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G. Miles

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CONVOY COUNTERAMBUSH WEAPONS SYSTEMS (U)

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FINAL REPORT

By

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CONVOY COUNTERAMBUSH WEAPON SYSTEMS (U)

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By: Sidney Wise

March 1966

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U. S. ARMY LIMITED WAR LABORATORY

Aberdeen Proving Ground
Maryland

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ABSTRACT

(U) The U. S. Army Limited War Laboratory has been given the responsibility for developing a convoy counterambush weapon system. Toward this end, a study has been conducted to delineate the pertinent aspects of the convoy ambush situation and to determine and evaluate appropriate counterambush techniques and materiel.

TABLE OF CONTENTS

(U) INTRODUCTION

An identifying characteristic of wars of low intensity, particularly those involving insurgency, is the utilization of the ambush by guerrilla forces. This tactic is quite important to the overall plan of the insurgency since its successful execution creates a number of tactical, logistical, economic, psychological and political problems for the government. In addition, captured supplies provide materiel support for the continuation of the insurgency.

The U. S. Army Limited War Laboratory has been given the responsibility for developing a convoy counterambush weapon system and as a result has concentrated a portion of its effort to studying the various aspects of the ambush situation and to determine appropriate counterambush techniques and materiel. The end results of these studies is to lead to the development of an effective counterambush reaction system which when used in conjunction with appropriate tactics will not only protect against the ambush, but will aid in defeating the ambushing forces.

(U) TACTICAL SITUATION

The standard techniques used by guerrillas is to attempt to isolate a portion of the convoy, and to attack that portion with rapid, intensive fire. In general, if the vehicle(s) under attack cannot be satisfactorily protected, the guerrillas will proceed with their planned action. If the convoy appears to be capable of successful counteraction, the attack will usually be discontinued, since traditionally guerrillas continue only if relatively sure of success. In those situations where a pitched battle ensues, the resulting activity will develop into a conventional engagement rather than the limited activity usually associated with guerrilla activity.

Any convoy with a sufficiently large military escort should be able to be brought to its destination. However, this use of extensive military support may not always be expedient, nor does it guarantee an acceptable loss level. The research emphasis must, therefore, be placed on developing materiel and/or tactics to assist the convoy to arrive safely at its destination with a minimum loss of men and/or materiel. As a secondary, but major point, an entire convoy counterambush system should be developed which will make it undesirable for the guerrilla to undertake further ambushes.

At the present time there is only limited information available concerning the specifics of convoy ambushes, so that certain assumptions have had to be made as the basis for a quantitative evaluation of various possible competitive systems. Table 1 gives an indication of our knowledge of the ambush characteristics which cannot be controlled by the convoy and also the assumptions that were made as a basis for the study. Table 2 shows present U. S. counterambush doctrine.

Based on the available information, the apparent requirements for a total convoy counterambush system have been determined and are indicated in Table 3. The basic conclusion is that to be effective, the convoy must react rapidly and effectively, immediately upon becoming aware that an ambush has been initiated. This action will permit any personnel in the convoy to deploy for a conventional counterattack.

It would be desirable for the end result of the neutralization phase to be the immediate destruction of the ambushing forces since this would negate the requirement for further action. However, since this does not appear to be possible within the present materiel state-of-the-art, the major contribution of the convoy counterambush weapon system will be to suppress the enemy capability (firepower) while the convoy is taking the required counter action.

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TABLE 1 (C)

VEHICLE AMBUSH CHARACTERISTICS (U)

	Status of Information	Assumptions
1. Location	Does not as yet appear to be a definite pattern to the location of ambushes by area, terrain or vegetation type.	Weapon system(s) must be considered against targets both in the open and/or protected by vegetation.
2. Time	Vehicle convoys travel primarily during the day.	The vehicle ambush will occur during the day. It will occur without warning to the convoy.
3. Type of Ambush	a) Harassing b) Killing c) Capture of people and/or supplies d) Combination	The ambushes are assumed to be both for the purpose of producing casualties and capturing material.
4. Number and Distribution of Ambushers and types of Weapons	Number and distribution of ambushers is not known. The information which is available indicates that personnel with small arms tend to be distributed at the closer ranges. Individual heavy weapons are located at a limited number of specific points at further ranges.	The distribution of opening ranges of engagements gives some indication of troop distribution. Within the first 50 meters from the vehicle, the target was assumed to be an area target composed of troops with small arms capability only. Beyond 50 meters from the vehicle, the targets were assumed to be point targets. Vertical distribution of targets can be considered qualitatively only. The actual number of targets is important only when aimed fire is used.

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TABLE 2 (U)

CONVOY COUNTERAMBUSH TECHNIQUES

Troop Protection:	The present policy is to "harden" all "soft" vehicles as much as possible in order to protect the personnel in the convoy from the initial enemy fire. (FM 31-22, U. S. Army Counterinsurgency Forces). It was assumed that the troop carrying vehicles are "hardened" for protection against small arms fire.
Counter-Tactics:	FM 31-22 - Guerrillas should know that every ambush they execute may result in rapid, violent and relentless pursuit by friendly forces. Such action executed automatically as a matter of first priority is most important to the over-all effort to reduce the effectiveness and frequency of guerrilla ambushes. They aim particularly at neutralizing the ambush and regaining the initiative. Pursuit of guerrilla ambush forces must be initiated with the least possible delay with only that degree of caution required to prevent falling into a larger and, perhaps, the primary guerrilla ambush. In addition, present doctrine indicates that the vehicles will not be used as forts. Any troops on the vehicles will dismount and counter-attack from the ground.
Type of Weaponry:	The weapon systems for initial neutralization is to be determined. Subsequent attack will be with conventional weapons and tactics.
Number, Type, and Spacing of Vehicles:	This must be decided as a function of the counterambush weapons and tactics.

TABLE 3 (U)

APPARENT REQUIREMENTS FOR CONVOY COUNTERAMBUSH SYSTEM

(1) Physical protection for any troops in the vehicles.

(2) Techniques for rapidly and efficiently neutralizing the enemy's immediate effectiveness by:

a. Reducing enemy fire concentrations,
b. Producing casualties (if possible),
c. Disrupting the ambush plan,
d. Gaining the fire superiority, and
e. Building a base of fire (if counterattack is possible).

(3) Communications for:

a. Alerting reinforcements, and
b. Providing ambush location information.

(4) Conventional weapons and tactics (assuming troops are available) for:

a. Isolating the battle area,
b. Preventing enemy withdrawal or reinforcement, and
c. Destroying the enemy.

Since the ambush characteristics are not clearly defined, the convoy suppressive action should be effective over a large area (100 meters wide) starting adjacent to the vehicle and extending out to 150 meters.

A. Vehicle Convoys Without Troop Protection

If a vehicle without troop protection remains mobile after the initiation of the ambush, it should be driven rapidly out of the zone of fire while utilizing all available weaponry to minimize the effectiveness of the enemy offensive fire. If proceeding at 20 mph, the vehicle could travel approximately 250 meters in 30 seconds and so would presumably drive out of the immediate danger zone within that time period. Any vehicles which are following must decide whether to drive through the ambush zone or to turn back.

If a vehicle in the convoy without troop protection is immobilized, it is essentially at the mercy of the ambushers. Any temporary non-decisive deterrent (limited casualty producing suppressive fire) will be useful only to help the ambushed personnel to attempt to escape. Because of this, the effectiveness of the presently contemplated counter-ambush techniques is greatly dependent on the availability of troops for support.

B. Vehicle Convoys With Troop Protection

If troop protection is available to the convoy, rather than dispersing the troops in all of the vehicles, the use of special troop carrying vehicles would appear desirable in order to minimize the number of vehicles required to be "hardened." The protected troop carrying vehicles should be dispersed throughout the convoy in order to provide rapid supporting action. They should be located so that part of the convoy protection can move rapidly into the fighting zone without being required to turn around.

In addition, it would be desirable to give each vehicle a suppressive fire capability (whether or not it is a troop-carrying vehicle) in order to pin down the attacking ambushers while the accompanying troops are preparing the counterattack. Vehicle spacing will be dependent on the supporting fire capabilities of the final weapon system and the tactics which will be employed.

(U) CATEGORIES OF COUNTERAMBUSH SYSTEMS

A. Firing Techniques

Table 4 shows the categories of counterambush systems by firing techniques, and a general comparison of the pros and cons of the various systems.

TABLE 4 (U)

COMPARISON OF SYSTEM TYPES (AIMED AND UNAIMED)

	PRO	CON
Un-Aimed Barrage Type System	1. Quick reaction time 2. Complete, constant area saturation 3. Deterrent over an extended area 4. No exposure of operating personnel	1. Limited pre-determined time of action 2. Effectiveness is dependent on relationship of terrain and pre-determined weapon alignment
Aimed System	1. Can place a continuous controlled deterrent on the target for an extended period of time 2. System effectiveness is relatively independent of terrain features because of the aiming capability. 3. One system is capable of being used on either side of the vehicle.	1. Increased reaction time. 2. Dependent on user judgment (effectiveness varies with skill of the operator) 3. Requires armor or personnel will be exposed to concentrated enemy fire.
Programmed System (with override)	1. Quick reaction time 2. Complete area saturation 3. Deterrent over an extended area 4. No exposure of operating personnel	1. Limited pre-determined time of action 2. Effectiveness is dependent on relationship of terrain and pre-determined weapon alignment. 3. System may be complex 4. System is dependent on an outside power source

1. Un-aimed "barrage type" systems -

   Such systems are arranged in units with each unit covering the target area with suppressive fire. Only a single action is required to initiate the entire system. The units may be fired consecutively or concurrently.

2. Aimed systems - The "aimed systems" are those where the aiming and firing of the system require continuous control by a man.

3. Programmed systems -

   Programmed systems utilize the same basic weapons as the aimed systems. However, they are pre-programmed so as to require only a single action to initiate the entire system. Personnel are not required during the period of fire.

B. Mechanisms for Producing Effectiveness

The mechanisms for producing effectiveness are independent of the firing technique and may be produced by either chemical or non-chemical means. Table 5 shows specific items of both types of systems which have been considered. A description of the specific systems and criteria of effectiveness will follow.

(U) TECHNIQUES AND CRITERIA OF EFFECTIVENESS

Temporary suppression of enemy effectiveness can be accomplished by the following techniques:

a. Casualty production
b. Threat
c. Obscuration

Table 6 shows the various criteria which have been used for each of these conditions. None of the criteria includes a direct evaluation of psychological effects, although it is recognized that the mechanisms for suppressive fire is primarily psychological. Unfortunately, since there are no satisfactory criteria for the evaluation of the psychological merit of weapon systems, the casualty production must continue to be used as an index of the psychological merit of a system. These criteria are enumerated in Table 6.

TABLE 5 (U)

COMPETITIVE COUNTERAMBUSH SYSTEMS

Non-Chemical Casualty Producing Systems:

a. Ball ammunition (rifles and machine guns)
b. Fragmenting ammunition (grenade launchers)
c. Shot and flechette rounds (automatic shotgun)
d. Barrage systems -

    (1) Claymorette
    (2) Miniature Rockets
    (3) Cartridge System

Chemical Systems:

a. Flame

    (1) Conventional flame throwing techniques
    (2) TEA
    (3) Mag Teflon

b. Smoke

    (1) Smoke generators
    (2) Grenades

c. Incapacitating agents

TABLE 6 (U)

TECHNIQUES AND CRITERIA FOR NEUTRALIZATION OF ENEMY

Techniques		Criteria
1. Casualty Production		
a. Non-chemical	1a.	Most complete of all information is available in BRL and Chemical Corps studies. For this study it is assumed that the target will be unable to react properly within 30 seconds after being hit. BRL type 2 casualty criteria for a nude man, with only head and neck exposed was used as the basis for determining casualty production (BRL 1297): Presented area, $A_p = 1\ ft^2$.
b. Chemical	1b.	The study does not presently consider the use of chemical agents. Flame has been considered only grossly since satisfactory effectiveness information is not available.
2. Threat	2.	Specific criteria are not available since only very little is known about the mechanisms and criteria for suppressive fire. Fire suppression is generally a function of fear (expectation of becoming a casualty) and the enemy's anticipation of the immediate future. It was assumed that the enemy will learn which weapons are the most likely to produce casualties so that the greatest casualty producing weapon potential will be the most effective suppressive system with the added limitation that the suppression must be continual over the target area for 30 seconds. In addition, it can be expected that since the enemy will learn that the suppressive fire will last for only 30 seconds, they are not likely to risk becoming casualties during that time but will more likely stay under cover with the expectation of renewing the attack after the suppressive fire is lifted even though at that time they may be susceptible to fire from conventional weapons. The psychological ramifications of the use of flame are unknown.
3. Obscuration	3.	Satisfactory quantitative criteria are not immediately available. Based on views of experienced personnel, we are using the following criteria: 1.0 lb (WP) - Instantaneous smoke, 35' radius for about 30 seconds 1.5 lb (HC) - Smoke starts in about 15 sec. - 20' radius for 1-3 min.

(C) DESCRIPTIONS OF SPECIFIC SYSTEMS (U)

Tables 7, 8 and 9 show the characteristics associated with the various competitive convoy counterambush systems that can be either specifically or tentatively described. In all cases, certain system characteristics and resulting system effectiveness can be changed by either varying the number of items of which the system is composed, by varying the ammunition load, or by varying the rate of fire. In this study the effectiveness of the systems are shown for total weights per side of 50 lbs., 100 lbs., and 150 lbs.

A. Rifle, U. S., Cal. .30 M-1: This is a general purpose shoulder weapon for use by an individual soldier.

Weight: 9.5 lbs.
Length of Barrel: 24 inches
Sight: Blade and aperture, adjustable for elevation and windage
Type: Gas-operated, self-load, semi-automatic
Rate-of-fire: Fast as trigger can be pulled
Feed: Clip-fed, 8 rds/clip

B. Gun, Machine, 7.62mm, M-60: General purpose rapid fire weapon.

Weight: 23 lbs.
Length: 43 inches
Barrel: Air-cooled, quick-change
Cyclic Rate: 450-600 rds/min.

C. M-75 Rocket Launcher: An automatic grenade launcher firing the standard 40mm grenade. The item may be designed for manual or automatic operation.

Weapon Weight w/o auxiliary equipment - 26 to 33 lbs. (depending on model)
Total System Weight: (Without armor or programming) Approximately 85 lbs.

D. WASP: The WASP system consists of a firing stand containing rocket modules. Each rocket module is composed of 20 individual standard 40mm fragmentation warhead rockets with the standard 40mm fuze.

Item	Wt. (lbs)	Size
Module w/20 rockets	21	.35 ft^3
Rocket	0.86	5.75" x 1.75"
Fuze	0.47	40mm
Fire Control and rack	10	.2 ft^3

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TABLE 7 (C)

SYSTEM PARAMETERS (NON-CHEMICAL) (U)

System	Model	Cal.	W/Gun (lbs)	W/CR/Link (lbs)	No. of Frag/Rd	M Grain	V_o (f/s)	Max. Eff. Range (m) (thru air)
Rifle	M-1	0.30	6.1	.057	N.A.	150	2800	>200
Machine Gun	M-60	0.30	23.0	.066	N.A.	150	2800	>200
Grenade Launcher	XM-75	40mm	85	1.00	300	2	4800	N.A.
	WASP	40mm	N.A.	1.00	300	2	4800	N.A.
Automatic Shotgun	Proposed Gatling Type	12 ga.	60					
		BBB		.15	79	10.4	1200	92
		#4 Buck		.15	41	20.6	1200	120
		#2 Buck		.15	28	29.4	1200	137
		0 Buck		.15	17	48.3	1200	168
		00 Buck		.15	15	53.8	1200	171
		Flechettes		.10	17	8.0	1700	200
Claymorette	----	-----	---	---	---	10.8	4000	140
Miniature Rockets	----	0.22	---	---	---	40	1500 f/s burnout	>200
Cartridge	----	0.22	---	---	---	40	1000	>200

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TABLE 8 (C)

SYSTEM PARAMETERS (U)

SMOKES

Grenade Launcher - E-5 - Present system weighs approximately 1,000 lbs w/o ammunition (anticipated that weight can be reduced to about 500 lbs.).

M-8 (H.C.) - 1.5 lbs
M-15 (W.P.) - 2.0 lbs
M-34 (W.P.) - 1.5 lbs

Number of rounds/side - 30
5 tubes/corner - 3 rounds/tube

Tank Screening System - 10 lbs/tube

M-8 (H.C.) - 1.5 lbs
M-15 (W.P.) - 2.0 lbs
M-34 (W.P.) - 1.5 lbs

4 tubes/side

Grenade Launcher - M-57 type - 40mm - Assume characteristics similar to other 40mm systems.

FLAME

M2A - Weight of System = 69 lbs.; R = 45 to 50 meters; 4 gal. of material/10 sec. Total time = 10 sec.

Magnesium Teflon
Tri-Ethyl-Aluminum
} Both are in research stage

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TABLE 9 (C)

SYSTEM CHARACTERISTICS (U)

System	Model	Cal.	System Weight (Pounds per Side)					
			50		100		150	
			No. of Rds per Side	No. Frags per Side	No. of Rds per Side	No. Frags per Side	No. of Rds per Side	No. Frags per Side
Rifle	M-1	0.30	128(1	N.A.	128(1	N.A.	128(1	N.A.
Machine Gun	M-60	0.30	300(2	N.A.	300(2	N.A.	300(2	N.A.
Grenade Launcher	XM-75	40mm	---	---	15	4,500	65	19,500
	WASP	40mm	---	---	50	15,000	100	30,000
Automatic Shotgun	Proposed Gatling Type	12 ga.						
		BBB	---	---	267	21,093	500(2	39,500
		#4 Buck	---	---	267	10,947	500(2	20,500
		#2 Buck	---	---	267	7,476	500(2	14,000
		0 Buck	---	---	267	4,539	500(2	8,500
		00 Buck	---	---	267	4,005	500(2	7,500
		Flechettes	---	---	400	6,800	500(2	8,500
Claymorette	Present		N.A.	340	N.A.	681	N.A.	1,022
	Proposed		N.A.	477	N.A.	953	N.A.	1,430
Miniature Rockets	-----	0.22	1866	N.A.	3,733	N.A.	5,600	N.A.
Cartridge	Proposed	0.22	3333	N.A.	6,667	N.A.	10,000	N.A.
	Comparable to Min. Rockets	0.22	1866	N.A.	3,733	N.A.	5,600	N.A.

(1 Limited to 8 men/side firing 2 clips/man

(2 Limited by rate-of-fire

All other systems are weight-limited

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E. Automatic Shotgun: The system is to consist of two turretized pods mounted on opposite sides of the truck by quick-attach brackets. The weapon systems would be actuated from the cab and/or truck bed as required.

The proposed system is to be a gatling type gun utilizing 3-5 barrels each designed to fire 12 gauge shot shell at a controlled rate-of-fire of 1000 r/m. The shells are belt-fed and percussion ignited. Power is supplied by a separate battery.

F. Claymorette: The Claymorette is a variation of the Claymore Anti-Personnel Weapon. It consists of a curved plastic tray filled with explosive which, upon initiation, propels fragments forward within a pre-determined spray pattern.

Size of item - 2 inches x 2 inches
Number of fragments/item = 73

The fragments appear to be distributed in three distinct vertical zones. Approximately 53 fragments are in the central vertical zone while the extreme zones contain an average of 10 fragments each. The fragments from each item are uniformly dispersed in the horizontal direction over a 150° arc.

The present complete system weighs 392 lbs. for 23 items or approximately 17 lbs/item. A newer version is in process which weighs only 275 lbs., or approximately 12 lbs/item.

G. Miniature Rockets: The weapon system would consist of a truck-mounted firing rack containing individual modules composed of spin stabilized miniature rockets. The firing rack and mount contains the wiring leading from the control consoles to the module holders. The dimensions are approximately 5" x 8" x 6". Each module is a complete unit containing the miniature rockets, fuzing and electrical ignitors. The modules can be oriented in azimuth and elevation as desired. Each module can be "ripple" fired from either the cab or truck bed for a pre-determined time period.

H. Cartridge System: The proposed system will consist of individual disposable one-shot modules of lightweight alloy or plastic. Each module, as presently conceived, will consist of a matrix in which will be a number of barrels for firing standard Cal. 0.22 long-rifle cartridges. The modules can be oriented in azimuth and elevation as desired. Each module can be "ripple" fired for a pre-determined time period.

(C) SYSTEM EFFECTIVENESS (U)

At the present time, it is not possible to satisfactorily compare the relative effectiveness of systems which use different techniques (chemical and non-chemical) to accomplish the same mission. In addition, state-of-the-art must be considered when making eventual comparisons of system effectiveness. Care must be taken to differentiate between those systems where the characteristics are known and those systems which are being projected into the near or distant future.

The results of a study to determine the availability of information indicated that in general a great deal more is known about the characteristics of those proposed counterambush systems which employ non-chemical techniques than is known about the characteristics of those systems which use chemical techniques. Both types of systems will be examined.

A. Chemical Systems

This study has not included chemical incapacitation agents since their present use is hampered by the close proximity of friendly and enemy troops and is dependent on wind and vegetation. In addition, the use of these agents would require the friendly troops to wear masks in anticipation of the attack. Newer tactics or dissemination techniques may make the chemical agents useful. However, they cannot presently be considered for the convoy counterambush role.

It is recognized that smoke may have value. For this role, the smoke may be disseminated either by smoke generators, which will place the smoke in the immediate vicinity of the vehicle, or by grenades, which can place the smoke either at the vehicle or at some distant point. Since it is generally considered to be more desirable to screen the attackers rather than the friendly vehicles, the emphasis of this study has been on the use of grenades to place smoke on the attackers rather than on the vehicle.

Available information indicates that approximately 7 M-34 W.P. rounds and 12 M-8 H.C. rounds will be the minimum requirement for adequate obscuration at about 50 meters from the vehicle. The means of placing these projectiles at this range are not immediately available in a convenient form. There are various concepts presently being considered for this role:

E-5)
40mm) - See Table 8
Tank System)

The use of flame has been considered only qualitatively because the available information on its effectiveness is limited. Investigations are currently underway to determine the relative merit of flame in the convoy counterambush role. In addition to the conventional flame producing techniques, the Laboratory is studying the potential of more sophisticated techniques such as the use of encapsulated Mag Teflon and TEA. Information on the effectiveness of these techniques as suppressive fire media and on the availability of hardware, except for the M-2 flame throwers are not currently available. Tests are currently being conducted to procure input information with which to conduct preliminary evaluations.

Flame is being considered primarily as a second generation counter-ambush procedure since the propulsion technique and appropriate evaluation techniques are not presently available.

B. <u>Non-Chemical Systems</u>

A study of available weaponry indicate that there are essentially two basic mechanisms for producing effectiveness by non-chemical means.

1. The fire may originate at the vehicle (rifle, machine guns, etc.) so that suppressive action can take place in the immediate vicinity of the vehicle without harming the vehicle or any personnel attempting to detruck, or

2. Omni-directional fragmentation items (grenades) may be used when the fire originates within the target area. These items are of primary value only at ranges beyond which they will not be dangerous to the vehicle or detrucking troops.

Basic to the casualty production determinations are:

a. Probability of a casualty given a hit, and

b. Probability of hitting the target.

Figure I shows the estimated probability that a random hit on the target (as defined) will cause a casualty as a function of range to target when the projectile is fired through air.

Table 10 shows the average probability of a casualty to a man as a function of distance to the target and estimated system weight/side for the following conditions:

a. Systems fired through air
b. The individual target area located on flat land
c. Number of fragments (or rounds) as shown in Table 9
d. Presented area of man - 1 ft^2 (head and shoulders only)
e. Type 2 casualty - 30 second assault.

Although the data shown in Table 10 are for flat land, it is recognized that the ambush can originate from slopes. For those situations involving counterambush fire not controlled by personnel, approximately 1/2 of the ammunition was utilized for the specified situation while the other 1/2 of the ammunition was allocated for use against those attacks originating from slopes.

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TABLE 10 (C)

AVERAGE PROBABILITY OF A CASUALTY ($\bar{P}_k$) (U)

Through Air, Flat Land, Type 2 Casualty, Head and Neck - A_p = 1 ft^2.

System	Model	Caliber	Effective Range (Meters)	$\bar{P}_k$: Range (m) = 0-50 meters, System Wt. (lb/Side) 150	100	50	$\bar{P}_k$: Range (m) = 50-150 meters, System Wt. (lb/Side) 150	100	50
Rifle	M-1	0.30	>200	.03	.03	.03	.06	.06	.06
Machine Gun	M-60	0.30	>200	.07	.07	.07	.15	.15	.15
Grenade Launcher	XM-75	40mm	---	---	---	---	.10	.02	---
	WASP	40mm	---	---	---	---	.14	.08	---
Automatic Shotgun	Proposed Gatling Type	BBB	92	.11	.06	---	.56	.35	---
		#4 Buck	120	.11	.06	---	.59	.39	---
		#2 Buck	137	.11	.06	---	.56	.35	---
		.0 Buck	168	.11	.06	---	.48	.30	---
		00 Buck	171	.11	.06	---	.46	.28	---
		Flechette	200	.09	.07	---	.34	.28	---
Claymorette	Present	---	140	.15	.11	.07	.01	.01	---
	Proposed	---	140	.18	.14	.08	.01	.01	- --
Miniature Rockets	----	0.25	>200	.40	.32	.20	.09	.06	---
Cartridge System	Proposed	0.22	>200	.46	.37	.25	.13	.09	.05
	Comparable to Min. Rockets	0.22	>200	.36	.28	.18	.08	.05	.03
Smoke	Must cover an arc approximately 450 ft: Requires 7 rds. W.P. - M-34; 12 rds. H.C. - M-8.								

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Rifles - (Cal. 0.30) - From Figure I, it can be seen that each Cal. 0.30 round when fired through air is potentially effective out to ranges of 150 meters and beyond. In addition, the individual round suppressive fire capability theoretically tends to increase with an increase of range within the specified range limitations since the more shallow angle of fire associated with increased range tends to make each round potentially more effective over a large area. However, although not specifically evaluated, as the approach angles become increasingly shallow, the rounds become more susceptible to small variations in the terrain.

It was assumed that during the engagement, fire will be produced by a maximum of 8 men per side with each man firing 2 clips of ammunition. In actuality, this value will be limited since the men will not be able to fire their weapons as they detruck. Since rifle fire requires men, it could not be used in those situations where the vehicle does not contain troops.

Since potential effectiveness is not decreased with range, within the ranges of interest, the value of the system is limited primarily by the tactics and rate-of-fire. The system is not weight limited since the rifles and ammunition are part of the basic equipment of the men in the vehicles.

Machine Gun - (Cal. 0.30 ammunition) - The terminal effectiveness information for Cal. 0.30 machine gun fire used in the counterambush role is essentially the same as that for fire from the Cal. 0.30 rifle. The primary difference and advantage to the use of the machine gun fire over rifle fire is the increased rate of fire and the ability of the men to detruck while the guns are being fired.

To be tactically effective, either protection must be provided for a machine gunner or the system must be pre-programmed. Either situation would create weight and/or complexity problems. However, if only gun and ammunition weights are considered for systems weighing 50 lbs. or more, rate of fire (300 rds. in 30 secs.) will be the limiting factor in effectiveness. Since the basic machine gun and 300 rounds of ammunition will weigh about 50 pounds, an increase in system weight above 50 pounds will allow the vehicle to carry more ammunition but will not increase the amount of fire within the specified suppressive firing time of 30 seconds.

A pre-programmed system must of necessity be time limited so as not to cause casualties to friendly troops entering the target area. If the system is man-operated, the fire can be directed at ranges beyond those occupied by the friendly forces.

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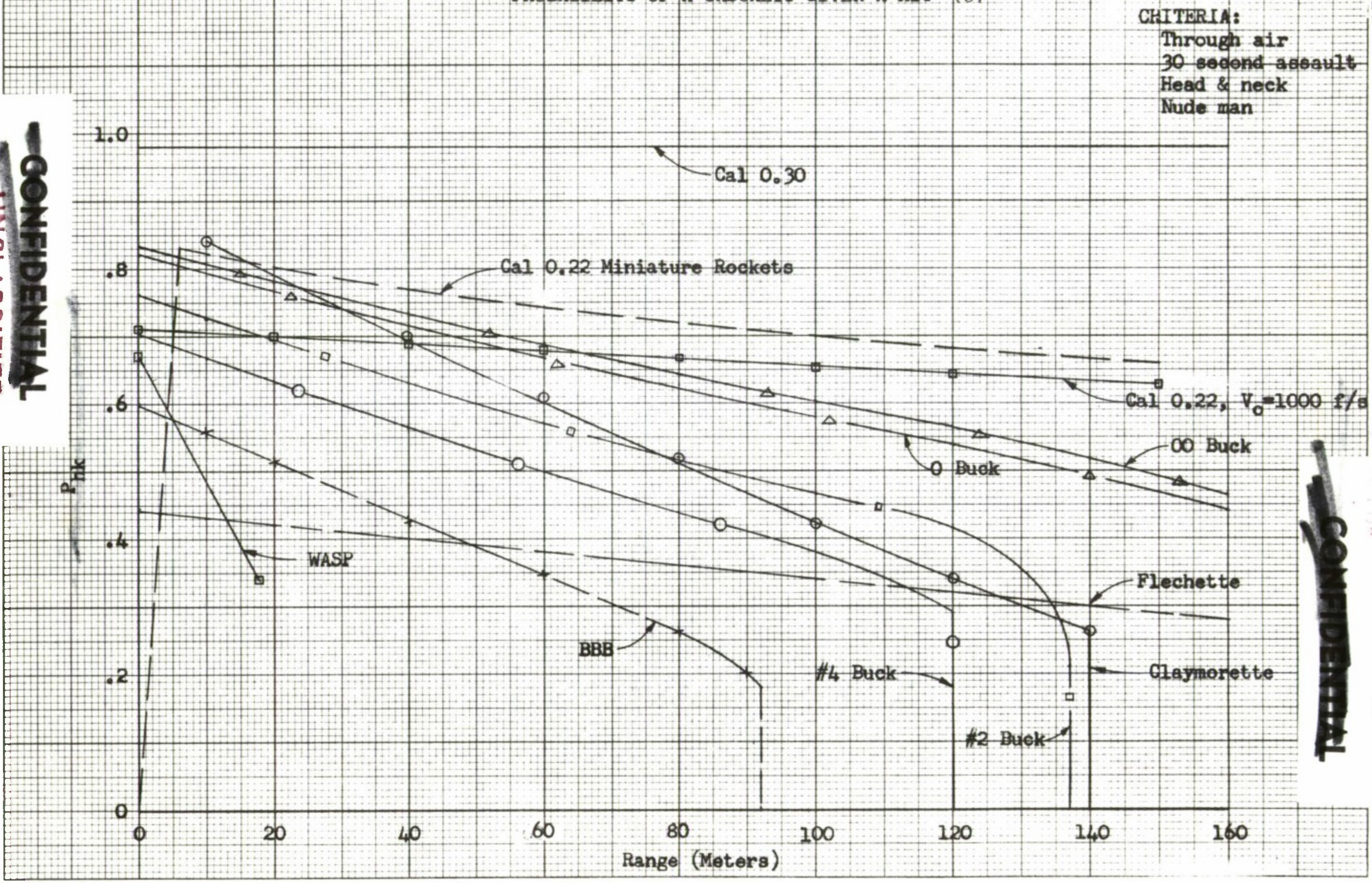
FIGURE 1 (C)

PROBABILITY OF A CASUALTY GIVEN A HIT (U)



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Grenade Launcher: The grenade system is the only non-chemical system where the fragments are omni-directional and originate within the target area rather than at the vehicle. Because of this, the use of fragmentation grenades is limited to ranges beyond which the fragments will constitute a danger to detrucking friendly troops.

The terminal effectiveness of the individual grenade is independent of the launching system. From Figure I it can be seen that the casualty potential of a single fragment is limited and drops rapidly as a function of range. Although some of this loss in effectiveness is offset by the fact that the fragments originate within the target area, the total casualty potential (and consequent suppression capability) of a single grenade is not high.

Two types of grenade launchers have been considered:

a. The standard gun-type, M-75 (either programmed or man-operated), and

b. a barrage-type rocket system, (WASP).

Weight is a limiting factor for both systems. From Table 7 it can be seen that the basic gun system weighs approximately 85 lbs. (No weight consideration for programming or protection for the operator.) The gun represents a fixed weight, so that effectiveness/pound increases as system weight increases (increase in weight represents increase in number of rounds). Since any programming system or armor protection must have some weight, it appears unlikely that a gun system (exclusive of ammunition) can be built for less than about 100 pounds.

Unlike a gun system, the number of rounds fired from a rocket system (WASP) would be roughly proportional to the weight of the system. Exclusive of programming or armor protection, for system weights less than about 250 lbs (170 rds.) per side the rocket system would be more effective than the gun system. As weight increases above about 250 lbs., the gun system would become increasingly more effective on a comparative weight basis.

Although the WASP system is characterized as a barrage system within the weight limitations it has only a limited capability to cover the entire area continually with fire for an extended period of time (30 seconds).

Automatic Shotgun: The effectiveness of the automatic shotgun system is dependent on the ability to adequately aim or program the system. In addition, the choice of size and type of load for the shotgun shell will influence the results. From Figure I it can be seen that when firing through air, it will be necessary to use either flechettes or at least 0 buck shot if the system is to have any casualty-producing capability to about 150 meters from the vehicle (in air).

In addition, the shotgun effectiveness is especially dependent on the spray size and angle of approach. For a specific shot dispersion at the closer ranges, the tendency is to get small patterns of concentrated fire due to the steep angle of fire and inability of the load to spread within the short range. As the distance from gun to target increases, the spray size increases and the angle of fire becomes more shallow, so that the load tends to cover increasingly greater areas. The problem of variations in terrain and fragment drop as a function of time has not been included. However, some compensations can be made for these factors. In addition, a single round from this type system does not cover the entire target area so that at any one time only a portion of the target will be covered by fire.

Either man-aimed or programmed fire is required to achieve the variation in azimuth and elevation required to cover the target area. As indicated previously, if man-operated, armor protection will be required. A programmed system will be both an asset and a detriment. Programming would increase weight and complexity. However, a well-programmed or man-fired system has the advantage of concentrating the fire in the target area. The presently evaluated barrage systems are fired with constant large azimuth spray angle (presently assumed = 150°). By aiming or programming the gun so that the total azimuth angle decreases as the elevation (range) increases, the spray can be confined to the target area of interest.

This assumed ability to aim a weapon to fire all rounds within the desired target area is responsible to a great extent for the high effectiveness numbers shown for the automatic shotgun system in Table 10. Unlike the barrage system which is oriented to cover the forward area and to accept as a bonus whatever capability exists at the further ranges, this system is evaluated as though all of the available rounds were directed either at the range from 0-50 meters or from 50-150 meters. Also, unlike the barrage systems (excluding WASP) the automatic shotgun is not evaluated in its ability to cover the entire area but only as a supplemental system. If this system is expected to cover the entire area, the effectiveness in each area would depend on what percentage of the total rounds were allocated per area.

The present automatic shotgun concept weighs approximately 60 lbs., exclusive of the weight of programming components or armor. This fact is reflected in Table 10, which shows the apparent system effectiveness as a function of system weight. Typical of gun systems, the effectiveness per unit weight is a uniformly increasing function of total system weight.

Barrage Systems: The barrage systems are composed of individual modules which can be fired either concurrently or consecutively (ripple fired) over a specific area within the required period of time.

The barrage systems have the advantage of continually covering the entire area with fire. In addition, they are relatively simple in design and do not require either programming or an armor-protected operator.

a. Claymorette -

When the Claymorette is fired, the individual shot show some potential casualty production capability out to about 140 meters. Because of the low density of pellets at the further ranges resulting from the large spray angle and the rapid decrease in pellet velocity, the system casualty production capability is extremely low beyond the first 50 meters from the vehicle. However, the system still has merit since it will perform as an un-aimed semi-automatic barrage system which can place fire over a target area of major importance.

There is a problem of blast pressure in the vehicle which results from the detonation of the explosive loading in the "Claymorette." Some recent test data indicates the following peak pressures occur within the vehicle when a single Claymorette is detonated:

Cab	.2 - .6 psi
Center of Body	3.0 psi
Along the sides of the Truck	6.2 psi

Although the blast information is available, it does not appear possible at this time to adequately interpret the information in terms of either physiological or psychological effects on man. A continuing effort is in progress to determine what effect the blast associated with the use of the Claymorette system will have on the ability of troops in or accompanying the vehicle to accomplish their mission.

Regardless of the degree of blast, if it can be conveniently avoided, it would be desirable to do so. It would appear that the use of either the miniature rockets or the cartridge system would help to alleviate this problem since in either case the associated back blast would be considerably less.

b. Miniature Rockets -

Assuming that the miniature rockets can be satisfactorily reduced in size to about Cal. 0.25 and will function adequately, they appear to have the potential for being part of an effective counter-ambush weapon system. Because of the ballistic shape, projectile weight, and burn-out velocity, the rocket potential effectiveness is initially high and remains relatively high as range increases (Figure 1).

As with most rocket systems, the number of projectiles is essentially a linear function of system weight. Because of this, within reason, the system can be made exceedingly light if we are willing to accept a corresponding decrease in effectiveness potential. The system weighs approximately one pound for each 37 rockets.

The use of miniature rockets can be considered as a means of accomplishing the entire mission. The average probability of a casualty (through air) 0-50 meters and 50-150 meters is shown in Figure 10. Since the capability of the miniature rockets at the further ranges is limited primarily by the density of items within the assumed 150° azimuth spray angle, it may be possible to limit the total azimuth angle for a portion of the modules and direct that portion to the further ranges. In this fashion, the density would be increased. For example, if firing 100 pounds of miniature rockets (3733 rockets) within 150° azimuth spray angle,

$$\bar{P}_k \text{ (0-50 meters)} = .32$$

$$\bar{P}_k \text{ (50-100 meters)} = .06$$

If instead, 50 pounds of rockets (1867 rockets) are fired within the 150° azimuth spray angle and the remaining 50 pounds of rockets are fired within a 70° azimuth spray angle without changing elevation, then

$$\bar{P}_k \text{ (0-50 meters)} = .20$$

$$\bar{P}_k \text{ (50-150 meters)} = .09$$

An approach such as this may be one way to cover the entire target area with suppressive fire from a single system.

c. Cartridge System

Two variations of the cartridge system have been considered. The first (proposed) has approximately 67 Cal. 0.22 cartridges/lb of system weight. This system has been suggested as being within the state-of-the-art. A second system (using miniature rockets) would have 37 cartridges/lb. The second system has been given a weight limitation comparable to that indicated for the miniature rocket. This system was included in case the original value of 67 Cal. 0.22 cartridge/lb could not be met.

All conclusions concerning the miniature rocket are essentially applicable to the cartridge system since the casualty producing and suppression producing mechansims are identical. The difference between the two systems is in propulsion techniques.

C. Effects of Vegetation

The effects of vegetation on the capability of each system are not known at this time. However, tests are presently being conducted to determine the degradation in effectiveness which occur when individual items (shot, flechettes, and ball ammunition) are fired through vegetation. This information will then be utilized as input to analytical studies to determine over-all system performance in appropriate vegetation.

D. Cost and Times for System Development

In conjunction with the effectiveness information, it is desirable to consider the availability of the various considered systems together with their development costs, and also the estimated cost to perform their specific function. Table II shows the estimated times to demonstrate system feasibility and costs to fire a single sortie for specific conditions. This information can be safely extrapolated (or interpolated) within the specified framework as stated within the text.

Costs for the rifle, machine gun and M-75 are not applicable since they represent systems currently in the inventory.

The gun costs for the automatic shotgun must be pro-rated over its expected life. These data are not immediately available. Other costs indicated in Table II are per firing for 150-pound systems.

The rifle, machine gun and M-75 launcher are standard equipment and do not need further development. However, further time will be required to develop a system for programming if the M-75 is not manually operated.

The automatic shotgun, miniature rocket and cartridge systems are in the concept stage. However, all three systems use proven techniques so that further efforts will be primarily for system development. The automatic shotgun will require the development of a programming system.

The Claymorette has been completed through the feasibility stage. Development time will be primarily for items to be put into the field.

(U) ENGINEERING ASPECTS

Since the item is to be developed for field use, it is desirable that certain engineering and tactical aspects usually considered desirable for military equipment be ascertained prior to final development. The following characteristics can all be met by the proposed systems:

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TABLE II (C)

ESTIMATED TIMES AND COSTS* (U)

System	Est. Times to Demon. Feasibility (mos.)	Est. Cost to Demon. Feasibility ($)	Est. Production Costs ($)	Est. Cost 150-lb System ($)	Remarks
Rifle	N.A.	N.A.	N.A.	------	
Machine Gun	N.A.	N.A.	N.A.	-----	Must consider either pro-gamming or protection
40mm M-75	N.A.	N.A.	N.A.	-----	
WASP	7 months	$2,000,000	$1000/firing of 100 items	$1,000	
Automatic Shotgun* (Springfield w/programming)	10 months	$225,000	$12,000 lots of 500 $ 3,500 lots of 5,000	>$3,500	Production costs do not include programming or ammunition costs
Claymorette	N.A.	N.A.	$30 each	≈$500	
Miniature Rockets*	3-6 months	7.62mm - $36,000 Cal. 0.25-$60,000	Approx. 10¢ per rocket	>$560	Cost of module and system components not known
Cartridge System*	6 months	$65,000	$10/module (no rifling) $20/module (rifling)	$150-$300	Cost of other system components not known

*Data is from various unsolicited proposals

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(1) System is simple in design and construction
(2) Firing mechanisms, when applicable, will be simple, reliable, and easy to install
(3) Firing mechanisms can be equipped with easily identifiable, conveniently located, positive safety
(4) All systems can be protected against accidental detonation
(5) All systems can be provided with visual safety indicators (in color if desired) for the convoy commander or traffic control personnel
(6) All systems can be equipped with safe fire mechanisms which can be determined by touch
(7) All components for a specific system can be interchangeable (left-to-right and right-to-left)
(8) None of the systems when initiated will damage the vehicle
(9) Reloading procedures will be relatively simple
(10) All weapons can be fired immediately after being reloaded
(11) Operation and maintenance is not expected to be beyond the comprehension of indigenous forces
(12) For those items involving semi-automatic fire, firing mechanisms can be located both in the vehicle cab and body.

(C) CONCLUSIONS (U)

1. The Claymorette system, even considering its weaknesses, is the most desirable, immediately available system. Feasibility has been demonstrated and the system can be put into the field with consideration of the possible problems which might result due to blast. At this time, the Claymorette should be considered as a desirable, but interim, solution to the problem.

2. Unless a satisfactory substitute is quickly found for the Claymorette, some advantage could be gained by supplementing the Claymorette System with smoke to obscure the convoy from those attackers beyond 50 meters from the vehicle.

3. The miniature rockets and/or cartridge system appear to have potential as replacements for the Claymorette. If either of these systems is successful, it could represent a possible single weapon solution to the vehicle counterambush problem.

4. Although not much is presently known about the effectiveness of flame systems, some recent test results indicate the possibilities for the future development of a successful flame weapon to be incorporated with a counterambush weapon system.

The report conclusions are based on the following premises:

a. It is desirable to be able to negate the effectiveness of enemy fire over a large area starting as close to the vehicle as safety permits out to about 150 meters for a period of 30 seconds from the time of the initiation of the ambush. Emphasis will be placed on the semi-automatic barrage type weapons rather than on those requiring control during the firing period.

b. Absolute system effectiveness cannot be determined at this time. All effectiveness information must be considered in relative terms only.

c. It is currently impossible to compare the effectiveness of systems which employ different mechanisms to achieve the specific desired results (e.g., fragmentation, smoke, flame).

d. Minimum time to place a system in the field is important because of the present urgency.

e. The convoy counterambush weapon system is not a substitute for troop action but is to complement it. By itself, the system will not likely achieve the ultimately desired end of ambush defeat.

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13. ABSTRACT

(U) The U. S. Army Limited War Laboratory has been given the responsibility for developing a convoy counterambush weapon system. Toward this end, a study has been conducted to delineate the pertinent aspects of the convoy ambush situation and to determine and evaluate appropriate counterambush techniques and materiel.

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