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UNITED STATES MILITARY ASSISTANCE COMMAND, VIETNAM
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MACSA 11 October 1967

SUBJECT: DMZ Artillery/Mortar/Rocket Study, Project ARMOROCCO (U)

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MACSA ARTILLERY/MORTAR/ROCKET COUNTERMEASURE STUDY

First Interim Report

I. RECONNAISSANCE AND LOCATION AIDS

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MACV Office of the Science Advisor
4 October 1967

SUMMARY

The MACSA/Artillery/Mortar/Rocket Countermeasure Study has been broken down into three major topics:

I. Reconnaissance and location aids.

II. Counterbattery weapons and weapons effectiveness.

III. Passive countermeasures.

Since this First Interim Report addresses possible applications of some 30 different location aids it is almost a summary in itself. The reader may find the Table of Contents helpful for quick reference and as an index of coverage.

RECONNAISSANCE AND LOCATION AIDS
CONTENTS

MACSA ARTILLERY/MORTAR/ROCKET COUNTERMEASURE STUDY

FIRST INTERIM REPORT

RECONNAISSANCE AND LOCATION AIDS

1. INTRODUCTION

At a MACV J-staff meeting called on 7 September 1967 to consider alternative Dye Marker plans in view of the intensification of enemy artillery fire in the DMZ area, the Science Advisor was asked to survey possible counter-artillery measures available in CONUS. A preliminary survey of available instrumentation was reported by MACSA to COMUSMACV by message[1] of 19 September. On the basis of this information several actions were initiated by the MACV staff, as reported in COMUSMACV message[2] reply of 22 September.

Since the problem of enemy artillery appeared to become increasingly critical, as measured both in numbers of rounds and in US casualties, COMUSMACV on 25 September tasked[3] MACSA to

> "Evaluate systems to detect launch locations of rocket/artillery/mortar rounds, to include currently available systems as well as systems under development or under study in CONUS. In addition, evaluate passive defense measures currently being utilized in I Corps. (Action: MACSA in coordination with J3 and USARV. Report estimated completion date by 2 Oct 67.)"

To accomplish the assigned coordination, an Advisory Group was constituted as follows:

DMZ Project Advisory Group

Agency	Representative
7^{O} AF	LGen Momyer
USARV	BGen Young (for LGen Palmer)
MACV CofS	MGen Kerwin
ACofS J2	BGen Davidson
ACofS J3	MGen Pearson; Col Spaulding (J342)
MACCOC	BGen Chaisson
MACSA	Dr McMillan

At its first meeting, on 27 September, the Advisory Group considered MACSA's proposed approach, from which emerged the project outline attached as Appendix A. A second meeting of the Group is scheduled for 4 October to consider progress to date, as described in this First Interim Report.

[1] DTG 191540Z Sep 67, W.G. McMillan to Gen W.C. Westmoreland
[2] DTG 221249Z Sep 67, Gen W.C. Westmoreland to W.G. McMillan
[3] MACV CofS Action Memo No. 67-97

Liaison with III MAF has been accomplished through two trips to Da Nang: a short session on 28 September, at which the Marines were presented with a set of questions (Appendix B); and an all-day session with MACSA members on 1 October, at which the responses to these questions were discussed in detail with representatives of III MAF Hqs, 1º MAW, 1º Marine Div and 12º Marines, especially artillery officers and veterans of Con Thien, Gio Linh, Cam Lo, Camp Carroll, etc.

Since representatives of 7º AF, 1º Marine Air Wing and Marine artillery units all expressed the opinion that they can, with the means at their disposal, destroy any enemy guns that can be accurately located, our first priority efforts--and this First Interim Report--have been focused on the problem of target location. Subsequent reports will examine the effectiveness of present and near-future weapons systems for destruction of artillery pieces and sites, as well as systems for improving passive defenses.

In considering possible technical aids to the problem of target location, three time frames have been considered:

i) systems immediately available;

ii) systems available within a short time, taken to be a few weeks; and

iii) systems now under development that can help in the future.

For each of the proposed technical aids considered in this report, those available in the shortest time will be considered first, with those available on longer time scales in progressive sequence.

2. OVERVIEW OF THE ARTILLERY THREAT

2.1 The DMZ Situation.

Assessment of the number of artillery pieces involved in the DMZ artillery threat has been particularly difficult because of the limited hard intelligence available. J2 holdings on enemy order of battle in and around the DMZ indicate the estimated artillery TO&E shown in Table 1.

Table 1. Estimated DMZ Enemy Artillery/Mortar/Rocket TO&E

Unit	85/100mm Gun	105/122mm How	130mm Gun	160mm Hvy Mtr	120mm Mtr	122/140mm Rocket Launchers
84º Arty Regt, MR IV	0	24	12	0	0	18
164º Arty Rgt, MR IV	12	0	12	12	0	18
78º Arty Regt/325º Div	12	12	0	0	12	0
Van An Arty/RKT Rgt (Possibly Part of 351º Arty Div)	Unk	Unk	Unk	Unk	Unk	18-140 18-122
U/I Arty Bn, Sub. of 270º Indep. Regt.	0	6	6	0	0	0
Sub Totals	24	42	30	12	12	72

Total[a]: 96 Gun/Howitzers + 24 Mortars + 72 RKT Launchers

[a]Less an estimated 23 destroyed, units unidentified.

It should be emphasized that these figures serve only as order-of-magnitude estimates since we have no information on NVN departures from their nominal TO&E or on their strength status.

Figs 1&2 summarizes the distribution of incoming enemy rounds on US positions near the DMZ by type and time for the period embracing the recent high activity. Estimates of the minimum number of tubes required to deliver the quantities of projectiles and the observed rates indicated in Figs 1&2 lead to a number of tubes possibly as low as 10 to 20. Discussions with III MAF artillery commanders have elicited a collective, intuitive and subjective guess of the total number of tubes in the neighborhood of 50 to 60.

The number of prepared field gun positions, both vacant and occupied, that have been identified from photography is in the neighborhood of 150. A total of 25 field guns have been identified through photography, although some of these may be duplicates resulting from movement of the guns. As a piece of incidental information, some 200 to 300 total AAA sites have been identified in the DMZ area.

To date (3 Oct) there have been twelve low-level (500 foot) reconnaissance flights under operation NEUTRALIZE. Although the quality of this photography is outstanding, the natural cover and camouflage employed by the enemy have limited identification of new field guns to a total of 25, and of new gun positions to 8.

It is apparent that, regardless of actual number of sites, the enemy has the capability to move his limited numbers of weapons to many different locations in the time available between our photo reconnaissance runs and the subsequent air strikes.

2.2 Comparison with Dien Bien Phu.

To provide some perspective on the present DMZ situation it is interesting to make a comparison with the forces[4] in the battle of Dien Bien Phu, in which French forces numbering about 11,000 men were opposed to some 50,000 North Vietnamese combat and 55,000 support troops. Arrayed against the French were the North Vietnamese 351° Heavy Artillery Division, the 675° Artillery Regiment, the 45° Artillery Regiment, the 367° AAA Regiment, the 237° Artillery Regiment and Infantry equipped with heavy weapons, mortars and AAA. The French estimate of the total NVN artillery is shown in Table 2.

Table 2. NVN Artillery OB at Dien Bien Phu

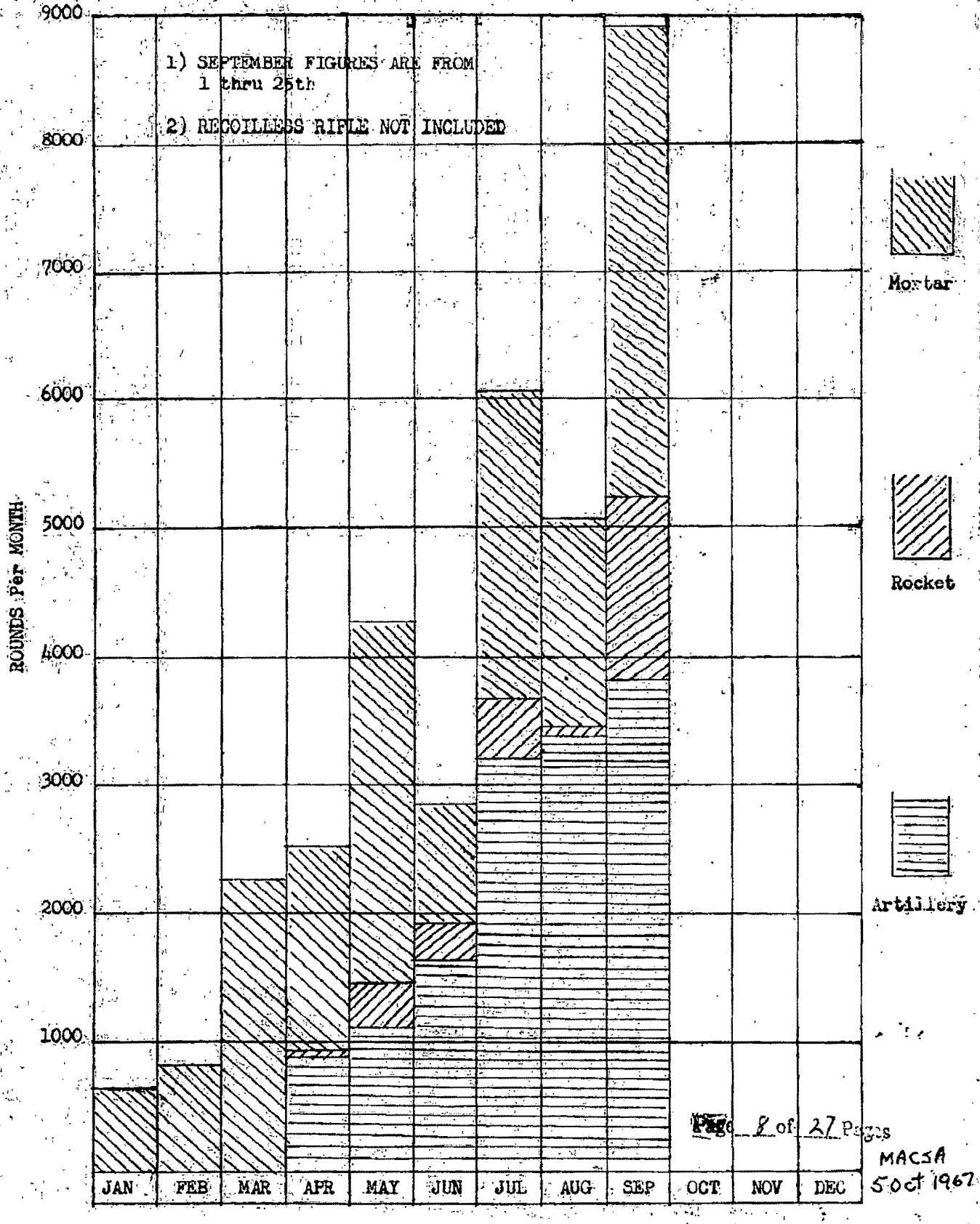
Type	Number
105mm Howitzer	48
75mm Pack Howitzer	48
120mm Mortar	48
75mm RR	48
Heavy Flak Gun	36

The North Vietnamese also used the "Katyusha" multi-tube rocket launchers. All told, some 200 NVN guns of caliber greater than 57mm rained an estimated 30,000 rounds of 105mm and 100,000 rounds of other caliber shells on French positions over a period of 56 days.

[4] cf. B. Fall, "Hell Is A Very Small Place"

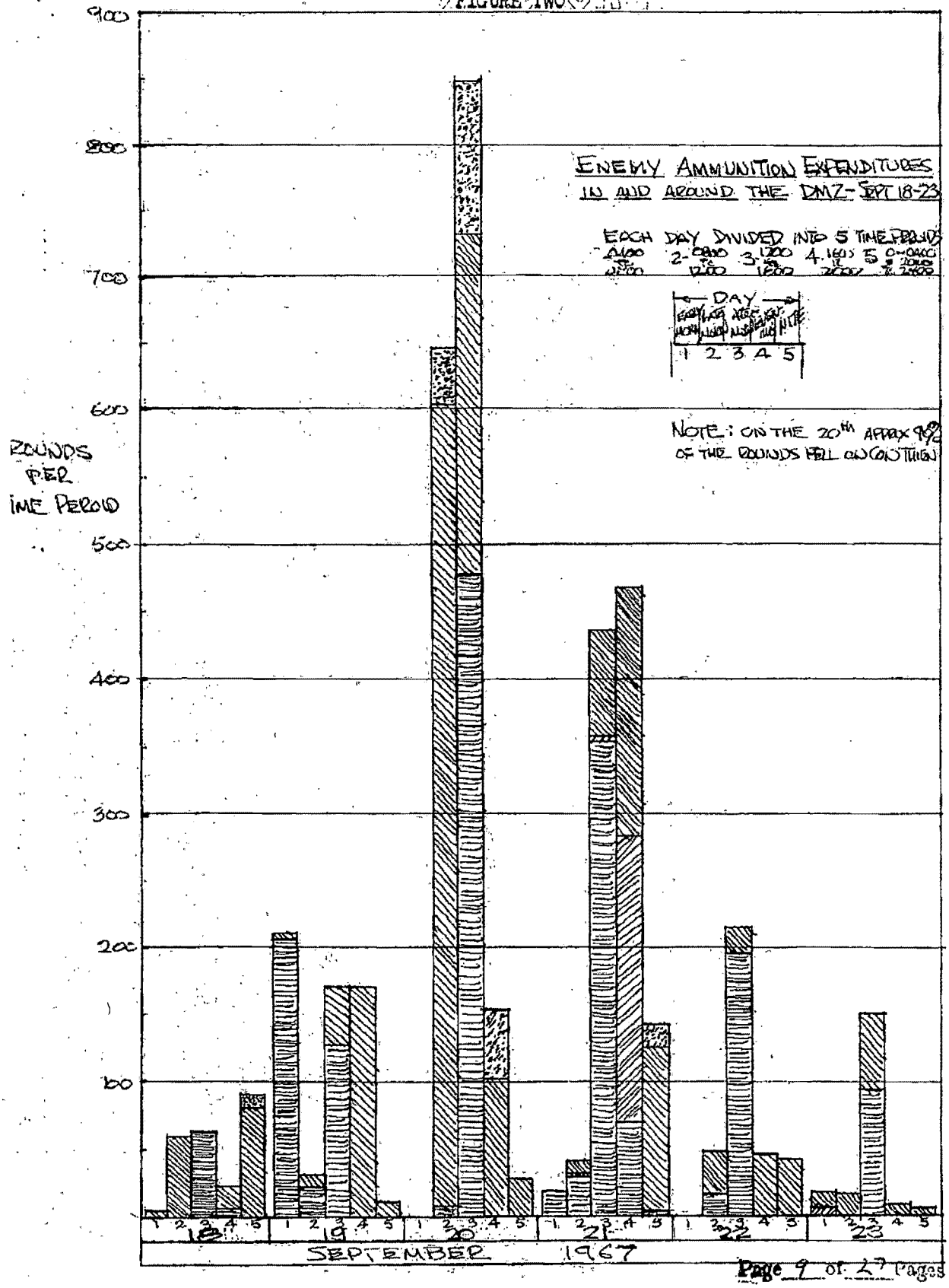
FIGURE ONE

TOTAL ENEMY AMMUNITION EXPENDITURES IN AND AROUND THE D.M.Z.



MACSA
5 Oct 1967

FIGURE TWO



SOURCE: CICV DATA

MACSA SEPT 67

It seems clear that Dien Bien Phu represented an artillery intensity well above what has so far confronted our forces in the DMZ. Nevertheless, the present enemy artillery strength evidently has grown very rapidly in the last few months and we would do well to remind ourselves of the lessons of Dien Bien Phu.

2.3 The VT Fuze Threat.

There have been repeated reports of suspected use of VT fuzing. These suspicions have been fostered by reports of air bursts at consistent heights of 30-50 feet. A fragment recovered by III MAF on or about 12 June was identified by CMEC as part of the US M517 VT fuze used on the 81mm mortar projectile. Large quantities of these fuzes fell into enemy hands during the Korean war and it is conceivable that the NVA could have modified them for use on artillery projectiles.

This is not regarded as a severe threat at the present time since such air bursts constitute a very small function of the total enemy rounds, but steps should be taken to mitigate the threat before it occurs.

> ACTION: MACSA has sent a message[5] to CONUS requesting information on the availability of man-portable jammers known to be in the inventory. In addition MACSA is attempting to locate sufficient test equipment locally to provide a simple VT recognition device.

3. PHOTOGRAPHY

3.1 High Speed Photo Reconnaissance.

The primary technique currently in use for locating the positions of enemy targets is airborne high-speed photo-reconnaissance. There are several limitations to the timely location of targets by the means now employed:

i) It is evident from recent low-level photography that the enemy is making extensive use of camouflage, both natural and artificial, to disguise the location of his weapons, supply caches and support headquarters.

ii) The "Intelligence-cycle time" required to photograph an area, return the film to base, process and read the film, and finally direct and carry out a strike against an identified target is long compared to the time required for the enemy to move his gun into another camouflaged site perhaps only a few hundred meters away.

iii) The number of reconnaissance flights that can be made per day is constrained by the availability of aircraft, the effectiveness of enemy anti-aircraft fire, weather conditions over the area of interest and, not least, by the limited photo-interpreter resources. These factors conspire against timely, large-area coverage of all possible target locations.

iv) The lack of good photo imagery taken during the hours of darkness provides the enemy with adequate time to change locations and resupply his operations.

[5] COMUSMACV ~~(TS)~~ Msg 32346, DTG 020746Z Oct 67 to Harry Diamond Labs, Washington.

Although the following sections suggest a number of potential improvements in aerial photoreconnaissance, it is clear that this technique must be augmented by other realtime location techniques if we are to determine the positions of enemy guns with precision in sanctuaries inaccessible to our ground forces.

3.2 Color and Camouflage-Detection Film.

There exist color films, both regular and infra-red, that can increase the probability of detecting a camouflaged target. These emphasize different parts of the spectrum to provide increased contrast between artificially camouflaged structures and the true natural background, or to provide improved contrast between natural foliage that has been damaged and other nearly normal foliage. The use of normal and infra-red camouflage detecting color films to photograph simultaneously the same target can often provide more information than the use of either film separately.

ACTION: DI of 7^{0} AF advises that color films of both types are in stock and are being programmed into project NEUTRALIZE.

Infra-red black and white films also exist that could provide increased information about camouflaged locations; but, more importantly, these films can be used in conjunction with infra-red xenon strobe lights to conduct covert night photography. Planes equipped with such lights have flown in Vietnam and others are now under construction in CONUS. The Naval Air Development Center has recently conducted tests of a covert IR flash photography system for the RA-5C. The system is spectrally peaked at 835 millimicrons and consists of six 1000 joule electronic flash heads, infra-red source filters, standard KA-51 framing camera, a 6 inch F15 lens, Kodak #5424 film, and special Versamat processing. Usable imagery can be obtained from 5000 feet, from which altitude the flash at ground level is invisible to the unaided eye. The use of such systems would provide information as to patterns of night movement of the enemy's resources. This information could help to pinpoint his location during the following daylight hours.

STATUS: Information has been requested[6] to determine if modifications can be made in theater for the use of this system with the RA-5C or other aircraft.

3.3 FAC Hand-Held Cameras.

For reasonably stable platforms (O1, F4, etc.) FAC use of ordinary hand-held 35mm cameras (e.g., Nikon, Cannon, etc.) can provide timely reconnaissance in the form of quickly-developed snapshots. These cameras are immediately available through supply sources in Japan if purchase funds exist that are not encumbered by goldflow constraints. The Marines have none of these hand-held cameras and would be very grateful to receive even a small number.

ACTION: MACSA will attempt to purchase a half dozen for the Marines with ODDR&E Zap Channel funds.

[6]COMUSMACV (S) Msg 32345, DTG 020745Z Oct 67 to NADC, Johnsville.

3.4 Stabilized Cameras.

To improve photographic detail and resolution from a considerable slant range--for example, of terrain in and north of the DMZ from a distance some kilometers to the south where the AAA threat is tolerable--one may use 35mm cameras equipped with long focal length (500 or 1000mm) cata-dioptic lenses fitted with Dynalens stabilizers. These long focal length lenses have rather small apertures (500mm: f5; 1000mm: f11) which require relatively long exposure times. The Dynalens stabilization compensates for camera motion during the time the shutter is open and thus permits a much greater degree of resolution than is possible without stabilization.

ACTION: Six cameras equipped with 500mm lenses and six with 1000mm lenses, each fitted with a Dynalens image motion stabilizer are being readied by ARPA for shipment to South Vietnam within a few weeks. MACSA has dispatched a message[7] to ARPA urging all possible speed in delivering these units

3.5 Color Film Development

The principal constraint in using color film is the lack of simple and rapid processing facilities in-theater. While the 7° Air Force has the capability to process color films, the processing must be done by hand. III MAF has neither the color film nor the processors but would eagerly use them if they were available.

ACTION: MACSA is investigating the availability[8] of commericial color processors.

3.6 Super-fast Black & White Film.

MACSA has acquired and can make available a small quantity of super-fast 35mm film (ASA 8000), designated SO166. This film can be used in hand-held cameras under low-light-level conditions or at high shutter speeds to contribute toward reducing image motion.

ACTION: 35mm film is immediately available from MACSA, and in other sizes on special order.

3.7 Color from Black & White.

Through the insertion of a small but very special filter in the lens of a 35mm camera one may record on black and white film a kind of holograph from which accurate full color may be reproduced.

ACTION: Several such cameras, along with visual color integrators and printers, are being readied by ARPA--hopefully for shipment within a few weeks.

[7] DTG 031121Z Oct 67 (S) McMillan (MACSA) to Cesaro (ARPA)
[8] DTG 040832Z Oct 67, W.G. McMillan to DIR/NPIC/Wash.

4. VISUAL TECHNIQUES

4.1 Towers.

Observers are now employed, often in towers, to look for flashes of light or puffs of smoke from firing guns. Such techniques can provide timely and relatively accurate gun location but are limited by the availability of personnel and towers, the types of optical aids available, weather and time of day.

The use of large numbers of visual sighting stations, coupled with real time communications between stations could greatly improve both day and night target location capability.

STATUS: III MAF has been furnished information[9] on tower availability by J42.

4.2 Tethered Balloons.

Because of supply and security difficulties the erection of a number of spotting towers in the Con Thien/Gio Linh area might present serious problems at this time. As a possible alternative or augmentation to towers, tethered balloons are capable of carrying weights of 2000 pounds to altitudes up to 10,000 feet and 500 pounds to altitudes of 20,000 feet. The tethered balloon offers the advantages of station keeping, ease of recovery, system re-use and short reaction time.

In the tactical employment a balloon-borne observer could be used for spotting at low altitudes; alternatively, sensors such as low light level television with a zoom lens could be employed, with transmission of the signals back to the ground along the tethering cable.

ACTION: By message to DIRNSA, MACSA is inquiring as to the availability of the NSA tethered balloon capability recently tested in Florida.

4.3 Visual Airborne Target Location Systems (VATLS).

The VATLS system consists of a heliborne 20-power stabilized telescope, an attitude system and a laser rangefinder to define within 100 feet the vector position from the helicopter to any target in GTM coordinates. The helicopter, bearing a transponder beacon, is then tracked by a special ground radar. Position data is computed using a FADAC computer located on the ground.

STATUS: Three complete VATLS systems are nearing completion of tests in CONUS. Communications frequencies have recently been cleared by J6 for test use in RVN. MACSA has requested from ODDR&E;[10] and J342 from DA;[11] complete VATLS system details and availability dates.

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[9] MACJ42-SU Ltr (U) of 30 Sep 67 to III MAF
[10] Sgn Item #2 of Telecon 23/67 (28 Sep 67)
[11] COMUSMACV (8) Msg 32577 DTG 040838Z Oct 67

4.4 Telescopes.

The Marines are currently using standard artillery BC scopes for spotting from towers and bunkers. Their capability against more distant targets could be immediately improved by providing higher magnification, wide angle-of-view optical telescopes mounted on azimuth circles. Such devices are available both in CONUS and Japan.

STATUS: We understand that the Marines requested one hundred of these devices some time ago through normal channels. This request should now be moved to a high priority status.

4.5 Stabilized Optics.

The Dynalens stabilization referred to in connection with hand-held cameras can be applied to almost any optical equipment. The Dynalens system consists of a liquid confined between two optically flat glass plates by a cylindrical bellows which permits a variable prism wedge angle. The wedge angle is servoed by gyros that sense and compensate for unwanted accelerations of the optical instrument. A second method of image stabilization, invented by Luis Alverez (UCB) and being manufactured by Mark Systems Incorporated, employs the gyro-stabilization of an internal prism. Our latest information is that some two hundred binoculars have been ordered by the Navy for delivery late in 1967.

STATUS: As part of a larger shipment of new instrumentation gear, ARPA is readying several pairs of binoculars with Dynalens stabilizers. These should arrive in Saigon within a few weeks.

4.6 Flash Instrumentation.

Six "MITHRAS" flash pulse detector units have recently been delivered to USAF but could be made available to MACV inasmuch as other elements of the USAF system will not be ready for some months. The MITHRAS sensors detect both visible and IR, and have been in use for some time in missile tracking at WSPG. They can be mounted on towers and are also compatible with both fixed wing and helicopter platforms, although platform position and orientation must be known. Accuracy is 10 percent of field of view, 1 percent with calibration.

STATUS: In response to MACSA's inquiry, ODDR&E reports that the MITHRAS system should be available for SVN test during October.

4.7 Glitter Camouflage Detection.

The Air Force Special Weapons Laboratory exhibited to MACSA on 15 September a movie demonstrating the use of a laboratory model of what might be called a Glitter Camouflage Detector. This device selects from natural sunlight illumination two spectral regions, one in the green and one in the near IR, for which natural foliage and artificial camouflage materials are apt to have very different reflective characteristics. A spinning filter which alternately examines these two frequencies causes any material of unusual reflectance to stand out as a blinking image against the background.

ACTION: AFWL has initiated a crash program to produce a prototype of this item for early test in Vietnam.

5. RADAR LOCATION SYSTEMS

5.1 MPQ-4A Countermortar Radar.

The Marines have three MPQ-4A countermortar radars, one each at Gio Linh, C-2, and Camp Carroll. An additional countermortar-counterbattery radar, the MPQ-10B, is also located at Camp Carroll. They have no long-range anti-personnel radars nor surveillance radars capable of detection across the DMZ.

The Marines have made very effective use of the MPQ-4A in its countermortar role. Two MPQ-4A were formerly located at Gio Linh; with the help of these radars the mortar threat was reduced so significantly (no mortar attacks since 3 July) that one set of equipment was moved, within the past 2 weeks, to C-2, where mortar attacks have been a continuing problem. The Marines do not regard the radars as especially vulnerable in these forward locations. Apparently the only damage suffered so far is a few shrapnel holes in the sail.

The MPQ-4A is a single trailer, Ku-band pulsed system. Two beams, separated by 36 mils in the vertical plane, are scanned horizontally over a 445 mil sector. The radar measures time and position of the projectile as it intercepts the two beams, and computes the trajectory back to the launch point. The radar is thus an excellent detector for high-angle (e.g., mortar) fire, but for counterbattery fire is limited to 10 kilometers range. The low angle trajectory of some projectiles reduces computation accuracy, and lack of simultaneous 360° coverage limits the number of locations that can be targeted.

These counter-battery limitations are much ameliorated if enough radars are available to provide simultaneous target coverage so as to permit triangulation from back-azimuth readings. The procedure used is to track incoming artillery fire on the down-leg of the trajectory simultaneously with two radars. The azimuth measurement of such close-in targets is quite precise, and triangulation from the two radars can thus identify the firing location at very long ranges. Although the MPQ-4A has been used effectively in this way against low angle fire (recoilless) at Long Binh and Bien Hoa, the Marines in III MAF have not been able to employ the technique because of insufficient number of radars. Under the high traffic of a barrage attack even more radars would not entirely solve the problem because of confusion of round identification and communication difficulties between sites. When fire is more sporadic, the technique should be quite valuable.

ACTION: USARV is furnishing a recommended plan to COMUSMACV[12] for such combined coverage, and offering to provide III MAF with both equipment and crews. Due to logistics and tactical limitations in the III MAF area, the plan can probably not be put into effect in toto (for example, there is no secure position for a radar location between Gio Linh and Con Thien), but most of the plan could and should be implemented. An additional advantage of the TPS-25 would be its capability as a target locator when enemy equipments are being moved at night.

[12] USARV Msg 71268 DTG 301310Z Sep to COMUSMACV

5.2 Long-Range MTI Radar.

By using a long range anti-personnel radar (such as the TPS-25, available in-country at Divisional levels) to augment the MPQ-4A, precise location of enemy batteries out to ranges of 18km should be possible from a single radar site. Back-azimuth techniques of the MPQ-4A would define direction, and the TPS-25 would range-strobe the ray-patch for indications of movement at the target.

5.3 Missile Tracking Radar.

Some of the naval guided missile ships such as the Long Beach possess very sophisticated phased array radars that are capable of tracking large numbers of targets at great ranges. Other guided missile ships also possess more conventional missile tracking radars that might be capable of tracking artillery projectiles in the DMZ. Even though these ships do not in general possess the computer facilities available on the Long Beach the tracking data might be sent back to computer facilities on shore by data link.

ACTION: MACSA personnel are now visiting the Intrepid and St. Paul to ascertain the capabilities that can be provided by the 7º Fleet.

5.4 Airborne Radar.

The Air Force is now developing an airborne phased-array radar that also might be capable of tracking artillery projectiles under the code name Rivet Amber. MACSA is in contact with CONUS on the availability and applicability of the Rivet Amber system.

5.5 Muzzle Plasma Backscatter.

The effluent from a gun barrel when it is fired consists in part of ionized particles that are good reflectors of microwave radiation. In theory a good radar system should be able to distinguish this enhanced backscatter at considerable distances.

ACTION: MACSA is in communication with CONUS laboratories particularly, the Los Alamos Scientific Laboratory and Aerospace Corp.) on the possible application of such a system.

6. SOUND RANGING SYSTEMS

6.1 General Capability.

Sound ranging can provide a rough azimuth for pointing countermortar radars or, with sufficient base-line and greater care, can give both azimuth and range. Intrinsic azimuth accuracy of one localized array or "station" is limited to perhaps 20 to 30 mils by meteorology and terrain, although sound-on-sound techniques

applied to the differential correction of counter-battery fire may significantly reduce this error. Under unfavorable conditions of atmospheric temperature lapse rate the effective range may be limited to a few kilometers.

STATUS: No sound-ranging equipment exists at III MAF locations. Observers are directed to listen for the muzzle blast and to estimate the azimuth from which the sound comes. This is a very imprecise method of azimuth determination, however, as has been shown by tests in Panama.

6.2 Sound and Flash-Ranging Units.

Program 5 includes a CINCPAC requirement for a modified Field Artillery Target Acquisition Battery, to include two sound-ranging platoons each with two sound-ranging set GR-8, and two flash-ranging platoons each with one flash ranging set AN/GTG-1. The 188-man unit will have none of its normal survey and counterbattery radar elements.

STATUS: Present information indicates this battery will be available in April 1968. By message to DA,[13] USARV has attempted to improve on the April date.

Two Target Acquisition Battalions (TAB) are in being in CONUS: the 3° TAB of the 25° Artillery at Ft Sill and the 2° TAB of the 26° Artillery at Ft Bragg. Both are assigned missions in USAR strike contingency plans. Each contains three batteries of one sound and one flash-ranging platoon each.

STATUS: As of the last readiness report on 30 June 1967, both battalions had most of their ranging personnel and equipment on hand, but the readiness rating of the 3/25 was C-4 and of the 2/26 was C-2.

ACTION: If either or both of these TABs are desired for MACV, special justification and manpower adjustments would have to be provided for.

6.3 Jet Propulsion Laboratory System TNS-9.

The JPL acoustic locator system, now designated the TNS-9, was developed in the last few months specifically for mortar location. It consists of two or more (five, in the Ft Sill prototype) 4-microphone arrays, 1 processor per array and 1 central station, all interconnected with hardwire. Considering sound propagation and meteorological conditions, this equipment is believed to have an intrinsic accuracy of the order of 30 mils in azimuth from any single 4-microphone array. Because of a tendency for the azimuth printer to pile up under high traffic conditions (e.g., under a barrage by ten guns each firing two shells per minute), JPL technicians have designed and are building a new prototype computer of extended capability. In late August the Department of Army[14] offered MACV two alternatives: i) to deploy the current manual system to RVN as soon as possible along with JPL techreps; ii) wait until January or February 1968 when the full computerized model is expected to be available.

[13] USARV (S) MSG AVHGC-O 71236 DTG 191240Z Sep 67.
[14] DA Msg 829426 DTG 242042Z Aug.

STATUS: Because of the urgency of the threat and the promise of the present TNS-9 system in helping pinpoint the DMZ artillery, MACSA recommended electing option (i) above for immediate deployment to RVN. This action was taken in a recent message[15] to DA from USARV.

6.4 Portable Sound Ranger AN/TNS-3.

Last Spring some thirty TNS-3 sound ranging sets were unearthed at Ft Monmouth. This equipment was developed at the close of WWII and used only in Okinawa. At MACSA's instigation ten of these sets plus spares were rejuvenated at Ft Monmouth and dispatched to USARV for testing under the aegis of MACSA and ACTIV. These sets have now arrived in-country, and are being offered to III MAF by USARV Msg DTG 301310Z Sep 67. Because of its simple design this equipment is severely limited in traffic handling capability, especially under a large noise background. It is therefore useful primarily in isolated outposts, such as a Special Forces camp which occasionally receives a few mortar rounds. Those most experienced with this equipment thus question its applicability in the Con Thien/Gio Linh area. Despite these qualifications, three considerations argue in favor of testing the TNS-3 system in the DMZ area:

i) the TNS-3 sets and an operator training team exist in-country and could be sent immediately to III MAF.

ii) the only other sound ranging gear available in the near future is the TNS-9 described above, which cannot be deployed to SVN before a few weeks.

iii) in recent days the number of rounds landing around Con Thien and Gio Linh has dropped dramatically from a peak of hundreds down to only a few per day. At this low level of activity the TNS-3 might well be able to cope with the location problem.

STATUS: Possible deployment of the TNS-3 to the DMZ awaits response by III MAF to USARV's offer.

6.5 Acoustic Mortar Location System AN/MNS-1.

One prototype AN/MNS-1 exists at Ft Monmouth and was in working order when demonstrated to MACSA last July. It is self-contained in a deployable van and could be available on relatively short notice. It has considerably more capability to operate in high noise backgrounds than the TNS-3, but there are no spares and maintenance would be a problem. The Army has discontinued development of the AN/MNS-1 in favor of the more promising JPL TNS-9.

ACTION: MACSA recommends that the MNS-1 be dropped from the list of candidate deployable systems.

[15] USARV AVHGC-O 64102 DTG 271112Z Sep 67 to DA.

6.6 Acoustic/Seismic/Flash Possibility.

A new concept for applying the Muscle Shoals acoubuoy or seismic sensors toward artillery location is as follows. Several of these sensors having the capability of radio interrogation readout from the air would be dropped in the general vicinity of suspected artillery positions. The approximate locations of these sensors could be determined by airborne DF equipment. The realtime signals of this close-in array of sensors, either of an acoustic or seismic nature, would provide a series of signal arrival-time differentials from which the gun location could be approximated. In favorable situations where the flash of the piece could be observed befofe the signal reached the seismic and acoustic detectors even fewer detectors would be required to determine the location of the gun. While the Muscle Shoals devices are not yet ready for deployment in Vietnam they could be in a very short time frame. Test programs are still in progress in CONUS and Panama under which this concept of employment could be easily evaluated for possible exploitation in the future should this appear necessary and useful.

This conceptualization has so far not been carefully evaluated, and is mentioned here only because it would make use of sensor assets soon to be available.

ACTION: The concept will be more thoroughly studied as time permits.

7. QUIET AIR BORNE PLATFORMS

7.1 ARPA QT-2 Aircraft.

There exist two copies of a very quiet aircraft, developed by Lockheed Aircraft Co. under an ARPA contract, that shows considerable promise as a night observation platform. These craft are sailplanes that have been modified by the addition of a small gasoline engine. Every effort has been made to eliminate all possible sources of noise. In CONUS tests this aircraft has proven to be inaudible in a quiet background at slant ranges greater than 800 feet.

Pilots briefed on this aircraft have expressed the opinion that it is possible for it to penetrate the enemy's territory in the vicinity of the DMZ at altitudes of 1000 feet with relative impunity. An observer in such a craft, equipped with night visual aids and a small hand-held camera, could provide considerable detail as to enemy locations and patterns of movement at night.

To be most effective these aircraft would require great secrecy in their operation. Secrecy might be best maintained by operating these planes from carriers at sea. The practicality of this approach is being investigated now.

ACTION: By message[16] of 4 October, MACSA has requested DDR&E to have the prototype aircrafts properly modified on a priority basis and shipped to Vietnam for testing under MACSA/ARPA-RDFU-V aegis.

[16] DTG 040149Z Oct.

7.2 Silent Joe.

ARPA has developed a balloon-borne acoustic sensor system that is due to arrive in Vietnam for test in the near future.

This system consists of a helium balloon powered by a small gasoline motor and propellor system for moving it over the ground. Acoustic sensors are arranged to listen for activity below the balloon and to relay this information back to the tracking site by radio link.

A system of this type could be useful for gathering intelligence data above the DMZ to locate concentrations of troops or positions of firing artillery.

ACTION: MACSA message DTG 040149Z Oct to ARPA Washington requesting full technical details and expected test dates.

7.3 High Altitude Balloons.

Techniques exist for keeping a high altitude balloon in traverse modes back and forth over a given area for several days at altitudes up to 70,000 feet. Such balloons can be provided with data packages weighing as much as 10,000 pounds to take high definition aerial photographs and to eject the film for recovery by aircraft over nonhostile areas.

While the use of such surveillance techniques is limited by weather, ground haze and to some extent the vagaries of high altitude winds, they can provide usable information at a relatively low cost with minimal risk.

The balloons are available in the present inventory and the acquisition time for the data system could probably be made minimal by using equipments that have been developed by the Air Force and NASA.

8. OTHER AIRCRAFT PLATFORMS

8.1 Drones.

Each of the services has drone aircraft that are configured or could be configured to perform a photographic reconnaissance function. For example the Army type AN/USD-1 drone was developed to provide target location information for a field artillery target acquisition battalion.

Several varieties should be available on a short lead time basis and in a longer time frame almost any craft can be adapted to a drone configuration.

The use of unmanned devices could provide improved low-level photography in areas that are too well defended to warrant risking a pilot and a high-performance aircraft.

8.2 Drone Antisubmarine Helicopter (DASH).

A modification of the QH-50D drone helicopter to provide television coverage is called SNOOPY. In addition to the usual radio controls, SNOOPY carries a

commercial TV camera with a 10:1 zoom lens. The zoom lens and the pitch of the camera are radio controlled from the launch station--a destroyer that has been modified with landing platform, radio controls and TV equipment.

SNOOPY is tracked by radar aboard the destroyer and positioned with a stick that provides left, right, forward and back control. Altitude is secured by switch. Very little training is required to position SNOOPY after takeoff. Maximum forward speed is 80 knots. The unmodified QH-50D has an endurance of 1.5 hours with a 2000 lb torpedo. Control range is better than 18 miles. Control and TV coverage are usable beyond the tracking range of the radar.

The original cost of the QH-50D was $80,000 each. Twenty sets of SNOOPY systems have been authorized. At least five have been delivered to SEASIA. Recent reports of use of SNOOPY by the destroyers Blue and Mansfield indicate that at 3000 ft it cannot be detected by the unaided eye. At least one SNOOPY has been lost to enemy fire.

These craft could be fitted with airborne personnel detectors (APD) which have the capability of detecting the effluents from a gun that has recently been fired. With a direct telemeter link back to a control point, either on the ground or in another aircraft, an operator could monitor signals from the APD and manipulate controls on the equipment remotely. The drones could be tracked by radar or equipped with television cameras, either normal or low-light-level types, so that targets, as determined by the APD, could be pinpointed in location through direct image matching with photo mosaics of the terrain or by map plots from the tracking radar.

There are currently nine of the APD's in Vietnam and USARV has requested an additional twenty. The leadtime on these additional units is 9-12 months after start of contract. Several of the current type systems could be available, with appropriate modification to permit remote operation, within a few months however if sufficient priority were given to their construction.

ACTION: MACSA personnel are inquiring about the availability of DASH on their visit to the 7° Fleet. NADC, Johnsville is currently modifying four DASH units with LLLTV for test in Vietnam.

A1. DMZ PROJECT OUTLINE

FACTS NEEDED

I. CURRENT SITUATION.

A. Deployment (Friend & Foe).

1. Positions of men and weapons.
2. Numbers of men & weapons.
3. Bunkers, shelters, etc.
4. Sensors; type, numbers, location.
5. Logistic support; men, vehicles, routes.

B. Casualties (Recent Data).

1. Time distributions.
2. Correlation with weather, tactical environment, or other parameters.
3. Location data; bunkers, field, patrols, supply lines, other.
4. Projections.

C. Intelligence Data.

1. How gathered; including detailed info from Recce, SOG.
2. Credibility; accuracy.
3. Type of data acquired.
4. Additional types needed.
5. Are duds collected? where are they?

II. SENSORS AND EQUIPMENT.

A. What types used; MPQ-4A, flash-ranging, sound-ranging, NOD or other. night-vision types, PPS-5, airborne, ECM, radio receivers for VT fuze monitoring, visual.

B. Effectiveness data for in-use sensors.

C. Limitations of in-use sensors.

D. Location data.

E. Availability of additional sensors needed.

III. WEAPONS (OURS).

A. In Use in Combat Area (Ground-type).

1. Type, location, protection provided, range data, numbers.
2. Supply problems.

B. Air-Delivered Munitions.

1. Type, where delivered, effectiveness.
2. Who has bomb damage assessment data?

C. Naval Gun-Fired.

1. Type, targets, range data, numbers effectiveness.
2. Supply problems.

D. Other Types Which Might Be Used.

1. What; when; quantities.
2. Where located.

IV. PROTECTION (DEFENSES).

A. Bunkers.

1. Type & numbers.
2. Degree of protection.
3. Time to construct.
4. Construction equipment available or needed.
5. Tunnels.

B. Mobile Protection.

1. Tanks.
2. Additional armor for M-113's.

C. Deception & Masking.

1. Smoke. How employed.
2. Decoys (e.g., any attempt to draw fire by troop maneuver or by use of balloons, dummies, etc).

POSSIBLE AIDS

I. TARGET IDENTIFICATION AND LOCATION.

A. Reconnaissance.

1. Immediately available.

a. Color camouflage film.
b. Development facilities at III MAF.
c. Hand-held cameras.
d. High-Speed Film.

2. Near-future availability.

a. Glitter camouflage detector.
b. Color from black and white.
c. Stabilized optics for hand-held cameras.

B. Location Equipment.

1. Immediately available.

a. Hawk acquisition radar to augment MPQ-4; TPS-25.
b. Additional TNS-3.
c. Training team for TNS-3.
d. Towers for flash ranging equipment and visual search.
e. Additional NOD's for visual observation.
f. Telescopes.

2. Future availability.

a. JPL TNS-9.
b. MITHRAS.
c. VATLS.
d. ARIS ship.
e. Periscopes for visual observation.
f. Silent aircraft.

II. TARGET DESTRUCTION.

A. Improved Spotting for Artillery and NGF.

1. Immediate.

a. DASH/drones.
b. Balloons.

2. Future.

a. Acoustic/seismic devices.
b. Realtime IR aircraft.
c. Naval radar tracking of projectiles.

B. Bombing & other Air-Delivered Ordnance.

1. Immediate.

a. CS bomblets and/or BLU-52.
b. WALLEYE, BULLPUP, ZUNI.

2. Future.

a. SIDEWINDER (MOD).
b. LASER-guided bomb.
c. TV-guided drones.

C. Additional Artillery.

1. Immediate.

a. CS shells.
b. BEEHIVE.

2. Future.

a. NIKE HERCULES.
b. HONEST JOHN.

A2. QUESTIONS FOR DISCUSSION WITH III MAF.
(MACSA Team Visit to III MAF Hqs, 1 October 1967).

1. What procedures and equipments are being used to locate enemy artillery positions?

2. How effective are procedures and equipment in locating enemy artillery positions?

3. Questions about specific location equipments: (MPQ-4A Counter Mortar Radar; MPQ-10A Counter Mortar Radar; TNS-3 Sound Ranging Equipment; GR-8 Sound Ranging Equipment; and GTC-1 Flash Ranging Equipment):

   a. How many are being used in DMZ area?
   b. Where are they located?
   c. How effective are they?
   d. What are limitations? Range? Confusion by counter fire? Operator training? Field of view?

4. If flash ranging equipment is being used to locate enemy artillery, what is:

   a. Nomenclature?
   b. Number?
   c. Location?
   d. Effectiveness?
   e. Limitations?

5. Questions about air bursts.

   a. What percentage of incoming rounds are air bursts?
   b. Do most bursts occur between 10 and 100 ft?
   c. Has there been any attempt to use monitor receivers to determine if VT fuzes are being employed?
   d. Is the Marine man-portable fuze jammer available in III MAF?
   e. Have dud or captured rounds been recovered? Numbers, kinds, analysis of fuze character...? (Can range be read off fuze setting?)

6. How effective is counter fire?

7. What do you need in improved equipment to locate enemy artillery positions?

   a. Improved accuracy?
   b. Better traffic handling capability?
   c. Better reconnaissance equipment?
   d. New techniques?

8. Are periscopes being used to obtain visual location of artillery positions?

9. Would naval periscopes provide better visual observation with more personnel protection? Are these worth considering for farther downstream?

10. Are enemy positions dug in or merely camouflaged?

Present location and azimuth determination methods.

a. Crater orientation and accuracy of method.
b. Eyeball-flash, smoke, other.
c. Ear-direction of muzzle sound, shell flight.
d. Instrumentation--what exists?
e. Spotters on towers? FAC A/C?

12. How determine number and type of NVA guns, & what are estimates.

a. Crater sizes.
b. Sound volume--of muzzle blast; of shell explosion.

13. If position exactly known, how many artillery rounds of various types are required to get 90% kill for various environments--above ground, revetted, bunkered.

14. What constitutes a kill--how close?

15. Any correlation of NVA firing pattern with time of day--esp day/night.

16. Is variation in barrage intensity due to ammo supply fluctuations? Estimate of NVN ammo stockage?

17. Have there been any attempts to use decoys to draw NVN fire?

18. State of USMC passive defenses at critical locations--foxholes, trenches, bunkers; mobile protection--tanks, APC's, etc.

19. Where and under what conditions have principal III MAF casualties occurred?

20. What smoke capability exists, and what is usage practice?

21. What evidence is there of NVA gun mobility, and that they are playing the shell game?

22. Has III MAF made any attempts to listen, locate, jam, or spoof forward artillery spotter radios.

23. What are III MAF estimates of NVA artillery reserves & supply rates--i.e., what could be the maximum threat in numbers of rounds per day?