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ARMY CONCEPT TEAM IN VIETNAM

APO SAN FRANCISCO 96384

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DEPARTMENT OF THE ARMY
ARMY CONCEPT TEAM IN VIETNAM
APO San Francisco 96384

FINAL REPORT

EVALUATION OF THE TUNNEL/CACHE DETECTOR - PORTABLE DIFFERENTIAL MAGNETOMETER (PDM)

ACTIV Project ACG-9/70I

APPROVED: 21 AUG 1970

RICHARD L. CLARKSON
Colonel, ADA
Commanding

AVHGC-DST(21 Aug 70) 1st Ind
SUBJECT: Final Report - Evaluation of the Tunnel/Cache Detector - Portable Differential Magnetometer (PDM)

DA, Headquarters United States Army Vietnam, APO San Francisco 96375
12 SEP 1970

THRU: Commander in Chief, United States Army Pacific, APO San Francisco 96558

TO: Assistant Chief of Staff for Force Development, Department of the Army, Washington, D. C. 20310

1. Subject final report is submitted for review and approval.

2. This headquarters concurs in the conclusions and recommendations as written.

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AVIB-GCD 21 AUG 1970

SUBJECT: Final Report - Evaluation of the Tunnel/Cache Detector - Portable Differential Magnetometer (PDM) ACG-9/70I

THRU: Commanding General
United States Army, Vietnam
ATTN: AVHGC-DST
APO 96375

TO: Assistant Chief of Staff for Force Development
Department of the Army
Washington, D. C. 20310

1. References:

a. Letter, AGAM-P(M) (2 May 69) FOR ACTIV, Hq DA, 8 May 1969, subject: Army Combat Developments and Materiel Evaluation (CD&ME) Program, Vietnam.

b. Letter, AVHGC-DI, Hq U. S. Army, Vietnam, 23 February 1967, subject: Letter of Instructions.

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D. S. CARROLL
CPT, AGC
Adjutant

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ABSTRACT

The Army Concept Team in Vietnam evaluated the Tunnel/ Cache Detector - Portable Differential Magnetometer (PDM) to determine its suitability as a tunnel and cache locator in the combat environment of Vietnam. The PDM consists of three subsystems - a sensor and staff assembly, an audio readout, and a rechargeable battery pack. The complete system also includes manuals, spare battery pack, battery charger, spare cables, earphones, and target recording materials. Total weight of the system including the 60-pound storage case was 106 pounds. The 1st Cavalry Division (Airmobile), the 25th Infantry Division, and 3d Brigade 9th Infantry Division operated seven PDM from 25 March to 25 May 1970. The PDM provided a limited capability to detect and trace tunnels and to detect caches. It was recommended that the PDM not be deployed to Vietnam and that future development efforts on tunnel and cache detection equipment be directed toward light weight, rugged, and reliable equipment that can operate effectively in dense vegetation.

DEPARTMENT OF THE ARMY
ARMY CONCEPT TEAM IN VIETNAM
APO San Francisco 96384

AVIB-GCD

FINAL REPORT

Evaluation of the Tunnel/Cache Detector - Portable Differential Magnetometer (PDM)

1. REFERENCES

a. Disposition Form, AVHGC-DST, Headquarters USARV, 6 February 1970, subject: Tunnel Detection Device (U).

b. Message, AVHGC-DST, Headquarters USARV, 070754Z, February 1970, subject: Tunnel Detection Device (Differential Magnetometer).

2. PURPOSE

To determine the suitability of the Tunnel/Cache Detector - Portable Differential Magnetometer (PDM) as a tunnel and cache locator in the Republic of Vietnam (RVN)

3. OBJECTIVES

a. Objective 1. To determine operational capabilities and limitations Tunnel/Cache Detector (PDM).

b. Objective 2. To determine the maintainability and reliability of the Tunnel/Cache Detector (PDM).

c. Objective 3. To determine the training requirements for the Tunnel/Cache Detector (PDM).

d. Objective 4. To determine the acceptability of the Tunnel/Cache Detector (PDM).

4. BACKGROUND

In the Republic of Vietnam, the enemy has made tactical

use of tunnels and caves for many years. Tunnels are used for routes of approach and escape; caves and underground bunkers are being used as firing positions and for protection against allied fires; and a common method of storing food and materiel is in underground caches. A capability to detect and trace subterranean cavities is needed to counter these enemy practices. Several technical approaches have been examined; among these, the magnetic detection approach appeared to offer a potential solution.

5. SCOPE

The evaluation was conducted from 25 March to 25 May 1970 in the 1st Cavalry Division (Airmobile), the 25th Infantry Division, and the 3d Brigade 9th Infantry Division; these devisions operated in the III Military Region (MR) of RVN. The PDM was employed by the evaluating units at the discretion of the unit commander and without interfering with tactical operations.

6. DESCRIPTION OF EQUIPMENT

a. The PDM (see Figure 1 and 2) consists of the sensor and staff assembly, the audio readout, rechargeable batteries, and accessories. The accessories include manuals, spare battery pack, battery charger, spare cables, earphones, and target recording materials. The sensor and staff, with the L1 and L2 heads assembled, is 8 feet long, and the system weighs 26 pounds when configured for field operations. The battery life is approximately 8 hours; the batteries can be fully recharged in 10 - 12 hours with a fast charge, or 24 hours with a slow charge.

b. The PDM provides a means to detect and trace tunnels, and to locate caches. Its operation is based on the principle that the presence of a cavity, tunnel, object, or cache creates a disturbance in the earth's magnetic field. In tunnel detection and tracing, the condition of the magnetic field is presented to the operator as an audio signature and by a visual meter indication on the readout box; any disturbance will cause changes in the readings. Tunnels located in soil that contains appreciable amounts of ferrous particles are easier to detect than those in soil of low ferromagnetic material content. Caches containing objects made of other like metals can be located in any type of soil, since the magnetic disturbance is caused by the object and not the soil.

FIGURE 1. Portable Differential Magnetometer.

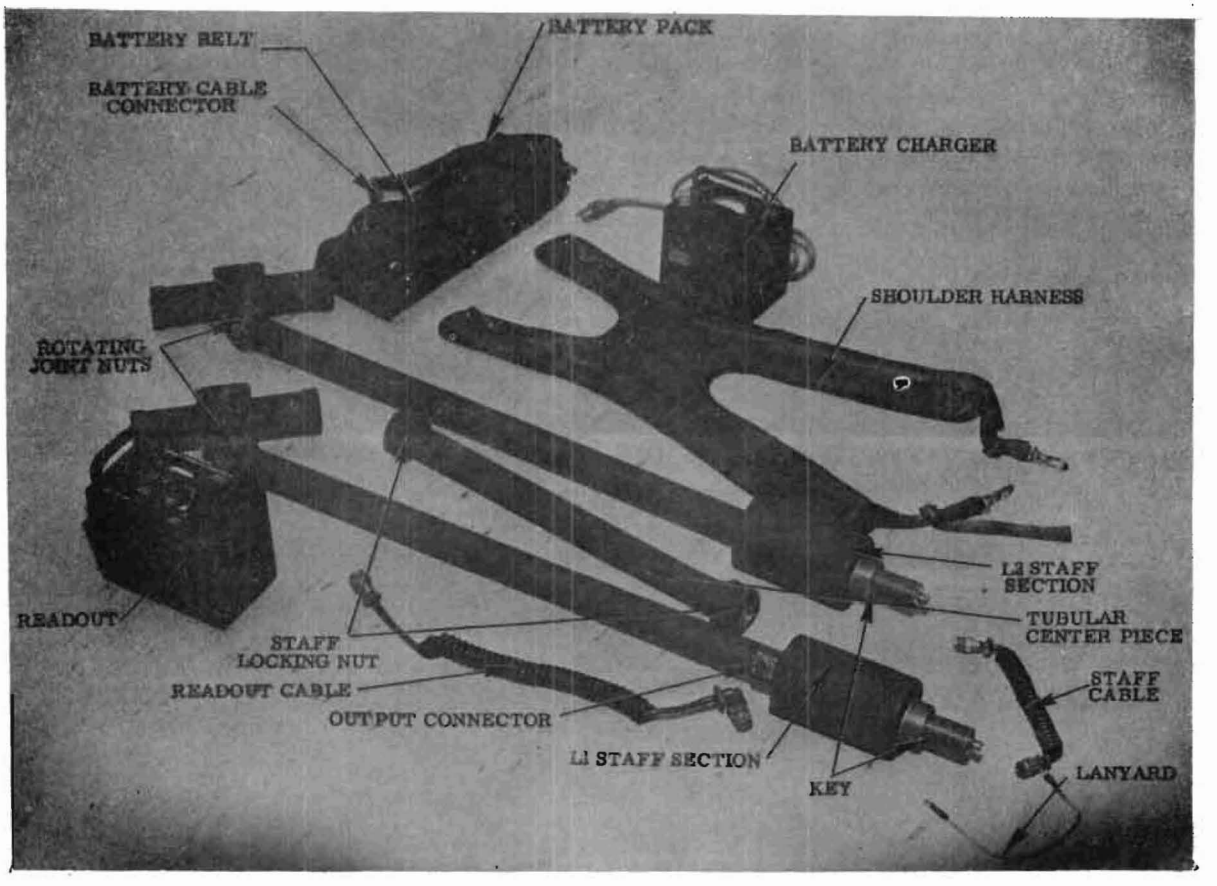

FIGURE 2. Portable Differential Magnetometer Components.

7. APPROACH

Seven PDM were assigned as follows: three to the 1st Cavalry Division (Airmobile), three to the 25th Infantry Division and one to the 3rd Brigade, 9th Infantry Division. All user personnel were trained at one time and returned to their units with the PDM. The 1st Cavalry Division assigned PDM to the divisional engineer battalion; these were further distributed to the companies in direct support of the three brigades. In the 3d Brigade, 9th Infantry Division, the PDM was used by the separate engineer company that was organic to the brigade. The 25th Infantry Division allocated one PDM to an infantry battalion in each of its three brigades. Data for the evaluation was collected by operator questionnaires, structured interviews, and personal observations of the ACTIV project officer.

8. ENVIRONMENT

a. The evaluation in the 1st Cavalry Division (Airmobile) took place in the northwest and northern sectors of the III Military Region (MR). This area contains undulating terrain and a series of low hills. The dense vegetation includes both natural forests and plantations, with triple-canopy jungle in the northern sector. The transition period between the northeast and southwest monsoons provided warm temperatures in April. In May, the southwest monsoon brought precipitation in the form of afternoon and evening thundershowers.

b. The evaluation in the 25th Infantry Division was in the southwest sector of the III Military Region (MR). The terrain is generally flat with two isolated mountains in the northern part of the sector. The vegetation is sparse in the western sector and becomes more dense in the eastern and northern sectors. The weather in this area was the same as that discussed above for the 1st Cavalry Division area.

c. The 3d Brigade, 9th Infantry Division area of operation (AO) was in a flat, stream-laced, rice producing area in the southwest sector of the III MR. When the southwest monsoon started, this area became inundated.

9. OBJECTIVE 1 - TO DETERMINE OPERATIONAL CAPABILITIES AND LIMITATIONS OF THE TUNNEL/CACHE DETECTOR (PDM)

a. Tactical Employment

During the evaluation, the detector was used on a special mission basis. Upon locating a tunnel entrance or an airhole leading into a tunnel, the tactical unit requested that the PDM and operator be brought to the tunnel location to trace the tunnel. The method of transportation used was either wheeled vehicle, tracked vehicle, or helicopter. The same type of tactical employment was used when a cache was suspected to be in the area. The supported unit provided security for the operator. The security force varied from an infantry squad to an infantry company, with an average force consisting of approximately a platoon.

b. Tunnel Detection

Only one tunnel was located during the evaluation using the PDM. A mechanized infantry battalion in the 25th Infantry Division had visually detected a tunnel in the area west of Cu Chi by finding two air holes. The unit employed the PDM in the area on a random search and found another tunnel that had been started and then abandoned. The tunnel was only 10 feet long, 2-1/2 feet wide, and had a maximum overburden of 4 feet. During this operation, in which the L1 and L2 sensors were used, the operator encountered many false signals from fragments of metal embedded in the soil in the vicinity of the tunnel.

c. Tunnel Tracing and Cache Detection

(1) After finding a tunnel south of Phouc Vinh, the 1st Cavalry Division (Airmobile) brought a PDM to the site and traced it. The operator used a circular search pattern, starting at the tunnel entrance. The tunnel, which extended 30 meters north, then turned 90 degrees to the east, was traced for 75 meters from this turning point before it was lost. During the tunnel trace, the operator obtained a signal of metallic objects in the tunnel. Further investigation revealed a cache of one 500-lb. bomb, three Chicom claymore mines, and two 82mm mortar rounds. During this operation, the operator used only the L1 sensor.

(2) The only other cache detection occurred when an infantry battalion from the 25th Infantry Division used

the PDM in a suspected tunnel complex location west of Dau Tieng. Using the L1 and L2 sensors and a random search pattern, the operator found one 82mm mortar round.

d. Environmental Limitations

(1) The initial data provided by the Land Warfare Laboratory (LWL) indicated that tunnel detection with the PDM would be more successful in the northern section of the III MR and in the Central Highlands, due to the magnetic characteristics of the soil in those areas. However, during the initial training phase at Cu Chi, the LWL New Equipment Training Team (NETT) personnel indicated that the audio and visual meter indications obtained at Cu Chi were the same as those obtained during CONUS testing. Therefore, the evaluation proceeded in the AOs of the 25th Infantry Division and 1st Cavalry Division (Airmobile).

(2) Other major environmental factors -- metallic objects in the soil, vegetation, and terrain -- limited the operation of the PDM.

(a) The metallic debris in the soil throughout all evaluating unit areas of operation produced many false signals.

(b) The vegetation in all unit areas of operation limited the maneuverability of the operator. In dense vegetation, it was extremely difficult to execute an adequate search pattern while orienting the sensor staff parallel to the ground and keeping it at the correct height. Even when using the L1 sensor alone, which obviated the necessity to keep the staff parallel with the ground, the vegetation created serious difficulties.

(c) The many canals and ditches in the AO of the 3d Brigade, 9th Infantry Division limited the size and shape of any search pattern attempted. When the operator conducted a search pattern, he was confronted with water obstacles that varied in depth from 3 feet to well over the man's head.

e. Findings

(1) The PDM was employed primarily on a special mission basis (9a).

(2) False signals were generated by metallic fragments in the soil of the areas (9b).

(3) The PDM detected one tunnel, traced one tunnel, and located two caches during the evaluation (9b,c).

(4) Terrain, vegetation, and water barriers limited systematic search patterns and proper manipulation of the PDM sensors (9d).

10. OBJECTIVE 2 - TO DETERMINE THE MAINTAINABILITY AND RELIABILITY OF THE TUNNEL/CACHE DETECTOR (PDM)

a. Maintainability

Maintenance support for the PDM was provided by the manufacturer's technical representative. The organizational maintenance performed by the operators consisted only of cleaning the PDM and charging the batteries. The units were instructed to contact the ACTIV project officer if a malfunction occurred. Figure 3 describes PDM malfunctions and the maintenance actions required to correct each failure.

b. Equipment Problems

Equipment problems encountered during the initial equipment checkout and shakedown were minor and were easily corrected by the contractor's representative. The recurring equipment problems encountered during the evaluation are described below.

(1) Loose Sensor and Rotating Joint Connections

The connections between the staff and the rotating joint and the rotating joint and the L1 and L2 sensor heads continually became loose. A field expedient using epoxy proved to be a satisfactory repair of these loose connections.

(2) Loose Circuit Boards in the Readout Box

Three readout boxes failed due to loose circuit boards. The holddown pad was made out of soft rubber, and was not firm enough to hold the circuit boards against the connections inside the readout box. The malfunctions were corrected by building up the holddown pad with layers of cloth tape or replacing it with a hard rubber eraser.

PDM SERIAL NUMBER	MALFUNCTIONS	CORRECTIVE ACTION
1	Low audio. Loose circuit boards in readout box. Three wires broken in power cable between readout box and sensor staff.	Repaired cold solder joint in crystal board. Built up holddown pad. Replaced cable.
2	Loose circuit boards in readout box. Rotating joint of sensors loose.	Built up holddown pad. Epoxied joint.
3	Loose circuit boards in readout box. L2 rotating joint loose. Connector on L2 head damaged. Cable out between sensor and readout box. L1 rotating joint loose and wires broken in sensor staff.	Built up holddown pad. Epoxied joint. Replaced connector. Replaced cable. Epoxied joint. Spliced wires.
5	L1 and L2 sensor heads loose and RF wire broken.	Returned to CONUS and replaced by PDM #8.
7	L2 sensor head loose. No audio.	Epoxied knuckle joint. Replaced amplifier cord. No. 1 circuit board replaced. L2 long signal amplifier circuit board replaced.

FIGURE 3. Equipment Malfunctions.

(3) Readout Cables

Two readout cables between the readout box and the sensor staff failed and were replaced with spares that accompanied the PDM. The cause of failure is not known.

c. Spare Parts

The manufacturer provided an adequate supply of spare parts to support the PDM throughout the evaluation. These spare parts included both major assemblies and their component parts, e.g., circuit boards.

d. Power Supply

Each PDM had two portable battery packs, which provided the unit with a continuous operating capability. The plug-in, 110-120 volt battery proved to be very reliable. No problems were encountered with either the battery system or the battery chargers.

e. Carrying Cases

The PDM was shipped and stored in a metal case 27-1/4" by 37-1/4" by 10-1/2". The case weighed 60 pounds empty; when it was loaded with the PDM and ancillary equipment, the total weight was 106 pounds. This metal container provided adequate storage and protection for the PDM during shipment. A canvas bag that was provided to carry the PDM for field use also proved adequate during the evaluation.

f. Ruggedness

With the exception of the L1 and L2 sensor heads and rotating joints, the PDM and auxiliary equipment proved to be rugged enough for the combat environment of RVN.

g. Reliability

Three of the PDM failed to operate properly on their first tactical mission. These failures are included in Figure 3. The contractor representative repaired all three PDM and returned them to the units. After these initial failures, all the PDM operated without any major problems, with the exception of one, which had to be retrograded to CONUS and was replaced. Three of the PDM did not require any repair during the evaluation, but one of these systems was only used for training and demonstration, and another was used on only one operation.

h. Findings

(1) Organizational maintenance was limited to cleaning and changing the batteries (10a).

(2) All DS maintenance was accomplished by the manufacturer's technical representative (10a).

(3) Five of the eight PDM experienced equipment malfunctions (10a).

(4) The sensor heads and rotating joints continually became loose (10a).

(5) Spare parts supply satisfied requirements (10c).

(6) No problems were encountered with the battery system or the battery charger (10d).

(7) The storage/shipping container and the field canvas bag fulfilled their designed purpose (10d).

11. OBJECTIVE 3 - TO DETERMINE THE TRAINING REQUIREMENTS FOR THE TUNNEL/CACHE DETECTOR (PDM)

a. General

The initial training on the PDM was accomplished at the 25th Infantry Division base camp at Cu Chi. An actual Viet Cong tunnel complex located in the mine and booby trap training area at the base camp was used for training. This location offered the desired environmental conditions and a secure area in which to present classroom and practical training to the operators. Two noncommissioned officers from LWL and one technical representative from the manufacturer conducted the training. The program of instruction covered assembly and disassembly, target identification, familiarization with false targets and background noises, search techniques, and operator maintenance. Practical exercises using enemy weapons and the tunnel complex at Cu Chi were included in the initial training.

b. Personnel

The 25th Infantry Division provided two enlisted personnel from each brigade; in addition there were two men from the 3d Brigade, 9th Infantry Division making a

total of eight personnel. Seven other personnel from the 1st Cavalry Division (Airmobile) were from the divisional engineer battalion, which provided two men from each company in direct support of each brigade and one training NCO from the battalion headquarters company. The 15 trainees ranged in grade from PVT E1 to SSG E6.

c. Scope of Training

All trainees stated they could operate the PDM after the 12 hours of initial training. Once the evaluation started, the confidence of the operators increased; throughout the evaluation, the operators indicated that the initial training program was adequate. Two of the operators became casualties; however, these casualties occurred in combat action not associated with the operation of the PDM. The technical representative from the manufacturer trained without difficulty replacement personnel for the unit that lost the two operators.

d. Findings

(1) The initial training was conducted by two LWL and one contractor representative with no difficulty (11a).

(2) Personnel were considered to be qualified to operate the PDM after 12 hours of instruction (11c).

12. OBJECTIVE 4 - TO DETERMINE THE ACCEPTABILITY OF THE TUNNEL/CACHE DETECTOR (PDM)

a. Employment

During the initial month of the evaluation, the PDM employment varied in all units from daily use to one or two operations per week. The employment of the PDM decreased drastically as the evaluation proceeded, until useage averaged less than one operation per week per unit. The PDM was employed only on an on-call, special mission basis at the end of the evaluation. The causes of the decreasing utilization rate are discussed below.

(1) The primary operator objections to the PDM were the weight of the detector and the difficulties in maneuvering the staff in heavy vegetation. In one operation, the PDM was employed with a dismounted infantry unit. Manipulating the PDM in heavy vegetation, and carrying its

weight combined with that of his personal equipment, quickly exhausted the operator and he could not keep up with his unit. The problems of properly orienting and maneuvering the PDM in effective search patterns, as discussed in Paragraph 9e, were additional causes for operator objections.

(2) Since most tunnels and caches were detected visually, commanders did not feel that the PDM provided the unit with a unique capability. In addition, the commanders thought that the VC/NVA were currently using bunker complexes more than tunnels.

b. Operational Techniques

The employment of the PDM required a slow, deliberate, thorough search of a suspected area. The supported unit was required to provide security for this operation. Unless the suspected area was of unusual importance, the unit was reluctant to tie up valuable combat assets in support of a slow operation. The effectiveness of units in locating tunnels and bunkers visually, in addition to the amount of time spent versus results obtained using the PDM, further influenced unit personnel acceptance. User acceptance progressively decreased as the evaluation proceeded.

c. Findings

(1) Initial user acceptance was high (12c).

(2) User acceptance of the PDM decreased during the evaluation (12c).

(3) The weight of the PDM and the difficulties in manipulating it in dense vegetation were major objections to the PDM (12c).

(4) Commanders did not believe that the PDM provided a unique capability to detect tunnels and caches (12a,b).

13 CONCLUSIONS

a. Objective 1. Operational Capabilities and Limitations. The PDM provided a limited capability to detect and trace tunnels and detect caches in Vietnam.

b. Objective 2. Maintainability and Reliability based on limited employment in the field. The system appeared to be maintainable; however, the data base was too restricted to quantitatively assess reliability.

c. Objective 3. Training Requirements. Personnel at the user level were readily trainable in the care and use of the PDM.

d. Objective 4. Acceptability. The acceptability of the PDM to user was reduced by the enviromental and operation limitations imposed on its employment.

14. RECOMMENDATIONS

It is recommended that:

a. The PDM not be deployed to RVN.

b. Future development efforts on tunnel and cache detection equipment be directed toward lightweight and rugged equipment that can operate effectively in dense vegetation.

ANNEX A

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13. ABSTRACT

The Army Concept Team in Vietnam evaluated the Tunnel/Cache Detector - Portable Differential Magnetometer (PDM) to determine its suitability as a tunnel and cache locator in the combat environment of Vietnam. The PDM consists of three subsystems - a sensor and staff assembly, an audio readout, and a rechargeable battery pack. The complete system also includes manuals, spare battery pack, battery charger, spare cables, earphones, and target recording materials. Total weight of the system including the 60-pound storage case was 106 pounds. The 1st Cavalry Division (Airmobile), the 25th Infantry Division, and 3d Brigade, 9th Infantry Division operated seven PDM from 25 March to 25 May 1970. The PDM provided a limited capability to detect and trace tunnels and to detect caches. It was recommended that the PDM not be deployed to Vietnam and that future development efforts on tunnel and cache detection equipment be directed toward light weight and rugged equipment that can operate effectively in dense vegetation.

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