained on duty during the day to perform such functions as computer off-line operations, round-the-clock DART I monitoring and certain analysis functions.[117] Although this new schedule was modified as enemy activity declined for the rainy season, the precedent had been set for subsequent dry season campaigns.

Use of IGLOO WHITE Outside of STEEL TIGER and South Vietnam

Cambodia. The involvement of Cambodia in hostilities against Communist forces opened this country for the first time to the possible employment of IGLOO WHITE sensors. A 19 May 1970 message from 7th AF Directorate of Targets Intelligence to TFA reported "considerable high level interest in the future need for sensor string coverage in north-eastern Cambodia."[118] A proposed area of interest was specified and TFA was instructed to determine the feasibility of such a Cambodian sensor field and the requirements for a read out orbit.[119] On 5 June 1970, a Hq 7AF staff paper discussed guidance from Military Assistance Command Vietnam (MACV) Directorate of Special Operations (JE-04) concerning sensor operations in Cambodia:[120]

a. U.S. forces would be out of Cambodia by 30 June 1970.

b. There would be no U.S. artillery firings across the border from the RVN after 30 June unless targets are definitely lucrative and firings are approved by Hq MACV (J-3).

c. Sensors left in Cambodia by U.S. forces were for intelligence purposes only.

d. Status of RVN forces in Cambodia after 30 June was unknown at that time.

The staff paper went on to review the approximately 170 stay-behind sensors emplaced by the 25th Infantry Division and the 1st Cavalry Division. These were all capable of being read out from relay points situated on mountains within the RVN (Nui Ba Den and Nui Ba Ra) as part of the Army's Battlefield Area Surveillance System (BASS) facilities. Also discussed was the need to relocate Orange Orbit if 7th AF assumed responsibility for monitoring Cambodian sensor fields and the impact this would have on existing IGLOO WHITE and DART requirements.[121/]

By 24 June, TFA decided that a sensor field of 20 strings would satisfy the minimum requirements of the coverage desired. Maps had been obtained and special photography to assist sensor implant planning was on order. A review of the Cambodian project, however, mentioned two difficulties: TFA had always been responsible for Laotian LOCs, and prior to the Allied incursion into Cambodia had no information concerning that country's route structure. The second and most difficult problem related to the fluid ground situation: FACs flying over Cambodia reported difficulties in distinguishing civilian from military traffic and friendly military from enemy military traffic. If these problems were not resolved it would be difficult to successfully apply IGLOO WHITE to Cambodia. The study also reported that the projected 20 string Cambodian sensor field would require two new read out orbits, since neither Purple nor Orange Orbits could be moved without serious detriment to IGLOO WHITE coverage of Southern Laos or the RVN.[122] By 30 July, the proposed field had been expanded to 25 strings, but plans for actual implementation of the sensor implants had been put "on the shelf" at 7th AF.[123]

On 27 September 1970, 7th AF directed that three sensor strings be implanted in northeastern Cambodia along Routes 13, 136, and 94 in hopes that they would detect an anticipated increase in enemy traffic from southern Laos into Cambodia.[124] The three strings were implanted on 3 and 4 October and two-three hours of Purple Orbit were diverted each day to monitor them.[125] These strings were monitored for a total of 36 hours from 4-16 October on a random basis, with one mover being detected along Route 13 on the night of 12 October. From these results, 7th AF concluded that the enemy was not moving vehicle traffic at night along the three routes.[126] In conjunction with this evaluation, 7th AF also indicated its desire to retain the FERRET III EC-121Rs as long as possible in any phase down of these aircraft, in order that X-T Plotters could provide real time traffic advisories to strike aircraft if the full Cambodian contingency plan were ever implemented.[127]

By the end of October, 7th AF Directorate of Targets Intelligence had decided that the objectives of a sensor field in northeastern Cambodia would be to "monitor the input routes from southern Laos into Cambodia and to monitor the throughput routes from southern Laos into southern MR III."[128] Since the October test had been designed to monitor the

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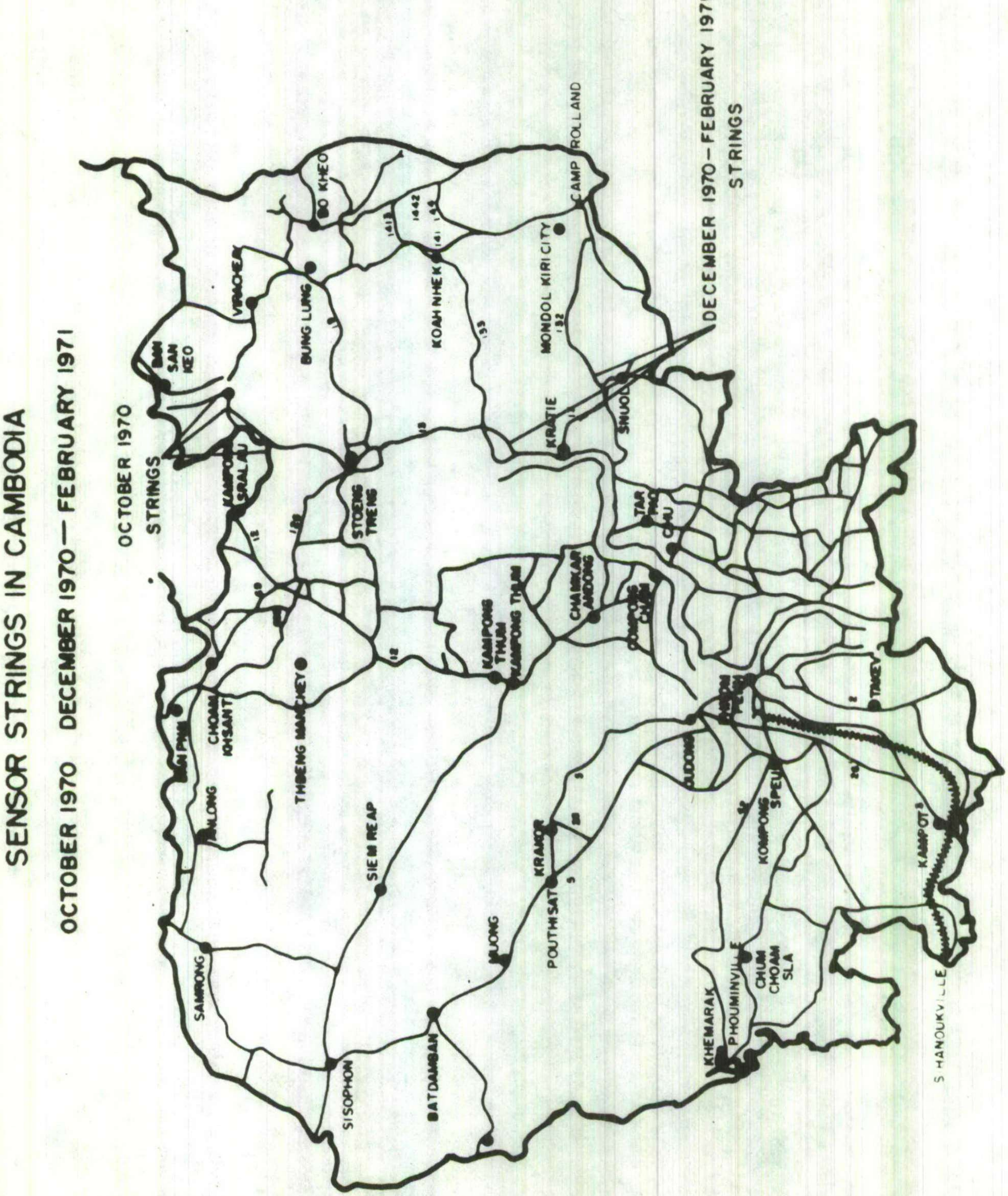

FIGURE 18

[redacted]

input routes, a second set of three sensor strings was implanted on 20 December along potential throughput Routes 13 and 132 in Cambodia.[129/]

Unlike the strings in October, these sensors were Army devices which were hand-implanted by Vietnamese Air Force (VNAF) helicopter-borne personnel in areas where significant traffic had been observed. The orbit of the Tactical Air Control Center (TACC) EC-121R (TACC-A, or Black Orbit) was modified to permit monitoring of these strings, which continued from 21 December to 7 February.[130/] During this time, two movers were detected on 24 December, one mover on 4 January and 11 on 14 January. A traffic advisory on one of the 24 December movers was passed to an AC-119G SHADOW gunship, but no results were reported. After the expiration of the sensor life spans, MACV felt that it was unlikely that a continuing sensor capability in that area would be worth the effort needed to monitor it effectively. It was recommended that if additional strings were desired, they should be placed on Routes 110A and 166B in southern Laos in order to detect traffic moving into Cambodia.[131/]

<u>BARREL ROLL</u>. Sensor strings were first employed in BARREL ROLL (Northern Laos) in August 1969 to determine enemy traffic patterns and levels during a critical ground campaign. A special Rose Orbit had been established to monitor the strings by manual read out. Additional sensors were utilized along Route 7 in October and November,[132/] but the changing situation made their continued employment unnecessary, and Rose Orbit was terminated on 24 January 1970.[133/]

In August 1971, the 7th AF Deputy Chief of Staff for Operations commented on the possibility of the BARREL ROLL Airborne Command and Control Center (ABCCC) C-130E performing a role similar to that successfully undertaken by its STEEL TIGER counterpart and monitoring a sensor field on Route 7 east of Ban Ban. An investigation by TFA of terrain masking problems and enemy threat to the monitor-relay aircraft determined that a favorable orbit with minimal risk could be established, although certain sections of the route would have to be monitored from a second orbit that would expose the aircraft to a certain degree of risk from AAA, MIGs, and Surface-to-Air Missiles (SAMs) fired from within North Vietnam.[134/] Since no read out would be possible aboard the relay aircraft, the data would have to be transmitted to TFA for interpretation. It was proposed to use the recently installed DART antenna and receiver for this purpose if the need ever arose, since all other equipment was required to support IGLOO WHITE and COMPASS FLAG.[135/] No decision was made to proceed with a BARREL ROLL sensor field at that time.

North Vietnam. Another area for which the employment of IGLOO WHITE sensors was considered briefly was North Vietnam. Intelligence reports in late 1970 had indicated the deployment of four SAM Firing Battalions into the North Vietnamese panhandle south of 18° north latitude, probably to attack USAF aircraft operating against Laotian LOCs near North Vietnam's border. Since none of the Firing Battalions had been located, 7th AF intelligence on 7 December requested a study to determine the feasibility of placing sensors on LOCs along which SAMs would have to be moved to reach convenient firing positions. Since

SAM units were believed to require seven or eight hours to prepare for action after occupying a firing position, sensor detection of their movement into position would give sufficient warning of the impending attack to allow aircrews to be alerted. The request suggested that electrical engine ignition signatures might be useful in differentiating SAM equipment from other vehicles.[136/] A 15 December message from the Commander, U.S. Military Assistance Command, Vietnam (COMUSMACV) commented on this feasibility study (then being conducted at TFA) and indicated that if the study were favorable a request would be prepared asking for authority for sensor implants in North Vietnam.[137/]

TFA concluded that the project was not feasible with current equipment and knowledge. Seismic sensors were unable to distinguish between different vehicles, while acoustic sensors were limited by the ability to differentiate only tracked from wheeled vehicles. Another problem was that the enemy would still be able to move SAM equipment at times when the ISC was not in operation. Sensors in North Vietnam would have to be read out by Green Orbit; a move toward North Vietnam would place the aircraft beyond the MIG Combat Air Patrol (CAP) line, while a more secure location would significantly degrade Green Orbit's ability to perform its primary mission of monitoring sensors in the Ban Karai and Ban Raving areas.[138/]

CHAPTER III

SENSORS, SENSOR-RELATED DEVICES AND SPECIAL USES

By February 1971, the last Phase I and II sensors had been retired from the IGLOO WHITE Program and entirely superseded by Phase III types. Phase I sensors consisted primarily of the Navy's SONABUOY and Air Delivered Seismic Intrusion Detectors (ADSID). The former had only an audio capability, while the latter was solely a seismic sensor. The SONABUOY was available in two versions: the CANOPY ACOUBUOY which was designed to hang in the upper layers of the jungle canopy, and the SPIKE ACOUBUOY (SPIKEBUOY) which implanted in the ground. Two other Phase I sensors used in small numbers were the Helicopter Emplaced Seismic Intrusion Detector (HELOSID) and the Hand Emplaced Seismic Intrusion Detector (HANDSID). None of these sensors were commandable, and they broadcast on 31 channels, each with 27 distinct addresses.[139/]

Phase II differed from Phase I sensors primarily in their commandability, especially the ability to command audio. These sensors could be instructed to send audio, go nonreal time (count impulses and store this information for later transmission on command), go real time (transmit impulses as they occur), and read out (transmit accumulated nonreal time impulses). ACOUBUOY and SPIKEBUOY sensors were converted to a Phase II mode, while the ADSID I was replaced by the Fighter Air Delivered Seismic Intrusion Detector (FADSID II). In addition, a combined seismic/acoustic sensor was delivered - the Acoustic-Seismic Intrusion Detector (ACOUSID II). High

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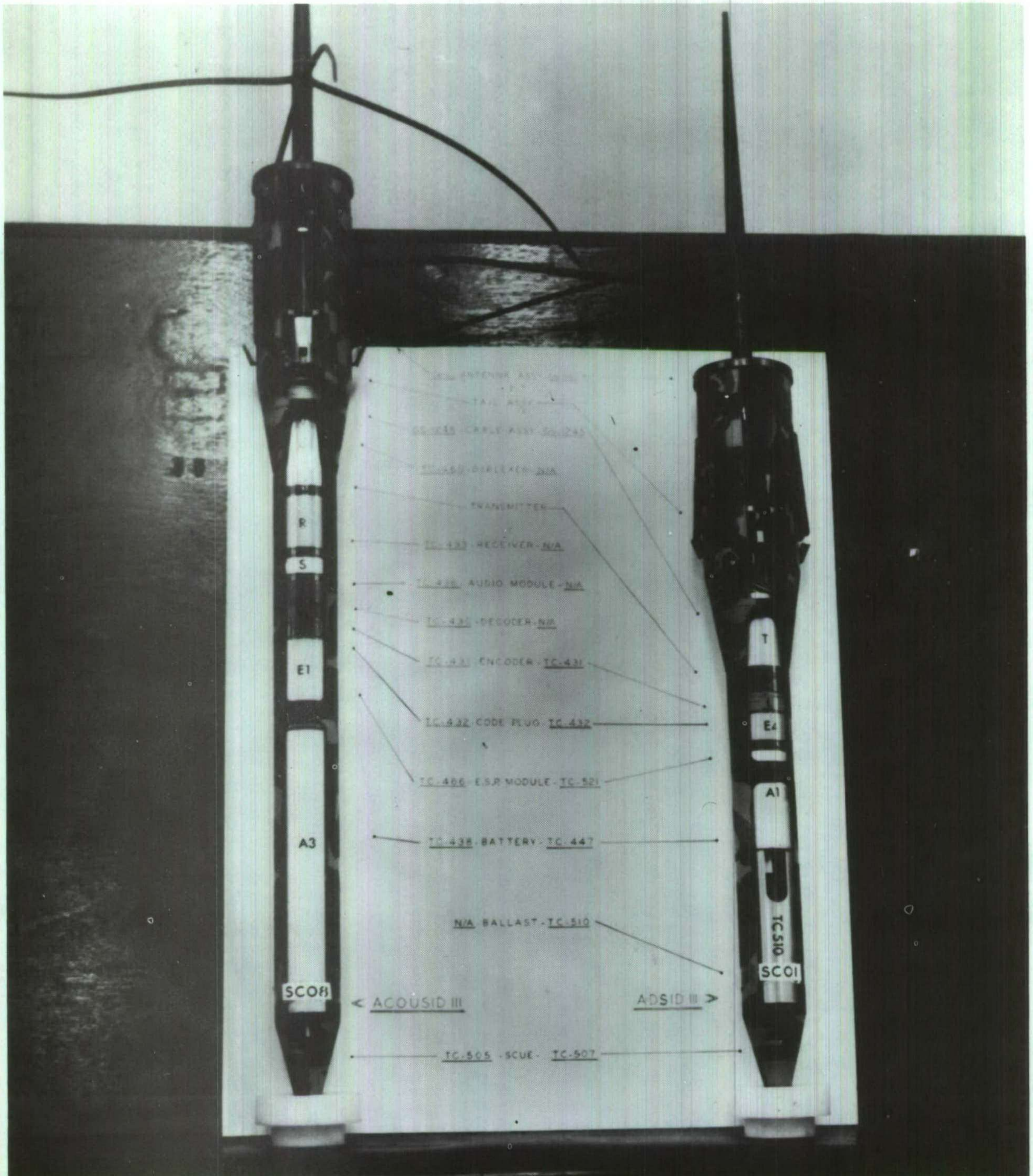

Phase III Sensors: Left, ACOUSID III
(4' long x 5" Maximum Diameter)
Right, ADSID III
(3' long x 5" Maximum Diameter)
Figure 19.

[redacted]

implant mortality rates for the FADSID II, however, resulted in the continued use of ADSID Is.[140/] A modified SPIKEBUOY called SPIKE Seismic Intrusion Detector (SPIKESID) was used in early 1970 on a test basis. This sensor was commandable and incorporated a seismic detection circuit and a field-selectable option which made SPIKESID acoustic or seismic or both.[141/]

Phase III sensors incorporated the commandable features of their predecessors, but increased the number of channels available to 32, with 64 sensor addresses each (instead of the previous 27).[142/] The use of common components in Phase III devices reduced costs and logistics complexities and allowed sensors to be tailored to specific situations.[143/] Sensors included Phase III versions of the ground implanted ADSID and ACOUSID, as well as the Commandable Microphone (COMMIKE III), which was suspended from jungle canopy.[144/]

Engine Detection Sensor (EDET III)

EDET III was an engine-detector sensor designed to detect pulsed radio frequency energy from the unshielded system of gasoline-powered engines.[145/] EDET electronic components were enclosed in standard COMMIKE III cases, restricting their use only to areas with sufficient jungle canopy to permit them to hang up. During an operational evaluation of the new sensor carried out by TFA from 27 March to 3 June 1971, 44 EDET IIIs were emplaced over existing, reliable ADSID/ACOUSID and COMMIKE strings to provide maximum verification of EDET III activations. As an LOC monitor, approximately 80 percent of the activations recorded during this test

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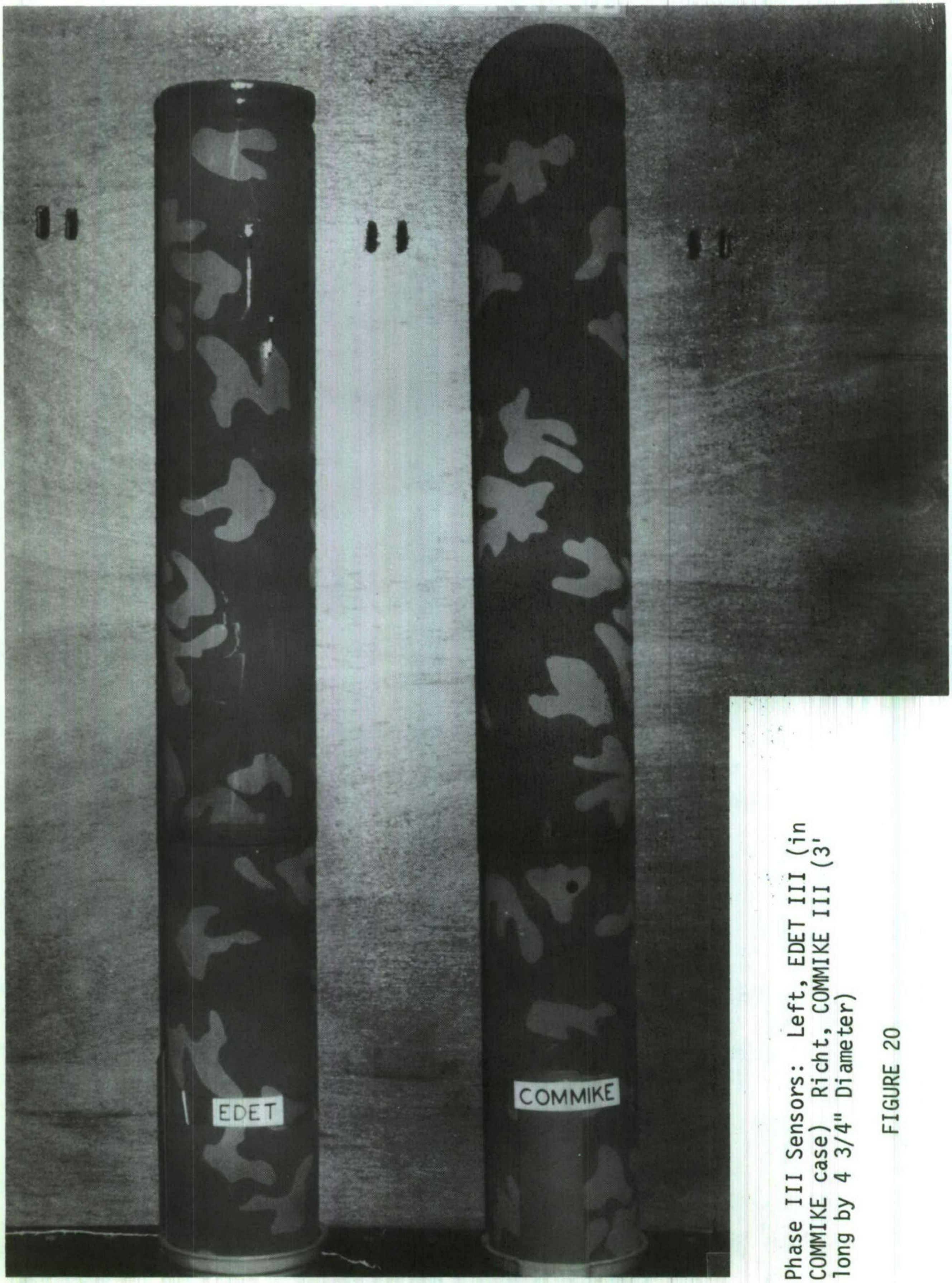


Phase III Sensors: Left, EDET III (in COMMIKE case) Richt, COMMIKE III (3' long by 4 3/4" Diameter)

FIGURE 20

CONFIDENTIAL

correlated directly with ADSID/ACOUSID sequences. An additional 12 percent of the sequences not detected by EDET III indicated the presence of diesel powered vehicles, demonstrating EDET's indirect capability to differentiate between different power plants.* The remaining eight percent were attributed to false alarms from weather and lightning.[146]

EDETs were partially successful as truck park monitors, especially when emplaced in conjunction with COMMIKEs. Like seismic sensors, EDETs responded automatically to an activation which was then displayed on the GSM's IBM 2250 display console. By polling COMMIKEs collocated with EDETs only when the EDET indicated activity, the acoustic sensors confirmed the presence of trucks 50 percent of the time. The standard TFA procedure was to poll COMMIKEs at random, a method which had only a six percent rate of truck detections. Per unit of time expended by the audio technician, the COMMIKE/EDET combination produced approximately eight times greater truck identification than the COMMIKE alone, and required only one-fifth the time. A combined COMMIKE/EDET system allowed a field to be monitored which was four to five times the size of one in which COMMIKEs were polled randomly. Lightning-produced false alarms were believed to have interferred occasionally with EDET truck identification, but the total number of such activations was considered much less than for ADSID/ACOUSID sensors because of the EDET's selective nature.[147]

* EDETs cannot detect diesel-powered vehicles--can only detect the ignition of gasoline-powered vehicles.

On 13 May 1971, TFA reported that EDETs when used in conjunction with other sensors would be most useful for truck park monitoring and for detecting special purpose vehicles such as tanks, caterpillar tractors, and those with diesel engines. TFA also considered it to be less useful as an LOC monitor in dense jungle areas;[148/] earlier tests at Eglin Air Force Base, Florida, had indicated that the EDET's detection range decreased rapidly as jungle density increased.[149/]

Although the utility of the EDET III had been proven operationally, the extent of its use during COMMANDO HUNT VII was uncertain at the time of this report. In May 1971, TFA had stated that approximately 826 EDETs would be used during the coming campaign if the first could be made available by October 1971.[150/] By mid-August, CINCPACAF had authorized Air Force Systems Command (AFSC) to begin price negotiations for the procurement of 400 EDT IIIs, with initial delivery to be on or before 1 February 1972. Delivery rate was specified at between 20 and 35 per week.[151/]

In early August 1971, the Saigon office of the Defense Special Projects Group (DSPG) responsible for the overall development of IGLOO WHITE and formerly known as the Defense Communications Planning Group reported to its Washington office that motorized sampan traffic in the Mekong Delta area of the RVN had increased significantly and inquired as to the suitability of EDET IIIs to monitor this traffic.[152/] DSPG replied that the use of EDETs was feasible for this purpose as long as the rpm of the sampan's engine was high enough.[153/] Possibly as an outgrowth of this exchange was a TFA plan of mid-September to emplace a string of EDETs (with one COMMIKE) along the Se Kong River in southern STEEL TIGER south of Attopeu in an effort to detect motorized waterway traffic. This was a test plan only, with EDETs being obtained from stocks remaining after the March to June evaluation.[154/]

Commandable Audio-Engine Detector (CAEDET)

During the March to June tests EDET III modules were enclosed and emplaced in standard COMMIKE cases. Consequently, they were usable only in areas of heavy canopy. Additionally, the evaluation demonstrated that the effectiveness of the EDET/COMMIKE combination could be limited because the sensors had to be delivered in separate cases. If delivery conditions resulted in excessive distances between the final locations of the sensors, valid audio assessments and correlations between the two were impossible.[155/]

Bearing in mind these factors, TFA in June 1971 raised the possibility of combining EDET and COMMIKE components/capabilities in the same case. Also mentioned was the development of an EDET sensor either with an implant capability, or as part of existing seismic sensors. If successfully developed, EDETs could be delivered in either a ground-implant or tree hang-up mode and paired with audio or seismic capabilities with no danger of delivery dispersion limiting the effectiveness of the string.[156/] Combined sensors would also reduce the number of delivery sorties required and allow strings of only two or three sensors to be used effectively.[157/]

TFA identified two significant deficiencies in current operational capabilities which sensors combining EDET, seismic, and acoustic characteristics would help correct. First, the enemy was increasing his use of diesel-powered tracked vehicles (tanks, bulldozers) and prime movers in Laos, but TFA was unable to distinguish these from those using conventional gasoline engines. Second, TFA could not adequately monitor the vast numbers of truck park/storage areas in use (or suspected use) by the enemy, or correctly determine the most lucrative time for strikes.[158/]

In July 1971, the Chief of Staff of the Air Force (CSAF) applied the term CAEDET to the proposed ignition/commandable acoustic sensor to prevent confusion with EDET III.[159/] Electronics Systems Division at Hanscom Field, Massachusetts, directed in August that the audio-ignition detection components would be designed to fit inside a container suitable for both a canopy hang-up and ground-implant role,[160/] but delivery of sensors was not believed possible before October 1972.[161/] As of the cut off date of this report, there were no firm plans to proceed with the development of an EDET combined with seismic capabilities.

<u>Radar Beacon Transponder (RABET II)</u>

Not all new sensor devices and applications were successful. One notable failure was the RABET II. This consisted of a 400 watt X-Band radar beacon enclosed in an ACOUSID II case which was implanted by an F-4. The beacon was designed as a target reference marker to aid radar bombing. When interrogated by an X-Band radar, the RABET II was supposed to transmit a response indicating its position.[162] Of six RABET II beacons test-dropped from July to October 1970, only one established contact after impact, and then only for seven or eight minutes.[163] These umpromising results led to the project's cancellation by the DCPG (now DSPG) on 24 December 1970.[164]

Acoustical Targeting

At the end of COMMANDO HUNT III, considerable doubt existed at TFA concerning the value of acoustic sensors. The presence of these sensors in LOC monitoring strings was regarded at that time as adding only insignificantly to the ability to define sequences, since three or four reliable seismic devices were believed adequate to confirm the presence of truck traffic. An acoustic capability was seen as useful only in certain special cases, such as with strings giving inadequate patterns because of ambiguity, high false alarm rates, or weak responses. Acoustic sensors were also useful at either end of COMMANDO BOLT strings to provide the maximum possible warning of approaching trucks, since acoustic detection range was approximately three times that of seismic.[165]

Acoustic sensors were considered of little value for area reconnaissance or monitoring purposes as well. From September 1968 to September 1969, 22 Reconnaissance by Acoustic (RBA) and "Occupational" (to determine enemy occupancy of an area)[166] sensor strings were in use in STEEL TIGER, but this had fallen to 16 for COMMANDO HUNT III.

One argument against RBA stressed the relative inefficiency of the RBA method as producers of target intelligence:[167/]

> *In general, by the time we go through the effort of determining by photo and visual reconnaissance whether an area would be a likely site for an RBA string, we will already know whether or not there is a target warranting strike in the area. Knowing that, there is little use in emplacing the RBA string which was intended to answer the same question.*

Other problems concerned the dispersed nature of enemy storage facilities which meant that even well-placed acoustic strings usually sensed only low levels of activity even in major complexes. RBA emplacement sorties were also difficult to obtain, since LOC monitoring strings had a higher priority.[168/]

A fresh look was taken at the value of acoustic targeting during COMMANDO HUNT V. In February 1971, an RBA program was initiated using COMMIKE IIIs to ascertain enemy activity in certain enemy truck park/storage areas covered by heavy canopy. A total of 11 COMMIKE strings were implanted in areas identified as potentially lucrative by evaluation of sensor patterns and inputs from all intelligence sources. Several targets were developed from this effort. In March, EDET IIIs were combined with the COMMIKEs as part of the evaluation of the new engine ignition detectors.[169/]

In July 1971, TFA inaugurated the concept of Acoustic Targeting Areas (ATA). Under this concept acoustic intelligence gathering and analysis were done in terms of an area, which was monitored by a series of strings of two or three sensors each. Previously, RBA strings had averaged nine sensors each[170] and had functioned primarily as an intelligence collector. When RBA sensors had indicated enemy activity in an area, visual and photographic reconnaissance were used to determine a set of strike coordinates. ATAs went beyond this concept in that strikes could be called in on the basis of acoustic indications alone.[171] As of July 1971, 27 ATAs had been implanted, 40 assessments had been made in 16 of the areas, and two strikes called in with unknown results.[172]

The reemphasis of TFA from its previous role of an intelligence gatherer to that of a target developer accounted for much of the fresh attention devoted to acoustic targeting. Sorties were now available for acoustic sensor implants, since greater importance was being attached to programs with BDA potential, rather than those intended to count trucks or monitor LOCs. TFA was also considering a plan for COMMANDO HUNT VII to implant acoustic sensors in areas of heavy canopy in grid patterns, rather than the straight lines used in the past.[173]

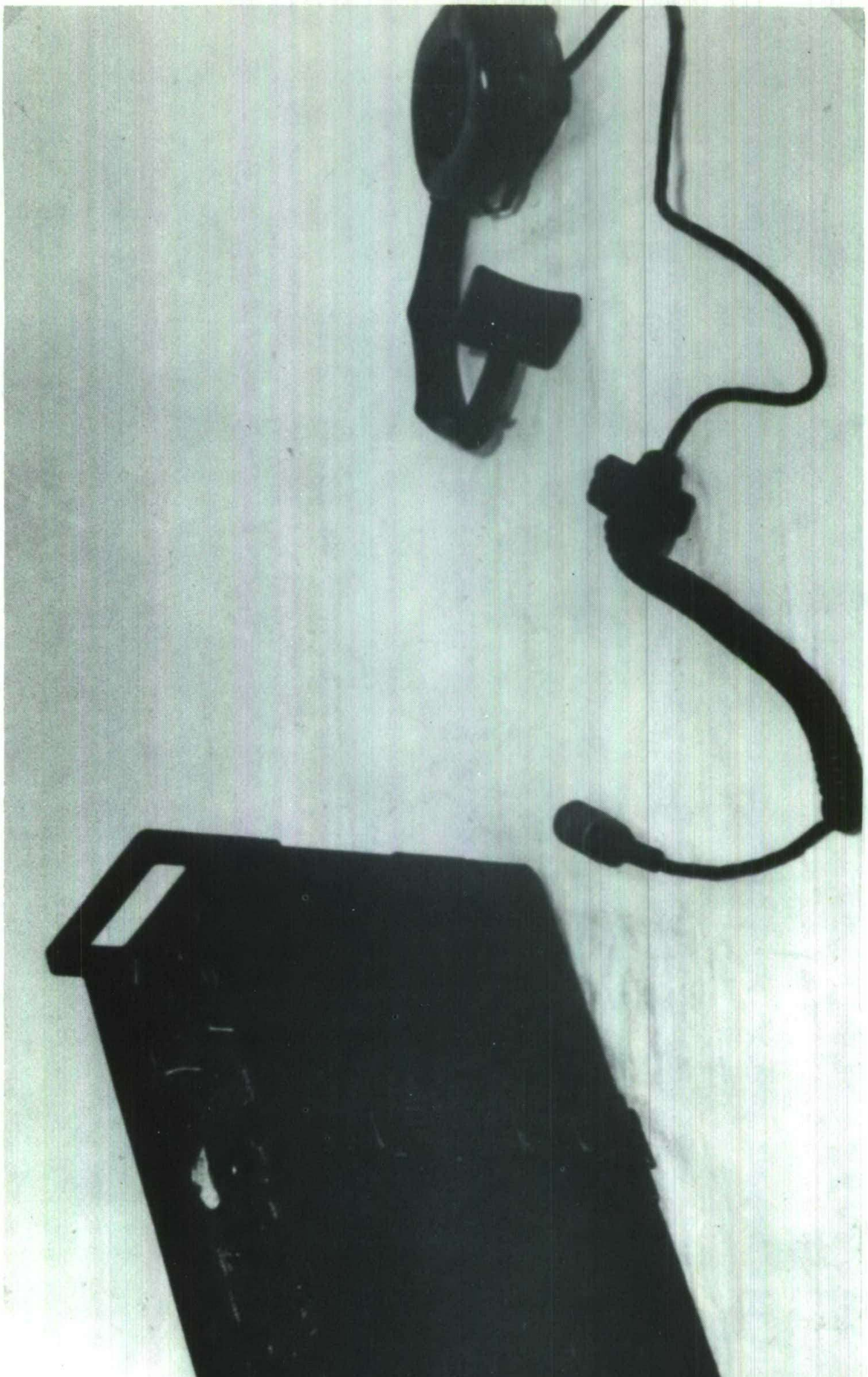
Use of Sensors for Assessing BDA

Sensors were used for determining BDA only to a limited extent. An April 1971 7th AF report pointed out that for any damage assessment to be made, the vehicles would have to be within the string at the time of the attack, and the attack coordinated with TFA. Although this was possible with COMMANDO BOLT operations, it would be extremely difficult with other fighters or gunships, especially since only 3.5 percent of the motorable Laotian route structure was covered by sensor strings.[174]

Sensors often recorded activations immediately following strikes, but it was difficult to determine precisely if these were caused by exploding ordnance, secondary explosions, or enemy activity. Detection of a significant amount of continuing activity after conclusion of a strike would indicate an enemy presence in the area and a response to the attack. This could be the basis for a recommendation that the target be restruck. Although sensor (especially acoustic) BDA was a factor which was taken into account by TFA, it was never considered quantifiable or capable of being entered into the TFA data base as confirmed BDA.[175]

<u>Portatale</u>

In January 1970, a 10-day test/evaluation program was conducted by three OV-10s of the 23d Tactical Air Support Squadron (TASS) at Nakhon Phanom Royal Thai Air Force Base, Thailand (NKP), to determine the feasibility of adopting Portatale I Very High Frequency (VHF) receivers as an airborne aid to enable FAC aircraft to receive and display signals directs from IGLOO WHITE sensors in areas where terrain conditions masked read out by conventional monitoring and relay procedures.[176] The Portatale was a light weight, portable device which had the capability of decoding and displaying signals from sensors on any of 31 channels, one at a time (See Figure 21). Marine OV-10 crews at Da Nang had been using the device for this purpose and reported it to be simple in



Portatale I and Headphone

FIGURE 21

operation and highly reliable. During the evaluation FACs of the 23TASS hoped to be able to conduct strikes on sensor-detected targets on a near-real time basis in areas where the use of sensors had previously been restricted, such as Rat Fink Valley and the Ban Laboy Fords, both near Ban Karai Pass.[177/]

In early January 1970, the Director of Materiel Management at Kelly Air Force Base, Texas, authorized the implementation of a Class IB modification to equip Air Force OV-10s with Portatales in accordance with Naval Air Systems directives and guidance.[178/] This was accomplished by Air Force Personnel at NKP assisted by advisors from the III Marine Air Wing (MAW).[179/] In addition, two special strike strings consisting of four ADSIDs and one SPIKESID apiece were emplaced for the operation on 12 January in the Delta 57 area in Laos near the Xe Bang Fai River.[180/] Deteriorating weather and increased enemy AAA defense had forced the test to be moved away from the preferred site, Route 912B in Rat Fink Valley.[181/] All sensors except the two SPIKESIDs functioned satisfactorily, and none could be read from EC-121R orbits.[182/]

The operational evaluation ran from 22-31 January 1970 and was conducted as a conventional Panther Team operation employing OV-10 FAC and A-1 strike aircraft:[183/]

> *The navigator in the OV-10 used a manual "CONFIRM" sheet to record a time history of sensor activations to provide sequences which were then interpreted to indicate the presence, number and approximate location of the trucks.*

During the 10-day period, a total of 31 Portatale-detected sequences indicated truck movement. Fourteen of these were visually investigated by means of the Night Observation Device (NOD, an available-light-augmentation instrument to improve visibility during night operations) carried on participating OV-10s and a 15th sequence was checked by an O-2 FAC. Results were as follows:[184/]

Sensor Activations	402	Trucks Sighted	31
Sensor Sequences	31	Trucks Struck	13
Sequences Investigated	15	Trucks Destroyed	11

In addition, three POL fires and one medium secondary explosion were reported. During the period of the test, Panther Teams had 23 FAC confirmed truck kills, 11 of which were directly attributable to Portatale equipped aircraft.[185/]

The evaluation demonstrated that FAC aircraft with a Portatale capability could effectively read out sensor strings masked from other monitor aircraft and utilize the information to detect, acquire and destroy enemy trucks. The test also determined that normal FAC crew duties and the time required to record and interpret sensors placed a limit on the number of sensors and the extent of the area that could be monitored.[186/]

Another Portatale strike string was emplaced on Route 912B in Rat Fink Valley on 3 February 1970 to be used in conjunction with OV-10 FACs and A-6s with Airborne Moving Target Indicator (AMTI) radar

[redacted]

JANUARY 1970 PORTATALE TEST

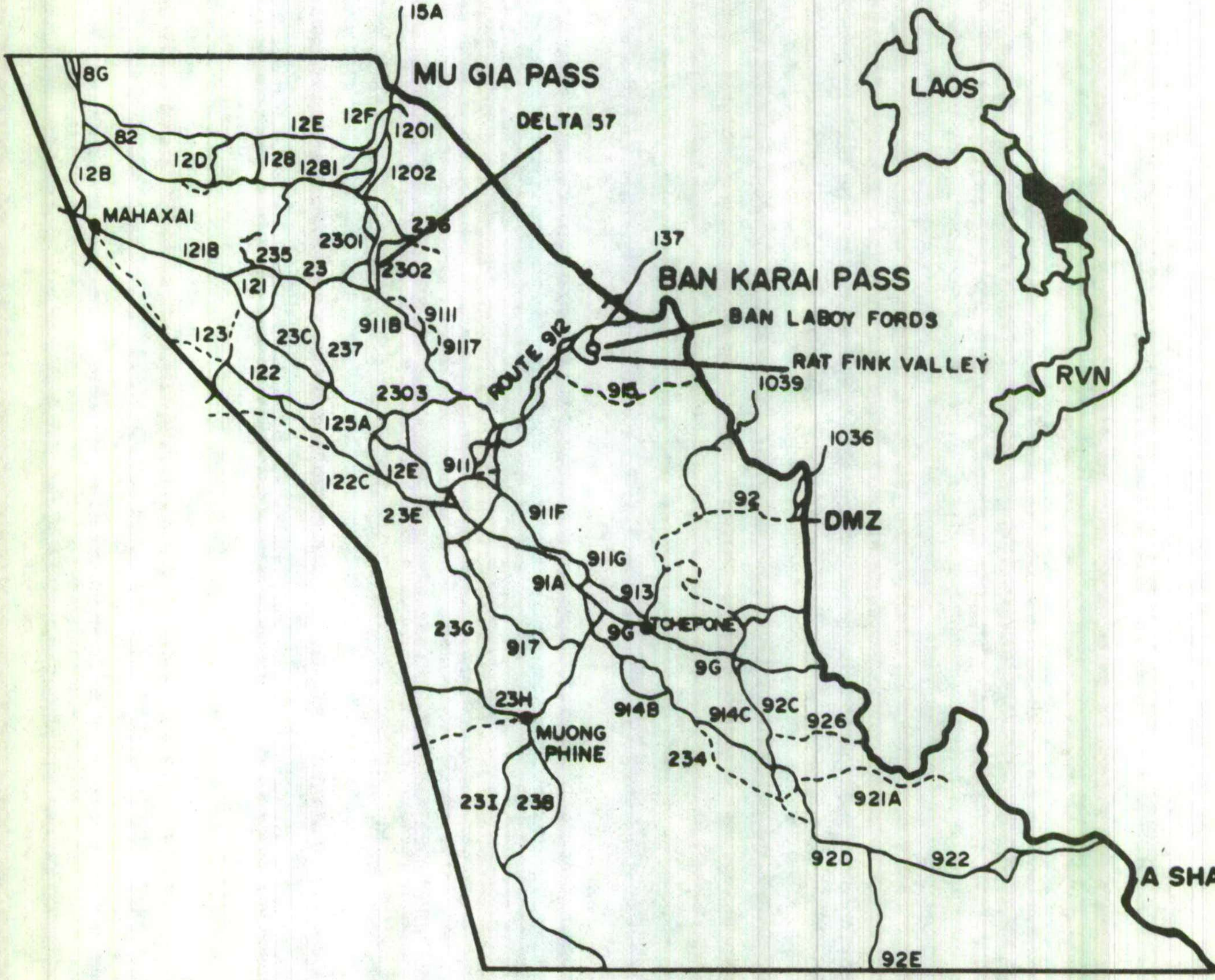


FIGURE 22

[redacted]

capability, but higher priority OV-10 requirements prevented this from being carried out.[187/]

Further TFA study of the widespread application of Portatale revealed numerous difficulties if gunships or even substantial numbers of FAC aircraft were to be equipped with the device on a regular basis. A 27 May 1970 study admitted the advantage in providing real time target information, but the cost of the necessary equipment and modifications (estimated at $300,000) for the FAC and gunship fleet, as well as the added burden on aircrews, were seen as serious drawbacks. The navigator's prime duty of keeping the aircraft above the LOC and searching for truck targets with the NOD would prevent him from adequately monitoring the Portatales and keeping the activation log which was necessary for determining the validity of an activation sequence, and, if valid, the direction of travel. For this reason, the Portatale might be little used or ignored completely, thus wasting the resources involved.[188/]

TFA also estimated that less than 10 percent of the sensor string location requests were refused because of terrain masking; many of these routes could be monitored just as effectively by putting the string elsewhere on the LOC. The Portatale-equipped FAC aircraft or gunship, because of its low operating altitude, would itself incur terrain masking problems more serious than those affecting EC-121Rs monitoring the sensor field from the normal orbits. Since the Portatale could receive on a small range of channels only, management of a larger

Portatale field would be extremely difficult, and Radio Frequency Interference (RFI) problems would increase. The January 1970 test had avoided this problem by using only two strings. TFA also pointed out that subsequent use of the Portatale had resulted in unspectacular BDA.[189/]

Portatale in CREDIBLE CHASE

The use of Portatale as an airborne sensor read out device surfaced again in September 1971 in connection with the CREDIBLE CHASE program to develop a minigunship based on the Short Take Off and Landing (STOL) Turbo-porter aircraft. During a 14-16 September CREDIBLE CHASE Conference at Eglin Air Force Base, Florida, the use by this aircraft of real time sensor information to assist in the location of targets was discussed. This information was to be provided by on-board read out of sensors through Portatale III devices; the necessary electrical connections were already being installed on all aircraft under existing contracts. In addition, DSPG recommended the installation of RO-376 Event Recorders in CREDIBLE CHASE aircraft to further assist sensor interpretation. At the cut off date for this report, details of this further modification had still to be settled, and no information was available concerning the anticipated employment of airborne Portatale IIIs.[190/]

Radio Frequency Interference (RFI)

IGLOO WHITE sensors have always been considered to be extremely vulnerable to hostile jamming efforts.[191/] Studies in 1966 during the early stages of the sensor program examined IGLOO WHITE's vulnerability to enemy Electronic Countermeasures (ECM), but decided that protective measures would slow program development and procurement. Consequently the risk was accepted and the project went ahead as scheduled. These studies concluded that the probable ECM target in the IGLOO WHITE system would be the sensor-to-aircraft VHF data relay.[192/]

While North Vietnamese forces failed to employ such tactics against IGLOO WHITE, RFI was noted on sensor monitoring channels on several occasions during COMMANDO HUNT V. An incident on 7 October 1970 featured severe sensor data interference lasting 90 minutes on Blue and Purple Orbits. There was no indication of the intentional introduction of non-data signals into the sensor channels, and the 553d Reconnaissance Wing speculated that it may have been a side effect of either friendly or enemy ECM/anti-ECM activities during B-52 missions.[193/] Similar incidents occurred from December 1970 to March 1971, with durations of a few minutes to nearly an hour.[194/] As predicted by the 1966 studies, the sensor to aircraft data relay proved to be highly vulnerable to RFI.

In early March 1971, the Air Force Special Communications Center at Headquarters Air Force Security Service in San Antonio, Texas, investigated 29 such incidents occurring since 25 January. A strong correlation was found was found between the interference and periods of ECM jamming performed by B-52s and their EB-66 escorts. North Vietnamese SPOON REST Surface-to-Air missile (SAM) acquisition radar frequencies operated near the IGLOO WHITE sensor-to-aircraft data relay; the necessity of jamming these radars raised the likelihood that this interference could be expected to recur in the future.[195/] Sensor data loss because of such incidents was small, however, and RFI represented an inconvenience, rather than a major obstacle to the successful operation of IGLOO WHITE.

At a sensor conference at Sandia Laboratories (the firm responsible for developing much of the IGLOO WHITE technology) in Albuquerque, New Mexico, on 28-30 April 1971, 7th AF reported the jamming problems and requested that the vulnerable channels be deleted and replaced by others in another frequency range.[196] COMUSMACV approved the change on 9 May and the seven most vulnerable sensor data channels were exchanged for seven new ones.[197]

A September 1971 TFA message stated that there had never been an attempt by the enemy to interfere electronically with IGLOO WHITE operations, but requested that ". . . every precaution be exercised to insure that knowledge of the potential vulnerability of the IGLOO WHITE system to ECM be safeguarded." The success of enemy jamming efforts "would be a function of the approach used," the message continued, but the size of the sensor field, its dispersal, and the foliage found in STEEL TIGER were all expected to limit the success of such an attempt.[198]

<u>Enemy Attempts to Neutralize IGLOO WHITE Sensors</u>

Interrogation of enemy captives and ralliers disclosed enemy awareness of sensors and countermeasures against them. Enemy personnel moving along infiltration trails in Laos received occasional briefings concerning sensors from North Vietnamese troops manning Commo-Liaison stations situated along their route. A typical briefing covered the appearance of sensors, common locations, correct procedures upon discovering such a device, methods of rendering them ineffective and the danger they represented.

One North Vietnamese rallier reported that sensors were described to his group as being one meter long and 62mm in diameter, and painted in a camouflage pattern (similar to that of uniforms) to resemble tropical trees. Sensors had four antennae, two for detecting voices and two for sending signals to waiting aircraft.[199] Most sources reported that the sensors were believed dropped by U.S. reconnaissance aircraft, although one prisoner was told that some were hand-implanted on trails by Army of the Republic of Vietnam (ARVN) Special Forces personnel.[200]

When moving through areas where sensors were suspected, personnel were instructed to walk slowly and quietly and refrain from speaking. Important messages were to be whispered only, and sticks for fires were to be cut, not broken. Any movement which the sensors detected could result in immediate artillery or air strikes.[201] The ground and trees in bivouac areas were always closely searched for air-dropped sensors and mines.[202]

Upon discovery of a sensor, infiltrating personnel were instructed to inform cadre or Commo-Liaison station personnel immediately. Sensors were deactivated by burning or stabbing with bayonets,[203] or were turned upside down and their antennae jammed into the ground. One rallier who reported that he had broken sensors open claimed that the larger devices contained some 54 "tubes and bulbs." This individual drew two sketches, which resembled transistors, for his interrogator.[204] None of the sources reported serious morale problems on account of sensors, although one group was said to have been nervous while passing through a suspected area.

The nature of his sensor-deactivation procedures indicates that the enemy was unaware that sensors automatically deactivated when tilted a certain angle from the vertical. The concern over limited individual conversation and movement while travelling through an area with possible sensor activity revealed that enemy forces believed sensors employed primarily acoustic, rather than seismic detection methods. Since all of the sources were infiltrating ground troops not associated with enemy trucking operations in Laos, no comment is possible about the awareness of enemy vehicle units of sensors and their seismic characteristics.

CHAPTER IV

IGLOO WHITE MONITOR AND RELAY AIRCRAFT

An essential component of the IGLOO WHITE system was the availability of a reliable airborne platform from which to read out emplaced sensors or transmit the data to the ISC. The primary relay/read out aircraft for the IGLOO WHITE program had always been former Navy EC-121Rs operated by the 553d Reconnaissance Wing at Korat Royal Thai Air Force Base, Thailand. Commencing operations in November 1967, the 553d RW eventually deployed 24 aircraft (with the call sign BATCAT) which flew 10-hour missions at altitudes of 16,000' to 18,000'. At that altitude sensor transmissions could be received for a radius of 43 nautical miles with about 90 percent accuracy.[205/]

Due to the age of the EC-121R increasing amounts of time were spent on maintenance, and spare parts were difficult to obtain. Other EC-121R shortcomings were its large crew of up to 22 men and limited altitude capabilities. IGLOO WHITE planners also believed that a higher-flying monitor relay platform would be able to cover the Laotian sensor field with fewer orbits and sorties. These considerations and the desire to reduce system costs made the early procurement of a follow-on relay aircraft a matter of great importance to IGLOO WHITE.[206/]

PAVE EAGLE I

Since early 1968, Headquarters Tactical Air Command (TAC) had sought the development of a drone ground sensor monitor which could

Figure 23.
Lockheed EC-121R BATCAT

operate in antiaircraft artillery (AAA) high threat areas where the vulnerable EC-121R and its large crew could not be risked. The aircraft chosen for this task was a Beechcraft Debonair modified with a turbo-super charged engine, additional fuel capacity, sensor data relay equipment and the capability to operate in a drone (or NULLO - No Live Operator Aboard) mode. This aircraft, designated YOU-22A and given the project name of PAVE EAGLE I, was expected to be suitable for orbits of 12 hours duration in a NULLO mode and six hours with a pilot aboard. PAVE EAGLE I was designed to operate solely as an airborne relay platform and even when manned had no capability to manually read out sensors or pass target advisories.[207]

Five OU-22A aircraft were in place at Nakhon Phanom Royal Thai Air Base, Thailand, by 7 December 1968 and began test and evaluation flights as part of the IGLOO WHITE program.[208] Although these test flights were conducted in the drone mode, a pilot was always aboard to prevent the loss of aircraft since radio frequency interference at NKP reduced the reliability of the drone control equipment.[209] During the evaluation (in which PAVE EAGLE Is flew one of three sensor monitoring orbits)[210] certain deficiencies were identified, such as the lack of sufficient power, deicing gear, and cabin pressurization. More serious shortcomings involving in-flight engine failures resulted in the QU-22A being restricted from flights over hostile territory on 1 July 1969.[211] QU-22A crashes in June and August prompted the return of all remaining aircraft to the United States in December 1969.[212]

PAVE EAGLE II

PAVE EAGLE II (QU-22B) succeeded PAVE EAGLE I. The B model was similar to its predecessor, but was based on the Beech Model 36. Cost considerations precluded the installation of certain desirable features such as cabin pressurization or a turbo-prop engine, although a larger reciprocating engine was installed.[213/] PAVE EAGLE II operated at altitudes of between 20,000' and 23,000' (6,000' higher than the EC-121R) and was normally flown in a remote control mode, although a pilot was on board in case of difficulties.[214/] A fleet of QU-22Bs was expected to perform the EC-121R mission at one-fifth the cost and one-fourth the personnel requirements of the larger aircraft.[215/]

Since the QU-22B was unable to read out sensors on board the aircraft, it was necessary that the location of the monitoring orbit for extreme southern STEEL TIGER be adjusted to permit the relay of data to TFA. EC-121R BATCATs flying Purple Orbit were able to read out sensor strings manually on board the aircraft, and conducted a traffic advisory service (FERRET III) for FACs and gunships in the area by use of X-T Plotters. The great distance of Purple Orbit from NKP, however, prevented relay of data to TFA for the accomplishment of these functions. The greater altitude capabilities of the QU-22B allowed a new orbit to be established (White Orbit) which could monitor all of Purple's sensors and at the same time effectively relay the data to TFA for read out. The optimum location for White Orbit was developed by test flying during late 1970-early 1971. Part of this program was a special STEEL TIGER test orbit designated Lavender.[216/]

[redacted]

Beech QU-22B

(PAVE EAGLE II)

FIGURE 24

[redacted]

The first five QU-22Bs arrived in SEA in early June 1970 to supplement the 18 remaining EC-121Rs.[217] Full coverage of Green Orbit (three sorties/12 hours a day) began on 1 October, and on 15 October QU-22Bs assumed coverage of Blue Orbit (another three sorties/12 hours per day). Rough running engines and the crash of an aircraft in Laos in late December, however, caused the temporary grounding of the entire fleet by the end of the year. By 31 January 1971, the 16 PAVE EAGLE IIs at NKP were again covering Green Orbit and had extended their flights to Blue Orbit (nine sorties/32 flying hours daily). At this time, the QU-22B was fulfilling all of its intended commitments,[218] and the 553d RW's EC-121Rs were covering Purple Orbit.

At no time during their operational evaluation had either PAVE EAGLE I or II flown missions solely in a NULLO mode. Reasoning that no mission degradation would result from operations in a manned mode only, PACAF on 8 March 1971 authorized the removal of drone equipment from all QU-22B aircraft and the disposition of the control vans and radio units. During the first 1500 hours of operation, two in-flight auto-pilot malfunctions would have resulted in loss of the aircraft if a pilot had not been aboard. PACAF concluded that the greater altitude capability of the QU-22B would allow orbits to be adjusted to avoid AAA threats without adversely affecting the quality of sensor read out.[219]

Since early December 1970, the QU-22B program had encountered increasing difficulties with the aircraft's powerplant, fuel system, maintenance and supply. In spite of these problems and the resultant lost orbit time, the increase in the QU-22B's operational commitment had been necessary to allow complete coverage of the two orbits in light of the dwindling EC-121R fleet. These increasing difficulties and the 8 February 1971 crash of a QU-22B in which the pilot was lost finally led to the EC-121R having to replace PAVE EAGLE II on half of Blue Orbit.[220/] On 23 March the QU-22B was relieved of the rest of Blue Orbit and continued on Green Orbit only, at a rate of three sorties a day.[221/]

The 56th Special Operations Wing (SOW) at NKP began a graduated test program on 26 April 1971 to evaluate the QU-22B's reliability and to discover the cause of the engine difficulties which had continually plagued both PAVE EAGLES. The first stage of the program consisted of four QU-22B sorties a day to cover Green Orbit and two other sorties flying a modified Green Orbit in the vicinity of NKP for test and training purposes. The number of sorties gradually increased until by 17 May a total of nine aircraft were flying daily (six on Green Orbit and three conducting local test flying).[222/] During the 26 April-7 June evaluation, 48 incidents of engine roughness were noted, with all but 16 of these occuring in the same four aircraft.[223/]

By 10 July 1971, PAVE EAGLE II was covering Green Orbit with four sorties a day (13 flying hours) and had assumed the late afternoon/early morning portions of Blue Orbit (three sorties/nine hours).[224/] Three QU-22B crashes in August, however, resulted in an 18 August directive from 7th AF that all aircraft were to be removed from IGLOO WHITE/COMPASS FLAG support activities.[225/]

Within a week of the new restrictions, the 56SOW began a 45-day test program consisting of flights under visual conditions within gliding distance of NKP. The tests were intended to determine engine reliability and sought to duplicate operational missions. Aircraft were flown between 16,000' and 20,000' in hopes of assessing the effect of altitude on engine performance. Additionally, a copilot was added to all flights to record instrument readings, identify deficient areas and increase crew confidence.[226/] A CINCPACAF message on 20 August reported that personnel and facilities at NKP were adequate for support of the program and that "additional on-site assistance may be counterproductive." The message admitted that engines were still the major cause of accidents, and that no significant trend or cause was identifiable; similar problems existed ". . . today that did a year ago."[227/]

By 15 September, the QU-22B had improved to such an extent that the aircraft was again allowed to fly Green Orbit and resume COMPASS FLAG testing. This schedule was to continue until the 1 October end of the 45-day test program.[228/] On that date, the QU-22B transferred Green Orbit to the Airborne Command and Control Center C-130E (ABCCC) and devoted all of its available resources to flying the more demanding (both in distance from NKP and hours of sortie time per day) Blue Orbit.[229/]

ABCCC as IGLOO WHITE Relay Aircraft

As early as February 1971, agencies associated with IGLOO WHITE began to investigate alternate relay aircraft in case the QU-22B's difficulties proved unresolvable. On 25 February, TFA reported to 7th AF that the T-39, U-21, U-2, and C-130 had been considered as IGLOO WHITE relay aircraft, but only the C-130 had been successfully flight-tested in this role. The test had been held the previous month at Eglin Air Force Base, Florida. TFA requested that an ABCCC C-130E be sent to NKP for ground tests to determine the compatibility of IGLOO WHITE and ABCCC equipment.[230]

Ground tests were successful and an ABCCC aircraft with IGLOO WHITE Prime Mission Equipment (PME) borrowed from a QU-22B was test-flown on Green Orbit on 18-20 June. No interference or operational degradation was noted between the two missions, and the C-130E's performance as a sensor monitor was considered identical with that of the PAVE EAGLE system. No additional personnel were required aboard the ABCCC aircraft, and the installation of the IGLOO WHITE PME and antennae could be accomplished during periodic C-130 maintenance.[231] The ABCCC C-130E functioned solely as a monitor/relay station, and possessed no manual read out or FERRET III capability.

The 18 August decision to remove all PAVE EAGLE IIs from IGLOO WHITE orbits also accelerated the program to install QU-22B relay equipment packages in the ABCCC C-130Es. These modifications were

[redacted]

Lockheed C-130E Airborne Battlefield Command and Control Center (ABCCC).

FIGURE 25

[redacted]

completed by the end of September. All nine remaining EC-121Rs were ordered retained in SEA through 1 October as an additional measure to ensure mission coverage.[232] The return of the QU-22B to operations in mid-September and the success of the ABCCC C-130E, however, allowed plans to go ahead for reducing the EC-121R fleet to six in early October.[233]

During late August and much of September 1971, ABCCC C-130Es regularly monitored the IGLOO WHITE sensor field in northern STEEL TIGER and relayed the information back to TFA. The sensor field in extreme southern STEEL TIGER was monitored from White Orbit by the ABCCC aircraft on a test basis, but during most of the period this area was covered by Purple Orbit EC-121Rs. When restricted to White Orbit, ABCCC found its command and control mission degraded, since the C-130E was unable to adjust its location to enhance communications with strike aircraft and Laotian ground forces. Similar difficulties occurred on Blue Orbit. Since ABCCC could best combine both missions on Green Orbit, it began flying at this location on 1 October when QU-22B improvements allowed the smaller aircraft to assume responsibility for Blue Orbit. Southern STEEL TIGER continued to be monitored by EC-121R BATCAT on Purple Orbit.[234]

C-130B as IGLOO WHITE/COMPASS FLAG Support Aircraft

In a continuing search for additional alternate airborne platforms for IGLOO WHITE and COMPASS FLAG, a standard C-130B was fitted with PME for both of these programs and test flown during late September from NKP.[235] The tests were completely successful and at the time of this report, requests and proposals for acquiring and specially modifying three C-130Bs for these missions were under consideration at 7th AF.[236]

[redacted]

CHAPTER V

DART I AND II AND DUFFLE BAG

Both of the Deployable Automatic Relay Terminal (DART) programs initially were deployed in support of U.S. Army operations in the RVN and were not considered part of IGLOO WHITE. They are included in this paper because they were developed and operated by the U.S. Air Force and employed IGLOO WHITE concepts and technology. DART I was transferred to TFA in July 1971 and integrated into IGLOO WHITE. DART II was terminated in September 1970, but knowledge of its difficulties and shortcomings is important for a proper appreciation of the role of sensors in Southeast Asia.

While IGLOO WHITE was directed almost exclusively against enemy vehicles and vehicle-related activities, the DART/DUFFLE BAG programs were concerned primarily with detecting the presence of enemy personnel. After its transfer to Quang Tri and subsequent move to TFA, however, DART I also played an important role in monitoring enemy vehicle activity on LOCs in northern MR I and the southern DMZ. Frequent use was made of hand-or-helicopter emplaced sensors in all these programs, although IGLOO WHITE-style F-4 sensor delivery became standard practice in both the DARTs.

DART I

DART I originally became operational at Bien Hoa Air Base, RVN, on 1 March 1969 to maintain sensor surveillance of infiltration from

[redacted]

[redacted]

DART I OPERATING LOCATIONS

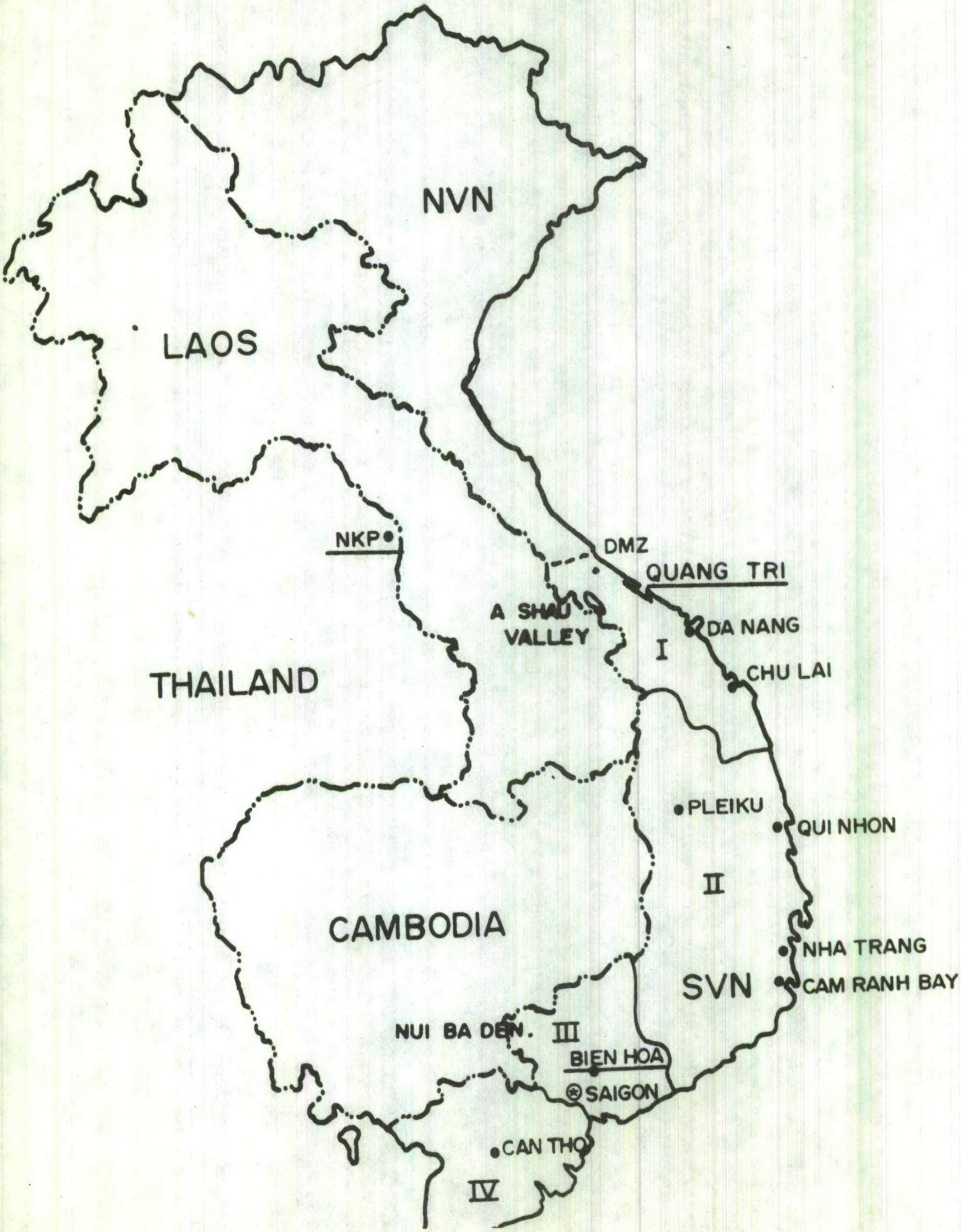


FIGURE 26

[redacted]