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AD 878514



RDTE PROJECT NO. 2X630401D718

USATECOM PROJECT NO. G-EG-155-000-002

USAACEBD PROJECT NO. CE 1569

USALWL PROJECT NO. _____

USACDC AC NO. 5854V

SERVICE TEST OF
GRAPNEL, LAUNCHER PROPELLED: XMI

FINAL REPORT
BY
JOSEPH D. RIPPARD, 2LT
AUGUST 1970

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US ARMY AIRBORNE, COMMUNICATIONS AND ELECTRONICS BOARD
Fort Bragg, North Carolina 28307

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ABSTRACT

Service testing was conducted to determine if the Grapnel, Launcher Propelled: XML, is safe for its intended use and is suitable for Army use. Testing was conducted at Fort Bragg, North Carolina, and Nantahala National Forest, North Carolina, during the period March - July 1970 by soldiers representative of those who will operate and maintain the equipment when it is fielded.

The Grapnel, Launcher Propelled: XML, was easy to operate and provided a means of ascending and descending vertical obstacles and traversing horizontal obstacles. All maintenance was performed by the operator. Six deficiencies were noted; average length of the rope after one firing was 390 feet; the rope produced injuries to bare hands; the rope did not provide a comfortable non-skid hand grip; the rope frayed from contact with abrasive surfaces; the rope detached from the grapnel while in flight; and the climbing devices separated from the rope. Six shortcomings were noted.

It is concluded the Grapnel, Launcher Propelled: XML, provided a means for ascending and descending vertical obstacles and traversing horizontal obstacles, but it is not suitable for Army use.

It is recommended that the Deficiencies and Shortcomings be corrected and the Grapnel, Launcher Propelled: XML, be subjected to check test.

FOREWORD

US Army Airborne, Communications and Electronics Board was responsible for preparing the test plan, test execution, and preparing the test report.

Personnel support was provided by Company C, 6th Special Forces Group (Airborne), 1st Special Forces, Fort Bragg, North Carolina.

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DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

25 NOV 1970

AMSTE-BC

SUBJECT: Suitability for US Army Use of Grapnel, Launcher Propelled,
XML, USATECOM Project Nos. 8-EG-155-000-001, 8-EG-155-000-002

Commanding Officer
US Army Land Warfare Laboratory
APG, Maryland 21005

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1. References.

- a. RDT&E Project No. 2X663701D718 (previously No. 2X630401D718).
- b. Letter, CDCMR-0, HQ, USACDC, 17 July 1968, subject: Department of the Army Approved Small Development Requirement (SDR) for a Grapnel w/Line (Propelled) (CDOG para 139(B)(d)(5)), with one inclosure.
- c. Draft Equipment Publication, (DEP), 9-1375-402-12 (PA-DC5), Operator and Organizational Maintenance for Grapnel, Launcher Propelled: XML, 15 January 1970.
- d. Final Engineer Design Test Report for Grapnel with Line (Propelled), USATECOM Project No. 8-9-7300-03, Aberdeen Proving Ground, February 1969.
- e. Letter, CDCIML-6B, USA Limited War Laboratory, 14 Apr 1969, subject: Minutes of Prototype System Characteristics In-Process Review for Grapnel with Line (Propelled), 19 March 1969.

2. Approval Statement. Inclosed reports of the Engineering Test and Service Test are approved except as stated herein.

3. Background of Test.

- a. Grapnel, Launcher Propelled, XML is intended to facilitate movement of personnel across obstacles such as streams, ravines, and cliffs. It consists of a munition for the M79 Grenade Launcher, a grapnel, and a rope pack. The system is man-portable. The propulsion system consists of a rocket motor with igniter cartridge. This

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munition is breech loaded, and the grapnel is muzzle loaded. The grapnel is attached to a 5/16 inch diameter, 400-foot, nylon line. After the grapnel impacts, the line is pulled manually to set the anchor. The total system, less launcher, weighs 28 pounds, 4 1/2 ounces, and is packaged in two bandoleers.

b. The launcher propelled grapnel was proposed by the 1st Special Forces Group which developed and utilized such a device in the Republic of Vietnam. A Small Development Requirement (SDR) for a Grapnel w/Line (Propelled) was approved by Department of the Army on 19 June 1968. A prototype grapnel system was developed by USA Land Warfare Laboratory. It was subjected to a limited engineer design test emphasizing safety and basic performance characteristics at Aberdeen Proving Ground October 1968 to January 1969.

c. The engineering test (ET) was conducted by the Materiel Test Directorate, Aberdeen Proving Ground from February to July 1970. The service test (ST) was conducted by USA Airborne, Communications and Electronics Board at Fort Bragg, North Carolina and Nantahala National Forest, North Carolina during the period March to July 1970.

d. The tests were conducted in accordance with the SDR and the approved plans of tests.

4. Test Results.

a. The test item met 20 of 29 requirements. There are two deficiencies and two shortcomings reported in the ET and six deficiencies and six shortcomings reported in the ST. After analysis, reclassification and consolidation by this headquarters, five deficiencies and seven shortcomings result.

b. Deficiencies (5):

(1) The rope did not meet the requirement for withstanding impact loads of 225 pounds in a sudden vertical drop of five feet (ET). This requirement was reported as being met in the service test because impact loads were applied at longer distances from the grapnel anchor.

(2) The rope did not provide a non-skid hand grip, and produced injury to bare hands. These were reported as two distinct deficiencies. They are combined by this headquarters into one rope associated deficiency correctable by the provision of gloves (ST).

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(3) The rope frayed from contact with abrasive surfaces (ST). See comment, paragraph 5a.

(4) The climbing devices separated from the rope (ST).

(5) The device did not meet the criterion for reaching heights of 150 feet (ET).

c. Shortcomings (7):

(1) The requirement for a rope length of 400 feet was not met. The average length of rope was 390 feet, varying from a minimum of 387 to 395 feet. ET classes this as a shortcoming. ST classes this as a deficiency. This headquarters classes this as a shortcoming since it did not lessen overall performance and can be corrected through improved quality control.

(2) The wire cable portion of the grapnel hook (10 of 33 cables) burned during firings (ET). See comment, paragraph 5b.

(3) The firing of the system was aurally detectable up to 800 meters (ST).

(4) In seven of 71 instances, the grapnel shafts bent as a result of direct impact on solid surfaces (rocks, trees), and could not be refired when re-anchoring was necessary (ST).

(5) The design of the foot loops of the climbing device ropes limited the ability of the operators to keep their feet in place (ST).

(6) Configuration of the climbing devices resulted in fatigue due to excessive stress on the operators' wrists (ST).

(7) Instructions contained in the Draft Equipment Publication for use of the safety ropes were inadequate in that they prescribed use of the rope in a configuration that interfered with the climbing devices.

d. Reclassification:

(1) The ST reported as a deficiency the lack of a positive lock on the rope snap hook which disengaged in flight (five of 240 firings). The ET reported this as a corrected shortcoming because retainers were provided to lock the snap hooks. This headquarters concurs in the ET report.

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(2) The service test report cites three instances where the grapnel could not be retrieved for refiring when anchoring had not been achieved. This was classified as a shortcoming. This condition is declassified and presented for information only, because of the low frequency and because the cause is inherent in the design of the grapnel hook.

e. Safety:

(1) The test item was unsafe to operate because of design deficiencies discussed in paragraphs 4b(1), 4b(3), and 4b(4). Other safety concerns are expressed in paragraphs 4c(2), 4c(5), and 4c(7).

(2) When fired at high launch angles into winds, the grapnel impacted in the vicinity of operating personnel. Also, at launch angles above 60°, it was found that the operator's hand could be struck by the grapnel attachment cable.

f. Maintainability:

(1) No organizational or higher level maintenance was required or authorized by the maintenance manual. No maintenance training was required. The maintenance manual was adequate except that it failed to provide instructions for frequent cleaning of the barrel of the M79 Grenade Launcher.

(2) Comments and suggested changes to DEP 9-1375-402-12 were submitted by the ST agency on DA Form 2028, dated 25 June 1970.

g. Reliability:

(1) Anchoring reliability, considering only those firings where the grapnel impacted in the designated area, was demonstrated as 76.8% with a 90% confidence level. The SDR desired anchoring reliability is 70%.

(2) Mechanical reliability was demonstrated on the basis of 240 firings in which there were five instances of a mechanical failure, i.e., separation of the line from the grapnel when the snap hook opened. The point estimate of mechanical reliability was 97.94%. At a 90% lower confidence limit, mechanical reliability was 96.8%. The requirement for 98% mechanical reliability was not met, however, this can be attributed to

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the five instances of snap hook opening and separation, which this head-quarters found to be a corrected shortcoming. With the correction, reliability is in excess of 98%, therefore, failure to meet the explicit mechanical reliability requirement is considered neither as a deficiency nor a shortcoming.

5. Comments.

a. The SDR specifies that the grapnel rope "will not fray". This was interpreted as being applicable after a single ascent or crossing. The service test report cites one instance where a rope frayed to the point where it was considered unsafe after being climbed by three personnel. By pulling the rope up and retieing behind the frayed section, the rope was capable of being climbed safely by other personnel. The expectation that a rope can remain unfrayed when moved under tension against an abrasive surface in repeated uses is unrealistic. This is particularly so because the SDR states that the device "once fired, will be retrieved and reused at the discretion of the user". The DEP cautions the user to inspect the rope after use and discard it if defects are observed. These instructions should be amplified to specify that the first man ascending inspect the rope for signs of fraying and make appropriate accommodation by retieing or substitution of other ropes when multiple ascents or crossings are to be made.

b. All ten instances of burned cable assemblies occurred on the second or subsequent firings. In seven instances only one of the two cables was burned. These seven cable assemblies withstood impact loads of 225 pounds in a sudden vertical drop of five feet. Three cable assemblies, where both cables were burned, broke under similar loading. This condition is considered a shortcoming since the SDR states that the device "once fired will be retrieved and reused at the discretion of the user". Competent instructions must be provided to the user to enable him to inspect the cable assemblies and exclude damaged items from further use.

c. Two matters require resolution before further testing as recommended below:

(1) For lack of definitive criteria it was assumed in the engineering test that it would be acceptable if a 150 foot vertical obstacle could be surmounted after expenditure of no more than two propulsion systems. The validity of this assumption should be ascertained.

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(2) Requirements listed in the service test report make reference to a decision at an In-Process Review to have the vertical height requirement changed from 150 feet to 150 feet \pm 10 feet. The SDR has not been changed to reflect this.

6. Conclusion. The Grapnel, Launcher Propelled, XML is unsuitable for US Army use.

7. Recommendations.

a. That the deficiencies and as many shortcomings as feasible be corrected and the Grapnel, Launcher Propelled, XML be submitted for check test.

b. That the Operator and Organizational Maintenance Manual be amended:

(1) To provide a warning to the user that when firing at high launch angles into winds, the grapnel may impact in the vicinity of operating personnel.

(2) To provide a warning that at launch angles above 60°, the operator's hand could be struck by the grapnel attachment cable.

(3) To provide instructions on the cleaning required for the barrel of the M79 Grenade Launcher when used with the grapnel system.

(4) To provide instructions that require the first man ascending or crossing the rope to inspect the rope for signs of fraying and to make appropriate accommodation by reticing or substitution of other ropes when multiple ascents or crossings are to be made.

(5) To provide instructions and describe the technique for user inspection of the cable assembly for evidence of burn damage and provide criteria for safe subsequent use of the assembly.

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c. That the validity of the requirement to surmount 150-foot obstacles and the assumption that the expenditure of two propulsion systems is acceptable to enable surmounting a 150-foot obstacle be ascertained prior to check test.

FOR THE COMMANDER:

Henry F. Grimm, Jr.

HENRY F. GRIMM, JR
Colonel, GS
DCS for Test and Eval

2 Incl

1. APG Rept MT-3666
2. USAACEBD Rept CE-1569
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SECTION 1. SUMMARY

1.1 BACKGROUND

a. The feasibility of the Grapnel with Line (Propelled) was demonstrated by personnel of the 1st Special Forces Group who constructed and used such a device in the Republic of Vietnam. A practice rifle grenade was modified by welding 20-penny nails equidistant around the head of the grenade and attaching a length of parachute suspension line to the grenade. The modified grenade was fired from a M7A3 Grenade Launcher (M1 Rifle). The grenade traveled across a 30-meter ravine and lodged in heavy vegetation which provided a firm anchor for the line at the terminal end. A 210-pound man was able to traverse the ravine using the line.

b. A proposal by the 1st Special Forces Group for a grapnel with line device was reviewed by the US Army John F. Kennedy Center for Special Warfare and US Army Special Warfare School. This review revealed that a requirement for a grapnel device does exist and that early procurement will enhance capabilities of Special Forces personnel operating in jungle and mountainous areas. A Small Development Requirement (SDR) for a Grapnel with Line (Propelled) was approved by the Department of the Army in June 1968 (Ref 1, App.V).

c. A prototype grapnel system was developed by US Army Limited Warfare Laboratory (USALWL) and subjected to engineer design test by Materiel Test Directorate, Aberdeen Proving Ground (Ref 2, App V). It was concluded that the grapnel system is safe for its intended use and transport and capable of propelling the line a distance of 175 feet as stipulated in the SDR.

d. In March 1969, US Army Test and Evaluation Command (USATECOM) directed US Army Airborne, Electronics and Special Warfare Board (USAAESWBD) (now US Army Airborne, Communications and Electronics Board (USAACEBD)) to conduct service test of the Grapnel with Line (Propelled) (Ref 3, App V).

e. Prior to receipt of Grapnel with Line (Propelled), it was nomenclatured Grapnel, Launcher Propelled: ~~XMI~~.

f. Forty each grapnel systems were received by USAACEBD in February 1970 and testing was initiated in March 1970.

1.2 DESCRIPTION OF MATERIEL

a. Grapnel, Launcher Propelled: XM1, the test item, consisted of two bandoleers containing the following:

(1) Hook and Cartridge Bandoleer (Fig 1, App I):

<u>Quantity</u>	<u>Item</u>
4 ea	Tines
1 ea	Head assembly
1 ea	Shaft
1 ea	Rocket motor shroud
1 ea	Attachment cable assembly
2 ea	Safety rope
1 ea	Goggles
2 ea	Climbing device
2 ea	Snap link
2 ea	Quick release pin
1 ea	Ground cloth
6 ea	Cartridge, XM688

(2) Rope Canister Bandoleer (Fig 2, App II):

<u>Quantity</u>	<u>Item</u>
1 ea	Rope (400-foot coil with snap hook)
1 ea	Rope canister
1 ea	Blast deflector

b. The M79 Grenade Launcher is used to fire the XM688 Cartridge and launch the grapnel assembly. The cartridge loads into the breech of the weapon and the grapnel loads into the muzzle. The cartridge rocket motor assembly inserts into the end of the grapnel. Upon firing, the rocket motor propels the grapnel which in turn pulls the line.

c. Assembly and usages of test item components are as follows:

(1) Grapnel Hook. It consists of four tines, head assembly with quick release pin, shaft, rocket motor shroud, and an attachment cable assembly. These components are assembled prior to being placed into the muzzle of the launch weapon (Fig 3 and 4, App I).

(2) Blast Deflector. This device is designed to protect the firer from the rocket back blast. Prior to loading the grapnel, the deflector is mounted on the muzzle of the launch weapon (Fig 4, App I).

(3) The Cartridge, XM688, consists of a 40MM cartridge case, expulsion ignition charge, and a rocket motor assembly. The rocket motor assembly contains 100 grams of black powder which is ignited immediately prior to, or shortly after, leaving the muzzle of the launch weapon.

(4) Nylon Rope (Man-Carrying Line/Grapple Line). The line is coiled in a canister. A retainer cup is placed through the dispenser hole to prevent the line from uncoiling until used. When the retainer cup is removed, the end of the line, with the quick release snaphook, is revealed (Fig 2, App I). The snaphook is connected to the grapple prior to firing. The rope canister is placed forward of the firing position (Fig 5, App I).

(5) Goggles. The goggles are used to protect the firer's eyes from sand or dust stirred up during the grapple launch (Fig 1, App I).

(6) Ground Cloth. The cloth is used to provide a smooth area on which to recoil the line for subsequent firings if the grapple fails to anchor after the line is dispensed from the rope canister (Fig 5, App I).

(7) Climbing Device. Two commercial climbing devices are provided for vertical operation. When attached to the nylon climbing rope, they enable the operator to ascend or descend a vertical obstacle (Fig 1, 6, and 7, App I).

(8) Safety Rope. Two safety ropes are provided. One rope may be used to provide a safety link between the climber and the climbing rope (Fig 7, App I). Both safety ropes may be used for various horizontal and vertical operations as described in FM 31-72 and FM 31-30 (Ref 4 and 5, App V).

(9) Safety Link. Two safety links (or "snap-links") are provided for use in various horizontal and vertical climbing techniques described in FM 31-72 and FM 31-30 (Ref 4 and 5, App V).

1.3 TEST OBJECTIVES

Determine if the Grapple, Launcher Propelled: XM1, is:

- a. Safe for its intended use.
- b. Suitable for Army use.

1.4 SCOPE

a. Service test of Grapnel, Launcher Propelled: XML, the test item, was conducted under field conditions in the vicinity of Fort Bragg, North Carolina, and Nantahala National Forest, North Carolina. The test was conducted by personnel of the US Army Airborne, Communications and Electronics Board (USAACEBD) assisted by soldiers from local tactical units during the period March 1970 to July 1970. Test personnel were representative of those who will operate and maintain the equipment in the field. Temperatures varied from 45 to 102 degrees Fahrenheit, and total rainfall was 17.3 inches during the test period.

b. Evaluations of operator training, line capabilities and characteristics, environmental effects, durability, maintainability and reliability, human factors, value analysis, and safety were conducted throughout the test period. The initial evaluation of safety, physical characteristics, and operator and maintenance training preceded the operational subtest.

c. The number of test items (40 systems) and the time allotted (3 months) was adequate for the conduct of the test. Operational and mechanical reliability were computed at a 90% confidence level.

d. Prior to placing the weight of a man on the deployed rope, qualified test personnel checked the anchor achieved. An independent safety rope was rigged and attached to the operator.

1.5 SUMMARY OF RESULTS

a. Grapnel, Launcher Propelled: XML, was easy to operate and operators required minimum training. It provided a means of ascending and traversing obstacles. The test item was not adversely affected by environmental conditions encountered during the test period nor by transport over primary and secondary roads and trails. Airdrop was accomplished without difficulty. There were no unessential features or accessories.

b. Maintenance Maintainability. No maintenance was required other than external visual inspection before firing and cleaning components before refiring.

c. Training. Test personnel (Special Forces "A" Team - less officers) with no previous experience on the test item or similar equipment could install, operate, and maintain without difficulty

following a 2-hour course of instruction presented by project personnel using instructional material provided. However, an additional 2 hours of practical exercises were required for test personnel to become proficient in the use of the climbing devices.

d. Safety. The following unsafe conditions were noted during testing:

- (1) The rope produced injuries to bare hands.
- (2) The climbing device separated from the rope.
- (3) The operator's feet came out of the foot loops.
- (4) The safety rope used as specified in the DEP provided no safety.

c. The following Deficiencies and Shortcomings were noted:

(1) Deficiencies:

(a) Average length of the rope after one firing was 390 feet (para 2.1, Sec 2).

(b) The rope produced injuries to bare hands (para 2.3 and 2.11, Sec 2).

(c) The rope did not provide a comfortable non-skid hand grip (para 2.3 and 2.8, Sec 2).

(d) The rope frayed from contact with abrasive surfaces (para 2.3, Sec 2).

(e) The rope detached from the grapnel while in flight (para 2.3, Sec 2).

(f) The climbing devices separated from the rope (para 2.11, Sec 2).

(2) Shortcomings:

(a) The grapnel hook could not always be retrieved or refired when an anchor was not achieved (para 2.4, Sec 2).

(b) The firing of the system was aurally detected up to 800 meters (para 2.4, Sec 2).

(c) The grapnel shafts bent on direct impact with solid surfaces (para 2.7, Sec 2).

(d) The operator's feet came out of the foot loops (para 2.11, Sec 2).

(e) The safety rope when used as prescribed in the DEP provided no safety (para 2.11, Sec 2).

(f) Configuration of the climbing device put undue stress on the operator's wrists (para 2.8, Sec 2).

1.6 CONCLUSIONS

a. Grapnel, Launcher Propelled: XML, provided a means for ascending and descending vertical obstacles and traversing horizontal obstacles.

b. Grapnel, Launcher Propelled: XML, is not suitable for Army use.

1.7 RECOMMENDATION

That the Deficiencies and Shortcomings be corrected and the Grapnel, Launcher Propelled: XML, be subjected to check test.

SECTION 2. DETAILS OF TEST

2.1 PHYSICAL CHARACTERISTICS

2.1.1 Objective

Determine the physical characteristics of the test item.

2.1.2 Criteria

a. (Essential) The total weight must not exceed 4.5 pounds (exclusive of the weight of the man-carrying line, climbing devices, safety link, extra munitions, and carrying case) (Item 1, App II).

b. (Essential) The device will have 400 feet of line available to the user (Item 2, App II).

2.1.3 Method

The test item was inspected, weighed, measured, and photographed.

2.1.4 Results

a. Total weight of the test item was 28 pounds 4½ ounces. Detailed weights and measurements are found in Tables 1 and 2, Appendix I.

b. The weight of the grapnel hook (grapnel head assembly and rocket motor shroud, grapnel tines, attachment cable assembly, and pin) was 4 pounds 3½ ounces (Fig 3, App I).

c. Since the ropes could not be recoiled in the canisters, they were measured subsequent to the initial firing. The average length of the rope provided was 390 feet, varying from a minimum of 387 feet to a maximum of 395 feet.

d. Photographs of the test item are shown in Figures 1 through 7, Appendix I.

2.1.5 Analysis

Did not meet criteria in that the average length of the rope after one firing was 390 feet (Deficiency).

2.2 OPERATOR TRAINING

2.2.1 Objectives

Determine:

a. If amount and type of training required for operators to become proficient in the installation/disassembly, operation, and operator maintenance of the test item conforms to training criteria of the stated requirements.

b. If amount and type of training required is in consonance with MOS and skill level of intended user personnel.

c. Adequacy of instructional material provided.

d. Need for special training aids.

2.2.2 Criteria

a. A class to familiarize students with the device and to demonstrate its use shall not exceed 2 hours (Item 3, App II).

b. No additional personnel will be required in TOE due to the introduction of this device. No new MOS will be required (Item 4, App II).

2.2.3 Method

a. A training program was prepared and presented to test personnel, Special Forces "A" Detachment, who were used as test item operators. The program included installation, disassembly, operation, and operator maintenance. Based upon stated training requirements, the training program consisted of orientation, theory, demonstration, and supervised practical application. To the greatest extent practicable, this training duplicated operator training to be given when the test item is introduced into the field. The amount of training presented by type was recorded. Following the training period, the proficiency of trainees was evaluated to determine if further training was required.

b. The instructional literature provided with the test item was evaluated. Emphasis was placed upon completeness, accuracy, propriety, organization, and suitability for use in training personnel. Comments from all test personnel on the instructional material were evaluated and DA Form 2028, Recommended Changes to Publications, was prepared and submitted.

c. Training difficulties were evaluated to determine if special training aids would facilitate operator training.

2.2.4 Results

a. Test personnel, trained as stated in the preceding method, could install, operate, and disassemble the test item and maintain it without difficulty following a 2-hour course of instruction. An additional 2 hours of practical exercises in ascending and traversing obstacles were required for test personnel to become proficient in the operation of the climbing devices.

b. FM 23-31, w/Change 1, 40MM Grenade Launcher, was adequate for instructional purposes. Draft Equipment Publication (DEP) 9-1375-402-12 (PA-DC5) Grapnel, Launcher Propelled: XM1, was adequate; however, recommended changes were submitted.

c. Training aids were not provided or required.

d. No additional personnel or new MOS's were required.

2.2.5 Analysis

Met criteria.

2.3 LINE CAPABILITIES AND CHARACTERISTICS

2.3.1 Objective

Determine the capabilities of the rope used with the test item.

2.3.2 Criteria

a. (Desirable) The device will have a self-contained line which will be extracted and extend freely during flight (Item 5, App II).

b. (Essential) The man-carrying line will be made of material which will be of sufficient strength to allow it to safely suspend the hanging weight of a 225-pound man (total weight) when crossing horizontal or ascending vertical obstacles and to withstand the impact load of a 225-pound man (total weight) in a sudden vertical drop of 5 feet (desirable, 300-pound man (total weight)) (Item 6a, App II).

c. (Essential) The line will not cut or produce injury to bare hands (Item 6b, App II).

d. (Essential) The line will provide as comfortable and non-skid hand grip as possible (Item 6c, App II).

e. (Essential) The line will not fray or burn from friction (Item 6d, App II).

f. (Essential) The line will not become detached from the grapnel until disconnected by the user. It will be capable of being released from the grapnel without the use of hand tools or special equipment not available to the user (Item 7, App II).

2.3.3 Method

a. Operators trained in 2.2.3, preceding, utilized methods described in the operators manual, fired the test item over a 120-foot vertical obstacle and obtained anchorage. A soldier with field equipment (total weight, 225 pounds) then climbed the line, using climbing devices provided and a rappel seat in lieu of the safety rope as described in the Draft Equipment Publication (DEP) (para 2.4.4 k). Upon surmounting the obstacle, he detached the grapnel from the climbing rope, secured it to a natural anchor, and descended using the seat rappel technique (Ref 4, App V). During the descent, he stopped approximately 15 feet above the ground. At this time he executed a 5-foot rappelling free fall and then continued to descend to the ground.

b. The test item was fired over a 120-foot vertical obstacle and anchorage was obtained. Three hundred pounds of equipment was hoisted to the top of the obstacle. Upon surmounting the obstacle, the 300 pounds of equipment was lowered to approximately 30 feet above the ground and stabilized. At this time a 5-foot free fall was executed and then its descent was continued to the ground.

c. The test item was fired over a 110-foot horizontal obstacle and obtained anchorage. This was accomplished using methods described in operators manual. A soldier with field equipment (total weight, 225 pounds) then traversed the obstacle using a one-rope bridge and a rappel seat (Ref 4, App V).

d. Method c, preceding, was repeated using 300 pounds of equipment which was pulled across the obstacle using another rope.

e. Methods preceding were repeated three times each.

f. The extraction of the rope from the rope canister and the detachment of the grapnel from the rope was observed throughout the test period.

g. Initially, test personnel operated the test item without gloves to determine if the rope would cut or produce injuries to bare hands and provide a positive non-skid hand grip. Subsequent testing was performed with gloves.

h. Throughout the testing period, the rope was observed for fraying, burning, and premature detachment.

2.3.4 Results

a. The rope extracted freely from all canisters during testing.

b. The rope supported the weight of test personnel and equipment and withstood the impact load of 300 pounds in a sudden 5-foot vertical drop.

c. The rope produced burns and blisters to bare hands when tightening the line. The line did not provide a comfortable or non-skid hand grip primarily because of its size and the characteristics of rope.

d. The rope caused no injuries to operators wearing gloves (Gloves Leather Strap Closure, Cream, Mens Work, M-1950, FSN 8415-268-7868).

e. The rope frayed when it came in contact with abrasive surfaces while under load and experienced any movement at the point of contact. On one occasion, a new rope frayed to the point it was considered unsafe after being climbed by only three personnel. This rope was employed over a 120-foot vertical obstacle with rocky ledge at the top. The rope was pulled up and retied behind the frayed section.

f. Out of 240 firings, the grapnel detached from the rope five times while in flight.

g. The rope has a stretch factor of approximately 30% (Fig 11, App I). As a result of this, when crossing a horizontal obstacle, the operator had to climb up hill the last half of the traverse using the climbing devices.

2.3.5 Analysis

Did not meet criteria in that:

- a. The rope produced injuries to bare hands (para 2.11.5).
- b. The rope did not provide a comfortable non-skid hand grip (para 2.8.5).
- c. The rope frayed from contact with abrasive surfaces (Deficiency).
- d. The rope detached from the grapnel while in flight (Deficiency).

2.4 TACTICAL INSTALLATION AND OPERATION

2.4.1 Objectives

Determine:

- a. Ease of tactical installation and operation.
- b. Adequacy and suitability of the operational and anchoring characteristics.
- c. The distance at which the discharge of the test item can be aurally detected.

2.4.2 Criteria

- a. (Essential) The device must be capable of being fired from the M79 Grenade Launcher (Item 8, App II).
- b. (Essential) The device will be fired in the same manner (aiming procedures) as grenades fired from the M79 Grenade Launcher (Item 9, App II).
- c. (Essential) The device will be designed with the grapnel tines retracted until activated by the firer (Item 10, App II).
- d. (Essential) The device will propel the line a distance of 175 feet (Item 2, App II).
- e. (Desirable) After firing, the device will be capable of being retrieved, reloaded by the user, and refired within a short period of time in case it fails to anchor on the first try (Item 11, App II).

f. (Desirable) The device will have a silent propellant charge for use where secrecy is necessary (Item 12, App II).

g. (Essential) The grapnel will be of such a design that, upon/after impacting with the ground, brush or trees, it will anchor itself when the line is pulled by the user, support the weight of a 225-pound man, and enable him to cross or ascend 150-foot obstacles \pm 10 feet (Item 13, App II).

h. (Desirable) Anchoring reliability desired is 70% (Item 14, App II).

2.4.3 Method

a. Personnel trained in 2.2.3, preceding, employed the test item in tactical locations (Fig 8 and 9, App I). The following test sites contained obstacles which ranged from 93 to 178 feet vertically and from 98 to 214 feet horizontally:

Site	Obstacle Orientation	Height/ Span	Location
1	Vertical	120	Nantahala National Forest
2	Horizontal	214	Nantahala National Forest
3	Horizontal	164	Nantahala National Forest
4	Vertical	131	Nantahala National Forest
5	Horizontal	160	Nantahala National Forest
6	Vertical	178	Nantahala National Forest
7	Vertical	155	Nantahala National Forest
8	Vertical	145	Nantahala National Forest
9	Horizontal	98	Nantahala National Forest
10	Vertical	93	Nantahala National Forest
11	Horizontal	110	Fort Bragg, North Carolina
12	Horizontal	120	Fort Bragg, North Carolina
13	Horizontal	140	Fort Bragg, North Carolina

b. The test item was fired from the M79 Grenade Launcher using aiming procedures specified in FM 23-31 or Change 1 to FM 23-31 (Ref 6, App V).

c. The test item was fired during hours of daylight and darkness over the obstacles listed in a, preceding. In each firing, success or failure of the grapnel to anchor itself was observed. If the grapnel did not anchor itself, it was retrieved and refired until adequate anchoring was achieved. Time required to retrieve and re-fire was recorded.

d. Throughout the test period, compatibility of the test item with the M79 Grenade Launcher was observed.

e. Test personnel were stationed 50 meters from the firing point. This distance was increased in 25-meter increments until firing was no longer aurally detectable.

2.4.4 Results

a. The grapnel system was successfully fired from the M79 Grenade Launcher.

b. The mark sling method of aiming the 40MM Grenade Launcher was successfully used for angles of 45 degrees or greater. The same general procedure was used for angles less than 45 degrees; however, these firing angles were estimated.

c. The grapnel tines were not retractable but were removable. The grapnel shafts and tines were stowed in the hook and cartridge bandoleer and assembled by the operator when ready for use (Fig 1, App I).

d. The grapnel system was propelled over horizontal obstacles up to 214 feet and vertical obstacles up to 145 feet. Attempts to clear a 155-foot vertical obstacle were unsuccessful.

e. In 15 cases out of 71 firings, where hooking was not achieved, the grapnel hook could not be retrieved. In five cases the snap hook separated from the attaching cable assembly. In three other cases the hook could not be retrieved from the face of a vertical obstacle. These were hooked in locations which were inaccessible and which did not permit successful ascending of the obstacle. In seven instances, the grapnel shaft was bent before an anchoring was obtained and could not be refired. Average time to retrieve and re-fire was 23 minutes.

f. Based upon 38 test samples (systems) used and the 15 instances where the grapnel could not be retrieved or refired, system reliability (the ability to obtain anchor with one of the 6 rounds in the system) was 53.2% with a 90% confidence level.

g. The firing of the test item was aurally detected to a distance of 800 meters in a remote mountainous area.

h. When the grapnel was being pulled to obtain an anchor, the rocket motor shroud base had a tendency to catch on objects causing the grapnel to pivot over these objects preventing anchoring.

i. The design of the tines was such that anchoring was generally obtained when one or more came in contact with objects of sufficient density/strength. When anchoring was achieved, the device supported the weight of a soldier and his equipment (225 pounds).

j. Of 200 attempts (firings) of the grapnel used to determine anchoring reliability, there were 126 successful anchorings. This resulted in an anchoring reliability of 69.8% with a 90% confidence level. Of the 74 unsuccessful attempts, 26 did not reach the impact (target) area due to mechanical failure, improper sighting, environmental effects (winds). Anchoring reliability, considering only attempts where the grapnel impacted in the designated area, was 76.8% with a 90% confidence level.

k. The 5/16-inch safety rope, when used as a safety rope as prescribed in DEP, interfered with the operation of the climbing devices. Observation of test personnel using the safety rope disclosed that this technique provided no safety (para 2.11.4). A rappelling seat was used in place of the chest rope.

l. The following difficulties were encountered while installing and operating the grapnel system under field conditions:

(1) The grapnel rope, when carried in any configuration other than rope canister, was time consuming to prepare for firing.

(2) The M79 barrel required swab cleaning after every XM688 Cartridge fired and cleaning with solvent after every four cartridges.

(3) In three observed cases, the connecting cable entangled in the tines of the grapnel hook. This caused the hook to be pulled from the head of the grapnel hook, thus preventing the tines from anchoring.

(4) In nine instances out of the 200 firings, the line tangled when fired from the ground cloth. The trajectory of the round was affected and in five cases the grapnel fell short of the target area.

(5) The point of impact of the grapnel in the horizontal plane varied from 36 feet left to 48 feet right of the target. The trajectory in the vertical plane was erratic.

(6) The climbing device separated from the grapnel rope three times (twice while ascending and once while descending). The grapnel rope became wedged between the rope guide and the rope release lever when the climbing device was moved and separated when the operator's weight was placed on the foot loop (Fig 10, App I) (para 2.11.4).

(7) The operators had difficulty in keeping their feet in the foot loops. An expedient heel strap was made out of rope to keep the foot loop on the climber's boot (para 2.11.4).

2.4.5 Analysis

Met criteria except that:

a. The grapnel hook could not always be retrieved or refired when anchoring was not achieved (Shortcoming).

b. The firing of the system was aurally detected up to 800 meters (Shortcoming).

2.5 ENVIRONMENTAL EFFECTS

2.5.1 Objective

Determine the capability of the test item to operate satisfactorily under temperate environmental conditions encountered during the test period.

2.5.2 Criterion

(Desired) The device must function under intermediate climatic conditions as outlined by paragraph 7c, Change 1, AR 705-15 (now AR 70-38) (Item 15, App II).

2.5.3 Method

a. Throughout the test period, the test item was transported and operated under field conditions while exposed to environmental factors encountered. Test sites were selected which provided a wide variety of soil types and terrain features as practicable. Testing was conducted during the hours of daylight and darkness in order to expose the test item to as wide a temperature range as possible.

b. Applicable weather data were collected at each test site on an hourly basis. Manual Meteorological Station, AN/PMQ-4, was used to determine the wind direction and speed. Precipitation data were periodically obtained from an official weather station near the test site.

c. Two grapnel systems with 12 cartridges were submerged in fresh water to a covering depth of 3 feet. At the end of 1 hour, one system and two cartridges were removed and various expedient means were used to dry the test item. The test item was fired and results observed. The grapnel system was resubmerged. The process was repeated at 1-hour intervals, alternating between systems.

2.5.4 Results

a. Throughout the test period, the test item was exposed to and operated in temperatures varying from 45 to 102 degrees Fahrenheit, rain, and dust with no adverse effects.

b. The trajectory of the grapnel was adversely affected by winds greater than 8 mph. When fired at a 60-degree elevation into a 15 mph wind, the grapnel landed approximately 48 feet behind the firer. Allowances in deflection had to be made when firing in cross-winds to hit the target area.

c. The horizontal and vertical distance achieved was reduced when the grapnel rope was wet (submersion test). The horizontal distance was 173 to 178 feet as compared to a distance of 182 to 195 feet for dry rope. The vertical distance was not measured.

2.5.5 Analysis

Met criterion under the conditions encountered.

2.6 DURABILITY

2.6.1 Objective

Determine if the test item is sufficiently durable to withstand normal field use.

2.6.2 Criteria

a. The device will be sufficiently rugged to withstand conditions and stresses encountered during tactical operations (Item 16, App II).

b. (Essential) The device should be rugged so that if accidentally dropped, it will be safe for subsequent use (Item 17, App II).

2.6.3 Method

a. Throughout the test period, the test item was subjected to normal field use and operation. The test item was inspected and employed.

b. The test item, in its carrying configuration, was dropped on hard earth from a height of 4 feet to simulate accidental droppage. Following the drop, the test item was inspected for damage and then employed.

c. Method b, preceding, was repeated from a height of 8 feet.

d. Methods b and c, preceding, were repeated with the test item packed in a rucksack with other field equipment.

e. The test item was transported in a Truck, Utility, $\frac{1}{4}$ -Ton, M151A1, as follows:

(1) Cross-country - 10 miles.

(2) Over dirt roads and trails - 50 miles.

(3) Over primary and secondary roads - 240 miles. At periodic intervals, the test item was inspected for damage. At the conclusion of the transport test, the test item was employed.

2.6.4 Results

a. No adverse effects were noted from normal field handling and transport. However, during employment, seven of the grapnel shafts bent upon direct impact with solid surfaces (rocks and trees) and could not be reused. The range to point of impact was 85 to 141 feet (para 2.4.4).

b. During employment, seven quick release pins were bent or broken. Two occurred on direct impact with solid surfaces (a, preceding) and five as a result of indirect impact with solid surfaces (rock or trees). In none of these cases was the mission impaired due to the damaged quick release pin. The spare pin provided was utilized for subsequent firings.

2.6.5 Analysis

Met criteria except that the grapnel shafts bent on direct impact with solid surfaces (Shortcoming).

2.7 MAINTAINABILITY AND RELIABILITY

2.7.1 Objectives

Determine:

- a. If the test item meets maintenance and maintainability requirements as defined by the criteria.
- b. The reliability of the test item under normal operation.
- c. If the technical manuals provided are suitable for their intended use.

2.7.2 Criteria

- a. The device should be of such simple design that 98% mechanical reliability can be obtained (Item 14, App II).
- b. No maintenance will be required other than visual inspection prior to firing (Item 18, App II).
- c. The device will be considered expendable and, once fired, will be retrieved and reused at the discretion of the user (Item 19, App II).
- d. No special maintenance training is anticipated (Item 20, App II).

2.7.3 Method

- a. Maintenance. The test item was examined before each operation to determine if any organizational or higher level maintenance was required. The requirement for maintenance training was evaluated.

b. Maintenance Literature. The technical manual provided was utilized during the test period and its suitability evaluated.

c. Mechanical Reliability. Each firing operation of the test item was observed with special attention being directed toward detecting mechanical failures of the equipment.

2.7.4 Results

a. No organizational or higher level maintenance was required or authorized by the maintenance manual. No maintenance training was required.

b. The maintenance manual (Chart, App IV) was suitable. Comments and suggested changes were submitted on DA Form 2028.

c. The test item was fired 240 times during the test period. On five occasions the grapnel separated from the line while in flight. The mean number of firings between failures (MFBF) was 48.0. The point estimate reliability was 97.94%. When computed at a 90% lower confidence limit, the predicted mechanical reliability is 96.8%.

2.7.5 Analysis

a. Met criteria.

b. Mechanical reliability was 96.8% against a requirement for 98% which was not considered significant enough to classify as a Deficiency or Shortcoming.

2.8 HUMAN FACTORS EVALUATION

2.8.1 Objective

Determine if the test item conforms to the principles of human factors engineering.

2.8.2 Criterion

(Essential) The man-carrying line will be made of material which will provide as comfortable and non-skid hand grip as possible (Item 6c, App II).

2.8.3 Method

a. A Human Factors Evaluation Committee was formed consisting of the branch chief, section chief, equipment specialists, and project officer. This committee evaluated all indications of improper or

inefficient man-machine relationships that were noted throughout the test in order to determine those areas which required correction or improvement.

b. Test personnel were observed throughout the test period as they installed, operated, maintained, disassembled, and transported the test item. Each detail requiring human attention and action was studied and areas of concern were presented to the Human Factors Evaluation Committee. Emphasis was placed on the following:

- (1) Indices, markings, and other indicators.
- (2) Handles, fasteners, and other controls requiring manual manipulation.
- (3) Operations which were unduly time-consuming, fatiguing, inconvenient, or awkward.

c. Throughout the test period, all test personnel reported areas of human factors difficulties. The Human Factors Evaluation Committee considered these difficulties along with personal observation of the reported difficulty.

2.8.4 Results

The test item was simple to operate. Controls were minimal in number and were arranged to facilitate ease of operation. However, the following difficulties were encountered:

a. Gloves were required to maintain a positive hand grip while tightening the rope (para 2.3.4).

b. When using the equipment as specified in the DEP, the operator could not rest when he became fatigued while ascending the rope. The chest safety rope was removed and used as a rappel seat which was attached to the right climbing device using a snap link and additional rope. This allowed the operator to stop and sit in the rappel seat to rest.

c. When climbing vertical obstacles with the climbing devices, the operator had a tendency to spin on the rope when he could not maintain physical contact with his feet on the obstacle which he was ascending.

d. When the climbing devices were placed on the rope as prescribed in the DEP, the equal lengths of the leg ropes made the climb

unnatural and caused undue operator fatigue. When the leg rope of the lower climber was shortened by approximately 9 inches, the operator experienced less difficulty and fatigue while ascending the rope.

e. The operator's hands were at right angles to the line of motion when using the climbing devices, placing undue stress on the wrists. This resulted in unnecessary fatigue.

2.8.5 Analysis

Did not meet criterion in that:

a. The rope did not provide a comfortable non-skid hand grip (Deficiency).

b. Configuration of the climbing device put undue stress on the operator's wrists (Shortcoming).

2.9 AIRDROP

2.9.1 Objective

Determine the suitability of the test item for airdrop.

2.9.2 Criteria

a. The device will be capable of aerial delivery during Phase I airborne operations (Item 21, App II).

b. The device shall be suitable for attachment to a parachutist as part of his combat load or suitable for stowing in a personnel equipment container carried by a parachutist while parachuting from US Air Force or US Army aircraft (Item 22, App II).

c. The device shall be suitable for stowing in a standard airdrop container or on an airdrop platform as part of an accompanying load dropped by parachute from US Air Force or US Army aircraft (Item 23, App II).

d. The device shall be sufficiently durable to withstand the normal shock incident to airdrop when attached to a parachutist, when stowed as part of an accompanying load packed in a standard airdrop container, or on an airdrop platform (Item 24, App II).

e. Performance of the device after airdrop shall be demonstrated by operation (Item 25, App II).

2.9.3 Method

- a. Technical data and safety release were reviewed.
- b. The test item was inspected for serviceability and studied with reference to adaptability for:
 - (1) Attachment to an individual parachutist as part of his combat load.
 - (2) Packing in standard personnel equipment containers.
 - (3) Packing in standard airdrop containers or rigging on airdrop platforms as part of an accompanying load.
- c. The test item was attached to a parachutist who jumped from a US Air Force C-130 aircraft nine times. The test item was inspected for damage and employed after each drop.
- d. The test item was packed in a standard A-21 Equipment Bag and dropped from a US Air Force C-130 aircraft three times. The test item was inspected for damage and employed after each drop.

2.9.4 Results

- a. The device was successfully delivered nine times by a parachutist, who jumped from a US Air Force C-130 aircraft.
- b. The device was attached to the parachutist in three configurations.
 - (1) Lashed to the front of a rucksack.
 - (2) Placed in an aviator's kit bag and rigged in an H-harness.
 - (3) Placed in a weapon and individual equipment container together with other items of equipment.
- c. The device was stowed in an A-21 Cargo Bag as an accompanying load with a G-13 Cargo Parachute attached and successfully air-dropped three times from a US Air Force C-130 aircraft flying at 1,250 feet altitude and 130 KIAS.
- d. No damage was noted during post drop inspection and employment.

e. No safety hazards were noted.

2.9.5 Analysis

Met criteria.

2.10 VALUE ANALYSIS

2.10.1 Objective

Determine if the test item has unnecessary, costly, or nice-to-have features.

2.10.2 Criterion

Unnecessary, costly, or nice-to-have features that are revealed during conduct of test programs will be observed and reported (Item 26, App II).

2.10.3 Method

All test personnel were instructed to report unnecessary, costly, or nice-to-have features of the test item that may be eliminated without sacrificing performance, maintainability, reliability, quality, or mission accomplishment.

2.10.4 Results

The test item has no costly or nice-to-have features.

2.10.5 Analysis

Met criterion.

2.11 SAFETY

2.11.1 Objective

Determine if the test item is safe for its intended use.

2.11.2 Criteria

a. (Essential) The man-carrying line will be made of material which will not cut or produce injury to bare hands (Item 6, App II).

b. (Essential) The device will be designed with the grapnel tines retracted until activated by the firer (Item 10, App II).

c. (Essential) The device will be equipped with a positive safety device that will prevent premature or accidental firing (Item 27, App II).

d. (Essential) The device should be rugged so that if accidentally dropped it will be safe for subsequent use (Item 17, App II).

e. The equipment shall be safe for its intended use (Item 28, App II).

f. The only test or checkout to be performed prior to firing will be a visual inspection to determine if the device is safe to fire (Item 29, App II).

2.11.3 Method

a. The Safety Committee was formed consisting of the project officer, project NCO, and qualified test personnel. This committee:

(1) Reviewed the safety release.

(2) Reviewed operator and maintenance manuals provided with the test item with reference to safety precautions and/or warning contained in this literature.

(3) Inspected the test item with reference to safety precautions/warnings posted thereon.

(4) Inspected the test item with reference to provisions made for the safety of operator and maintenance personnel.

(5) Inspected the test item for evidence of unsafe conditions not covered by precautions/warnings in the manuals or posted on the equipment. The inspection included:

(a) Modifications and changes to the test item which may have been made subsequent to the issuance of the safety release and might affect safety.

(b) Presence of toxic or other harmful materials.

(c) Presence of explosive materials (to include fuels.

(d) Sharp or protruding edges or corners.

(6) Observed assembling of the test item and its employment over vertical and horizontal obstacles. Qualified test personnel checked anchoring as described in operators manual and negotiated these obstacles using appropriate components of the test item. Particular attention was given to the following:

(a) Installational, operational, and operator maintenance procedures.

(b) Unsafe noise levels.

(c) Proper operation of all safety devices.

b. A summary of safety procedures, precautions, protections, and emergency procedures for all hazards associated with the test item as determined in method a, preceding, was made and presented to all test personnel prior to the initiation of the operational phases of this test.

c. Throughout the test period, all test personnel reported unsafe conditions or actions that existed or developed as a result of field usage or maintenance for evaluation and appropriate action.

2.11.4 Results

a. The rope produced burns and blisters to bare hands when tightening the line (para 2.3.4).

b. The grapnel shaft and tines were carried separately in the grapnel bandoleer. They were assembled by the operator when ready to fire.

c. The M79 Grenade Launcher was equipped with a positive safety device.

d. The test item was dropped from heights of 4 and 8 feet (para 2.6). Subsequent inspection and employment of these items disclosed no unsafe conditions.

e. The only test or checkout required prior to the employment of the test item was visual inspection.

f. The following unsafe conditions were noted:

(1) The climbing device separated from the rope (Fig 10, App I) (para 2.4.4).

(2) On five occasions out of approximately 60 firings, when fired above a 60-degree angle, the operator's hand was hit by the attachment cable assembly and minor cuts were sustained.

(3) The operator's feet came out of the foot loops (para 2.4.4).

(4) The safety ropes, when used in accordance with instructions contained in the DEP, interfered with the climbing device and did not provide any safety (para 2.4.4).

2.11.5 Analysis

Did not meet criteria in that:

- a. The rope produced injuries to bare hands (Deficiency).
- b. The climbing devices separated from the rope (Deficiency).
- c. The operator's feet came out of the foot loops (Shortcoming).
- d. The safety rope, when used as specified in the DEP, provided no safety (Shortcoming).

SECTION 3. APPENDICES

APPENDIX I. TEST DATA

Table 1. Hook and Cartridge Bandoleer*

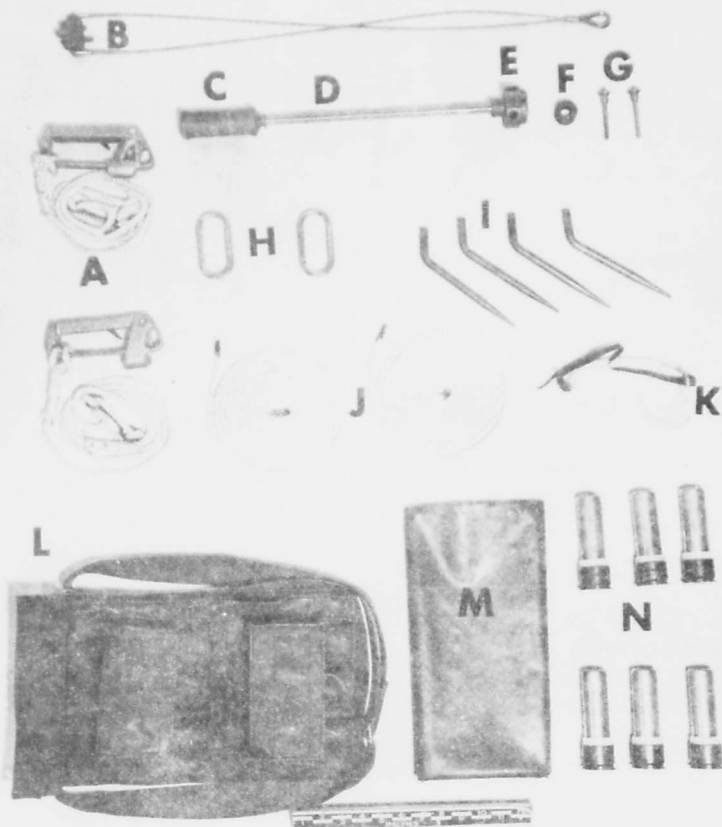
Item (Quantity/System)	Dimension (In)			Unit Weight	
	Length	Width	Height	Lbs	Oz
Hook and Cartridge Bandoleer Complete (1)	16 7/8	9 7/16	3 5/8	13	13 1/2
XM688 Cartridge (6 RD/System)	4 7/8	1 3/4	1 3/4		10
Grapnel Head Assembly, Shaft and Rocket Motor Shroud (1)	19 1/8	1 5/8	1 5/8	2	3
Grapnel Tines (4)	7 11/16	1/2 Tapered to point	1/2 Tapered to point		6
Attachment Cable Assembly (1)	31 1/2	2 7/16	1 5/16		8
Ground Cloth (1)	53 1/16	54 5/16		1	8
Safety Rope (2)	140 1/4	5/16	5/16		5
Snap Link (2)	4	2	3/8		3
Climbing Devices with Ropes (2)	61 7/16	3	1 1/2		11
Safety Goggles (1)	7 1/4	3 3/8	2 1/8		1 1/2
Quick Release Pin (2)	2 15/16	3/4	3/4		1/2
Bandoleer Bag, Empty (1)	16 7/8	9 7/16	3 5/8	1	14

* All weights and measurements are based by an average sampling of 10 test items.

Table 2. Rope Canister Bandoleer*

Item (Quantity/System)	Dimension (In)			Unit Weight	
	Length	Width	Height	Lbs	Oz
Rope Canister Bandoleer, Complete (1)	11 11/16	14 9/16	4 1/2	14	7
Elast Deflector (1)	11	11	1 3/4		11
Rope Canister, Empty (1)	14 1/8	14 1/8	4 1/16	2	6 1/2
Metal Core (1)	5 1/4	5 1/4	3 5/8		3
Nylon Rope (1)	4680 (390 ft)	5/16	5/16	9	15
Rope Bandoleer, Empty (1)	11 11/16	14 9/16	4 1/2	1	3 1/2

* All weights and measurements based by an average sampling of 10 test items.

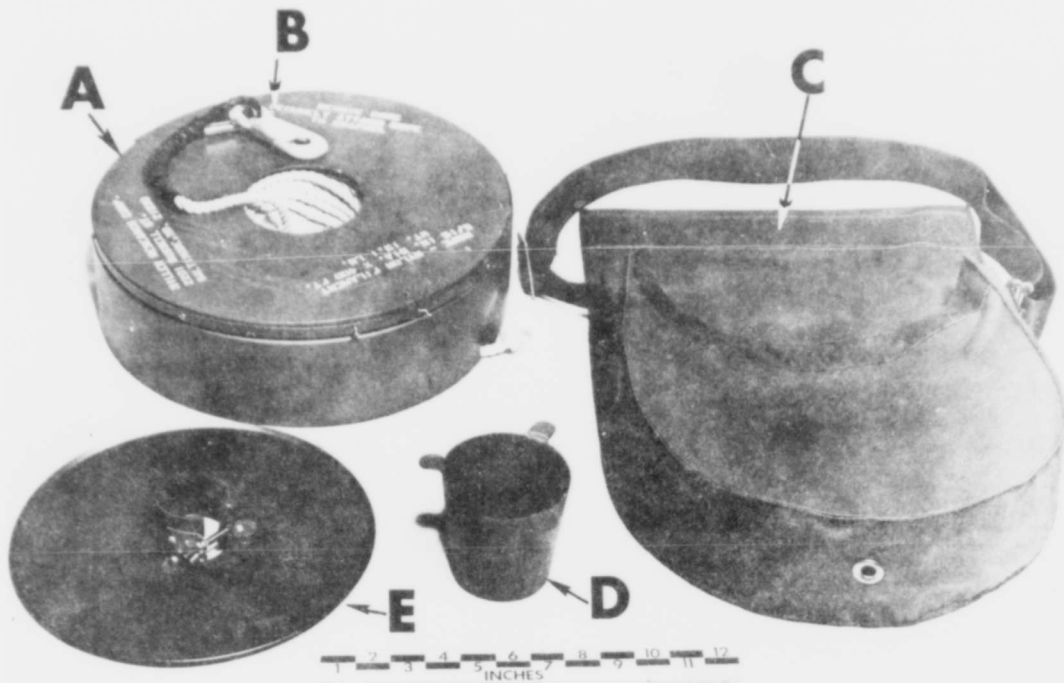


SERVICE TEST OF GRAPNEL, LAUNCHER PROPELLED: XM1

LIST OF COMPONENTS CARRIED IN HOOK
AND CARTRIDGE BANDOLEER

- | | |
|-------------------------------|------------------------|
| A. CLIMBING DEVICES. | H. SNAP LINKS. |
| B. ATTACHMENT CABLE ASSEMBLY. | I. TINES. |
| C. ROCKET MOTOR SHROUD. | J. SAFETY ROPE. |
| D. SHAFT. | K. GOGGLES. |
| E. GRAPNEL HEAD. | L. BANDOLEER. |
| F. TINE RETAINING COLLAR. | M. GROUND CLOTH. |
| G. QUICK RELEASE PINS. | N. CARTRIDGES (XM688). |

8-EG-155-000-002
 CE 1569
 7001-330-2/
 USATECOM-70



SERVICE TEST OF GRAPNEL, LAUNCHER PROPELLED: XM1

FIGURE 2

APPENDIX I

PROJECT NO:

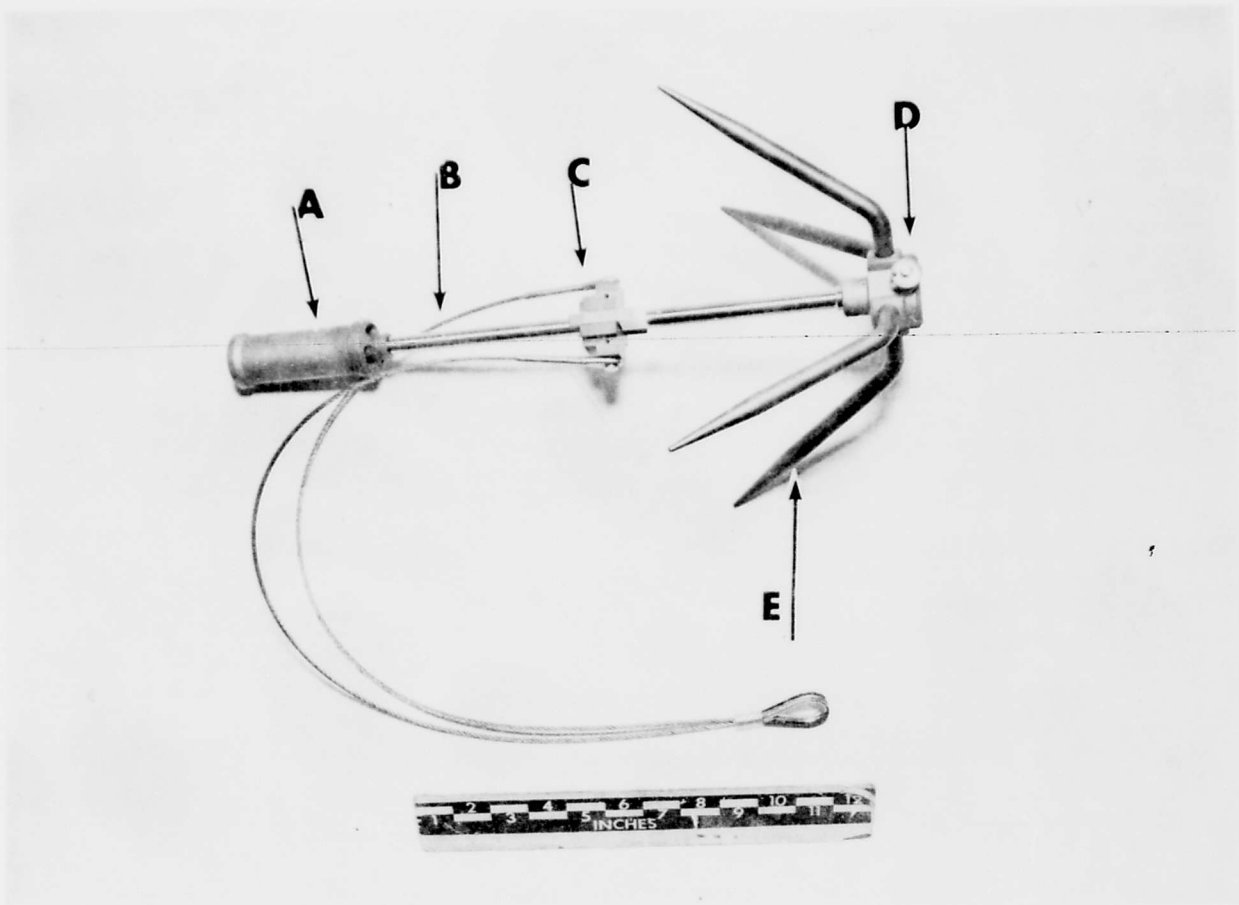
WARRANTY 8-EG-155-000-002

DESIGNATION CE 1569

WARRANTY NO. 7001-334-1/
USATECOM-69

CONTENTS OF ROPE CANISTER BANDOLEER

- A. ROPE CANISTER.
- B. QUICK RELEASE SNAPHOOK.
- C. ROPE CANISTER BANDOLEER.
- D. RETAINER CUP.
- E. BLAST DEFLECTOR.



SERVICE TEST OF GRAPNEL, LAUNCHER PROPELLED: XM1

FIGURE 3

APPENDIX I

PROJECT NO:

USATECOM 8-EG-155-000-002

USARTCOM CE 1569

NEGATIVE NO. 7001-330-3/

USATECOM-70

GRAPNEL ASSEMBLY

- A. ROCKET MOTOR SHROUD.
- B. SHAFT.
- C. ATTACHMENT CABLE ASSEMBLY.
- D. QUICK RELEASE PIN.
- E. TINES.



FIG. NO. 4

APPENDIX I

PROJECT NO.

STATE NO. B-EG-155-000-002

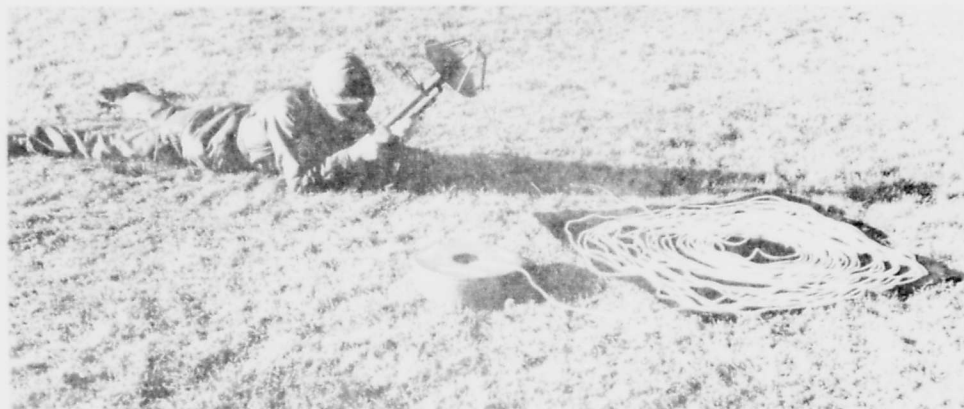
ORGANIZATION CE 1569

REPORT NO. 7001-334-70/
USATECOM-69

SERVICE TEST OF GRAPNEL, LAUNCHER PROPELLED: XMI

PLACEMENT OF BLAST DEFLECTOR AND
LOADING GRAPNEL ASSEMBLY

- A. GRAPNEL ASSEMBLY.
- B. BLAST DEFLECTOR.



FORM 5

REPORT I

REPORT NO:

REPORT NO: 8-17-155-000-002

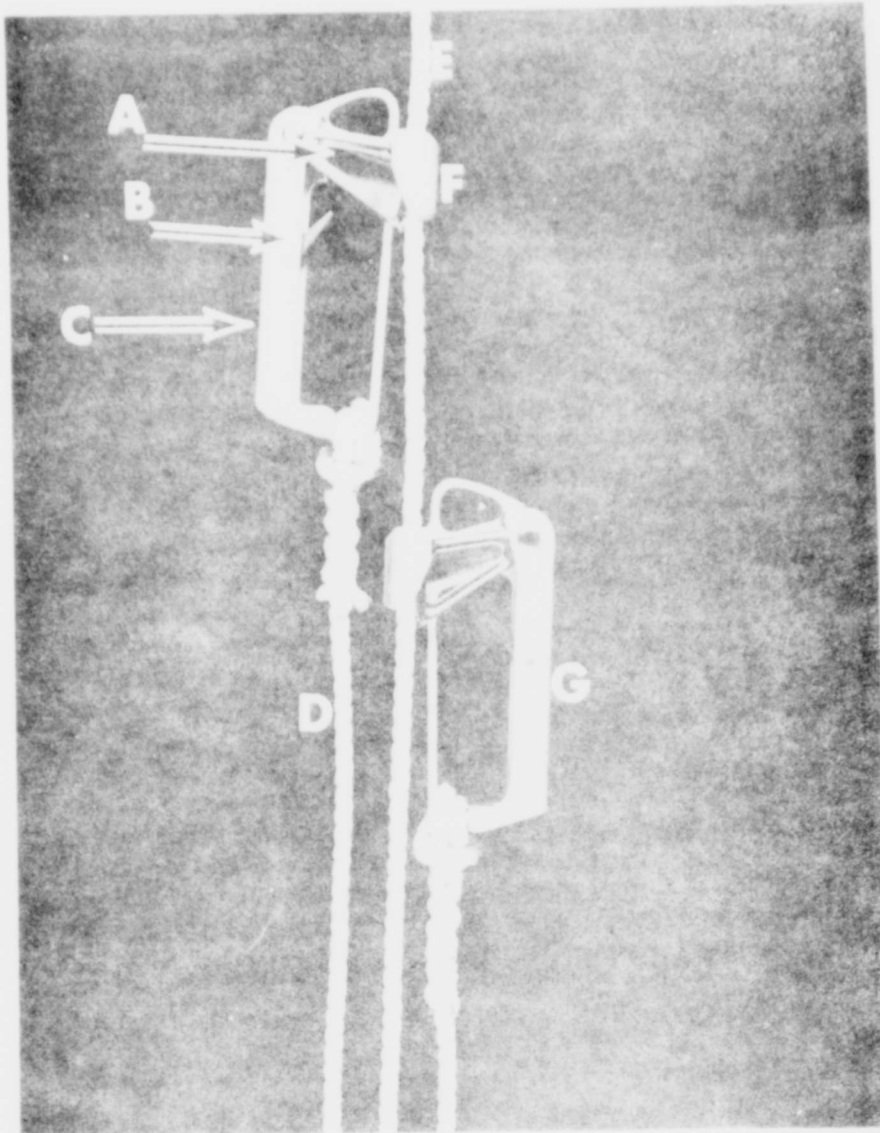
REPORT NO: CE 1569

REPORT NO: 7001-334-5, -4/
USATECOM-69

SERVICE TEST OF GRAPNEL, LAUNCHER PROPELLED: XM1

UPPER: POSITION OF ROPE CANISTER ON FIRST FIRING.

LOWER: POSITION OF ROPE ON GROUND CLOTH FOR
SUBSEQUENT FIRINGS.



SERVICE TEST OF GRAPNEL, LAUNCHER PROPELLED: **XM1**

FIGURE 6

APPENDIX 1

PROJECT NO.

USATC OM 8-EC 155-000-002

USATC NO CE 1569

NEGATIVE NO. 7001-334-9/
USATECOM-69

CLIMBING DEVICES ATTACHED TO ROPE

- A. ROPE RELEASE LEVER.
- B. LOCKING LEVER.
- C. LEFT HAND GRIP.
- D. FOOT LOOP ROPE.
- E. ROPE.
- F. ROPE GUIDE.
- G. RIGHT HAND GRIP.



FIGURE 7

APPENDIX I

PROJECT NO:

USARVICOM 8-EG-155-000-002

USARVICOM CE 1569

NEGATIVE NO. 7001-334-8, -6/
USATECOM-69

SERVICE TEST OF GRAPNEL, LAUNCHER PROPELLED: XM1

LEFT: SOLDIER WEARING SAFETY ROPE.

RIGHT: SOLDIER SUSPENDED FROM ROPE USING
CLIMBING DEVICES AND SAFETY ROPE.



FIGURE 8

APPENDIX I

PROJECT NO:

USATECOM 8-EG-155-000-002

USAAESWED CE 1569

NEGATIVE NO. 7001-658-12/

USATECOM-70

SERVICE TEST OF GRAPNEL, LAUNCHER PROPELLED: XM1

TEST SITE NO. 9 - 98-FOOT HORIZONTAL OBSTACLE



FIGURE 9

APPENDIX I

PROJECT NO:

USATECOM 8-EG-155-000-002

USAA&WHD CE 1569

NEGATIVE NO. 7001-631-3/

USATECOM-70

SERVICE TEST OF GRAPNEL, LAUNCHER PROPELLED: XM1

TEST SITE NO. 12 - 120-FOOT HORIZONTAL OBSTACLE

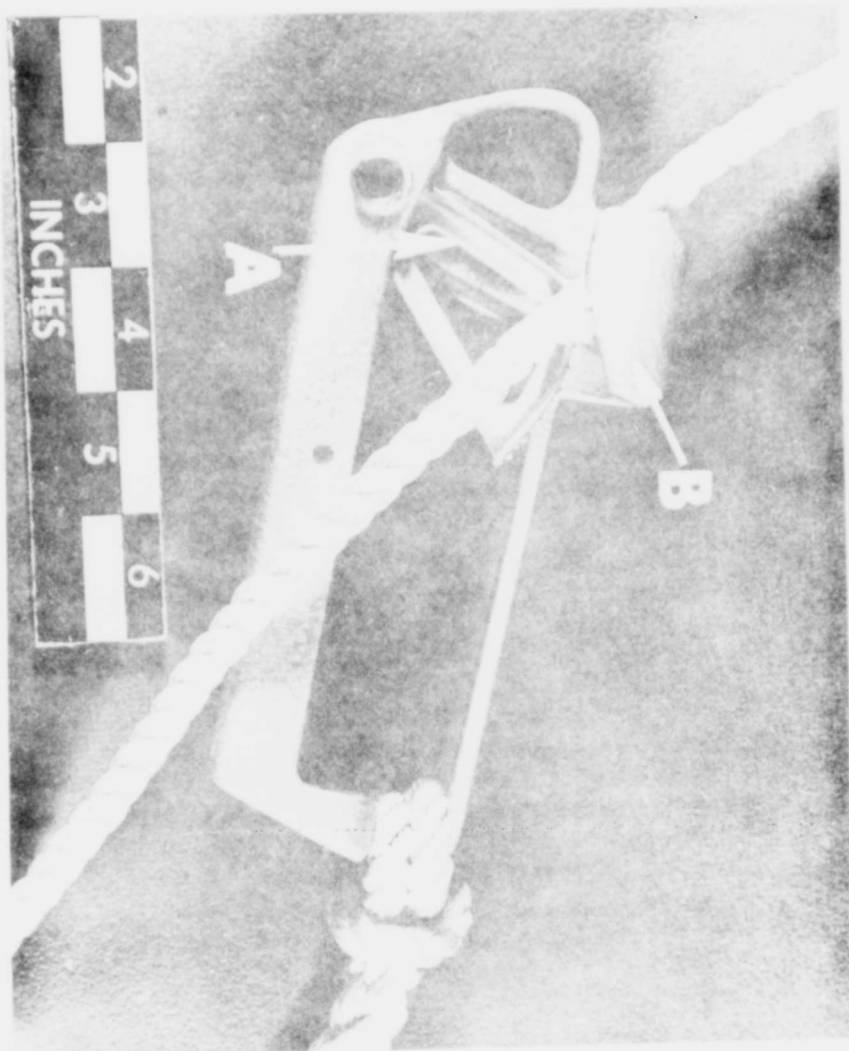


FIGURE 10

SERVICE TEST OF GRAPNEL, LAUNCHER PROPELLED: **XM1**

APPENDIX I

PROJECT NO:

CLIMBING DEVICE SHOWING SEPARATION
OF ROPE FROM ROPE GUIDE

USATECOM 8-EG-155-000-002

USASNSWD CE 1559

A. ROPE RELEASE LEVER.

NEGATIVE NO. 7001-503-1/

USATECOM-70

B. ROPE GUIDE.

APPENDIX II. TEST FINDINGS

ITEM	SOURCE	REQUIREMENTS	APPLICABLE		REMARKS
			SUBTEST		
1	SDR para 2c(1)	(Essential) The total weight must not exceed 4.5 lbs (exclusive of the weight of the man-carrying line, climbing devices, safety link, extra munitions and carrying case).	2.1	Met.	
2	SDR para 2c(3)	(Essential) The device will propel the line a distance of 175 feet. 400 feet of line will be available to the user.	2.1 2.4		Not met. Average length of the rope after one firing was 390 feet. See Deficiency, para 1.1, App III.
3	SDR para 6d(1)	A class will be necessary to familiarize students with the device and a demonstration to show its use. This will require a maximum of two hours.	2.2	Met.	
4	SDR para 6f	No additional personnel will be required in TOE due to the introduction of this device. No new MOS will be required.	2.2	Met.	
5	SDR para 2c(4)	(Desirable) The device will have a self-contained line which will be extracted and extend freely during flight.	2.3	Met.	

ITEM	SOURCE	REQUIREMENTS	APPLICABLE		REMARKS
			SUBTEST		
6	SDR para 2c(5)	<p>(Essential) The man-carrying line will be made of material which will:</p> <p>a. Be of sufficient strength to allow it to safely suspend the hanging weight of a 225 lb man (total weight) when crossing horizontal or ascending vertical obstacles and to withstand the impact load of a 225 lb man (total weight) in a sudden vertical drop of five feet, desirable 300 lb man (total weight).</p> <p>b. Not cut or produce injury to bare hands (an attachable handle will be acceptable).</p> <p>c. Provide as comfortable and non-skid hand grip as possible (an attachable handle will be acceptable).</p> <p>d. Not fray or burn from friction.</p>	2.3		Met.
			2.8		
			2.11		
					Not met. The rope produced injuries to bare hands. See Deficiency, para 1.2, App III.
					Not met. The rope did not provide a comfortable non-skid hand grip. See Deficiency, para 1.3, App III.
					Not met. The rope frayed from contact with abrasive surfaces. See Deficiency, para 1.4, App III.

ITEM	SOURCE	REQUIREMENTS	APPLICABLE		REMARKS
			SUBTEST		
7	SDR para 2c(7)	(Essential) The line(s) will not become detached from the grapnel until disconnected by the user. It (they) will be capable of being released from the grapnel without the use of hand tools or special equipment not available to the user.	2.3		Not met. The rope detached from the grapnel while in flight. See Deficiency, para 1.5, App III.
8	SDR para 2c(2)	(Essential) The device must be capable of being fired from the M79 Grenade Launcher.	2.4		Met.
9	SDR para 2c(11)	(Essential) The device will be fired in the same manner (aiming procedures) as grenades fired from the M79.	2.4		Met.
10	SDR para 2c(8)	(Essential) The device will be designed with grapnel tongs retracted until activated by the firer.	2.4 2.11		Met.
11	SDR para 2c(13)	(Desirable) After firing, the device will be capable of being retrieved, reloaded by the user, and refired within a short period of time, in case it fails to anchor on the first try.	2.4		Not met. The grapnel hook could not always be retrieved or refired when anchoring was not achieved. See Shortcoming, para 2.1, App III.

ITEM	SOURCE	APPLICABLE		REMARKS
		REQUIREMENTS	SUBTEST	
12	SDR para 2c(14)	(Desirable) The device will have a silent propellant charge for use where secrecy is necessary.	2.4	Not met. Firing of the system was aurally detected up to 800 meters. See Shortcoming, para 2.2, App III.
13	SDR para 2c(6) and 2b as modified by IPR (Ref 3, App VI)	(Essential) The grapnel will be of such a design that, upon/ after impacting with the ground, brush or trees, it will anchor itself when the line is pulled by the user and support the weight of a 225 lb man for an indefinite period without shifting, slipping, or otherwise becoming dislodged and enable him to cross or ascend 150 foot obstacles, + 10 feet.	2.4	Met.
14	SDR para 3c	Mission Reliability: The device should be of such simple design that 98% mechanical reliability can be obtained. (Desired) Anchoring reliability should be 70%.	2.4 2.7	Met.
15	SDR para 3d	(Desired) The device must function under intermediate climatic conditions as outlined by paragraph 7c, Change 1, AR 705-1.	2.5	Met.

ITEM	SOURCE	APPLICABLE		REMARKS
		REQUIREMENTS	SUBTEST	
16	Approved Test Plan	The device will be sufficiently rugged to withstand conditions and stresses encountered during tactical operations.	2.6	Not met. The grapnel shafts bent on direct impact with solid surfaces. See Shortcoming, para 2.3, App III.
17	SDR para 2c(10)	(Essential) The device should be rugged so that if accidentally dropped it will be safe for subsequent use, provided it is visibly serviceable.	2.6 2.11	Met.
18	SDR para 5c	No maintenance will be required other than a visual safety inspection prior to firing.	2.7	Met.
19	SDR para 2d	Predicted turnaround time required: Not applicable. The device will be considered expendable and, once fired, will be retrieved and reused at the discretion of the user.	2.7	Met.
20	SDR para 6d(3)	No special maintenance is anticipated.	2.7	Met.
21	SDR para 2c(12)	(Essential) The device will be capable of aerial delivery during Phase I airborne operations.	2.9	Met.

ITEM	SOURCE	APPLICABLE		REMARKS.
		REQUIREMENTS	SUBTEST	
22	USAACEBD Derived from AR 705-35	The device shall be suitable for attachment to a parachutist as part of his combat load or suitable for stowing in a personnel equipment container carried by a parachutist while parachuting from US Air Force or US Army aircraft.	2.9	Met.
23	USAACEBD Derived from AR 705-35	The device shall be suitable for stowing in a standard airdrop container or on an airdrop platform as part of an accompanying load dropped by parachute from US Air Force or US Army aircraft.	2.9	Met.
24	USAACEBD Derived from AR 705-35	The device shall be sufficiently durable to withstand the normal shock incident to airdrop when attached to a parachutist, when stowed as part of an accompanying load packed in a standard airdrop container, or on an airdrop platform.	2.9	Met.
25	USAACEBD Derived from AR 705-35	Performance of the device after airdrop shall be demonstrated by operation.	2.9	Met.

ITEM	SOURCE	REQUIREMENTS	APPLICABLE		REMARKS
			SUBTEST		
26	USATECOM Reg No. 700-1	Unnecessary, costly, or nice-to-have features that are revealed during conduct of test programs will be observed and reported.	2.10		Met.
27	SDR para 2c(9)	(Essential) The equipment will be equipped with a positive safety device that will prevent premature or accidental firing.	2.11		Met.
28	USATECOM Reg No. 385-7	The equipment shall be safe for its intended use.	2.11		Not met. The climbing device separated from the rope. See Deficiency, para 1.6, App III. The operator's feet came out of the foot loops. See Shortcomings, para 2.4, App III. The safety rope, when used as specified in the DEP, provided no safety. See Shortcoming, para 2.5, App III.
29	SDR para 5d	Test and Checkout Methodology: The only test or checkout to be performed prior to firing will be a visual inspection to determine if device is safe to fire.	2.11		Met.

APPENDIX III. DEFICIENCIES AND SHORTCOMINGS

1. DEFICIENCIES

<u>Deficiency</u>	<u>Suggested Corrective Action</u>	<u>Remarks</u>
1.1 The average length of the rope after one firing was 390 feet (para 2.1, Sec 2).	Provide 400 feet of rope.	
1.2 The rope produced injury to bare hands (para 2.3 and 2.11, Sec 2).	Equipment manual should state that leather gloves should be worn when working with the rope.	Operators experienced no difficulty in employing the test item when wearing leather gloves.
1.3 The rope did not provide a comfortable non-skid hand grip (para 2.3 and 2.8, Sec 2).	Equipment manual should state that leather gloves should be worn when working with the rope.	Operators experienced no difficulty in employing the test item when wearing leather gloves.
1.4 The rope frayed from contact with abrasive surfaces (para 2.3, Sec 2).	Waive requirement.	
1.5 The rope detached from the grapnel while in flight (para 2.3, Sec 2).	Provide a snaphook with a positive lock.	
1.6 The climbing devices separated from the rope (para 2.11, Sec 2).		Figure 10, Appendix I.

2. SHORTCOMINGS

<u>Shortcoming</u>	<u>Suggested Corrective Action</u>	<u>Remarks</u>
2.1 The grapnel hook could not always be retrieved or refired when anchoring was not achieved (para 2.4, Sec 2).	Waive requirement.	
2.2 The firing of the system was aurally detected up to 800 meters (para 2.4, Sec 2).	Waive requirement.	
2.3 The grapnel shafts bent upon direct impact with solid surfaces (para 2.7, Sec 2).		
2.4 The operator's feet came out of the foot loops (para 2.11, Sec 2).	Prescribe the use of heel ropes.	Operators experienced no difficulty in employing the test item when using heel ropes.
2.5 The safety rope, when used as specified in the DEP, provided no safety (para 2.11, Sec 2).	Prescribe the use of the rappel seat connected to one of the climbing devices.	Operators experienced no difficulty and less fatigue in employing the test item when using the rappel seat.
2.6 Configuration of the climbing device put undue stress on the operator's wrists (para 2.8, Sec 2).		

3. CORRECTED DEFICIENCIES AND SHORTCOMINGS

<u>Deficiency/Shortcoming</u>	<u>Corrective Action</u>	<u>Remarks</u>
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None.

APPENDIX IV. MAINTENANCE EVALUATION

CHART - INSTRUCTIONS

COLUMN

- 1 Enter Army or manufacturer's publication or draft manual number.
- 2 Number of copies received. Insert "0" if none were supplied. Use Chapter 9, AR 310-3, as a guide to determine those publications that should accompany the test item. Publications contained in the maintenance test package should cover operations and functions through general support maintenance and should specify the categories involved.
- 3 Complete title.
- 4 Enter date publication was received.
- 5 Enter date test item or materiel was received.
- 6, 7 Insert "X" in appropriate block. Minor errors noted on DA Form 2028 are not in themselves sufficient reasons to term a publication inadequate.
- 8 Insert EPR number (if appropriate) and date DA Form 2028 was forwarded.
- 9 In addition to appropriate remarks, explain if manuscript was not evaluated and the reason therefor.

CHART

MAINTENANCE PACKAGE LITERATURE CHART		PROJECT NO.		NOTIFICATION		Service Test of Grapnel, Launcher Propelled: XMI		FORM 2028		REMARKS
MANUSCRIPT		8-EG-155-000-002		DATE RECEIVED		EVALUATION		Date Forwarded		
Number	Qty	Title	Lit	Mat	Adqt	Inadqt	Date Forwarded			
1	2	Operator and Organizational Maintenance for Grapnel, Launcher Propelled: XMI	26 Feb 1970	24 Feb 1970	X		25 June 1970	8	9	

APPENDIX V. REFERENCES

1. Letter, CDCMR-O, HQ, USACDC, 17 July 1968, subject: Department of the Army Approved Small Development Requirement (SDR) for a Grapnel w/Line (Propelled) (CDOG para 139(B)d(5)), with one inclosure.
2. Final Report on Engineer Design Test of Grapnel with Line (Propelled), RDT&E Project No. zX630401D718, USATECOM Project No. 8-9-7300-03, February 1969, Aberdeen Proving Ground.
3. Letter, AMSTE-BC, USATECOM, 10 March 1969, subject: Test Directive, Engineering and Service Test of Grapnel Launcher Propelled: XML, USATECOM Project Nos. 8-9-7300-01/02.
4. FM 31-72, Mountain Operations, Department of the Army, 19 May 1964.
5. FM 31-30, Jungle Training and Operations, Department of the Army, 23 September 1965.
6. FM 23-31, 40MM Grenade Launcher, M79, Department of the Army, 3 August 1967, with Change 1.

APPENDIX VI. DISTRIBUTION LIST

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1. ORIGINATING ACTIVITY (Component author) US ARMY AIRBORNE, COMMUNICATIONS AND ELECTRONICS BOARD Fort Bragg, North Carolina 28307		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
		2b. GROUP	
3. REPORT TITLE Service Test of Grapnel, Launcher Propelled: XM1			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Final Report March - July 1970			
5. AUTHOR(S) (First name, middle initial, last name) JOSEPH D. RIPPARD, 2LT			
6. REPORT DATE August 1970		7a. TOTAL NO. OF PAGES 63	7b. NO. OF REFS 6
8a. CONTRACT OR GRANT NO.		8a. ORIGINATOR'S REPORT NUMBER(S) CE 1569	
b. PROJECT NO. 8EGL55000002		8b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) Firing Code: 0	
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11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY US Army Land Warfare Laboratory Aberdeen Proving Ground, Maryland 21005	
13. ABSTRACT Service testing was conducted to determine if the Grapnel, Launcher Propelled: XM1, is safe for its intended use and is suitable for Army use. Testing was conducted at Fort Bragg, North Carolina, and Nantahala National Forest, North Carolina, during the period March - July 1970 by soldiers representative of those who will operate and maintain the equipment when it is fielded. The Grapnel, Launcher Propelled: XM1, was easy to operate and provided a means of ascending and descending vertical obstacles and traversing horizontal obstacles. All maintenance was performed by the operator. Six Deficiencies were noted; average length of the rope after one firing was 390 feet; the rope produced injuries to bare hands; the rope did not provide a comfortable non-skid hand grip; the rope frayed from contact with abrasive surfaces; the rope detached from the grapnel while in flight; and the climbing devices separated from the rope. Six Shortcomings were noted. It is concluded the Grapnel, Launcher Propelled: XM1, provided a means for ascending and descending vertical obstacles and traversing horizontal obstacles, but it is not suitable for Army use. It is recommended that the Deficiencies and Shortcomings be corrected and the Grapnel, Launcher Propelled: XM1, be subjected to check test.			

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18. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
GRAPNEL						
LAUNCHER						
PROPELLED						
XMI						

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