National Defence / Défense nationale

B-GL-385-014/PT-001

WEAPONS

TOW LONG RANGE ANTI-ARMOUR WEAPON

(ENGLISH)

(This publication supercedes B-GL-317-011/PT-001, 1991-02-01)

Issued on the authority of the Chief of the Land Staff

Canada

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WARNING

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Issued on the authority of the Chief of the Land Staff

OPI: Infantry School **2002-03-30**

Canada

WARNING
MISUSE OF WEAPONS, AMMUNITION AND EXPLOSIVES

PURPOSE

1. This order outlines Canadian Forces policy governing the use or misuse of weapons, ammunition and explosives.

WEAPONS

2. Firing or attempting to fire locally manufactured weapons, obsolete service or foreign weapons, or weapons used for display, ceremonial or trophy purposes in museums, messes, parade grounds, armouries or such like area is prohibited except when specifically authorised by NDHQ.

3. Attention is also drawn to the following references which concern offences connected with the use or misuse of weapons:

a. National Defence Act, Section 117;

b. Criminal Code of Canada, Sections 82 to 106; and

c. QR & O 103.59.

AMMUNITION AND EXPLOSIVES

4. Tampering with or use of service and commercial ammunition or explosives for other than their designed purpose is prohibited.

5. Except as prescribed in paragraph 6, the modification, breakdown or sectioning of live ammunition for experimental, instructional or any other purpose, or manufacture of explosives is forbidden; this prohibition includes:

a. unauthorised interchange of fuzes or primers or both;

b. experiments with blank ammunition to alter the powder charge or to introduce any other substance into the cartridge case or into the weapon with the approved cartridge;

c. experiments involving the use of altered propelling charges or bursting charges with ammunition of any type;

d. the use of any non-service or obsolete ammunition;

e. the use of foreign ammunition other than that received through normal supply channels or supplied in accordance with NATO Standardisation Agreements;

f. the manufacture and use of locally fabricated explosive training devices, battle simulators, saluting charges, etc.;

g. any alteration to the design of ammunition or explosive devices;

h. deviations from authorised drills for use of ammunition or explosive devices; and

i. rendering live ammunition inert for the use as museum or instructional items.

6. The prohibition in paragraph 5 does not apply to:

a. authorised experiments, modifications, etc., carried out by experimental, research, proof or inspection establishments;

b. authorised breakdown, modification, repairs, proof-testing, etc, carried out as normal functions of a Canadian Forces ammunition depot or base ammunition facility;

c. personnel employed at Canadian Forces School of Electrical and Mechanical Engineering as instructors

or trainees under supervision, when breaking down is carried out as part of a course training standard and in accordance with an approved course training plan;

d. the use for its designed role of commercial pattern ammunition, which is obtained by local purchase as specified in CFP 137 or as authorised by NDHQ in accordance with CFAO 36-19;

e. the use for its designed role of commercial pattern ammunition which is taken into service and catalogued;

f. hand-loading small arms ammunition in accordance with CFAO 50-18; or

g. other cases, when specifically authorised by NDHQ.

FOREWORD

1. B-GL-385-014/PT-001, *Weapons, TOW Long-range Anti-armour Weapon* is issued on the authority of the Chief of the Land Staff.

2. This publication is the primary reference for the employment of the TOW Long-Range Anti-Armour Weapon. It supersedes B-GL-317-011/PT-001, *TOW Long-range Anti-armour Weapon System* dated 01 February 1991.

3. Requests for changes to this publication are to be sent through normal channels to the Infantry School (Attention: C Stds O)

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INTRODUCTION

AIM

1. This manual is a guide for training anti-armour detachments equipped with the Tube Launched, Optically Tracked, Wire-Command Link (TOW 2) guided missile weapon system, both ground and vehicle mounted. The user unit may find modifications necessary, but as a rule the procedures described herein should be complied with. The technical aspects in this manual are based on TM 9-1425-450-12 *Operator and Organisational Maintenance Manual*.

BACKGROUND

2. The original TOW was developed for the United States Army. It was used by the Israeli Defence Force in the 1973 Yom Kippur War and the 1982 Operation Peace for Galilee in Southern Lebanon, as well as by Iran in the 1980 - 88 Gulf War. More recently, it has been used by Moroccan Forces operating in the Western Sahara against the Polisario Frontland and by the Allied Forces in the 1990 Gulf War. The weapon proved highly reliable and accurate; it could defeat all known armour at the time. Several NATO countries including Canada adopted it. The latest tank has improved manoeuvrability and better armour protection including reactive armour that the basic or improved TOW cannot penetrate. In the on-going technological race of armour versus anti-armour, the TOW 2 was developed. The TOW 2 has several modifications that enable it to defeat electronic countermeasures and battlefield obscuration and it can fire a missile capable of defeating reactive armour. As well the top-attack TOW-2B has been developed.

CONDUCT OF DETACHMENT DRILLS

3. **General**. All training must be progressive; unnecessary repetition is bad instructional practice. Soldiers learn skills and facts in the basic lessons, which should be taught only once during their service. Soldiers then require continuation training in order to speed up their action and get the facts firmly fixed in their minds.

4. The sequence for each stage of detachment drill is:

   a. remind by explanation;

   b. assess weaknesses by practice or test;

   c. improve on weaknesses by practice; and

   d. progressive practice by competitions.

5. Detachment drills are intended as a guide to exercise the detachment members during their training. The instructor should plan the period based on the members' weak points.

6. Faults should be immediately brought to the attention of the individual members and corrected, otherwise the members will continue to make the same mistakes.

7. If it becomes obvious during a practice period that the detachment members have not grasped a particular skill or teaching point, the instructor should repeat that part of the lesson again.

8. Detachment drills are repeated according to progress. Instructors should remember that constant instruction and practice without firing makes the subject boring. Every effort should be made to introduce live firing of the blast simulator as soon as it is feasible.

9. **Competition**. The incentive of competition always helps to make drills more interesting. The entire detachment drill period can be based on competitions if the instructor so wishes. Some points on organising competitions are:

   a. They may be on an individual or on a detachment basis.

   b. If run as a detachment, the instructor must ensure that the selected detachments are nearly equal in performance.

   c. Marks can be awarded up to a given total, or start with a total and deduct marks for mistakes as the competition progresses.

d. A chart drawn on a chalkboard or a sheet of paper should always be used to record the results.

e. Additional interest can always be gained by making one detachment or individual watch another, criticising and then awarding or deducting marks as required.

f. Above all the instructor should ensure that competitions are simple and realistic for example that they exercise the members in the teaching points and skills already taught.

g. Prior to the commencement of detachment drills, number the members as individuals and/or detachments, as necessary. Ideally, there should be no more than two detachments (eight persons) per instructor, with each detachment operateing one TOW 2 system.

10. **Master and Pupil**. The master and pupil method of practice, in its simplest form, is for one person (the pupil) to work under the supervision of another (the master); while the instructor keeps an eye on both. At all levels of training, this method stimulates interest, keenness and attention to detail. It is particularly useful with detachments and in competitions. Used regularly, it also develops initiative and leadership. Potential leaders may be discovered by instructors watching these masters at work.

SAFETY PRECAUTIONS

11. Before and after every classroom detachment drill period, inspect all missile simulation rounds and dummy missile containers to insure that there are NO LIVE BLAST SIMULATORS present. All missile stowage racks, smoke grenade launchers and machine guns will be proven safe.

12. All personnel must pay strict attention to all DANGERS, WARNINGS, and CAUTIONS in this manual and the ones printed on various components or configurations of the TOW 2.

CHAPTER 2
TOW 2 WEAPON SYSTEM GROUND MOUNTED

LESSON 1
DESCRIPTION

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following:

   a. general description;

   b. role;

   c. characteristics;

   d. safety precautions; and

   e. firing limitations.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores are required:

   a. multimedia projector;

   b. screen;

   c. slides on teaching points and backblast danger area;

   d. hand-outs on teaching points one per student; and

   e. TOW 2 complete.

5. **Preparation**. Prior to the commencement of the first period:

a. set up the classroom;

b. check the projector, slides and hand-outs; and

c. checkout the weapon system.

6. **Miscellaneous**:

a. be prepared to answer any questions pertaining to anti-armour; and

b. let the students satisfy their curiosity by handling the weapon system during any breaks in the lesson.

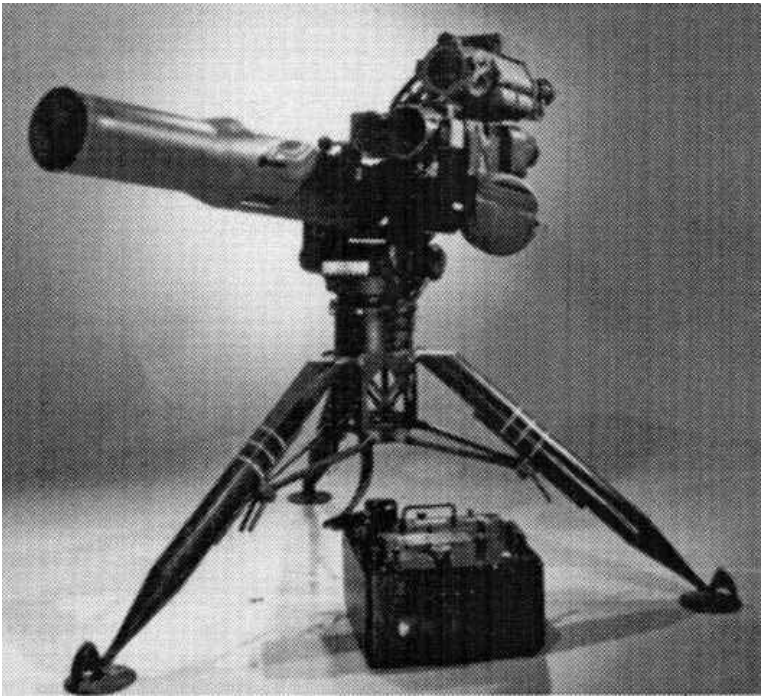


Figure 2-1-1: TOW 2 Ground Mounted

Figure 2-1-2: M113A2 TOW Under Armour (TUA)

Figure 2-1-3: TOW 2 BV-2063

CONDUCT OF THE LESSON

7. **Safety Precautions**. Inspect missile simulation round.

8. **Review**. Nil.

9. **Introduction**. Give the history of anti-tank weapons as follows:

a. In 1916 the tank made its first appearance on the battlefield, and weapons to counter them followed shortly thereafter. Since the first tanks were constructed of a relatively thin plate of metal, a standard high explosive shell could do sufficient damage to put the tank out of action. The only guns capable of doing this were field guns thus, these guns were brought forward and sited to cover likely tank approaches. A field gun employed in such a manner was however being taken away from its primary role, but no attempts were made to develop specialised anti-tank weapons. Two distinct branches evolved: first, a one-person infantry weapon and second, a crew-served artillery weapon.

b. By the end of World War I the Germans were using a 13 mm Mauser anti-tank rifle and a 37 mm artillery piece, pioneering anti-tank weaponry.

c. World War II saw many developments in both the one-man and crew-served weapon systems. Some of the most notable of these was the British 17-pounder and perhaps the American Bazooka. Following these, came the recoilless rifles (75 mm and 106 mm), guided missiles (ENTAC and SS11) plus numerous one-man weapons (the 3.2 inch rocket and the Carl Gustaf).

d. In the case of anti-tank missiles, the original guidance was purely optical; the operator observed the target, launched the missile and steered it manually by means of a joystick. Since then, a more sophisticated method of guidance has been introduced. Today's missile carries an infrared (IR) source in its tail and at the launcher there is an infrared sensor that

measures the angle between the missile's path and the direct line of sight. If the missile deviates from this line, correcting signals are automatically passed down the wires to bring it back on target. All the operator has to do is to keep the cross-hairs of the sight on the target. An example of this is the TOW weapon system.

e. There have been constant improvements in the development of anti-tank guided missiles and consequently, the original TOW itself has been improved. The missile now carries a thermal beacon in its tail end. In addition to the infrared sensor, there is a thermal imagery sensor sight that gives the system accuracy at night as well as in obscured battlefield conditions. There are several other important modifications. In particular, missile improvements have increased the lethality of the weapon system. The TOW 2 missile (BGM71D) has been fitted with a tip charge, to defeat reactive armour, and is known as TOW 2A. The TOW 2B (BGM 71F) is a top attack missile that flies 2.25 metres above the line of sight and discharges its warhead straight down onto the lightly armoured top of the tank.

10. **General Description**. The Tube Launched, Optically Tracked, Wire-Command Link (TOW 2) guided missile weapon system can be either man-portable or vehicle-mounted. It is technically referred to as the Long Range Anti-Armour Weapon (LRAAW). It consists of a launcher, which has tracking and control capabilities and the TOW 2 guided missile encased in a launch container. The launcher has self-contained replaceable units. The TOW 2 can be employed effectively in obscured light conditions (fog or battlefield smoke) and at night with the use of its thermal imagery sight. The missile can be launched from a ground mount (see Figure 2-1-1), or from a vehicle mount, which has been adapted to two vehicles; the M113A2 TOW Under Armour (TUA) (see Figure 2-1-2) and the Carrier, Tracked, Articulated, Amphibious, TOW (BV 2063) (see Figure 2-1-3). The TOW 2 is designed primarily to provide long range anti-

armour fire. The TOW 2 is also effective against fortified bunkers, pillboxes, slow moving helicopters and gun emplacements.

11. **Tracking and/or Control Capabilities**. The automatic missile tracking and/or control capability of the TOW 2 gives a high first-round hit probability. To operate the system, the gunner places the cross-hairs of either the optical sight or the thermal imagery (TI) sight on the target, fires the missile and keeps the cross-hairs centred on the target until missile impact. The tracking and command function within the system guides the missile along the operator's line of sight. The operator does not apply leads, windage or elevation. The TOW 2B uses the same point of aim as other TOW missiles.

12. **Assembly**. Assembly and disassembly of the system is accomplished in the field without the use of tools. The operational condition of the assembled weapon system can be checked at any time by using the built-in, self-test circuits. Launcher components that fail the self-test may be replaced at the operating site.

13. Confirm by questions.

ROLE

14. The role of the TOW 2 is to provide long range anti-armour direct fire support by:

a. providing depth to unit/formation defence;

b. firing into gaps between sub-units/units/formations and to the flanks, giving mutual support to adjacent units/formations;

c. strengthening sub-unit/unit anti-armour defence; and

d. fire support for the movement of tanks and infantry in the advance, attack and withdrawal.

15. Confirm by questions.

CHARACTERISTICS

16. TOW 2 is a Tube launched, Optically tracked, Wire-command link guided missile weapon system with the following characteristics:

a. **Range**. All missiles have the following range data:

(1) minimum 500-1000 metres, maximum 3750 metres (see note below); and

(2) maximum range is 3400 metres at temperature range from -12°C to 32°C.

NOTE

1. Due to the obscuration time of 3 to 4 seconds and the time to reacquire the target, the minimum effective range of basic TOW and ITOW is 1000 metres.

2. Due to the obscuration time of 1 to 2 seconds and the time to reacquire the target, the minimum effective range for TOW 2 and TOW 2B is 500 metres.

b. **Mobility**:

(1) the TOW 2 can be man-packed for short distances;

(2) the system can be loaded into a helicopter for transportation to areas that are not accessible by wheeled or tracked vehicles;

(3) the system can be mounted on two vehicles, the M113A2 TOW Under Armour (TUA) and the BV 2063; and

(4) the mobility of the weapon system will affect its survivability and flexibility.

c. **Tracking**:

(1) against any target, the operator must maintain the point of aim throughout the missile's time of flight (approximately 21 seconds at maximum range of 3750 metres). During the tracking period, the weapon must remain stationary;

(2) accuracy increases proportionately with increased tracking time, but tracking time influences survivability, mobility and rate of fire; and

(3) the maximum tracking speed of a target is 65 km/h.

d. **Accuracy**:

(1) the weapon's design makes it very accurate at ranges from 200 to 3750 metres; and

(2) hit probability may be affected by:

(a) operator distraction;

(b) strong, gusting winds affecting the gunner; and/or

(c) a missile malfunction.

e. **Rate of Fire**:

(1) TOW 2 can fire approximately two rounds per minute; and

(2) the weapon can be reloaded and aimed in approximately 25 seconds (except TUA, which has two launchers).

f. **Flexibility**:

(1) The TOW 2 is highly effective against a wide variety of targets including tanks, self-propelled (SP) guns, specialist engineer equipment and helicopters as well as above ground-fixed installations and fortified points. The long range of TOW 2 permits it to cover targets over a wide area, given good line-of-sight in both day and night operations. The advent of the TOW 2B also allows dug-in and hull-down targets to be engaged.

(2) When vehicle-mounted, the TOW 2's flexibility is considerably enhanced.

g. **Penetration**. TOW 2 can penetrate all known armour including reactive armour as well as heavily fortified installations.

h. **Survivability**:

(1) **Vulnerability**:

(a) The weapon does not have a remote firing capability. Both the detachment and the weapon system are vulnerable during firing and tracking because the weapon must remain stationary. The degree of vulnerability, of

course, varies with the degree of protection afforded by ground or the use of protective armour (in the case of TUA). An exposed detachment's hit probability may be adversely affected.

(b) Engagement at long range, as well as careful siting, sound tactics and the proper preparation of defensive positions will reduce vulnerability.

(2) **Silhouette**:

(a) the weapon has a small silhouette when dismounted; and

(b) when mounted, the weapon and vehicle have a high silhouette, which may be reduced by careful siting.

(3) **Signature**. The backblast may lead to weapon detection, however, engagement at long ranges and careful choice of site and site preparation, reduces the likelihood of the backblast being detected.

17. Confirm by questions.

SAFETY PRECAUTIONS

18. **Safety Precautions**. Because of the danger to troops from the backblast when a missile is launched, extreme care must be exercised in all phases of instruction. The danger must be emphasised from the earliest stages of training. All detachment

drills, position exercises, tracking exercises and firing with the missile simulation round must be conducted as though live missiles were being fired. The launch tube and all missile simulation rounds will be checked to ensure that they are safe during the following occasions:

a. before and after instruction;

b. before stripping;

c. during issue and return to stores;

d. before and after range practices; and

e. whenever the safety is in doubt.

19. **Backblast**. The TOW 2 missile backblast area extends 75 metres to the rear of the launcher and forms a 1600 mil danger area fan. It is divided into two zones: a DANGER ZONE and a CAUTION ZONE. In the DANGER ZONE, which extends 50 metres to the rear of the launcher, serious casualties or fatalities are likely to occur, due to the blast and flying debris. In the CAUTION ZONE, personnel are relatively safe, providing they do not face the back end of the launcher. This area extends an additional 25 metres to the rear of the danger zone. It is always kept clear during training (see Figure 2-1-4).

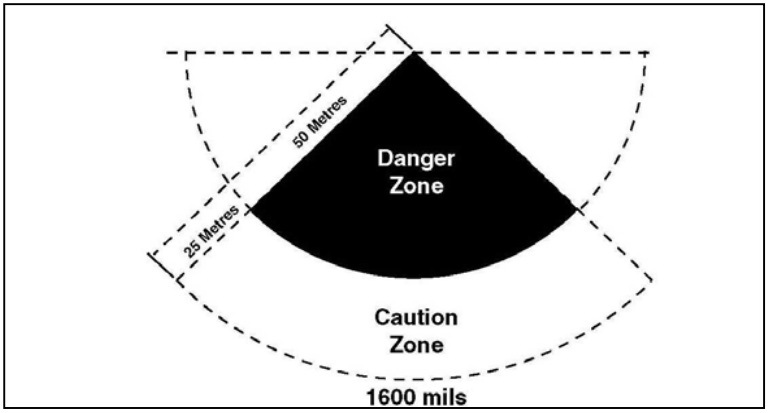


Figure 2-1-4: TOW 2 Backblast Danger Areas

20. **Sighting and Aiming Precautions**. TOW 2 cannot be fired directly into the sun when using the optical sight because of possible eye damage to the operators and guidance interference. Maximum range firings have been conducted down to 124 mils between the line to the sun and the operator's line-of-sight. The practical sun angle limit is estimated to be approximately 107 mils. There is no limitation if TOW 2 is fired away from the sun.

21. **Hearing Conservation**. Failure to use the proper hearing protection during missile firing may cause serious injury. All crewmembers shall wear ear defenders or earplugs. Further information on the subject of hearing conservation is available in CFAO 34-22 and B-GL-381-001/TS-001.

22. Confirm by questions.

FIRING LIMITATION

23. **Firing Limitation**. The TOW 2 weapon system has the following firing limitations

a. The firing angle limits are generally the same as the traversing unit's limits when external restrictions are not imposed. Since the traversing unit is not restricted in azimuth, 6400 mil movement is possible. Mechanical stops limit the elevation angle coverage to 350 mils below and 530 mils above the horizontal plane. Before the missile is fired, the line-of-sight angle should be estimated at the expected time of launch and throughout the expected missile flight time. The firing position should be changed or a different target selected if an expected line-of-sight angle exceeds the firing limitation angle.

WARNING

At elevation angles greater than 350 mils above the horizontal plane, hazards to the gunner and damage to equipment may exist due to air pressure waves and flying debris. Training at angles greater than 350 mils should be restricted. This restriction applies to both ground-employed and vehicle-mounted systems.

b. In both ground and vehicle-mounted systems the missiles shall NOT be fired over live power lines, through brush or brush fires, branches or other obstructions that might interfere with the missile guidance by damaging the command-link wires.

c. Troops and equipment shall NOT be positioned forward of the weapon during training when live or practice rounds are being fired.

d. Additional firing limitations for vehicle-mounted systems can be found in Chapters 3 and 4.

e. Firing over water limitations may be found in B-GL-392-007/FT-001 Anti-armour in Battle.

24. Confirm by questions.

CONCLUSION

25. Take questions from the class on the entire lesson.

26. Confirm by questions.

27. Pass out hand-outs to students.

28. **Summary**. To include the following:

a. the importance of understanding the capabilities of the weapon;

b. the importance of understanding the role of TOW 2;

c. the importance of understanding the safety precautions and firing limitations; and

d. a forecast of the next lesson in this subject.

LESSON 2
DESCRIPTION AND FUNCTION OF MAJOR COMPONENTS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the description and function of the components of the TOW 2.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores are required:

   a. TOW 2 complete;

   b. pointer; and

   c. hand-outs on technical data one per student.

5. **Preparation**. Prior to the commencement of the first period:

   a. set up the classroom;

   b. check over all the weapon system's components;

   c. leave the weapon system disassembled; and

   d. check hand-outs.

6. **Miscellaneous**:

   a. have students sitting in a semicircle around the weapon system; and

   b. if students cannot see a specific item, have them stand up and gather in closer.

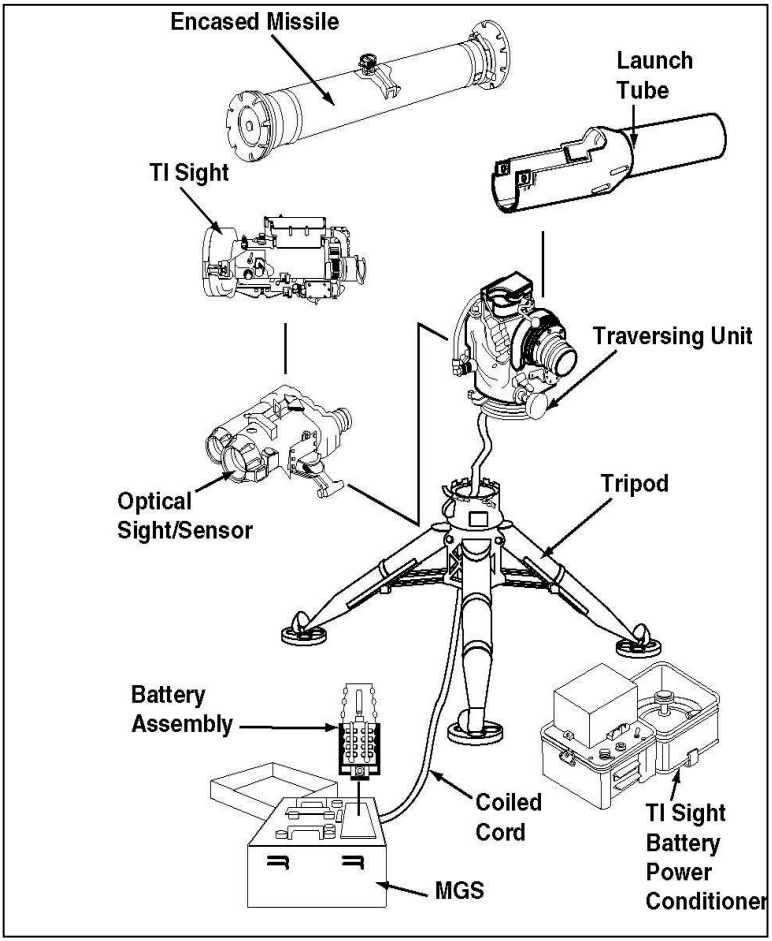


Figure 2-2-1: TOW 2 Components

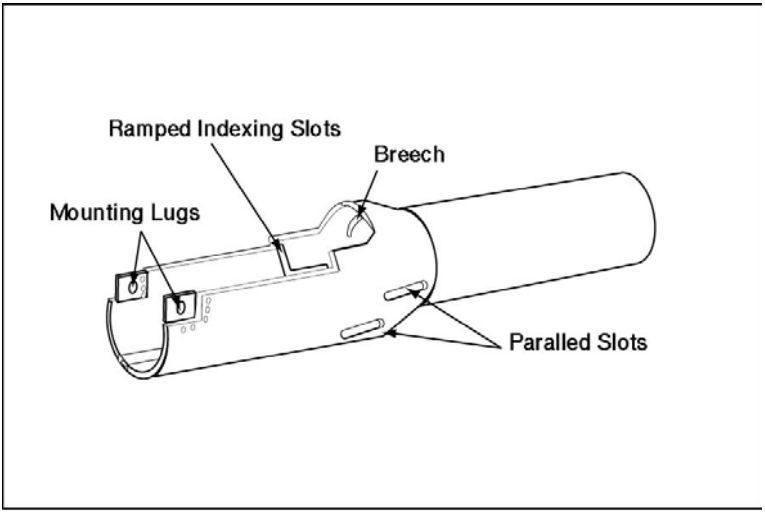


Figure 2-2-2: Launch Tube

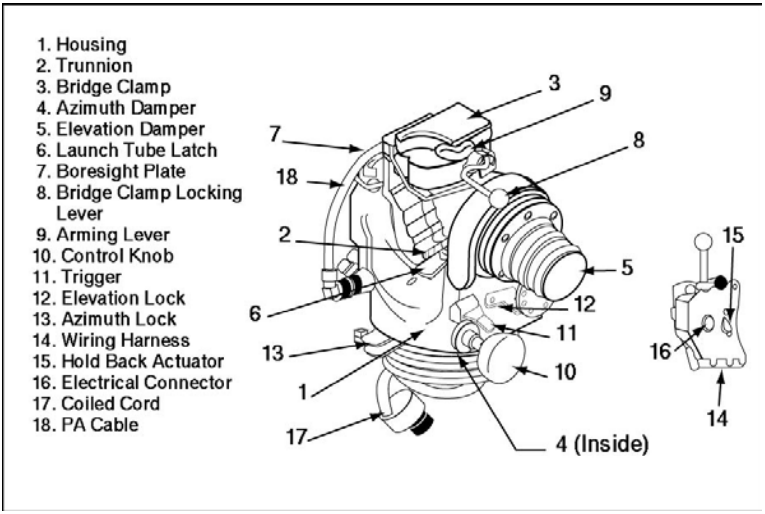


Figure 2-2-3: Traversing Unit

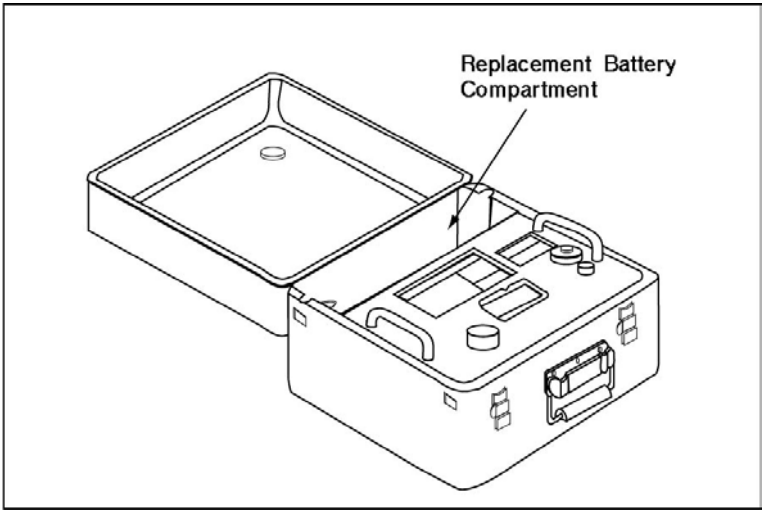


Figure 2-2-4: Missile Guidance Set

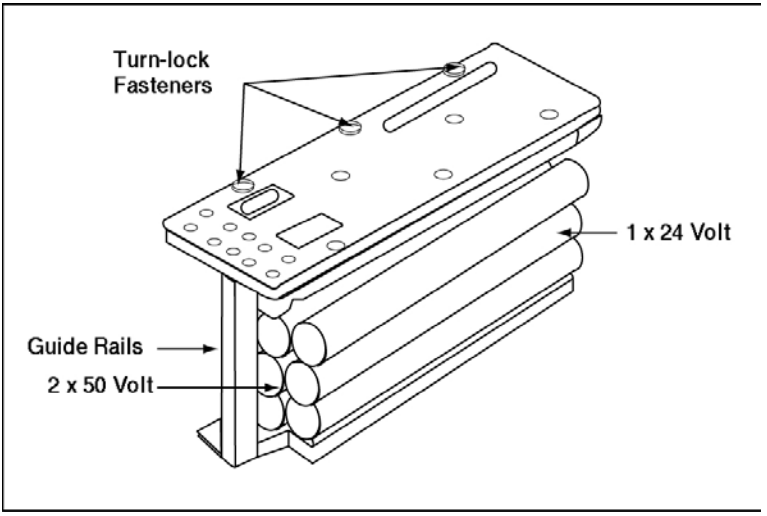


Figure 2-2-5: Battery Assembly

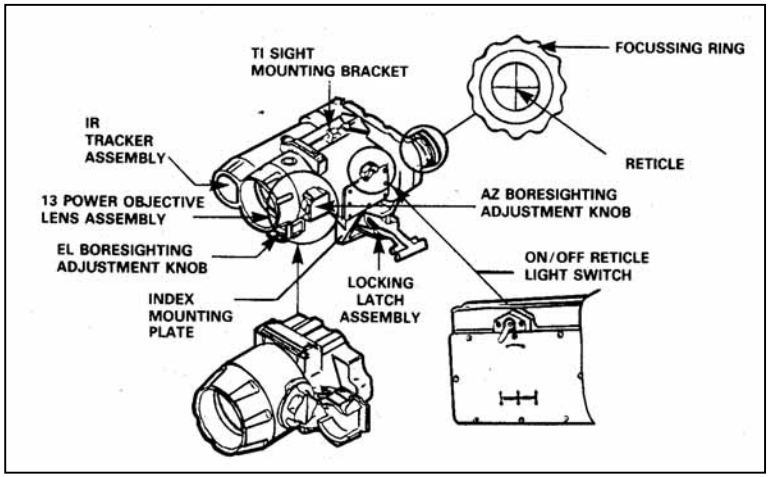


Figure 2-2-6: Optical Sight

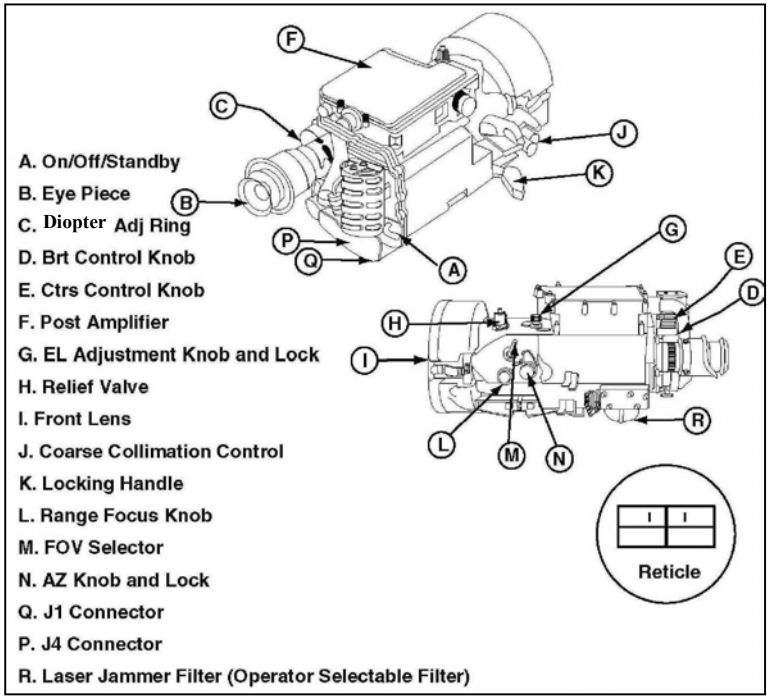


Figure 2-2-7: Thermal Sight

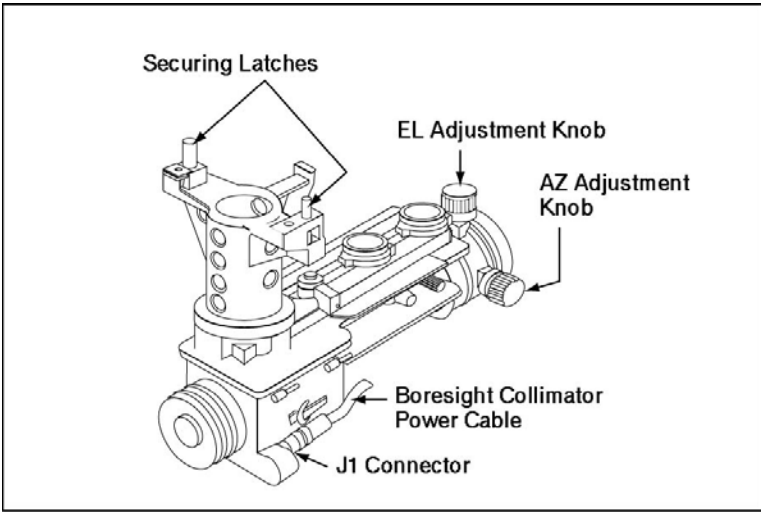


Figure 2-2-8: Boresight Collimator

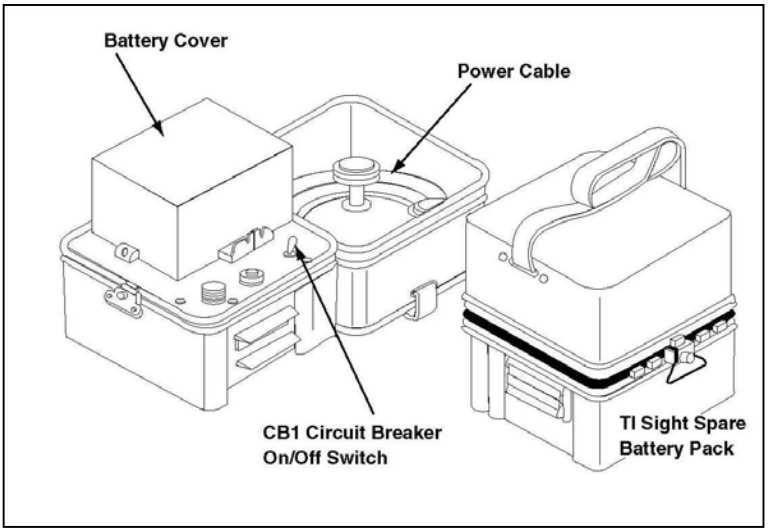


Figure 2-2-9: Thermal Imagery Sight Battery Power Conditioner and Spare Battery Pack

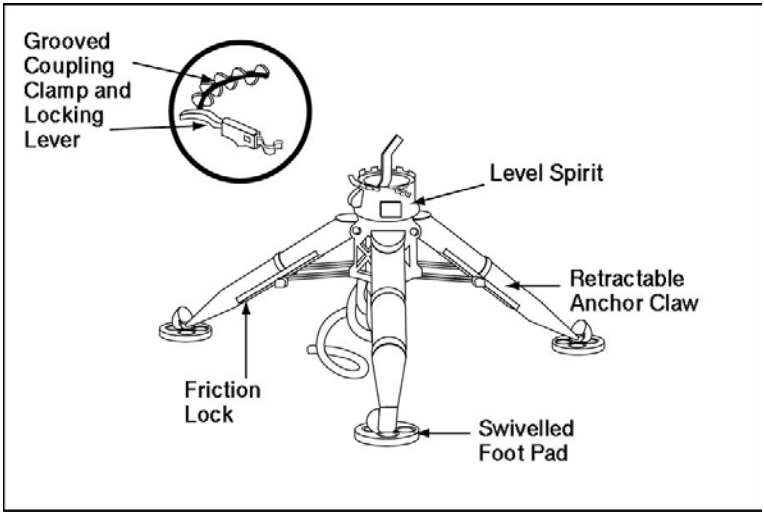


Figure 2-2-10: Tripod

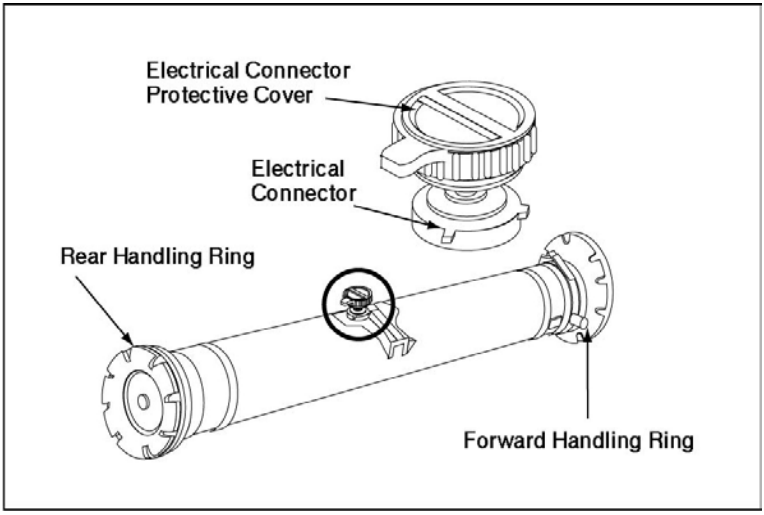


Figure 2-2-11: Encased Missile

CONDUCT OF THE LESSON

7. **Safety Precautions**. Check to ensure that there are NO LIVE BLAST SIMULATORS PRESENT.

8. **Review**. Review the safety precautions and the role and characteristics of the TOW 2.

9. **Introduction**. Explain that the names and weights of the weapon system's components are important for the safe operation and maintenance of the system.

10. The TOW 2 consists of the following ten major components (see Figures 2-2-1 and 2-2-9):

a. launch tube—5 kg;

b. traversing unit—26.3 kg;

c. missile guidance set (MGS)—17.2 kg;

d. battery assembly—9.3 kg;

e. optical sight—14 kg;

f. thermal imagery (TI) sight:

(1) without case—9.5 kg; and

(2) with case—13.3 kg .

g. boresight collimator with case—8.6 kg;

h. thermal imagery sight battery power conditioner:

(1) with batteries—7 kg; and

(2) without batteries—4.8 kg.

i. spare battery case with two lithium batteries—3.9 kg;

j. tripod—10 kg;

k. encased missile (BGM71-3B)—28.1 kg ; and

l. total weight of weapon system, with collimator, carrying cases and one missile, is 142.7 kg.

11. Confirm by questions.

12. **Launch Tube**. The launch tube is constructed of a lightweight honeycomb material, covered with laminated fibreglass, which acts as a breech and holds the encased missile on the launcher. The launch tube provides initial trajectory and stability to the missile, and protects the gunners from the motor blast when the missile is fired. The launch tube mounts on the trunnion of the traversing unit by means of two mounting lugs and a location pin, which is secured by the launch tube latch. The breech is about 65 cm forward of the trunnion. The tube is U-shaped from the breech back to the mounting surface and contains ramp indexing slots which accept the index lugs on the missile launch container for the proper alignment of the encased missile. The tube has its centre of gravity just behind the breech and has three parallel slots on the bottom of the tube. These slots are 12 cm long and 3.7 cm wide, and provide a grip for carrying. Two additional drain slots are provided to prevent accumulation of debris (see Figure 2-2-2).

13. **Traversing Unit (TU)**. TheTU is an electro-mechanical assembly which attaches to the tripod or the vehicle pedestal mount, and is the mounting base for the optical sight and the launch tube. The main assemblies of the TU are the housing, trunnion, bridge clamp, azimuth and elevation dampers and the wiring harness (see Figure 2-2-3). Details of the major components of the TU are:

a. **Main Housing**. The main housing provides the necessary framework to attach and house all other parts, and is capable of revolving 6400 mils in the azimuth (horizontal) plane.

b. **Boresight Plate**. A boresight plate on the TU receives the optical sight, aligning the launch tube axis and the optical line-of-sight. The boresight

plate rotates with elevation movement of the trunnion.

c. **Bridge Clamp**. The bridge clamp, when pivoted to the LEFT leg of the trunnion U, allows the encased missile to be loaded and properly aligned with the launch tube. The bridge clamp-locking lever secures the bridge clamp in the closed position and operates the holdback actuator. This forces a shear pin in the missile to be placed in a low shear position for launch. The electrical connector of the bridge clamp mates with the electrical connector of the encased missile when the arming lever is raised. A mechanical interlock prevents electrical contact unless the bridge clamp locking lever is properly engaged.

d. **Control Knobs**. The control knobs that control the dampers, one on either side of the main housing, are for tracking a target in azimuth and elevation. The dampers facilitate smooth target tracking. Tachometers built into the dampers generate rate signals that are used by circuits in the missile guidance set for developing the missile steering command signals. The trigger is located above the RIGHT hand control knob.

e. **Elevation Lock and Brake**. The elevation lock has detents in the 530 mil and 130 mil positions. The elevation brake locks in intermediate positions; and

f. **Coil Cord**. A coiled cord transfers signals between the TU and the missile guidance set. It is mounted in a cup underneath the main housing. The cord attaches to a receptacle on the missile guidance set by means of the J-1 plug.

14. Confirm by questions.

15. **Missile Guidance Set (MGS)**. The MGS can be thought of as a two-part assembly; one section contains the replaceable battery

or, when vehicle power is available, may contain the vehicle power conditioner. The other section contains a series of replaceable printed circuit boards which develop steering commands, self-test functions, system timing and power conversion capability to control the missile flight (see Figure 2-2-4).

16. **Battery Assembly**. The battery is a field-replaceable, plug-in unit that supplies three independent direct current (dc) voltages to operate the TOW. The battery assembly contains two identical rechargeable 50V dc batteries and one rechargeable 24V dc battery. Each battery is a heavy-duty, nickel-cadmium type using a potassium hydroxide electrolyte. Under normal conditions, the battery assembly is non-hazardous, however, if a battery should become damaged, care should be taken to prevent any part of the body (especially the eyes) coming into contact with the electrolyte since it is highly corrosive. The battery assembly mounts in the top compartment of the MGS and is secured in place by six turn-lock fasteners. The battery assembly is capable of firing 50 missiles. A self-test will cause as much drain on the battery as two missile firings (see Figure 2-2-5).

17. Confirm by questions.

18. **Optical Sight**. The laser protected optical sight is used to track a target and to detect the infrared (IR) signal emitted by the missile in flight. The optical sight contains a 13-power objective lens assembly, boresighted to an IR tracker assembly housed in an aluminium casting. The large lens on the front is the 13-power objective lens entrance and the smaller lens is the IR tracker lens entrance. The 13 power optical sight has a field of view of 108 mils. Focussing the telescope is accomplished by rotating the focussing ring. A soft rubber eye rest attaches to the eyepiece. The cross-hairs (reticle) that appear in the eyepiece may be illuminated by turning the on/off reticle light switch to ON. No adjustment in illumination level is possible (see Figure 2-2-6).

a. **Boresighting**. The line of sight of the telescope and the axis of the IR tracker assembly are boresighted during a system self-test by means of an internal IR boresight source, the two boresight knobs and the MGS. The boresight knobs are under spring-loaded covers that secure the position

of the boresight knobs when closed. Boresight adjustments are used to obtain the lighting of the green light in the centre of the AZ(azimuth) and EL(elevation) display lamps on the MGS during a boresight self-test. The lighting of red lights outside of the centre of the AZ/EL lamp display indicate that the line-of-sight objective lens system is not properly aligned with the line-of-sight of the IR tracker assembly. Adjustment is accomplished by shifting the 13 power objective lens to +3 and turning either or both AZ and EL boresighting knobs until you get the centre green light display.

b. **Locking Latch Assembly**. The optical sight attaches to the boresight plate and is secured in place by a locking latch. The sight is attached to the boresight plate with the locking latch in the DOWN position. Raising the latch to the UP position locks the sight in place. The index mounting plate of the optical sight is adjusted so that the optical line-of-sight will be aligned to the axis of the launch tube when it is mounted to the TU. All electrical connections to the optical sight are made through a connector plug. This engages with a receptacle in the boresight receptacle in the boresight plate when the locking latch of the optical sight is placed in the locked (UP) position.

c. **Mounting Bracket**. A mounting bracket for a thermal imagery sight is found on the top of the optical sight.

d. **Humidity Indicator**. The humidity indicator shows the moisture content of the air in the optical sight.

e. **The IR Tracker**. The IR tracker has a wide (WFOV) and a narrow field of view (NFOV). The WFOV is 70 mils and is used for missile acquisition during the first 1.76 seconds after launch (launch transient period). The NFOV is 10 mils and is used for guidance at longer ranges. This begins 1.76 seconds after launch and

continues until missile impact (steady state tracking phase).

19. Confirm by questions.

20. **Thermal Imagery (TI) Sight**. The TI sight is a passive, electro-optical instrument that uses thermal-imaging technology. It is used to allow the weapon system to track the target in conditions of darkness and reduced visibility. It is mounted on top of and collimated with the optical sight (see Figure 2-2-7):

a. **On/Off/Stby—Switch**. This is located to the rear right of the TI sight. When placed in the following positions it will:

(1) ON—turn on power to the TI sight cooler;

(2) STBY—(standby) give power to cooler only, which saves battery power conditioner power; and

(3) OFF—turn off power to the TI sight and cooler.

b. **Laser Jammer Filter**. (Operator Selectable Filter(OSF)) This is used to prevent laser jamming of the TI sight. There are 4 lens (3 filters and one clear lens) that can be assessed by using the control toggle, located on the left side of the TI sight. There are 3 positions: Neutral, Reset and Step. The setting, Step changes the filter to get the best picture when being jammed. Reset should be used when there is no jamming. The remote connection is only used in the American Improved TOW Vehicle (ITV).

NOTES

1. The gunner should never select a filter while the missile is in flight.

2. If laser jamming is not present the OSF should be in the Reset—Clear position.

3. Whenever something in the scene doesn't look quite right or an unusually bright spot appears on the target cycle through the filters return to the first filter, where the scene should substantially change.

4. If no filter substantially changes the scene, switch to the Reset—Clear position.

c. **Eyepiece**. This is located to rear and left of the TI sight. It has a security shutter that prevents emissions of light escaping from the eyepiece. Looking inside the eyepiece you will see Range Stadia Lines that are used to determine if the target is in range. (If the edge of a broadside tank touches the stadia lines the target (tank) is within range. If the edge of a head-on tank touches one of the stadia lines and the vertical cross-hair line, it is within range.) You will also see the battery monitor which when lit, indicates that the battery charge is low and has less than 10 minutes of operational time left

d. **Diopter Adjustment Ring**. This is located just forward of the rubber eyepieceand is used to focus the eyepiece lens for a sharp reticle.

e. **BRT (Brightness) Control Knob**. Located over the diopter adjustment ring, it is used to adjust the brightness of the image.

f. **CTRS (Contrast) Control Knob**. Located to the right of the BRT control knob, it is used to adjust the contrast of the image.

g. **Post Amplifier (PA)**. Located on the top of the TI sight, it is used to amplify the tracking signals before they are sent to the MGS (PA cable connector is on the right).

h. **Relief Valve**. Located forward of the EL knob, it is used to maintain positive pressure inside the TI sight.

i. **Front Lens Cover and Front Lens**. The front lens cover protects the front lens from damage and should always remain on the front lens when the TI sight is not in use.

j. **Coarse Collimation Control**. This is located forward and on the right side of the TI sight. It can be placed in one of two positions as an aid for TI sight boresighting.

k. **Latching Lever**. This is located back from the coarse azimuth control and is used to lock the TI sight securely to the day sight. It is positioned forward to lock and rearward to release.

l. **Range Focus Knob**. This is located forward and on the left side of the TI sight. It is used to adjust the focus of the image seen in the TI sight.

m. **Field-of-View (FOV) Selector**. This is located to the right and above the range focus knob. It enables the gunner to choose the field-of-view seen in the TI sight. WFOV means Wide Field-of-View, which is 60 x 120 mils and has a 4 power-magnification. NFOV means Narrow Field-of-View, which is 20 x 40 mils and has a 12 power magnification.

n. **AZ (Azimuth Boresight) Knob and Lock**. This is located to the right of the FOV selector. It is used to adjust the TI sight reticle in azimuth to align with the day sight during boresighting procedures.

o. **EL (Elevation Boresight) Knob and Lock**. Located in front of the PA, it is used to adjust the TI sight reticle in elevation to align with the day sight during boresighting procedures.

p. **Connector J1**. This is located under and to the right rear of the TI sight. This is where the battery power conditioner output cable is connected.

q. **Connector J4**. This is located to the left of the connector J1. This is where the boresight collimator power cable is connected.

NOTE

All TOW 2 and TOW 2B missiles require that the TI sight be ON, focussed and the FOV selector in the NFOV position. This will allow the TI sight to track the missile thermal beacon. Failure to do this will result in a missile flight failure.

21. Confirm by questions.

22. **Collimator**. The boresight collimator is used to boresight (align) the TI sight with the optical sight. This is done to ensure that both sights are focused upon the same point. The boresight collimator is secured to the TI sight by aligning the two mating surfaces of the collimator to the locating pins and pads of the TI sight and locked in place by the two securing latches of the boresight collimator. One end of the boresight collimator power cable is connected to the J1 connector of the boresight collimator and the other end to the J4 connector of the TI sight. The boresight collimator azimuth adjustment knob is located at the lower left of the collimator. It is used to align in azimuth the reticle pattern of the collimator with the cross-hairs of the day sight. The boresight collimator elevation adjustment knob is located at the lower rear of the collimator and is used to align the elevation of the collimator reticle with the cross-hairs of the day sight. The boresight collimator comes with its own case and power cable (see Figure 2-2-8).

23. **Thermal Imagery Sight Battery Power Conditioner**. The TI sight battery power conditioner provides the power necessary

to operate the TI sight when the TOW 2 is not installed in a motor vehicle equipped with a vehicle power conditioner. The power is provided by two non-rechargeable lithium batteries that are replaced when exhausted. The battery power condition has a CB1 circuit breaker On/Off switch that turns on the power to the TI sight and protects it from current overload. The battery power conditioner comes with its own power cable that is stored in the cover (see Figure 2-2-9).

24. **Thermal Imagery Sight Spare Battery Pack**. (Figure 2-2-9) The TI sight spare battery pack is used to carry the two spare lithium batteries for the TI sight when the TOW 2 is employed in the ground-mounted role. It weighs 3.9 kg with batteries. The lithium batteries are each of 24 V dc. Most of this power (16.8 V dc) is for the closed-cycle cooler. The sight itself uses 4.8 V dc.

WARNING

Lithium batteries DO NOT DECOMPOSE and may present an environmental hazard. They shall be disposed of through the proper channels.

25. Confirm by questions.

26. **Tripod**. (Figure 2-2-10) The tripod provides a level and rigid ground-mounting base for the TU. The tripod has three legs that are adjustable to allow the system to be levelled on terrain slopes of up to 530 mils and to permit folding for ease of handling when the equipment is being transported. Each leg is equipped with a friction lock that locks the leg in place after it has been adjusted to the desired position. The detent stop level provides three detent stop positions for rough levelling. A horizontal level and a vertical level mounted 1600 mils apart on the tripod permit the system to be levelled. Each leg has a footpad, which can swivel and a retractable anchor claw. In soft ground, the claw may be driven into the soil for additional stability of the system. Each footpad has a hole that permits the unit to be staked down on sandy or soft terrain slopes. The TU is mounted in the cylindrical opening at the top of the tripod body and secured in place by a grooved coupling clamp and locking lever.

27. **Encased Missile**. The encased missile (see Figure 2-2-11) is olive drab in colour and has identifying stripes or squares midway from centre to either ends to indicate a practice (blue) or a live (white or yellow) missile. Early encased missiles weighed 25.5 kg. with the BGM71F weighing 29.1 kg. All encased missiles are 128 cm in length and 22 cm in diameter. They have a forward handling ring and an electrical connector protective cover that is removed when preparing the encased missile for loading into the launch tube. The rear handling ring with diaphragm shall not be removed at any time. (More information on the missile may be found in Chapter 5 of this manual).

28. Confirm by questions.

CONCLUSION

29. Take questions from the class on the entire lesson.

30. Confirm by questions.

31. Pack kit.

32. **Summary**. To include the following:

    a. the importance of knowing the names and functions of the major components; and

    b. a forecast of the next lesson on this subject.

LESSON 3
ASSEMBLY/DISASSEMBLY/WEAPON SYSTEM CHECKOUT PROCEDURE

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following checkout procedures:

   a. assembly and disassembly of the TOW 2 Ground Mounted;

   b. weapon self test procedure; and

   c. boresight/collimation procedure.

2. **Timing**. Five 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. A complete TOW 2 is required.

5. **Preparation**:

   a. check to ensure all major components are present;

   b. layout the components in sequence from left to right; and

   c. remove the batteries from missile guidance set (MGS) and battery power conditioner.

6. **Miscellaneous**. When confirming by practice, divide class into four detachments.

CONDUCT OF THE LESSON

7. **Safety Precautions**:

   a. conduct safety precautions; and

b. practice keeping personnel out of the backblast danger area.

8. **Review**. Review the names of the major components.

9. **Introduction**. Explain the importance of the proper sequence to use when assembling and disassembling a TOW 2.

ASSEMBLE AND DISASSEMBLE THE TOW 2

10. **Setting up the Tripod**. The following sequence of actions is carried out to set up the tripod:

a. release the friction lock on the tripod legs;

b. point the downhill leg towards the target area;

c. depress the detent stop levers;

d. allow the legs to spread to the appropriate detent stop, which will allow the gunner to use the thermal imagery (TI) sight;

e. ensure the tripod mounting base is level by checking the two levels;

f. engage the friction locks on the tripod legs; and

g. release the grooved coupling clamp and locking lever.

11. **Mounting the Traversing Unit**. Mounting of the traversing unit is done in the following sequence with assistance:

a. Extend the coil cord from its stored position.

b. Pass the coil cord through the base of the tripod.

c. Mount the traversing unit on the tripod and ensure it is properly seated.

d. Align the traversing unit with the tripod by the use of the red indication arrows and ensure the azimuth lock is in line with the back level.

e. Close and lock the grooved coupling clamp and locking lever. Engage the safety spring.

f. Ensure the traversing unit is securely mounted.

g. Turn traversing unit from side to side until it locks into place.

h. Check the 2W1P1 connector on the coil cord for damage and cleanliness.

i. Check the trigger operation by lifting the cover and depressing the trigger. Ensure the spring returns the trigger to the original position and close the cover.

j. Check the bridge clamp operation to ensure it locks onto the trunnion.

k. Check the electrical connector by raising the bridge clamp and arming the lever. Push the sleeve of the connector up and inspect the connector for damage and dirt.

l. Check the operation of the bridge clamp locking lever (two successive clicks should be heard when the lever is being raised or lowered).

m. Check the operation of the arming lever. When the bridge clamp locking lever is locked, the arming lever should remain up when raised and go down on its own when the bridge clamp is unlocked.

CAUTION

Connector pins are fragile. Do not use side to side pressure when installing connectors as this can cause misalignment and bent or broken pins.

12. **Mounting the Optical Sight System (OSS)**. The optical sight must be handled with care. It is a precision device and has fragile electro-optic components. It is mounted as follows:

a. release the sight locking latch by placing it in the down position;

b. align the sight mounting bracket with the boresighting plate on the traversing unit;

c. raise the optical sight locking latch until the lock engages;

d. physically ensure that the optical sight is securely mounted;

e. ensure reticle light is off;

f. rotate the focus ring to +3; and

g. check humidity indicator.

13. **Installing the Launch Tube**. Installation of the launch tube is done in the following sequence:

a. Raise the forward end of the launch tube and slide the mounting lugs into the horizontal hooks of the trunnion.

b. Lift the launch tube latch and lower the launch tube until the locating pin is engaged.

c. Secure the launch tube in position by closing the latch.

d. Check launch tube latch to ensure it is engaging the launch tube and remains locked.

e. Ensure launch tube is securely attached to the trunnion and is free of dirt, missile wire and foreign matters.

14. Confirm by questions.

15. **Installing the Battery Assembly in the Missile Guidance Set (MGS)**. The battery is installed in the MGS in the following sequence:

a. remove the cover from the MGS;

b. remove the protective cap from the battery assembly connector and place it on the storage connector;

c. align the rails of the battery assembly with the battery guides of the MGS;

d. allow the battery assembly to slide into the battery compartment under control;

e. apply pressure to the top of the battery assembly connector and ensure it is flush with the top of the MGS; and

f. turn and tighten all turn lock fasteners.

16. **Connecting the Traversing Unit to the MGS**. To connect the traversing unit to the MGS these procedures must be followed in sequence:

a. the MGS is positioned to the right of the down hill leg;

b. align the colour guides and grooves on the coil cord connector and the MGS J1 connector;

c. engage the connector with a minimum of force; and

d. to secure the connection, tighten the locking nut until the red mark on the MGS J1 connector cannot be seen.

17. **Mounting the TI Sight**. The TI sight must be handled with care. It is a precision device and has fragile electro-optic components. It is mounted as follows:

a. Remove the TI sight from field handling case.

b. Place the coarse collimation control in position one (forward position). Some TI sights require that the coarse azimuth control knob be placed in position two. This is easy to verify as collimation will be impossible in position one.

c. Move latch lever towards rear of TI sight.

d. Align and seat the TI sight on top of the optical sight.

e. Move latch handle forward to secure TI sight.

f. Ensure that the TI sight is secure.

g. Remove and inspect post amplifier (PA) cable and connect it to the TI sight by aligning the yellow lines.

CAUTION

Keep the PA cable clear of the bridge clamp.

18. **Installing Batteries into the Battery Power Conditioner and Connecting to the TI Sight**:

a. remove the battery cover by sliding the spring locks off the posts and removing the cover;

b. place two non-rechargeable lithium batteries into the power conditioner, ensuring the connectors are properly aligned;

c. replace the cover and secure the spring locks;

d. attach the power cable to both the battery power conditioner and the J1 connection on the TI sight;

e. set the circuit breaker (CBI) switch to ON;

f. turn the TI sight On/Off/Stby switch to ON; and

WARNING

Continuous running of the TI sight cooler for more than 5 minutes is considered a serious malfunction and could damage sensitive components. A qualified technician should inspect the sight.

NOTE

When the TI sight On/Off/Stby switch is turned ON, the cooler should immediately start. If the cooler does not start follow the procedures in Annex A to Chapter 2

g. remove front lens cover and set the FOV (Field of View) selector to NFOV (Narrow Field of View).

19. Confirm by practice.

20. Disassembly is done in the reverse order.

WEAPON SELF TEST

21. No weapon or weapon system should be used without first ensuring that the equipment is in proper working order. Assembly is not complete until a weapon's self test and boresight/collimation is complete.

22. The self-test provisions in the MGS allow the operational state of the battery assembly, MGS, TI sight PA and OSS to be checked. It also allows the boresighting of the optical sight.

23. A self-test and optical sight boresighting should be performed in the following circumstances:

a. when a temperature variation of more than 5.5 °C occurs;

b. every four hours;

c. at the end of travelling a long distance;

d. after a move over rough terrain;

e. whenever the system is assembled; and

f. when in doubt.

24. Before the self-test can begin, TOW 2 components should be assembled and connected. No missile of any type will be loaded. The system should not be moved during the test. To preserve battery life, the self-test should be accomplished quickly (20 seconds). The gunner should proceed as follows (see Annex A to Chapter 2 for corrective measures):

a. Ensure the TI sight On/Off/Stby switch is ON and ensure the FOV is on NFOV.

b. Ensure the focussing ring of the OSS is at +3 and open the boresight adjustment knob covers.

c. Lock the system down, ensuring the arming lever is down and there is no missile in the launch tube.

NOTE

If the TEST/OPERATE switch is released during the self-test allow at least 3 seconds before restarting test.

d. Push and hold the TEST/OPERATE switch to TEST position for the duration of the test.

e. The digital display will appear and all lamps (red and green) will light for the first three seconds of the test.

f. Observe the PASS (green) and FAIL (red) lamps for test results.

NOTES

1. If the TI sight is not mounted, the display will indicate PA FAIL, MGS FAIL.

2. If PA is the only failure, then a missile can be fired and boresighting is allowed. The system would then be operating only with basic TOW characteristics. TOW 2 may still be fired but it will use the IR tracker of the OSS. TOW 2B cannot be fired without the TI sight.

g. Adjust the boresight of the OSS using the AZ/EL (Azimuth/Elevation) adjustment knobs until the green lamp in the centre of the cross-hair is on and not blinking. Once complete, close the boresight adjustment knob covers.

h. Maintain the TEST/OPERATE switch in the TEST position, unlock the system and move the TU left/right and up/down to verify the cross-hair lamps for corresponding movement.

i. Release the TEST/OPERATE switch and close the cover.

j. Lock the weapon system down.

k. Check the operation of the reticle light in the OSS. In order to facilitate the check during daylight, the front lens of the sight should be covered.

BORESIGHT COLLIMATION

25. Once the system checkout procedure is completed, the TI sight must be collimated to the OSS. If a weapon self test is conducted and the boresight knobs are adjusted to achieve a steady

green lamp indication then a boresight collimation must be done. The following procedure must be performed:

a. Align the boresight collimator with the TI sight bracket ensuring that the boresight collimator is in line and flush with the TI sight collimator bracket. Secure the boresight collimator to the TI sight by pushing in and turning the securing latches outwards.

b. Connect the power cable to the 3J1connector on the boresight collimator and J4 connector on the TI sight. Ensure the TI sight On/Off/Stby switch is ON.

c. Looking into the OSS eyepiece, adjust the OSS focusing ring and the boresight collimator elevation and azimuth adjustment knobs to align the centre dot of the boresight collimator reticle with the optical sight cross-hairs.

d. On the TI sight ensure the reticle is displayed, battery monitor light is off, the FOV selector in set to NFOV and adjust the BRT (Brightness), CTRS (Contrast), and RANGE FOCUS knobs for the best focus of the boresight collimator reticle.

e. Move the azimuth and elevation locking levers of the TI sight fully counter-clockwise to unlock the AZ/EL knobs.

f. Looking into the TI sight eyepiece, adjust the azimuth and elevation knobs on the TI sight until the TI cross-hairs are aligned with the collimator red dot.

g. Lock the TI sight azimuth and elevation locking levers by moving them fully clockwise. Looking into the eyepiece of both sights, check the alignment of the boresight collimator reticle to ensure it has not moved.

CAUTION

The operator should be careful NOT to touch the range focus knob when changing the FOV selector during boresight collimation. Movement of the range focus knob will result in the TI sight going out of focus and the boresight collimation will fail. This may result in the TI sight unnecessarily being sent to first line for repairs.

h. Set the TI sight FOV selector to WFOV and adjust the BRT and CTRS controls to obtain the best image of the boresight collimator reticle. The centre dot of the boresight collimator reticle should be less than one diameter from the centre of the TI sight reticle cross-hair and the four-bar resolution target should be visible.

i. FOV selector should remain set to WFOV. Disconnect and stow the boresight collimator.

j. Check the operation of the operator's selectable filter and ensure it is back to the Reset-clear position.

k. The position of the TI sight On/Off/Stby switch will be determined by the operational situation.

NOTES

1. Collimation should be verified whenever in doubt.

2. Although less reliable, an expedient collimation can be conducted under combat situations. Using the OSS, lock the system onto a specific point on a target at more than 2000 metres. The gunner will then align the TI sight to the target using the AZ/EL boresight adjustment knobs.

3. Some TI sights are set for use with the coarse azimuth knob placed at position two. This should be known when installing the TI sight. If it is impossible to collimate the TI sight, try again with the coarse azimuth control in the other position. If the sight still fails to collimate, replace the TI sight.

4. Check the operation of the STBY position of the TI sight. When on STBY the cooler should immediately start and run for a maximum of 160 seconds. It will resume running on an irregular cycle interval.

26. Confirm by practice.

CONCLUSION

27. Take questions from the class on the entire lesson.

28. Confirm by practice.

29. Pack kit.

30. **Summary**. To include the following:

    a. the importance of following the proper sequence to assemble and strip the TOW 2; and

    b. a forecast of the next lesson in this subject.

LESSON 4
DETACHMENT DRILLS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following drills:

   a. load;

   b. target engagement;

   c. cease tracking; and

   d. cease tracking unload.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. TOW 2 System complete;

   b. missile simulation round; and

   c. hand-outs on the drills one per student.

5. **Preparation**. Check all major components for serviceability.

6. **Miscellaneous**: When confirming lesson by practice, divide class into detachments.

CONDUCT OF THE LESSON

7. **Safety Precautions.** Normal.

8. **Review**. Review the procedures for weapon system checkout.

9. **Introduction**. This lesson details the drills to be carried out by the No. 2 and the No. 3 during the loading, unloading, carrying out a target engagement and cease tracking of the TOW 2.

LOAD

10. Prior to loading, a self-test and collimation will already have been completed as taught in Lesson 3.

11. **Actions of the No. 2**. The No. 1 using the command LOAD or LOAD 2B initiates loading drills. Upon hearing the command, the No. 2:

a. ensures azimuth and elevation friction locks are engaged and weapon is locked down;

b. ensures trigger cover is down;

c. ensures the thermal imagery (TI) sight On/Off/Stby switch is ON;

d. operates selectable filter to the Reset/clear position;

e. ensures WFOV (Wide Field of View) is selected;

f. ensures both sight covers are off;

g. repeats the command, LOAD or LOAD 2B; and

h. remains in the firing position and observes the arcs of fire.

12. **Actions of the No. 3**. All actions of the No. 3 are initiated by the command LOAD or LOAD 2B given by the No. 2. Upon hearing the command LOAD or LOAD 2B, the No. 3:

a. repeats the command LOAD or LOAD 2B;

b. raises the bridge clamp and inspects the launch tube;

c. visually inspects the specified encased missile;

d. checks the humidity indicator;

e. removes the forward handling ring and clamp and inspects the diaphragm;

f. removes and retains the electrical connector cap;

g. with the electrical connector upwards, aligns the indexing lugs of the encased missile with the indexing slots of the launch tube and slides the encased missile forward and down until the missile is fully seated; and

h. lowers the bridge clamp (apply pressure with the right hand while locking it with the left).

13. **Actions of the No. 2**. Once the No. 3 has locked the bridge clamp, the No. 2 reports READY.

14. Confirm by practice.

TARGET ENGAGEMENT

15. **Actions of the No. 2**. The command TARGET or a fire control order given by the No. 1 initiates all actions of the No. 2. Upon hearing the command, the No. 2:

a. repeats the command TARGET; and

b. ensures the TI sight is on WFOV.

16. **Actions of the No. 3**. All actions of the No. 3 are initiated by the command TARGET given by the No. 2. Upon hearing the command, the No. 3:

a. checks the backblast danger area and reports BACKBLAST; and

b. observes the backblast danger area ensuring it remains safe until the missile is fired.

17. **Actions of the No. 2**. Upon hearing BACKBLAST from the No. 3, the No. 2:

a. disengages the azimuth and elevation brake and locks;

b. rough aligns the weapon to the direction of the target while repeating the target indication;

c. searches for and aligns the cross-hairs on the target;

d. switches the TI sight to NFOV (Narrow Field of View), focuses and adjust the sight picture; and

e. reports, ON.

18. **Actions of the No. 3**. Upon hearing ON from the No. 2, the No. 3:

a. repeats ON; and

b. raises the arming lever and reports ARMED.

19. **Actions of the No. 2**. Upon hearing ARMED from the No. 3, the No. 2:

a. raises the trigger cover; and

b. awaits further orders from the No. 1 or engages the target as per fire control orders.

NOTES

1. In combat the TI sight should always be ON.

2. If the TOW system is not being used, the TI sight may be placed on STBY to save batteries.

3. TOW 2 and 2B cannot be fired without the TI sight ON, in NFOV, and focused.

20. Confirm by practice.

CEASE TRACKING AND CEASE TRACKING UNLOAD

21. The command CEASE TRACKING will be employed when the target being engaged is either destroyed or can no longer be engaged. The command CEASE TRACKING UNLOAD will be employed when there is no requirement to reload the weapon.

MISSILE NOT FIRED—CEASE TRACKING UNLOAD

22. **Actions of the No. 2**. The command CEASE TRACKING UNLOAD will be given by the No. 1. Upon hearing the command the No. 2:

a. lowers the trigger cover;

b. repeats CEASE TRACKING UNLOAD; and

c. continues to observe the arcs of fire.

23. **Actions of the No. 3**. Upon hearing CEASE TRACKING UNLOAD from the No. 2, the No. 3:

a. repeats CEASE TRACKING UNLOAD; and

b. lowers the arming lever and reports, DISARMED.

24. **Actions of the No. 2**. Upon hearing DISARMED from the No. 3, the No. 2:

a. ensures the trigger cover is lowered;

b. engages the elevation lock and brake;

c. engages the azimuth lock;

d. locks the weapon system down;

e. places the TI On/Off/Stby switch to STBY;

f. places the TI sight to WFOV;

g. replaces the TI sight cover; and

h. remains in firing position and observes arcs of fire.

25. **Actions of the No. 3**. When the weapon system has been locked down, the No. 3:

a. unlocks and raises the bridge clamp;

b. removes the encased missile from the launch tube;

c. inspects the launch tube, closes the bridge clamp and reports LAUNCH TUBE CLEAR;

d. replaces the forward handling ring and clamp;

e. replaces the electrical connector cap;

f. secures the encased missile; and

g. remains in position observing the arcs of fire and awaits further orders from the No. 2.

26. **Actions of the No. 2**. Upon hearing LAUNCH TUBE CLEAR from the No. 3, the No. 2:

a. reports, ALL CLEAR; and

b. remains in his firing position observing arcs of fire, awaits further orders from No. 1.

CEASE TRACKING

27. **Actions of the No. 2**. The No. 1 will give the command CEASE TRACKING. Upon hearing the command the No. 2:

a. lowers the trigger cover;

b. repeats CEASE TRACKING; and

c. remains in the firing position.

28. **Actions of the No. 3**. Upon hearing CEASE TRACKING from the No. 2, the No. 3:

a. repeats CEASE TRACKING;

b. lowers the arming lever;

c. reports DISARMED; and

d. remains in position observing the arcs of fire and awaits further orders from the No. 2.

29. **Actions of the No. 2**. Upon hearing DISARMED from the No. 3, the No. 2:

a. ensures the trigger cover is lowered;

b. places the TI sight to WFOV, and reports DISARMED READY; and

c. remains in firing position observing arcs of fire, while awaiting further orders.

30. Confirm by practice.

MISSILE FIRED—CEASE TRACKING UNLOAD

31. **Actions of the No. 2**. The command CEASE TRACKING UNLOAD will be given by the No. 1. Upon hearing the command, the No. 2:

a. lowers the trigger cover;

b. engages the elevation lock and brake;

c. engages the azimuth lock;

d. locks the weapon system down;

e. repeats CEASE TRACKING UNLOAD;

f. places the TI On/Off/Stby switch to STBY;

g. places the TI sight to WFOV;

h. replaces the TI sight cover; and

i. remains in firing position and observes arcs of fire.

32. **Actions of the No. 3**. Upon hearing CEASE TRACKING UNLOAD from the No. 2, the No. 3:

a. repeats CEASE TRACKING UNLOAD;

b. unlocks and raises the bridge clamp;

c. removes the empty missile container from the launch tube;

d. inspects the launch tube and closes the bridge clamp;

e. reports LAUNCH TUBE CLEAR; and

f. remains in position observing the arcs of fire and awaits further orders from No. 2.

33. **Actions of the No. 2**. Upon hearing LAUNCH TUBE CLEAR from the No. 3, the No. 2:

a. reports, ALL CLEAR; and

b. remains in firing position observing the arcs of fire and awaits further instructions from No. 1.

CEASE TRACKING LOAD

34. **Actions of the No. 2**. The No. 1 will give the command CEASE TRACKING LOAD. Upon hearing the command the No. 2:

a. lowers the trigger cover;

b. engages the elevation lock and brake;

c. engages the azimuth lock;

d. locks the weapon system down;

e. repeats CEASE TRACKING LOAD; and

f. remains in this fire position and observes arcs of fire.

35. **Actions of the No. 3**. Upon hearing CEASE TRACKING LOAD from the No. 2, the No. 3:

a. repeats CEASE TRACKING LOAD;

b. unlocks and raises the bridge clamp;

c. removes the empty missile container and inspects the launch tube; and

d. without orders, prepares and loads another missile.

36. Confirm by practice.

CONCLUSION

37. Take questions from the class on the entire lesson.

38. Confirm by questions/practice.

39. Pack kit.

40. **Summary**. To include the following:

a. the importance of practising the drills until they become second nature; and

b. a forecast of the next lesson on this subject.

LESSON 5
HOLDS, AIMS AND FIRES

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following:

   a. gunner's fire position;

   b. holding;

   c. correct sight picture;

   d. breathing; and

   e. firing and tracking.

2. **Timing**. One 40-minute period.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores are required:

   a. TOW 2 system complete; and

   b. a missile simulation round (MSR).

5. **Preparation**. Check equipment for serviceability.

CONDUCT OF THE LESSON

6. **Safety Precautions**. Normal.

7. **Review**. Review target engagement drills and procedures.

8. **Introduction**. Preparatory marksmanship training is divided into steps that are normally taught in the following sequence:

   a. positions;

b. manipulation of control knobs/holding;

c. sighting and aiming;

d. breathing;

e. trigger control;

f. follow through; and

g. tracking.

9. **Positions**. Exercises are used to teach the correct positions for the No. 2 and the No. 3 when firing from either vehicle or ground mount at stationary or moving targets. Aiming and loading procedures can be included in position exercises. By paying close attention to details during position exercises, the detachment should be able to take positions automatically.

10. **Firing Positions**:

a. takes position behind the thermal imagery (TI) sight;

b. kneels on either one or both knees when using the ground mount;

c. correctly adjusts the weapon or tripod mount;

d. positions the gunner close enough to the weapon system so that the gunner does not touch the MSR (if possible);

e. ensures the gunner is comfortable; and

f. looks through the TI sight.

11. **Control Knob Manipulation/Holding**:

a. **General**. The TI sight is aligned by the No. 2, by applying equal pressure to the LEFT and RIGHT

control knobs. Proper manipulation of the control knobs is an important part to successful tracking.

b. **Traverse**. To traverse the launcher horizontally, the No. 2 applies a smooth steady lateral force to both control knobs not only by the use of arms but by using his body from the waist up as well. The No. 2 should have a comfortable tracking position and maintain the same arm, shoulder, and eye position throughout the firing and tracking exercise. No part of the body should touch the launcher, therefore ensuring the maintenance of the same sight picture and making it possible to track smoothly.

c. **Vertical Adjust**. To adjust the launcher vertical, the No. 2 applies a smooth steady force to both control knobs by twisting the wrists.

d. **Body Control**. Good body control and position is essential to control knob manipulation. Any change in body position other than leaning with the controls will cause a jerking motion. Since the traversing unit tachometers send tracking rate signals to the missile guidance set, which in turn sends steering commands to the missile, a jerking motion could cause an erratic manoeuvre and possibly cause the missile to impact with the ground. In addition, the missile may not have enough time to recover from excessive steering commands.

NOTE

The angle of the body is important. The gunner should be comfortable throughout tracking, changing the body position causes jerking and may cause the missile to impact on the ground.

12. **Control Knob Manipulation**. The recommended method for manipulating the control knobs is to:

a. grip each control knob (one for azimuth, one for elevations) with one hand;

b. position yourself so that there is no strain or reaching;

c. combine the motion of the body and arms;

d. maintain smooth, steady lateral force (pressure) on the control knobs;

e. maintain smooth, steady twist of wrists;

f. keep the body upright; and

g. keep the same eye, arm and shoulder position throughout tracking.

13. **Correct Sight Picture**. The target is indicated to the No. 2 who uses the control knobs to rotate the traversing unit to align the TI sight with the target. The No. 2 will superimpose the cross-hairs of the TI sight on the centre of visible mass of the target and keep the cross-hairs on one selected point from launch to impact. It is important that the No. 2 continually keeps the cross-hairs of the TI sight on the centre of the visible mass of the target when it is moving or stationary. The No. 2 does NOT adjust the point of aim for range or lead the target.

NOTE

The No. 2 must concentrate on the point of aim and not be distracted by the thermal beacon in the sight picture.

14. **Sighting and Aiming.** The procedure for sighting and aiming is to:

a. use the control knobs;

b. look at the target and select the point of aim;

c. align the cross-hairs on the point of aim (centre of the visible mass);

d. ensure the point of aim is kept in the centre of the TI sight;

e. maintain the point of aim whether the target is stationary or moving; and

f. use the same point of aim for TOW 2B.

15. **Breathing**. Proper breathing techniques are:

a. the gunner takes a deep breath; and

b. prior to firing, the gunner lets part of it out and fires. After launch of the missile, the gunner relaxes and breathes regularly until missile impact.

16. **Firing and Tracking**. The procedure for firing and tracking is to:

a. maintain a light pressure on the trigger;

b. press then release the trigger slowly; and

c. keep the point of aim for one to two seconds after trigger depression.

NOTE

The firing of blast simulators will help correct flinching during live firing.

17. Follow through after firing:

a. The gunner must keep his eye open during obscuration and wait three to four seconds until the target reappears.

b. The gunner must not look for the target with the system. The gunner looks with his eye at the sight picture for the target.

c. When the target reappears, it will be close to or still in the gunner's point of aim.

18. Confirm by questions/practice.

CONCLUSION

19. Take questions from the class on entire lesson.

20. Pack kit.

21. **Summary**. To include the following:

a. stress the importance of good tracking for the gunner to have a first-round hit; and

b. forecast of the next lesson on this subject.

LESSON 6
MALFUNCTIONS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following points:

   a. types of malfunctions;

   b. misfire drill; and

   c. reporting procedures.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. TOW 2 System complete;

   b. missile simulation round; and

   c. hand-outs on drills one per student.

5. **Preparation**:

   a. check the equipment for serviceability; and

   b. check hand-outs.

6. **Miscellaneous**. When confirming drills by practice, divide class into detachments for ease of instruction.

CONDUCT OF THE LESSON

7. **Safety Precaution**. Normal.

8. **Review**. Review the Load/Cease Tracking drills.

9. **Introduction**. A malfunction is the failure of ammunition to function correctly when fired, or the unexpected functioning of explosive components during a test not intended to cause them to function.

10. **Malfunctions**. The following constitute a malfunction:

a. premature functioning during handling, maintenance, storage, transportation or deployment; and

b. subsequent to pressing the trigger:

(1) failure to launch:

(a) hang fire; and

(b) misfire; and

(2) in-flight malfunctions:

(a) duds; and

(b) erratic flight.

WARNING

The crew must exercise extreme care to avoid injury from a delayed missile launch. A delayed launch usually occurs within one minute. However, it could occur as long as thirty minutes after pressing the trigger. Defective missiles (either fired or encased) must be disposed of only by Ammunition Technicians and must be reported in accordance with CFAO 71-4.

11. **Definitions**:

a. **Failure to Launch**. When the missile fails to leave the launch tube after the normal 1.5 seconds delay after having pressed the trigger, either a

FAILURE TO LAUNCH—HANGFIRE or a FAILURE TO LAUNCH—MISFIRE condition exists.

b. **Hang Fire**. After the trigger is pressed, usually the distinctive impulse of the squibs firing to activate the missile batteries and gyro, and the gyro spin noise can be heard. When the missile fails to launch and the pre-fire functions are heard, the condition is a FAILURE TO LAUNCH—HANGFIRE.

c. **Misfire**. When the missile fails to launch and the pre-fire functions are NOT heard, the condition is a FAILURE TO LAUNCH-MISFIRE.

d. **Dud**. A dud is an explosive munition which has not been armed as intended or which has failed to explode after being armed. The warhead of all duds must be considered to be armed and, therefore, extremely dangerous. The location of all duds shall be noted and referred to an Ammunition Technical Officer (ATO) or an Ammunition Technician for disposal.

e. **Erratic Flight**. An erratic or uncontrolled flight of the missile may occur as a result of any of the following conditions:

(1) command link wire, which have shorted out or broken;

(2) defective missile wing or control surface;

(3) defective flight motor; or

(4) poor gunner tracking.

12. Confirm by questions.

MISFIRE DRILLS.

NOTE

Whether pre-fire functions are heard or not, these drills shall apply.

13. **Actions of the No. 2**. The No. 2 initiates misfire drills by alerting the crew, the No. 2:

a. alerts the crew by reporting MISFIRE; and

b. continues tracking for one minute.

14. **Actions of the No. 3**. Upon hearing MISFIRE from the No. 2, the No. 3:

a. repeats MISFIRE;

b. initiates a missile guidance set (MGS) self-test to ensure the batteries are functioning properly and if the batteries fail, the No. 3 replaces the battery assembly;

c. ensures the coil cord is properly secured to the MGS, ensures the bridge clamp locking lever is secure and the arming lever is fully raised;

d. after the one minute wait, disconnects the coil cord and lowers the arming lever;

e. secures the coil cord to the MGS and raises the arming lever (ensuring the back blast is clear) and reports ARMED.

15. **Actions of the No. 2**. Upon hearing ARMED from the No. 3, the No. 2:

a. fires the weapon; and

b. if it still fails to fire a second time, reports MISFIRE TWO; and

c. continues tracking for one minute counting aloud.

16. **Actions of the No. 3**. Upon hearing MISFIRE TWO from the No. 2, the No. 3:

a. repeats MISFIRE TWO;

b. continues to observe the back blast;

c. counts aloud with the No. 2 for one minute;

d. disconnects the coil cord; and

e. lowers the arming lever and reports DISARMED.

17. **Actions of the No. 2**. Upon hearing DISARMED from the No. 3, the No. 2:

a. repeats DISARMED;

b. lowers the trigger cover;

c. locks the system in position, immobilising the launch tube with the cross-hairs on target; and

d. observes a 30 minute waiting period, ensuring the backblast danger area remains clear.

18. **Actions of the No. 3**. After the waiting period, the No. 3:

a. unloads the missile;

b. steps back and places the missile on the ground;

c. steps over the missile and turns around;

d. picks up the missile, ensuring it is horizontal and pointing down range; and

e. places it a safe distance away from troops and equipment (200 m) or in a dud pit.

19. Confirm by practice.

REPORTING PROCEDURES

20. In addition to the drills detailed above, the following reporting procedures apply:

a. If two consecutive malfunctions occur in the same launcher, that launcher is isolated. The missiles are disposed of on the authority of the Ammunition Technician, provided it is determined that the missiles are defective. The matter is referred to NDHQ by priority message outlining the action taken and requesting additional direction if required. The launching system is held for complete inspection by the second-line Fire Control System (FCS) Technicians.

b. If two subsequent missile malfunctions occur from a different launcher, during the same firing practice, and the missile involved has the same lot number, carry out the procedures outlined in sub-paragraph a., suspend firing of missiles bearing the same lot number and seek NDHQ (DSSPM 4) direction by telephone.

c. If a malfunction occurs that may be attributed to the launching system, the weapon is isolated and tested by unit FCS Technicians. Back-up systems are made available to account for this possibility.

d. In the event of a wire break, once the missile has been fired; recover all available wire, particularly that portion on either side of the break, and send the wire to NDHQ, Attention: DSSPM 4.

e. Notwithstanding the special reporting provisions of this paragraph, all malfunctions are reported on the TOW Firing Report.

f. All malfunctions of the missile are reported in accordance with CFAO 71-4, Ammunition Accident, Incident, Defect and Malfunction Reports.

21. Confirm by questions.

CONCLUSION

22. Take questions from the class on the entire lesson.

23. Confirm by practice and questions.

24. Pack kit.

25. **Summary**. To include the following:

a. the importance of knowing the drills well enough so that they become second nature; and

b. a forecast of the next lesson on this subject.

LESSON 7
INDIVIDUAL DUTIES

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following points:

    a. duties of detachment numbers; and

    b. detachment drill position.

2. **Timing**One 40-minute period.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

    a. multimedia projector;

    b. screen;

    c. slides showing detachment number positions;

    d. hand-outs on drill positions one per student; and

    e. TOW 2 ground mounted complete.

5. **Preparation**. Prior to the period:

    a. Set up the classroom;

    b. Check the power point slides; and

    c. Check the hand-outs.

6. **Miscellaneous**. Leave weapon systems assembled after review.

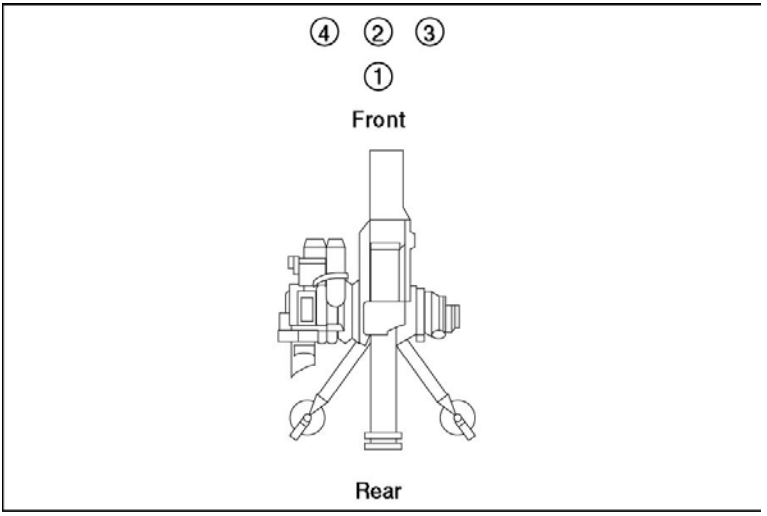


Figure 2-7-1: Detachment Drill Front

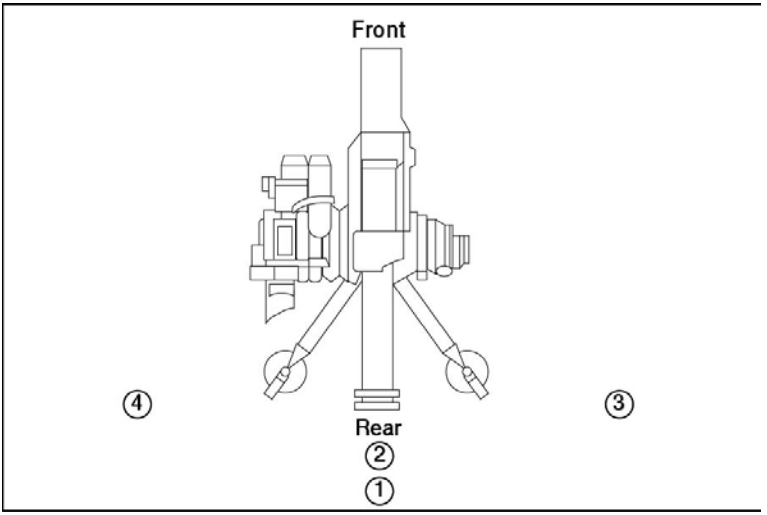


Figure 2-7-2: Detachment Drill Rear

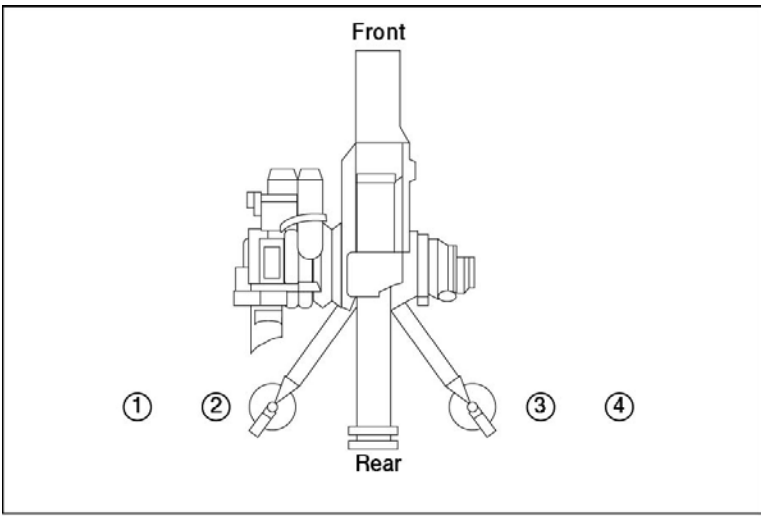


Figure 2-7-3: Detachment Positions for TOW 2 Ground Mounted Operations

CONDUCT OF THE LESSON

7. **Safety Precautions**. Normal.

8. **Review**. Review assembly/disassembly of the TOW 2.

DETACHMENT DRILLS

9. **Introduction**. Preparatory marksmanship training teaches essential skills and develops fixed and correct procedures in marksmanship before range practice begins. Through instruction and carefully supervised practice in the preparatory phase saves time and ammunition during range firing and develops techniques and procedures necessary for well-trained TOW 2 detachments.

DUTIES OF DETACHMENT NUMBERS

10. **The Detachment Commander** is the No. 1 and is responsible for the weapon system. The commander observes,

controls and supervises the conduct of fire of the TOW 2. The No. 1 employs the detachment according to the orders of the platoon commander or section commander and is responsible for the detailed siting and concealment of the weapon. The No. 1 keeps the platoon commander or section commander informed of the status of the ammunition supply and supervises the detachment's resupply.

11. **The Gunner** is the No. 2 and is responsible for acquiring, smooth tracking and firing at designated targets. The gunner performs checkout procedures including self-test, boresighting and collimation and maintains the weapon system.

12. **The Loader** is the No. 3 and is responsible for the preparation of the launcher and the first encased missile for loading. The loader is responsible for the loading and arming of the weapon system, assisting the gunner in performing the checkout procedures, acting as gunner if the necessity arises, carrying ammunition and checking clearance of the backblast area before firing.

13. **The Driver** of the weapon system carrier is the No. 4. The No. 4's duties include the maintenance, concealment, camouflage of the vehicle and checking the radio equipment. The driver assists in ammunition resupply with or without the vehicle, and prepares subsequent encased missiles for loading on command.

14. Confirm by questions.

DETACHMENT DRILL POSITIONS

15. Detachment drills develops teamwork, precision and speed in putting the weapon system into action. Precision is achieved by strict adherence to prescribed training procedures. Teamwork is attained by frequently rotating the duties so that each crewman becomes proficient in the duties of every other member.

16. Practice for speed is done in the last phase of training. During this phase, however, emphasis on precision and teamwork are never sacrificed for speed. Unless otherwise prescribed, moves from one position to the next are made in double time, but initial training for precision is performed in quick time.

17. **Front**. The term FRONT used in the detachment drills is defined as:

a. when the weapon is ground mounted, front, is the direction that the launch tube is pointed; and

b. when the weapon is vehicle mounted, front, is the direction that the vehicle is facing.

18. **Detachment Front**. On the command, DETACHMENT FRONT (see Figure 2-7-1):

a. the No. 2 shall be positioned facing front three paces forward and centred on the weapon or vehicle;

b. the No. 3 shall be positioned one pace to the right of the No. 2;

c. the No. 4 shall be positioned one pace to the left of the No. 2; and

d. the No. 1 shall be positioned one pace to the rear of and in line with the No. 2.

19. **Detachment Rear**. On the command, DETACHMENT REAR (see Figure 2-7-2):

a. the No. 2 shall be positioned facing the front, two paces to the rear and centred on the weapon or vehicle;

b. the No. 3 shall be positioned one pace to the right of the No. 2;

c. the No. 4 shall be positioned one pace to the left of the No. 2; and

d. the No. 1 shall be positioned one pace to the rear of and in line with the No. 2.

20. Confirm by practice.

21. **Numbering**. To assign duties for detachment drills, give the command NUMBER. On that command the detachment call their numbers: ONE, TWO, THREE, FOUR. Upon hearing FOUR, the detachment stands at ease.

22. **Changing Around**. To enable all of the detachment members to practice one another's duties, the CHANGE AROUND drill has been developed. This drill can be carried out from either the detachment rear or detachment front position. With the command CHANGE AROUND, the detachment members will come to attention and move counter-clockwise to their new positions as follows:

a. the No. 1 takes a pace to the RIGHT and a pace forward;

b. the No. 2 takes a pace to the LEFT;

c. the No. 3 takes a pace to the LEFT;

d. the No. 4 takes a pace to the rear and pace to the RIGHT; and

e. when the change round is completed the detachment remains at attention, the detachment commander renumbers and the detachment stands at ease upon hearing FOUR called by the No. 4.

23. **Prepare for Action**. The command PREPARE FOR ACTION is normally given from the detachment front or detachment rear position. Upon hearing the command PREPARE FOR ACTION, the detachment comes to attention, doubles to their positions at the weapon and checks it to ensure it is serviceable as follows (see Figure 2-7-3):

a. The No. 1 ensures that:

(1) the proper maps are on hand;

(2) binoculars have clean lenses and are serviceable; and

(3) compass is serviceable.

b. The No. 2 assisted by the No. 3 performs the checkout procedures; and

c. The No. 4 inspects the encased missiles.

24. When the detachment numbers have completed their inspection of the stores, they return to the detachment front (or rear) and stand at ease. When all are present the command REPORT YOUR STORES is given. Upon hearing this command the detachment numbers take the following action:

a. The No. 4 comes to attention and reports FOUR CORRECT or reports any deficiency.

b. The No. 3 comes to attention and reports THREE CORRECT or reports any deficiency.

c. The No. 2 comes to attention and reports TWO CORRECT or reports any deficiency.

d. The No. 1 reports 72 ALPHA(or their call sign) READY FOR ACTION or reports any deficiency.

e. On the word ACTION, the detachment stands at ease. (If there is more than one detachment reporting stores, the No. 1s report in turn, commencing from the detachment on the right.)

25. **Falling Out**. On the word of command FALL OUT, the detachment members turn to the right and double to the rear of the weapon.

26. Confirm by practice.

CONCLUSION

27. Take questions from class on entire lesson.

28. Confirm by practice.

29. Pass out hand-outs.

30. **Summary**. To include the following:

    a. importance of having the detachment working together as a team; and

    b. forecast of the next lesson of this subject.

LESSON 8
DISMOUNTED TOW 2 DRILLS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following drills:

   a. dismounted TOW 2 drills close to the vehicle:

   b. assembly of the weapon system;

   c. ready state;

   d. disassembly of the weapon system; and

   e. dismounted TOW 2 drills for distances longer than 500 metres from the vehicle.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. TOW 2 ground mounted complete;

   b. carrying straps, cases and bags;

   c. missile simulation round (MSR)one per TOW 2;

   d. hand-outs on what each member is responsible for carrying;

   e. hand-outs on action of each member;

   f. man-packed radio;

   g. pick;

   h. shovel; and

i. Laser Range Finder.

5. **Preparation**. Prior to commencing the first period:

a. check the weapon system and equipment;

b. check the hand-outs; and

c. set up the classroom.

6. **Miscellaneous**. Lesson may be conducted outside to practice disassembly, moving to alternate positions and assembly.

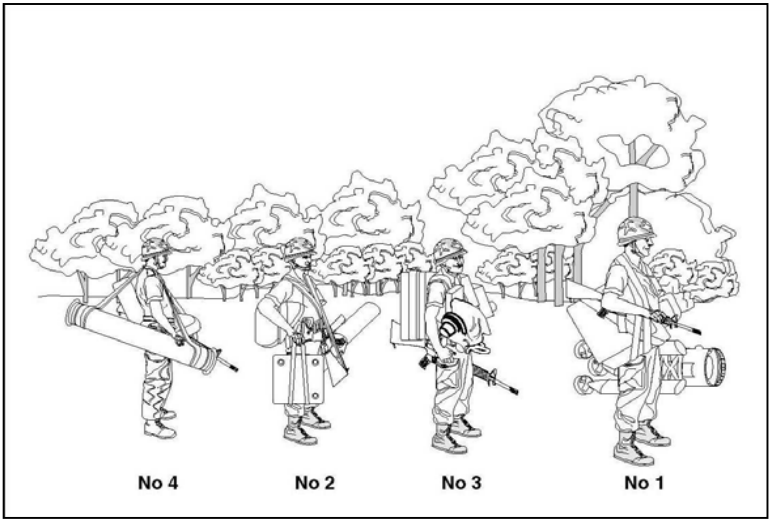


Figure 2-8-1: TOW 2 Detachment Carrying Configuration for Dismounted Operations Carried Out Close to the Vehicle

CONDUCT OF THE LESSON

7. **Safety Precautions**. Normal.

8. **Review**. Review the individual duties of the TOW 2 Detachment.

ASSEMBLY OF THE WEAPON SYSTEM

9. **Introduction**. When the system is to be moved from one dismounted position to another or dismounted from any weapon platform, it can be disassembled and carried. For speed in assembling at the new position, the detachment should move in the following order of march: 1, 3, 2 and 4. Each member is responsible for carrying the following components (see Figure 2-8-1):

a. **The No. 1**: the tripod, optical sight and power conditioner spare batteries, AN/PRC 521 Radio, pick and shovel in the tripod.

b. **The No. 3**: the traversing unit and collimator in its protective case.

c. **The No. 2**: the launch tube, missile guidance set (MGS) and laser range finder.

d. **The No. 4**: one encased missile, thermal imagery (TI) sight power conditioner and TI sight in its protective case.

10. **Actions of the No. 1**. Upon reaching the new dismounted position, the No. 1 carries out the following actions:

a. sites the weapon by setting up the tripod with the downhill leg toward the centre of the arc of fire; and

b. sets up the tripod.

11. **Actions of the No. 3**. Upon reaching the tripod the No. 3:

a. mounts the traversing unit (TU) on the tripod with the assistance of the No. 2; and

b. takes the launch tube from the No. 2 and attaches it to the TU.

12. **Actions of the No. 2**. Upon reaching the tripod the No. 2:

a. assists the No. 3 mounting the TU on the tripod;

b. installs the MGS forward left of the tripod with the display facing away from the downhill leg; and

c. connects the coil cord to the MGS.

13. **Actions of the No. 4**:

a. opens the TI sight case;

b. opens the battery power conditioner case and places it forward right of the tripod rear leg;

c. prepares a missile for firing if ordered; and

d. if necessary, carries missiles from the vehicle to the firing position.

14. The detachment places the remainder of the components on the ground and the following occurs:

a. the No. 1 removes the optical sight system (OSS) from its protective bag and hands it to the No. 3;

b. the No. 1 after handing off the OSS adopts a position of observation and supervises the remainder of the set up and prepares a range card;

c. the No. 3 upon receiving the OSS from the No. 1 passes the OSS to the No. 2;

d. the No. 2 upon receiving the OSS mounts the OSS;

e. the No. 3 upon passing the OSS to the No. 2, removes the TI sight from its protective case and passes the TI sight to the No. 2;

f. the No. 2 mounts the TI sight;

g. the No. 3 upon passing the TI sight to the No. 2, prepares the battery power conditioner and passes the cable to the No. 2;

h. the No. 2 connects the battery power conditioner cable;

i. the No. 2 and 3 conduct a MGS self test and boresight/collimation;

j. the No. 2 once the boresight/collimation is complete reports SYSTEM READY;

k. the No. 2 and 3 observes the arcs and awaits further orders; and

l. once the No. 2 reports SYSTEM READY the No. 1 gives the command LOAD. When complete the No. 2 reports READY.

15. Confirm by practice.

READY STATE

16. The term READY confirms that the detachment, on receipt of a fire control order, can engage a target quickly. It applies to all TOW 2 vehicle configurations and in the dismounted role. It is used to reduce the reaction time to a minimum when enemy contact is imminent. When reported, READY, this indicates to the No. 1 that the weapon system is in the following state:

a. boresight/collimation is completed;

b. an encased missile is loaded;

c. the system is locked in the depressed position;

d. the trigger cover is closed;

e. TI sight On/Off/Stby is in the ON position;

f. TI is in WFOV (Wide Field of View);

g. TI sight lens protective cover off; and

h. the system is DISARMED.

17. Confirm by practice.

NOTE

When dismounted, the weapon is normally sited as close to the detachment vehicle as tactically possible. This will allow the detachment to quickly remount and move.

DISASSEMBLY OF THE WEAPON SYSTEM

18. There may be times when it is necessary to move to an alternate or secondary position during target engagements. This is usually done by vehicle but it can be done dismounted if necessary. In either case, the following action takes place.

19. **Actions of the No. 1**:

a. orders, CEASE TRACKING, UNLOAD (during firing), PREPARE TO MOVE;

b. supervises the stripping of the weapon and puts the optical sight back in its protective bag; and

c. assists with placing the equipment in the proper order of march.

20. **Actions of the No. 2**:

a. reports ALL CLEAR once the unload is completed;

b. turns both the power conditioner CB1 (circuit breaker 1) and the TI sight On/Off/Stby switches to OFF;

c. fastens the TI sight lens protective cover;

d. disconnects the TI sight battery power conditioner cable from the TI sight and the battery power conditioner;

e. disassembles the TI sight and hands it over to the No. 3;

f. disassembles the optical sight and hands it over to the No. 1;

g. disconnects the coil cord from the MGS;

h. unhooks the groove coupling clamp and assist the No. 3 stripping the TU by feeding out the coil cord and placing the cord in to the TU housing;

i. closes the MGS cover;

j. closes the TI sight battery power conditioner case; and

k. closes the tripod and hands it over to the No. 1.

21. **Actions of the No. 3.** Upon hearing the command ALL CLEAR from the No. 2, the No. 3:

a. disconnects the TI sight post amplifier cable from the TI sight and inserts it in its TU housing;

b. stores the TI sight and the battery power conditioner cable into the protective case ensuring that the TI sight eyepiece is fully screwed in;

c. places the optical sight into its protective bag, if not already done by the No. 1;

d. removes the launch tube; and

e. disassembles the TU with assistance from the No. 2.

22. **Actions of the No. 4**. The No. 4 does not take part in disassembly of the weapon system except for carrying back unfired missiles to the vehicle and driving the vehicle closer to the firing position if possible. If needed, the No. 4 will help carry the components.

DISMOUNTED TOW 2 DRILLS FOR LONGER DISTANCES

23. **Introduction**. A four-person detachment carries an average of 35 kg (75 lb) of bulky TOW 2 equipment per person and one missile. Depending on the distance required to be traversed and the type of operation to be conducted, additional soldiers will be required to carry missiles, rations and survival equipment. Generally a crew of eight soldiers would be required to move one TOW 2 system and missiles any distance beyond 500 metres (see Figure 2-8-2).

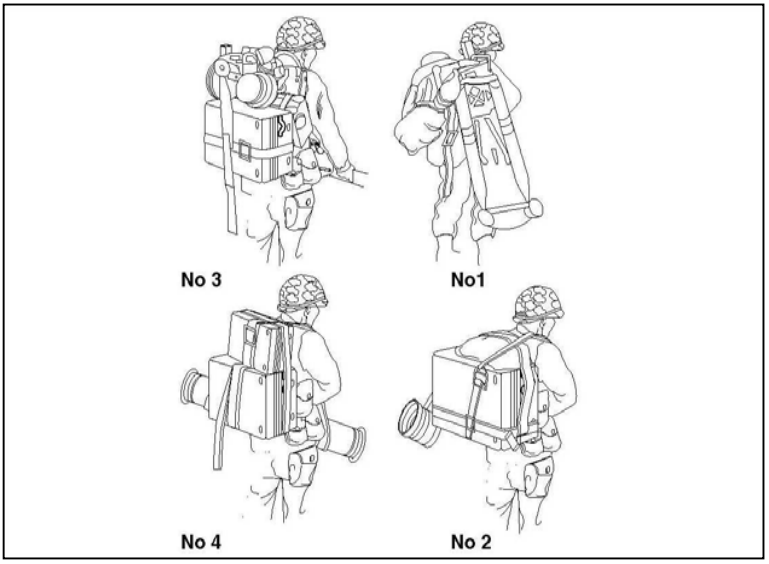


Figure 2-8-2: Rigging of TOW 2 Equipment for Long-distance Carrying

NOTE

It must be stressed that dismounted operations greatly increase the vulnerability of TOW 2 as well as decreasing its effectiveness. If dismounted operations must be performed, a TOW 2 detachment requires four extra members to enhance its survivability on the battlefield (see Figure 2-8-3).

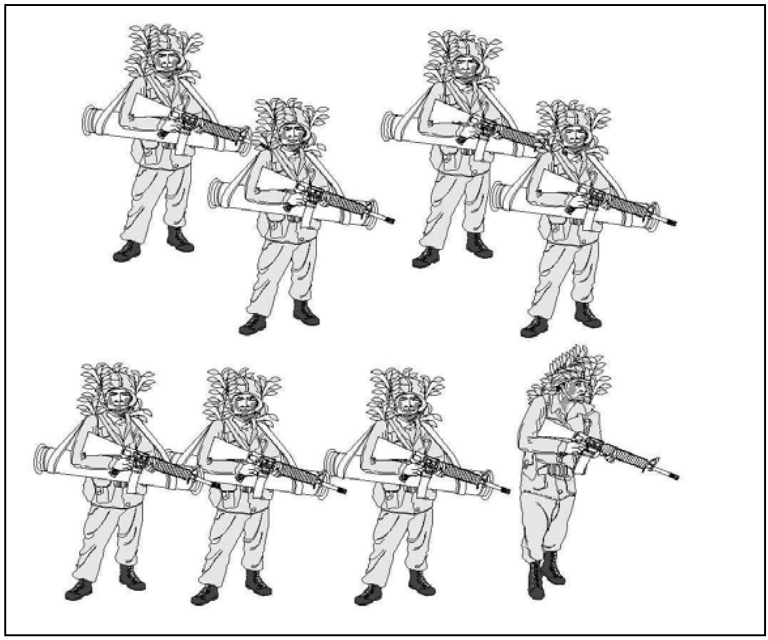


Figure 2-8-3: TOW 2 Detachment (Augmented) on a Dismounted Operation of More Than 1/2 km

24. The original members of the detachment carry much the same equipment as for dismounted operations close to the vehicle. The components are rigged on the rucksack as follows:

a. In the No. 1's rucksack:

(1) in the top portion of the rucksack is the OSS and radio;

(2) in the bottom portion is the spare battery case;

(3) the tripod is strapped to the outside of the rucksack facing up; and

(4) the pick and shovel are placed in the tripod.

b. In the No. 2's rucksack:

(1) the laser range finder is carried in the bottom portion of the rucksack;

(2) the MGS is placed on the outer top portion of the rucksack and is fastened using the rucksack top flap and quick release straps; and

(3) the launch tube is placed upside down in the centre of the MGS and fastened into place using tie-down straps.

c. In the No. 3's rucksack:

(1) the boresight collimator is fastened horizontal with the handle facing out, to the outside bottom half of the rucksack using tie-down straps; and

(2) the TU is placed on its side with the bridge clamp lever to the left the post amplifier cable facing out, and strapped to the top portion of the rucksack.

d. In the No. 4's rucksack:

(1) the TI sight battery power conditioner is placed in the bottom portion of the rucksack;

(2) the TI sight is placed in the upper portion of the rucksack; and

(3) one encased missile is fastened vertically in the centre of the rucksack with the nose up using tie-downs.

25. Confirm by practice.

CONCLUSION

26. Take questions from the class on the entire lesson.

27. Confirm the lesson by practice.

28. Pass out hand-outs.

29. **Summary**. To include the following:

a. stress that the occasion will arise when the TOW 2 must be man-packed to alternate and secondary positions that are inaccessible to vehicles; and

b. a forecast of the next lesson on this subject.

LESSON 9
OPERATOR'S MAINTENANCE

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following points:

   a. preventive maintenance;

   b. equipment log book;

   c. general cleaning of metal, rubber and glass; and

   d. extreme climate maintenance.

2. **Timing**. One 40-minute period.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. TOW 2 weapon complete;

   b. 20 litres of clean water;

   c. .5 litres of detergent;

   d. 1 litre of alcohol;

   e. 1 litre of toluene;

   f. 1 litre of glycerol;

   g. 1 litre of de-icer;

   h. 1 litre of lens cleaning solution;

   i. lens paper;

   j. clean wiping rags;

k. gloves one pair per student, gloves rubber, acid and alkali resistant;

l. safety glasses/goggles one per student;

m. two scrub brushes;

n. ten orangewood sticks;

o. two rubber syringes;

p. 20 cotton pads;

q. camel hair brush;

r. hand-outs on, Preventive Maintenance Checks and Services one per student;

s. hand-outs on General Cleaning Procedures one per student;

t. eyewash kit;

u. type B fire extinguisher;

v. two wash basins;

w. two, 1 litre containers (pitcher); and

x. anti-Fog (Safeco) liquid.

5. **Preparation**. Prior to the commencement of the period:

a. prepare a well-ventilated classroom;

b. check to ensure you have all the stores; and

c. check the hand-outs.

CONDUCT OF THE LESSON

6. **Safety Precautions**. Normal.

7. **Review**. Review assembly/disassembly of the components.

8. **Introduction**. Explain that the TOW 2 detachment must perform preventive maintenance. Proper preventive maintenance ensures proper functioning and increases the operational life of the weapon.

9. Grit and dirt accumulated over time may cause the connectors, dials and knobs to malfunction, resulting in the application of excessive force that could cause damage to components.

10. Particular care must be taken to avoid rough handling of the thermal imagery (TI) and optical sights, missile guidance set, traversing unit, and the encased missile. Rough handling may cause a malfunction, inaccurate missile flight after launch, or a safety hazard.

PREVENTIVE MAINTENANCE

11. **Preventive Maintenance Checks and Services (PMCS)**. Maintaining the TOW 2 in operating condition includes cleaning and inspections. Unit maintenance personnel should only do paint touch up procedures. If your equipment fails to operate, report any deficiencies using the proper standard operational procedures (SOPs). PMCS tables may be found in Annex B of this Chapter.

EQUIPMENT LOG BOOK

12. **Equipment Log Book**. The equipment log book is designed to keep an accurate record of the TOW 2 and is normally held by the Unit FCS Section.

13. **Contents**. The log book includes the following:

a. record of transfers (ie, between units or between a unit and a repair depot);

b. daily record of missiles fired (used at the conclusion of each day's firing to record the number of missiles fired from each system);

c. details of inspection (filled out by technicians upon routine inspections);

d. repairs and modifications of the ordnance (normally filled out by the repair depot); and

e. repairs and modifications of the mounting (normally filled out by the repair depot).

14. **Recording**. In addition to the above mentioned, the weapon system checklist should be recorded. This is a detailed list of every item of the weapon system issued, which gives the user the following:

a. NATO stock number (NSN);

b. proper nomenclature; and

c. quantity.

15. **Importance of the Log Book**. It is important to keep the log book up to date for the following reasons:

a. provides commanders with up to date information on the material readiness of their equipment;

b. permits accurate screening of the equipment that requires the most maintenance; and

c. provides a guide for evaluating the equipment's adequacy and length of service.

16. Confirm by questions.

17. **General Cleaning of the TOW 2**. Cleaning the TOW 2 is important to maintain proper operation of the system. If the TOW 2 is not kept clean, damage may be hidden and not found during an initial inspection. General cleaning is done by detachment personnel in the following manner while observing the following warnings and cautions:

WARNING
SOLVENT AND ALCOHOL ARE INFLAMMABLE AND CAN HARM EYES AND SKIN

Keep solvents away from heat and open flame. Use only in a well ventilated area. If personnel are burned, get medical help immediately. Try not to get solvent on your bare skin. If solvents get in eyes, wash them with plenty of water and get medical help immediately. After using a solvent, wash carefully so that there is none on bare skin.

CAUTION
RUBBER PARTS OR SEALANTS

Do not get alcohol or toluene on rubber parts or sealant as they can cause rubber parts to crack and sealant to melt.

CAUTION
CLEANING GLASS SURFACES

Do not clean surfaces with rags or scrub brushes. These materials can scratch glass surfaces and cause the system to work improperly.

18. Confirm by questions.

GENERAL CLEANING

19. General cleaning is accomplish using the following:

a. scrub brushes;

b. wiping rags;

c. gloves; and

d. goggles.

20. General cleaning is done in the following steps:

a. wipe area to be cleaned with wiping rag;

b. for stubborn dirt, brush area to be cleaned with scrub brush;

c. for grease or dirt that the scrub brush cannot remove, wet a wiping rag with toluene;

d. wipe area to be cleaned with a wet wiping rag; and

e. clean off any toluene left with clean, dry wiping rag.

21. Confirm by practice.

22. Cleaning of rubber parts is accomplished using the following:

a. detergent;

b. wiping rags; and

c. glycerol.

23. Cleaning of the rubber parts is done in the following steps:

a. wipe rubber parts with wiping rags to clean off loose dirt and dust;

b. for grease, or if dry wiping rag cannot remove the dirt, mix detergent with water;

c. wet a clean wiping rag with detergent and water mixture;

d. wipe rubber parts with wet wiping rag; and

e. wipe any excess detergent and water mixture from rubber parts using a clean wiping rag dampened with water only.

NOTES

1. If detergent is not available, plain water can be used to clean rubber parts.

2. For cold weather operations (temperatures below 0°C), add glycerol to cleaning water. Glycerol prevents water from freezing during use.

24. Confirm by practice.

25. Cleaning battery assembly is accomplished using the following:

a. scrub brushes; and

b. wiping rags.

WARNING
BATTERY CORROSION POWDER WILL BURN

Do not let battery corrosion powder get on skin or clothing. If it gets on skin or clothes, wash immediately. Destroy all wiping rags after use.

26. Cleaning battery assembly is done in the following steps:

a. wet a wiping rag with water;

b. wipe battery assembly with the wet wiping rag;

c. make sure no dust or deposit of white, powdery substance is on battery surface;

d. for stubborn dirt, clean battery assembly with scrub brush; and

e. dry battery assembly with clean, dry cloth.

27. Confirm by practice.

28. Cleaning battery connectors is accomplished using the following:

a. alcohol;

b. orangewood sticks; and

c. wiping rags.

29. Cleaning the connectors is done in the following steps:

a. wrap clean wiping rag around stick to form a swab;

b. wet swab with alcohol;

c. clean the contact area of the connector with a wet swab; and

d. repeat steps in sub-paragraphs a. through c. until all contacts of the connector are clean.

30. Confirm by practice.

31. Cleaning Day Sight Tracker Lens is accomplished using the following:

a. alcohol;

b. camel hair brush;

c. lens paper;

d. rubber syringe;

e. de-icer; and

f. wiping rags.

NOTES

1. DO NOT use this procedure to clean TI SIGHT LENS. Refer to paragraph 34 for special cleaning of TI sight lens. DO NOT touch lens surface with fingers. If moisture has frozen on lens surfaces, perform step in paragraph 32.a. If moisture has not frozen on lens surface, start with paragraph 32.b.

2. DO NOT wipe lens surface with side of lens paper that you touched.

32. Cleaning the Day Sight Tracker Lens is done in the following steps:

a. in winter conditions apply de-icer to lens surface or place glass part in a warm area until ice melts;

b. pat lens surfaces with clean absorbent wiping rag (do not rub);

c. when lens surfaces are dry, using the rubber syringe, blow loose dust off lens surfaces;

d. for dust sticking to lens surfaces, lightly brush glass surfaces with camel hair brush;

e. if lens surface is still dirty, fold lens paper in half;

f. again fold lens paper in half;

g. lightly wipe lens surfaces with folded lens paper;

h. start wiping at centre of lens surfaces;

i. wipe lens surface using circular motion, slowly moving outward; and

j. to remove grease or stubborn dirt, use a clean lens paper dampened with alcohol.

33. Confirm by practice.

34. Cleaning TI Sight Lens is accomplished using the following:

a. cotton pads;

b. lens cleaning solution; and

c. clean water.

35. Cleaning the TI Sight Lens is done in the following steps:

a. in winter conditions apply de-icer to lens surface or place glass part in a warm area until ice melts;

b. rinse TI sight lens by pouring clean drinking water over lens surface;

c. wet cotton pad with lens cleaning solution;

d. lightly dab (do not rub) pad with lens cleaning solution on lens surface;

e. wait between one to three minutes for lens cleaning solution to loosen heavy dirt;

f. rinse lens cleaning solution off TI sight lens by pouring clean drinking water over the len's surface;

g. repeat the steps in subparagraphs c. through f. until all dirt is cleaned off of TI sight lens;

h. apply lens cleaning solution to a small area of TI sight lens;

i. gently wipe lens surface with clean cotton pads in one direction only, (left to right);

j. rinse TI sight lens with clean drinking water; and

k. dry TI sight lens with clean dry cotton pad by wiping in one direction only, (left to right).

NOTES

1. DO NOT clean TI sight with anything other than the materials listed. DO NOT let lens cleaning solution dry on TI sight lens as damage to TI sight could occur. When wiping lens, wiping motion should be in one direction only (left to right). Wiping in more than one direction can cause damage to TI sight. Throw away dirty cotton pads. Do not re-use.

2. During cold weather, use warm water and lens cleaning solution. Make sure these liquids are not hot; just warm enough not to freeze on TI sight lens.

36. Confirm by practice.

EXTREME CLIMATE MAINTENANCE

37. **High Humidity Maintenance**:

a. All moisture should be carefully removed from all surfaces that have protective covers, caps, etc. The encased missiles and all weapon system components surfaces should be dried when time and conditions permit. Electrical connectors and exposed electrical pins should NOT be allowed to get wet.

b. Moisture can be prevented from settling on the lenses by frequent use of the anti- fogging liquid.

CAUTION

Do not use anti-fogging liquid on front lens of the TI sight. This will degrade the infrared image.

NOTE

The anti-fogging liquid does not prevent the formation of frost.

38. **Cold Weather Maintenance**:

a. TI/optical sights' optics must not be contaminated with snow or ice as this will affect firing. The initial inspection should confirm that the optics are free of snow or ice. In addition, the TI/optical sight eyepieces tend to fog during extended tracking operations and may require cleaning.

WARNING

The TOW 2 should never be operated if the temperature is less than -31.5° C.

b. avoid breathing on the day sight tracker optics; and

c. check all mechanical devices such as switches, clamps and levers for ice or snow.

39. **Hot Weather Maintenance**. Subjecting the encased missiles and weapon system components to prolonged direct sunlight in hot weather must be avoided. Particular weapon components that should NOT be exposed are the TI sight, optical sight, missile guidance set and traversing unit. If no suitable shelter is available to protect the encased missiles and weapon system components, any available material (tarpaulins, cloth, leafy branches, etc.) may be used to provide as much shade or cover as possible.

WARNING

The TOW 2 should never be operated if the temperature is higher that +60°C.

40. **First and Second Line Checks**. Every 90 days, a first line FCS verification is required and annually, a second line FCS verification is required.

41. Confirm by questions.

CONCLUSION

42. Take questions from the class on the entire lesson.

43. Confirm by questions.

44. **Summary**. To include the following:

    a. products to be used in cleaning the TI sight;

    b. reiterate DO NOT allow lens cleaning solution to dry on the TI sight lens;

    c. TOW should never be operated in a temperatures of less than –31.5° C or temperatures greater than 60°C; and

    d. forecast of the next lesson.

LESSON 10
SECURITY AND DESTRUCTION OF THE TOW 2

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following points:

   a. weapon system storage and security; and

   b. destruction of the TOW 2.

2. **Timing**. One 40-minute period.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores are required:

   a. multimedia projector;

   b. screen; and

   c. slides detailing the security and destruction of the TOW 2.

5. **Preparation**. Prior to the start of the period:

   a. set-up the classroom;

   b. confirm the lesson plan; and

   c. confirm the slides.

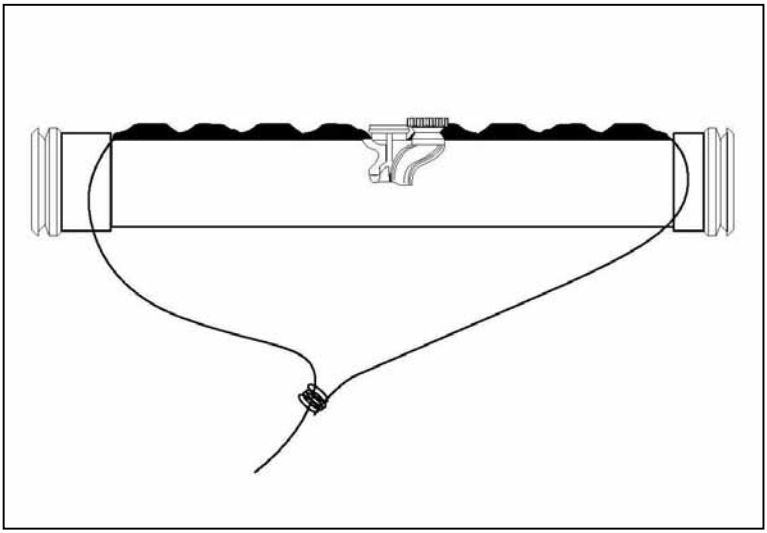


Figure 2-10-1: Demolition of an Encased Missile

CONDUCT OF THE LESSON

6. **Safety Precautions**. Normal

7. **Review**. Review what is required for operator maintenance.

8. **Introduction**. Before the weapon system can be placed in storage it must be disassembled and inspected to ensure that each component is serviceable and protected.

TOW 2 WEAPON SYSTEM STORAGE AND SECURITY

9. **Weapon System Storage Area**. The storage area should have the following characteristics:

a. maximum protection against physical damage, deterioration and corrosion;

b. ambient temperature of -54 to +68°C;

c. be on level ground;

d. provide protection from the elements;

e. have adequate drainage;

f. provide an easy means of surveillance;

g. be equipped with lightning protection devices; and

h. be isolated from any source of electro-magnetic radiation.

10. **Weapon System Storage**. The weapon system should be stored as follows:

a. The TOW 2 weapon system should never be stored directly on the ground.

b. TOW 2 weapon system components should be placed in their travelling cases prior to storage or in special storage cabinets constructed to give necessary protection.

11. Confirm by questions.

12. **Security**. The TOW 2 and encased missile are a complete weapon system, which can be assembled and fired in less than two minutes. Therefore, safeguarding of the weapon system and encased missile is important. The security measures adopted for the handling and safeguarding of the TOW 2 weapon system are basically the same as those prescribed for other crew-served weapons and are contained in A-SJ-100-001/AS-000, Security Orders for the Canadian Forces.

13. **Security Measures**:

a. It is desirable that the five essential components of the TOW 2 (thermal imagery (TI) sight, optical sight, missile guidance set (MGS), traversing unit and launch tube) be stored together in a unit look-up.

b. Where space limitations, readiness considerations and other factors may preclude storage of all components in a lock-up, the following minimum standard will apply:

(1) The MGS and TI sight are stored in a weapons lock-up. They are not stored in a tactical vehicle or in field bivouac areas unless under constant surveillance.

(2) The traversing unit, launch tube, optical sight and the Crew Commanders Target Acquisition System (CCTAS) may be stored in a secure container or locked room, or in a locked armoured vehicle.

14. Confirm by questions.

DESTRUCTION OF THE TOW 2

15. **Destruction of TOW 2**. Destruction of the encased missile and weapon system components is performed by the TOW detachment when these weapons are subject to imminent capture. This action is taken only when, in the judgement of the unit commander, the tactical situation warrants it or when otherwise ordered.

16. In general, TOW 2 components can be destroyed or rendered useless by mechanical means, explosives, gunfire or burning. In order to prevent the enemy from obtaining any useful information, the encased missile and certain weapon system components should be destroyed as completely as possible. When a lack of time or manpower prevents the complete destruction of all parts, it is essential that the encased missile and the priority components of each weapon system be destroyed. Destroying the same components of each weapon system will prevent the enemy from assembling a complete weapon system by cannibalisation.

17. Each unit should have standing operational procedures (SOPs) for TOW 2 destruction. The procedure should encompass priorities of destruction, methods of destruction, quantities of explosives required and detailed instructions concerning the techniques of destruction. The destruction plan should be sufficiently flexible to cover any situation.

18. Destruction of TOW 2 components should be done so thoroughly that the use or restoration to serviceable condition is impossible in the combat zone. In addition, certain weapon system

components could provide important information to the enemy. If time does not permit the destruction of the complete weapon system, as many of the same components as possible from all weapons should be destroyed in the following priority:

a. missile;

b. optical sight;

c. TI sight;

d. MGS;

e. traversing unit;

f. battery assembly;

g. launch tube;

h. tripod; and

i. battery power conditioner.

19. **Destruction of Encased Missiles**. The individual encased missile, because it is a complete round of ammunition, is the priority item and should be destroyed as a complete round in one of the following ways:

a. **Launching**. The simplest and most effective method of destroying the encased missile is to fire it into enemy-held territory. The launching should be done so that missile detonation hinders the enemy in every way possible without endangering friendly troops or equipment.

b. **Demolition Requirements**. The demolition of live ammunition is referred to in B-GL-381-001/TS-000 *Training Safety*. TOW detachment commanders should be thoroughly familiar with the procedures contained in this reference for the destruction of live missiles. To destroy one encased TOW missile, you require the following stores:

(1) 4 kgs (8 blocks) of C4 explosives;

(2) non-electric detonator;

(3) appropriate length of safety fuse; and

(4) a Match Fusee.

c. **Demolition Assembly**. Assembling the demolition is done in the following manner:

(1) Assemble four equal sets of charges by stacking two blocks of C4 on top of each other. Connect each pair together using tape and then lay the four sets in a line. Ensuring positive longitudinal contact between each set of charges tape them together to form one long charge consisting of all eight blocks (see Figure 2-10-1

(2) Make a hole for the detonator near the top centre of the charge. Place the charge along the top of the missile case. Connect the detonator to the required length of safety fuse.

(3) Before directly inserting the detonator into the charge, ensure that you have selected an accessible area that will provide sufficient cover. Finally, insert the detonator and light the scarfed end of the safety fuse, using the Match Fusee. Take cover immediately.

NOTE

Safety Fuse is supposed to burn at a rate of 118-144 seconds per metre To confirm the burning time, first cut off 30 cm of fuse and discard it. Then burn and time a one metre length of fuse to confirm the above burning time. Next calculate the required time to safely reach protective cover (at a walking rate) and cut sufficient Safety Fuse to provide this time.

20. Confirm by questions.

21. **Destruction Methods for the TOW 2 Components**. In selecting the method of destroying TOW 2 components, one must consider the location of friendly troops, availability of personnel, materials required to accomplish destruction and time available. The following methods of destruction are listed in priority, however, the factors stated above could change the priority or method of destruction employed:

WARNING

Do NOT attempt to destroy an encased missile by mechanical methods.

a. **Explosives**. Prepare and place a primed charge of at least 0.5 kg on each major component. Place the explosives inside the part, if possible, to cause the greatest destruction. For example, remove the coil cable and place the charge in the traversing unit, or remove the battery assembly from the MGS, place the charge in the battery well, and replace the battery. After placing the charge, cover the parts with filled sandbags or other heavy materials to increase the explosive effect. Then fire either electrically or non-electrically.

b. **Aimed Fire**. Well-aimed shots from artillery, rockets, tank guns, rifle grenades, rifle fire or other small arms fire should be adequate to render the weapon system useless to the enemy. When using small arms fire, aim for critical component parts,for example the TI/optical sight and MGS.

c. **Mechanical**. This method involves smashing the TOW components, with the exception of the battery assembly, with axes, picks, crowbars, rocks or other means, or driving over each component with a tracked vehicle. Remember the complete destruction of components in their order of priority must be achieved.

WARNING

DO NOT attempt to destroy the BATTERY ASSEMBLY by mechanical methods; as an electrical safety hazard may result if the power output terminals should short-circuit. Discard the battery assembly if no other means of destruction is available.

d. **Burning**. After maximum damage has been done to the weapon system components by the above methods of destruction, and if time permits, the resulting debris should be burned. Vehicle fuels and lubricants can be used to facilitate burning. Another method is the use of one or more incendiary grenades, which can be placed on each component.

22. Confirm by questions.

CONCLUSION

23. Take questions from the class on the entire lesson.

24. Confirm by questions.

25. **Summary**. To include the following:

a. emphasise that the encased missile is a complete round and has priority in destruction;

b. reiterate DO NOT attempt to destroy the BATTERY ASSEMBLY by mechanical methods;

c. stress, when time does not permit the destruction of the complete system then as many as possible of the same component from all systemsshould be destroyed; and

d. a forecast of the next lesson.

LESSON 11
BATTERY CHARGER PP-4884

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following points about the battery charger:

   a. general description;

   b. operational instructions; and

   c. cleaning and preventive maintenance instructions.

2. **Timing** Two 40-minute periods.

3. **Method**. A basic demonstration period.

4. **Stores**. The following stores are required:

   a. battery charger with battery; and

   b. generator.

5. **Preparation**. Check all training aids to ensure everything is operational. Instructors may want to give a quick presentation on the operation of the generator at this time.

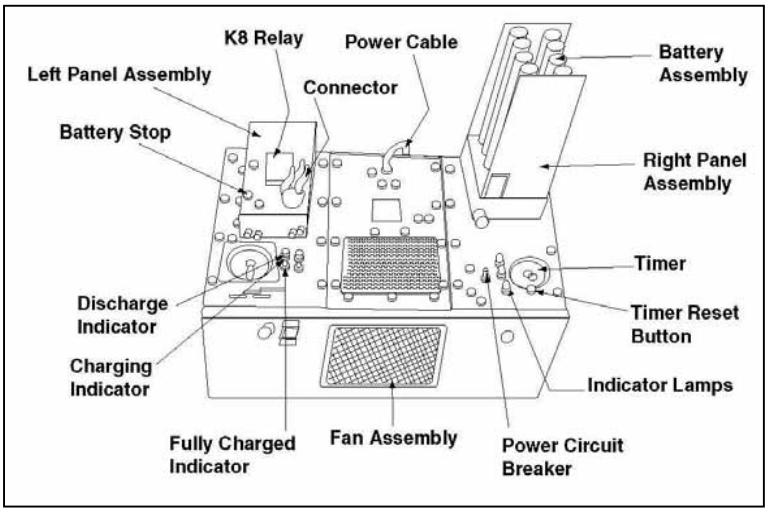


Figure 2-11-1: Battery Charger PP-4884

CONDUCT OF THE LESSON

6. **Review**. Review the description of and data for the TOW Battery.

GENERAL DESCRIPTION

7. **Description**. The battery charger consists of a metallic case, which houses two independently operated battery charging units. The device can be used for either charging a single battery assembly or for simultaneously charging two battery assemblies. Each unit of the device operates by first discharging then recharging the battery assembly. During the discharge cycle, the battery assembly is automatically disconnected from the discharge circuits when the state of discharge reaches a pre-determined level. When this occurs the charging circuits are automatically connected to the battery assembly and the timer is activated. The battery assembly charging cycle will charge for four hours then automatically stop..

8. **Components**. The battery charger consist of the following components:

a. **Relay K8** (mechanical actuator). Automatically assures that the charge/discharge is in the discharge state when the battery is inserted.

b. **Power Cable**. Supplies 110 Volt power to the battery charger.

c. **Fan Assembly**. Cools the battery charger while in operation.

d. **Power Circuit Breaker**. Applies power to the charge/discharge circuits and to the cooling fan.

e. **Fully Charged Indicator**. GREEN light appears when the battery assembly is fully charged.

f. **Charging Indicator**. AMBER light appears when the battery assembly is being charged.

g. **Discharging Indicator**. RED light appears when the battery assembly is being discharged.

h. **Timer**. Measures the charge time and disconnects the charging circuit when the charge time ends.

i. **Timer Reset Button**. Resets the timer and starts the normal discharge/charge cycle.

j. **Battery Stop**. Positions the battery.

k. **Connector**. Connects the battery to the circuit.

l. **Lamp Test Switch**. Test the discharge/charge indicator lights (GREEN, AMBER and RED).

9. **Data and Functioning**. The battery charger operates on 110/120 V, 50-60 cycles, or 400 Hertz power. The POWER circuit breaker must be turned on and the timer-reset button pressed to indicate the discharge/charge cycle. Three coloured indicator lights display the discharge/charge state of the battery charger throughout the cycle. The length of time to complete battery assembly discharge varies depending on the amount of charge in the battery

assembly. After the discharge cycle (indicated by the RED lamp) is completed, the charge cycle (indicated by the AMBER lamp) charges the battery assembly to a full charge in four hours. When the fully charged state is reached (indicated by the GREEN lamp), the battery assembly will be removed and returned to use. A fan controlled by a thermoswitch provides adequate cooling for the battery charger. When the temperature exceeds 53°C, the fan will start cooling operations. If the temperature exceeds 83°C, a second thermoswitch opens to remove power from the discharge/charge circuits.

10. Confirm by questions.

OPERATION

11. **Controls and Indicators.** The top portion of the opened battery charger is equipped with dual controls and indicators to facilitate charging two batteries simultaneously if desired.

12. **Charging Procedure**. There are three major steps to be followed in the battery assembly charging procedures and they are discussed in detail in the following paragraphs. The three major steps in the charging procedures are:

a. battery assembly installation;

b. battery assembly charging; and

c. battery assembly removal.

13. **Battery Assembly Installation**. This is done using the following procedure:

a. Remove the cover from the battery charger.

b. Position the battery charger to allow adequate free air flow through the vents. (Ensure that the POWER circuit breaker is set to OFF).

c. Connect the battery charger to 110/120 V, 50-60 cycles, or 400 Hertz power outlet.

WARNING

The electrolyte in the batteries contains potassium hydroxide, a caustic chemical agent. Should a battery assembly be damaged, care should be taken to prevent the electrolyte from coming in contact with any part of the body. If contact is made, use a boric acid solution and cleanse immediately. Distilled eyewash and a CO2 fire extinguisher must be present at all times.

NOTE

The battery charger should be charged only within the battery temperature limits of -18°C to 80°C. If the battery has been subjected to temperatures outside these limits it should be allowed to stabilise within these limits before attempting to charge.

d. Remove the battery assembly that is to be charged from its carrying case.

e. Remove the protective cap from the connector on the battery assembly by pulling on the outer ring. Store the cap on the storage connector of the battery assembly.

f. Install the battery on the battery charger by holding it vertically and sliding the battery assembly firmly against the battery stop.

g. Ensure that the mechanical actuator on the connector of the PP-4884 slides back and makes a proper connection with the battery assembly when it is installed.

h. Secure the battery assembly to the battery stop with the two lower turn lock fasteners.

14. **Battery Assembly Charging**. The procedure is as follows:

a. Ensure that the black pointer on the timer is set for a four hour charging cycle.

b. Set the power circuit breaker to ON. Rotate the indicator lamp holders for the desired level of illumination.

c. Press the LAMP TEST switch. All lamps should light.

d. Press the timer button firmly to start the discharge/charge cycle.

NOTE

In the following step, if the battery has already been discharged, the RED discharging indicator will immediately extinguish and the AMBER charging indicator will light.

e. Ensure that the RED discharging indicator lights up after the timer button is pressed indicating that the discharge cycle has begun. Ensure that the RED pointer of the timer rotates from zero to the position of the BLACK pointer (set to four hours). If the battery assembly is being discharged for repair, as soon as the discharger cycle is complete, (indicated by illumination of the AMBER charging indicator) remove the battery assembly and return it for repair.

f. Record the date of the charge and the battery charger serial number on a label. Attach the label to the battery assembly between the handle and the two stud fasteners opposite the nameplate. The time for complete battery assembly discharge varies, depending on the amount of remaining charge. After the discharge cycle is complete (3.75 hours maximum), the charge cycle automatically begins (indicated by the AMBER lamp being lit) and charges the battery assembly to a full charge in a period of four hours. Should the charge cycle be temporarily interrupted by

removal of input power (whether due to a power failure, disconnecting the input power connector, operation of the power control thermoswitch, or by the setting of the power circuit breaker to OFF), the charge cycle will continue from the same point when the power returns. However, if power is interrupted and a battery assembly is removed and replaced, the battery charger will return to the discharge cycle when the power is reapplied. When the charge cycle is completed (indicated by the GREEN indicator lamp), the battery assembly can be returned to the user.

15. **Battery Assembly Removal**. To remove the battery assembly proceed as follows:

a. after the battery has reached a fully charged state (indicated by the GREEN light), set the power circuit breaker to OFF;

b. loosen the turn-lock fasteners and carefully remove the battery assembly from the charger;

c. remove the protective cap from the storage connector and install the cap on the connector of the battery assembly;

d. place the battery assembly in its carrying case;

e. disconnect and secure the power input cable; and

f. place the cover on the battery charger.

NOTE

DO NOT press the timer button before removing the charged battery assembly from the charger as this will again start the discharge/charge cycle. DO NOT remove the battery assembly before setting the POWER circuit breaker to OFF.

CLEANING AND PREVENTIVE MAINENANCE

16. **General Cleaning**. The battery charger should always be kept clean of dust, grease or dirt. If this is not done, defects that would otherwise be seen in a visual inspection may not be observed, resulting in equipment failure. General cleaning is as follows:

a. On metal parts use dry, clean rags to remove dust, dirt, grease, moisture and other foreign matter from the battery charger. If the foreign matter cannot be removed using dry rags, dampen a rag with alcohol and gently wipe the area.

b. Clean the rubber parts using a mild detergent and warm water, then dry the parts using a clean, absorbent wiping rag.

c. Use a dry rag to wipe loose particles of dust and lint from glass surfaces. Then, wipe the surface in a circular motion using a lens tissue, either dry or moistened with ethyl alcohol. If dirt, lint or smears remain on the glass, make a swab with a piece of lens tissue. Beginning at the centre of the surface, swab with a circular motion while applying a light downward pressure. Gradually increase the radius of the area being cleaned until the surface has been covered. If necessary, use a rubber syringe to blow away any remaining dust or lint.

17. **Cold Weather Cleaning**. If the temperature is below 0° C, add glycerol to the cleaning water. This prevents it from freezing on the part being cleaned.

18. Alcohol, applied with a lens tissue, may be used to clean the glass surfaces if dry lens tissue does not work satisfactorily. (Do not allow alcohol to contact the rubber parts or sealants as it may cause them to dissolve.)

19. If moisture has frozen on the glass surfaces, apply de-icer or place the unit in a warm area until the ice melts, then pat the surface with a clean absorbent rag. DO NOT RUB. Clean glass surface with lens tissue when the surfaces are dry.

INSPECTION

20. The battery charger inspection should be performed on a weekly basis or more often if required due to extensive use, adverse weather conditions, etc. Check for the following:

a. Accumulation of dirt, oil, grease and other foreign matter.

b. Check exterior for breaks, distortion and other evidence of damage.

c. Check connectors for serviceability and for evidence of damage, wear, bent or broken connector pins.

d. Check for rust, corrosion and missing, chipped or blistered paint. Clean and spot paint as required.

e. Check for legible nomenclature.

LIMITED STORAGE

21. Storage facilities for the battery charger should be on level ground with adequate drainage for maximum protection against physical damage, deterioration and corrosion during the storage period. The facilities should also be maintained at an ambient temperature within the range of 12° C to 20° C.

22. Confirm by practice.

CONCLUSION

23. Take questions from class on entire lesson.

24. Confirm lesson by questions and practice.

25. **Summary**. To include the following:

    a. the importance of good maintenance; and

    b. a forecast of the next lesson.

LESSON 12
CH-146 LOADING AND UNLOADING TOW 2 COMPONENTS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following:

   a. aircraft configuration;

   b. safety rules;

   c. load/unload drills, short distance carry; and

   d. load/unload drills, long distance carry.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic demonstration period.

4. **Stores**. The following stores and equipment are required:

   a. CH-146 or mock-up;

   b. TOW 2 complete;

   c. four rucksacks with tie-downs; and

   d. carrying straps.

5. **Preparation**. Prior to the lecture, the TOW 2 components should be laid out by position number in accordance with Lesson 8 of this Chapter. A detachment's load of equipment should also be rigged prior to the demonstration.

CONDUCT OF THE LESSON

6. **Safety Precautions**. A flight engineer will brief on the safety precautions as they apply to aircraft drills.

7. **Review**. Review dismounted TOW 2 detachment drills.

AIRCRAFT CONFIGURATION

8. **Introduction**. TOW 2 detachments can be employed in many types of missions using the CH-146 helicopter for transport. The nature of the mission determines how many people and what equipment is needed. The aircraft load limit determines the load configuration and how much equipment is loaded on a helicopter. Many aircraft configurations may be used for this purpose but it has been found more convenient to have the two passenger side-facing seats raised or, preferably, removed.

9. Ideally, a TOW 2 detachment has a basic load of 10 missiles. This is possible in certain operations where the LZ is very close to the TOW firing position. Further dumping of missiles carried by additional helicopters is also possible if the tactical situation permits it. However, if the detachment must walk a distance of more than 500 metres from the LZ to the firing position, the number of missiles is limited by what the personnel can carry. In those cases, the conditions described in Lesson 8 (TOW Detachment Drills) apply.

10. Although it is possible to carry two detachments in a single CH 146 helicopter, this severely restricts the number of missiles that can be carried and/or the flight time of the aircraft. Thus, in nearly all cases, a single CH-146 helicopter as described in this Chapter carries only one detachment.

SAFETY RULES

11. **Safety Rules**. The following safety rules apply with respect to helicopters:

a. Prior to loading the following will be checked:

(1) chin strap of the helmet is fastened or field caps are removed;

(2) loose equipment and clothing are tied down;

(3) weapon bipods folded;

(4) grenades secured;

(5) bayonet unfixed;

(6) weapons on safe, no rounds in chamber, no magazine on the weapon;

(7) camouflage checked for security;

(8) radio antenna folded down; and

(9) the loading order of section must be known.

b. During the loading and the flight the procedure is to:

(1) load when the crew gives approval (thumbs up). Chalk leader acknowledges with thumbs up;

(2) move at the double, with a low silhouette;

(3) approach the CH-146 from the front at the 12 o'clock position reference the helicopter;

(4) load in the assigned order;

(5) avoid the tail rotor;

(6) tie down the cargo which is the flight engineer’s responsibility;

(7) fasten safety belts, with the detachment commander wearing the headset;

(8) position weapons between legs, vertical with the muzzles up; and

(9) minimise movement and no smoking.

12. Confirm by questions.

LOADING/UNLOADING DRILLS, SHORT DISTANCE CARRY (LESS THAN 500 METRES)

13. **Loading Drills**. When preparing to board the aircraft, the TOW detachment should line up at the 12 o'clock position facing the aircraft and with their respective equipment. The order of march will be No. 1, No. 2, No. 4 and No. 3.

14. **Loading**. After having received the thumbs up from the pilot, the TOW detachment will place their components one metre from the jump seat door on the port side. This will allow enough room to load the components without tripping on them. Load the TOW 2 components in the following order:

a. After placing his components on the ground the No. 1 places the tripod in the rear back corner against the bulkhead and remains by the door to load the remainder of the components.

b. The No. 2 will pass the launch tube to the No. 1 and places the rest of his components on the ground and boards the helicopter. Meanwhile the No. 1 places the launch tube against engine compartment and the tripod.

c. The No. 4 will pass the missile to the No. 1 and places the remainder of his components on the ground and boards the helicopter. Meanwhile the No. 1 places the missile nose up against the engine compartment and the launch tube (see Figure 2-12-1).

Figure 2-12-1: Stowage of Tripod, Launch Tube and Missile

d. The No. 3 will pass the boresight collimator to the No. 1, place the remainder of the components on the ground and remains to assist the No. 1. Meanwhile the No. 1 places the boresight collimator with the handle out against the bulkhead and the tripod.

e. With assistance from the No. 3, the No. 1 loads the remainder of the components in the following order:

(1) thermal imagery (TI) sight, handle out, on top of the boresight collimator;

(2) the missile guidance set (MGS), on its side, handle out against the boresight collimator and missile (see Figure 2-12-2);

Figure 2-12-2: Stowage of MGS, Collimator and Thermal Sight

(3) the battery power conditioner, on top of the TI sight against the bulkhead;

(4) the spare battery case, on top of the TI sight, beside the battery power conditioner;

(5) the traversing unit (TU) on top of the MGS, with the coil cord down and the bride clamp lever towards the missile (see Figure 2-12-3);

Figure 2-12-3: Stowage of Traversing Unit, Battery Power Conditioner and Spare Battery Case

(6) the optical sight system (OSS), on top of the battery power conditioner and spare battery case.

f. Once the No. 3 has passed the OSS to the No. 1, the No. 3 boards the helicopter.

g. Once the No. 1 has loaded the OSS, the No. 1 boards the helicopter and puts on the headset.

15. The flight engineer will now secure the components and partially close the door handing it off to the No. 1, who will secure the door (See Figure 2-12-4).

Figure 2-12-4: Stowage of OSS and Securing of Cargo

16. Confirm by practice.

NOTES

1. If two detachments are boarding the helicopter, the section commander's detachment loads on the port side, while the section 2IC's detachment loads on the starboard side.

2. If only one detachment is boarding the helicopter, additional missiles are strapped vertically with the noses up, loaded in the starboard jump seat area.

17. **Unloading**. At the destination the flight engineer opens the starboard door and unfastens the straps retaining the additional missiles/TOW components on the starboard side. The section/detachment commander opens the port door and the detachment unloads the equipment after receiving the signal from one of the aircraft crew. The procedure is as follows:

a. The detachment unloads the TOW 2 components in the reverse order of the load drill.

b. The first member of the detachment lays down on the ground in line with the pilot two meters from the skids. The remainder of the detachment lay down in succession away from the helicopter with their legs touching.

18. Confirm by practice.

LOADING/UNLOADING DRILLS, LONG DISTANCE CARRY (GREATER THAN 500 METRES)

19. **Loading**. After having received the thumbs up from the pilot, the TOW detachment will move to the port side door and perform the following:

a. The No. 1 puts his rucksack on the helicopter floor, then assists the No. 2 in removing his rucksack.

b. Once the No. 2 hands his rucksack over to the No. 1, he boards the helicopter and places the No. 1's rucksack behind the pilot.

c. The No. 1 then hands his rucksack to the No. 2 who places it behind the co-pilot. The No. 1 then assist the No. 4 in removing his rucksack.

d. Once the No. 4 has his rucksack off, he boards the helicopter and takes up the proper position in the aircraft. The No. 1 then hands the No. 4's rucksack to the No. 2 who places it on top of the No. 1's rucksack.

e. Once the No. 1 hands off the No. 4's rucksack he assists the No. 3 in removing his rucksack.

f. The No. 3 then boards the helicopter and takes up the proper position in the aircraft. The No. 1 hands the rucksack to the No. 2 who places it on top of the No. 2's rucksack.

g. The No. 1 and the No. 2 seat themselves.

h. At this time the flight engineer will secure the rucksacks to the floor boards and partially close the port side door.

i. The No. 1 will close and secure the door and then put on the headset.

20. Confirm by practice.

21. **Unloading**. At the destination the flight engineer opens the starboard door and unfastens the rucksacks. The detachment commander opens the port door and after receiving the signal from one of the aircraft crew, the detachment unloads the equipment as follows:

a. The detachment unloads the rucksacks in the reverse order of the load drill.

b. The first member of the detachment lays down on the ground in line with the pilot two meters from the skids. The remainder of the detachment lay down in succession away from the helicopter with their legs touching.

22. Confirm by practice.

CONCLUSION

23. Take questions from the class on the entire lesson.

24. Confirm lesson by practice.

25. Pack kit.

26. **Summary**. To include the following:

a. stress that the TOW 2 is man-packed for short distances only, due to the weight; and

b. give a forecast of the next lesson.

LESSON 13
TOW TRENCH

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following:

   a. characteristics of a TOW position;

   b. occupation of a TOW position;

   c. stages of construction; and

   d. clearances for dismounted TOW.

2. **Timing**. Nine 40-minute periods.

3. **Method**. The training will be conducted using both lecture and practice techniques.

4. **Stores**. The following stores and equipment are required:

   a. dismounted TOW as per checklist;

   b. defensive stores;

   c. section stores; and

   d. a suitable training area.

5. **Preparation**. If an actual trench can not be prepared, a model or detailed diagram should be provided. A detachment's worth of kit and ammunition should be loaded into the trench.

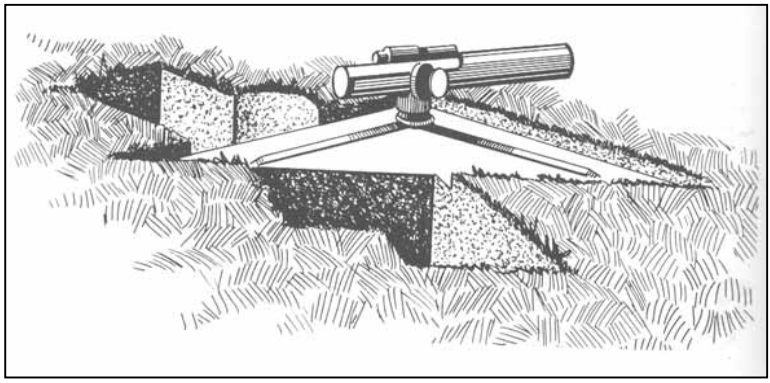


Figure 2-13-1: Example of a Dismounted TOW Trench

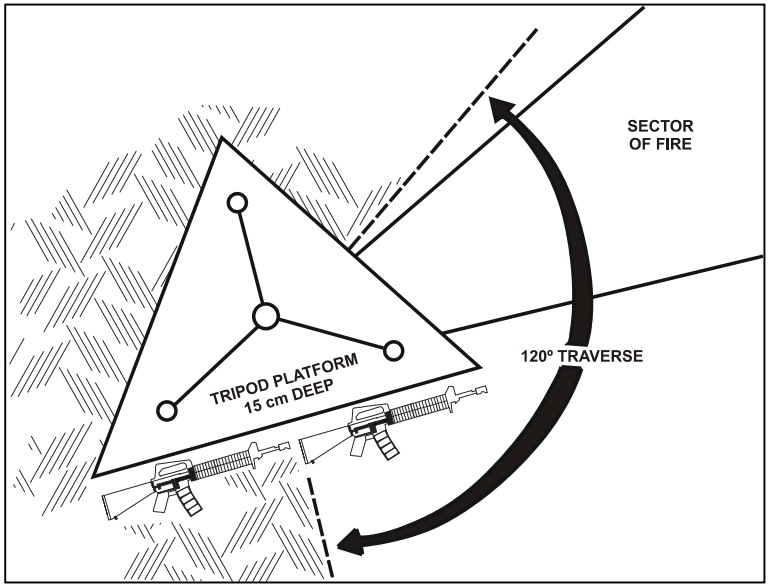


Figure 2-13-2: TOW Trench Weapon Platform

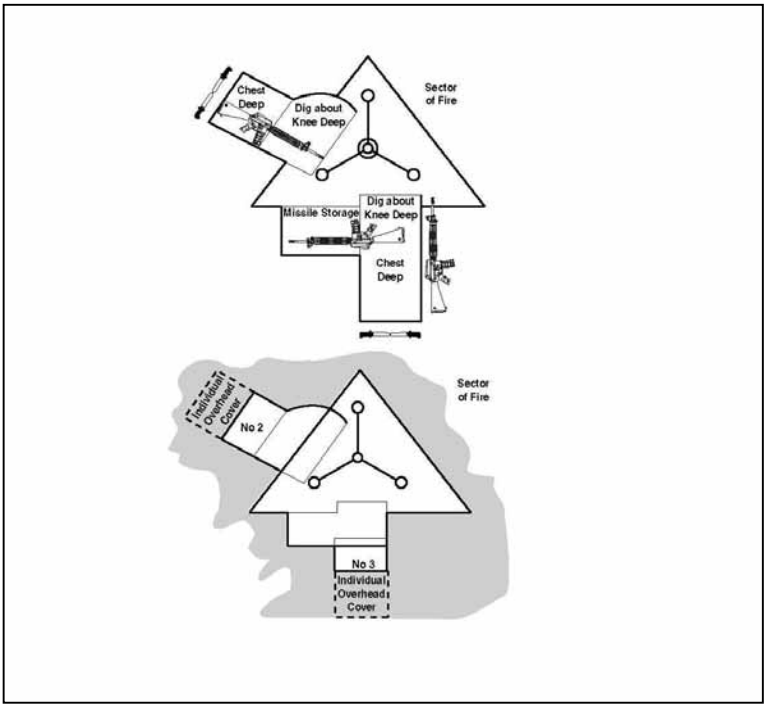


Figure 2-13-3: TOW Trench Simplified Measurements

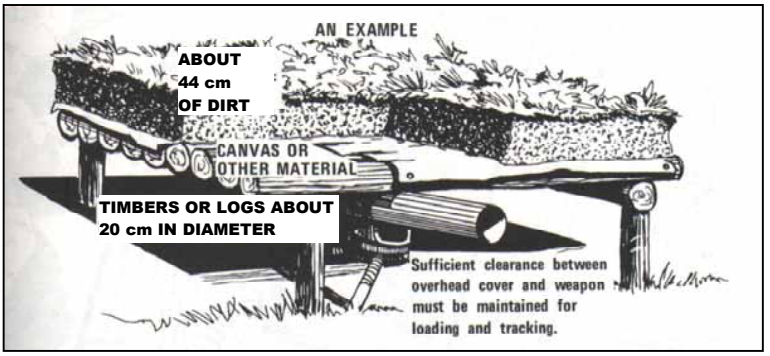


Figure 2-13-4: Example of TOW Trench with OHP

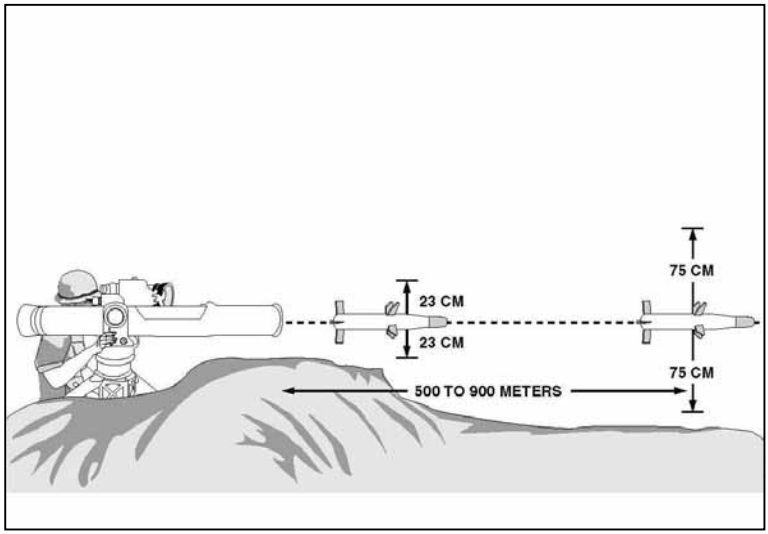


Figure 2-13-5: TOW Clearance Requirements

CONDUCT OF THE LESSON

6. **Safety Precautions**. Carry out normal safety precautions on the TOW and any personal weapons present.

7. **Review**. There is no review required.

8. **Introduction**. The dismounted TOW weapon system is highly vulnerable, since it has no protective armour and very little mobility. The TOW trench will afford it greater protection from direct and indirect fire through cover, concealment and the use of defilade positions. Whatever trench or position is adopted, it must satisfy certain missile clearance requirements. This section defines these clearances and examines the basic weapon system pit.

CHARACTERISTICS OF A GOOD TOW POSITION

9. A good TOW position should have the following characteristics:

a. provide cover from enemy fire and concealment from ground and air observation;

b. allow for observation of the arc of fire of the movement of our own troops;

c. have covered approaches;

d. have good exits; and

e. have good fields of fire.

10. Confirm by questions.

OCCUPATION OF A TOW POSITION

11. In the occupation of a TOW position every attempt should be made to do so undetected by the enemy. To achieve this, stealth, concealment and rapidity will need to be exercised by all members of the TOW crew.

12. The occupation of a TOW position is carried out in the following progressive steps:

a. The section commander receives orders assigning tasks and general location from the platoon commander.

b. The section commander gives a warning order to his section, and specifies a rendezvous (RV) with the detachment commander.

c. The section commander conducts his reconnaissance and returns to the RV where he briefs the section. He will take the detachment commander forward to point out the location of the weapon's site. He will indicate the arcs of responsibility and the exact location for the tripods.

d. The detachment commanders will return to their detachment and bring them forward.

13. On arrival of the detachment at the site, the detachment commander will:

a. designate the area for the tripod, then orders the weapon assembled;

b. brief the detachment on arcs of fire, targets and specific orders; and

c. ensures that a range card and a trace are completed.

14. Confirm by question and practice.

STAGES OF CONSTRUCTION OF A TOW POSITION

15. **Step 1—Weapon System Platform**. In this step, a triangular hole is dug 2 x 2 x 2 metreswith the base of the triangle being perpendicular to the enemy's advance. The depth of this hole should be 15 cm. (See Figure 2-13-2). This hole allows the weapon system to be set up with the tripod in the medium position and still maintain the minimum 23 cm (9 inch) clearance between the end of the launch tube and the ground. The digging of a small depression is required to accommodate the missile guidance set (MGS). It is not recommended that the tripod be set up in the high position as this will either result in a high weapon silhouette or in needless digging. Shellscrapes for the No. 2 and No. 3 may be dug perpendicular to their respective sides of the triangle.

NOTE

This configuration of the tripod legs restricts traverse to 120 degrees. Be sure the tripod legs don't interfere with tracking across the entire sector of fire.

16. **Step 2—Digging of Crew Compartment and Missile Bay**. If shellscrapes were not previously prepared, mark a hole for

the gunner to the left of the weapon and one for the loader to the right. These holes are one-man positions that are 1 metre long and 45 cm wide. Missiles are stored in an upright position. The missile storage area is 60 cm square and 1.5 metres deep (See Figure 2-13-3).

17. **Step 3—Revetment and Overhead Cover (OHC)**. Both the crew compartment and missile bay are revetted in the same manner and using the same materials as the standard two-man infantry battle trench. Overhead protection (OHP) can be constructed using any type of material that is strong enough to support 45 cm of dirt, but care must be taken to ensure that OHP does not extend over either end of the weapon (See Figure 2-13-4). Individual OHP or OHC may be constructed as an extension to the No. 2 and No. 3 position. The No. 1 and No. 4 may then dig their positions off of the No. 2 and No. 3 trenches respectively.

18. Confirm by practice.

CLEARANCES

19. There are two clearance requirements to ensure that a missile will not hit the ground before reaching a target:

a. There should be at least 23 cm (9 inches) of muzzle clearance around the forward end of the launch tube to ensure that the wings and control surfaces do not hit anything when they extend after the missile clears the launch tube. If the wings are damaged or catch on an object, the missile will fly erratically or impact the ground.

b. There should be at least 75 cm (30 inches) of line-of-sight clearance between the gunner's line of sight to a target and any ground or obstructions that is between 500 and 900 metres from the firing position. If line-of-sight clearance is less than 75 cm, the probability of the missile hitting the ground or obstruction is increased. This is because a missile does not precisely follow a gunner's line of sight to the target. At least 75 cm insures a

better than 90 percent probability of survival for the missile (See Figure 2-13-5).

CONCLUSION

20. Take questions from the class on the entire lesson.

21. Confirm by practice.

22. Pack kit.

23. **Summary**. To include the following:

    a. the sequence of occupation and preparation of a TOW position;

    b. the key factor which applies is the amount of time available and the resources that you have will determine the outcome of the position; and

    c. a forecast of the next lesson in this subject.

TIVE MEASURES

RECTIVE MEASURES
e optical sight
e optical sight
of VEHICLE POWER CONDITIONER
e BATTERY ASSEMBLY and tag battery
e MISSILE GUIDANCE SET
e MISSILE GUIDANCE SET
e BATTERY ASSEMBLY and tag battery
Y ASSEMBLE and allow MISSILE
to cool off for 5 to 10 minutes
e MISSILE GUIDANCE SET
e MISSILE GUIDANCE SET
MAL IMAGERY (TI) SIGHT cables are
s turned ON and the NFOV (Narrow Field
ted
ce TI SIGHT.
of POST AMPLIFIER (PA) cable
TI BATTERY POWER CONDITIONER
TI BATTERY POWER CONDITIONER
TI SIGHT BATTERY POWER
e TI SIGHT
S CONTROL on the OPTICAL sight (OSS)
TH and ELEVATION BORESIGHT
ne direction, then back off halfway
e OPTICAL SIGHT
ERATE SWITCH. Set boresight adjustment
re
e OPTICAL SIGHT
e MISSILE GUIDANCE SET
e TRAVERSING UNIT
e MISSILE GUIDANCE SET

COMPONENT	
TI SIGHT	- TI SIGHT C
	- TI SIGHT C steadily for m - RETICLE no MONITOR I
	- TI SIGHT RI IMAGE will clear when ac - FOV (Field o to see more a displayed ima when changi (Wide) - ON/OFF/STI COOLER do for 1 to 3 mi COOLER CY seconds and STBY MOD - TRIGGER d properly/click TRIGGER is - LAUNCH TU securely to T - BRIDGE CL open without - Second Click the BRIDGE LEVER is be lowered - ELECTRICA completely in CLAMP - ELECTRICA not extend ap ARMING LE
TRAVERSING UNIT	
	- ARMING LE when armed on its own wh is raised

ANNEX B
TOW 2 SYSTEM PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

NOTES

1. **Column 1, Item No**. Column 1 numbers the checks and services to be performed in chronological order. This column may also be used as a source of item numbers for the equipment logbook which is used to keep an accurate record of the TOW 2.

2. **Column 2, Interval**. Column 2 specifies the intervals at which the PMCS will be performed. An (X) in any Interval column indicates when you are to perform that PMCS. The letters indicate the interval as follows:

B — Before operation,

D — During operation,

P — Post operation,

S — Once every six months (semi-annually by maintenance),

A — Once a year (annually by maintenance).

3. **Column 3, Item to be Checked**. Column 3 identifies the part of the equipment to be checked and the procedures for performing the check.

4. **Column 4**. Equipment will be reported not ready or not available as a result of the problem detailed in Column 4.

5. **DO NOT** perform PMCS with encased missile loaded in launch tube.

B—Before D—During P—Post S - Semi-Annually
A—Annually

ITEM No.	INTERVAL					ITEM TO BE CHECKED	FOR READINESS REPORTING, EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	P	S	A		
1.	X					**Connector J1** Check for damage or dirt	Connector is cracked or badly dented and cannot be used.
2.	X					**Tripod** Check operation of leg locks, and detent stop levers. Check for dirt, rust and loose, damaged or missing parts. Clean as necessary.	Leg locks are inoperable. Detent stop levers do not operate properly. Coupling clamp broken or missing. Level vials broken or no bubble.
3.	X					**Traversing Unit** Check for damaged or missing parts on the optical sight, tracker and tube. Check that locking handle and arming lever work properly. Make sure the day sight tracker and launch tube can be mounted. Check that azimuth lock, elevation lock and elevation brake work properly. Check coil cable and post-amplifier cable for damage. Check cable connectors for damage, broken pins or foreign material.	Traversing unit will not mate with tripod. Coil cable or post-amplifier cable damaged.

ITEM No.	INTERVAL					ITEM TO BE CHECKED	FOR READINESS REPORTING, EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	P	S	A		
						Check umbilical connector for dirt, damage and broken pins. Clean if required.	Umbilical connector damaged.
						Check verification label to make sure semi-annual verification is not past due.	Verification date past due.
						Clean as necessary.	
4.	X					**Launch Tube**	
						Check launch tube for cracks, pits, tears, visible raised areas, exposed fabric or exposed threads inside. Check index lugs for damage. Check for dirt and other foreign material. Clean as required.	Inside bore split, cracked, pitted torn or gouged through one layer of fibreglass or has visible raised areas, exposed fabric or exposed threads.
							Index lugs damaged and will not engage traversing unit properly.
5.	X					**Optical Sight Tracker**	
						Check for damage or missing components.	
						Make sure that all controls operate properly.	
						Make sure that image can be seen through eyepiece.	A clear image in sharp focus cannot be seen.
						Make sure that the optical sight tracker mates securely with traversing unit.	Optical sight tracker will not mate with traversing unit.

ITEM No.	INTERVAL					ITEM TO BE CHECKED	FOR READINESS REPORTING, EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	P	S	A		
						Check humidity indicator to be sure that 30 percent section is blue. If 30 percent section is pink or white, notify support maintenance to replace desiccant.	
						Check verification label to make sure semi-annual and annual verification are not past due. Clean as required.	Verification date past due.
					X	Return to direct support for annual verification with LCSS or TOW Field Test Set (TFTS).	
6.	X					**Thermal Imagery (TI) Sight**	
						Check for damaged or missing components.	
						Make sure lens cover is installed and its retaining strap is not broken.	
						Make sure TI sight mounts securely on optical sight system (OSS).	TI sight will not mount on OSS.
						Make sure that all controls operate properly.	

ITEM No.	INTERVAL					ITEM TO BE CHECKED	FOR READINESS REPORTING, EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	P	S	A		
						Clean as required.	
						Check verification label to make sure semi-annual verification is not past due.	Verification date past due.
						Check battery power conditioner for dents, cracks or other damage that might prevent proper operation.	Battery power conditioner not serviceable.
						Check for two batteries installed in battery power conditioner	Batteries not installed.
						Check for two spare batteries.	Batteries not available.
				X		Notify direct support to perform TI sight verification.	
6.1	X					**Boresight Collimator**	
						Check collimator and case for damaged or missing components.	
						Inspect lenses and mirror for cracks or scratches.	Optics badly scratched or broken.
						Check serviceability of knobs.	Knobs inoperable.
						Check verification label to make sure semi-annual verification is not past due.	Verification date past due.

ITEM No.	INTERVAL					ITEM TO BE CHECKED	FOR READINESS REPORTING, EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	P	S	A		
				X		Notify direct support to perform boresight collimator verification.	
7.	X					**Missile Guidance Set**	
						Check for damaged or missing components.	Display damaged.
						Check connectors for damage and bent or broken pins.	Bent or broken pins or damaged connectors.
						Make sure that all controls operate properly.	
						Check that battery can be installed.	Battery cannot be installed.
						Check verification label to make sure semi-annual verification is not past due.	Verification due date past due.
				X		Notify direct support to perform a missile guidance set verification	
8.	X					**Battery Assembly**	
						NOTE The following checks must be performed on both battery assemblies for tripod-mounted system.	
						Check battery assembly for dents, cracks or other damage.	Battery assembly not serviceable.

ITEM No.	INTERVAL					ITEM TO BE CHECKED	FOR READINESS REPORTING, EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	P	S	A		
						Make sure that at least four wing nuts operate properly.	Fewer than four wing nuts are operable.
						Check that battery assembly can be installed in missile guidance set.	Battery assembly cannot be installed in missile guidance set.
9.	X					**TOW 2**	
						Perform system checkout procedure.	Fails system checkout procedure.
						NOTE 1. Both batteries must pass system checkout procedure. 2. When the weapon system is in storage (not in use), the system checkout procedure must be performed monthly.	One or both batteries fail system checkout procedure.
				X		Notify direct support to perform system verification.	

ANNEX C
PERFORMANCE OBJECTIVE
ASSEMBLE, DISASSEMBLE, SELF TEST AND BORESIGHT/COLLIMATION OF THE TOW 2 WEAPON

PART I

STUDENT'S NAME _____

DATE _____

This is a PASS/FAIL test.

Automatic FAIL for violation IAW remarks column.

FAIL if there are a total of 10 or more minor infractions.

PART II

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
1. **SETTING UP THE TRIPOD** a. release the friction locks on the tripod legs							

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
b. point down hill leg towards the target area							
c. depress the detent stop levers							
d. allow the legs to spread to the second detent stops							
e. ensure the tripod mounting base is level by checking the two levels							
f. engage the friction locks on the tripod legs							Fail if not done.
g. release the grooved coupling clamp locking lever							

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
2. **MOUNTING THE TRAVERSING UNIT (TU)** a. extend the coil cord from its stored position							
b. pass the coil cord through the base of the tripod							
c. mount the traversing unit on the tripod and ensure it is properly seated							
d. align the traversing unit with the tripod by the use of the red indication arrows and ensure the azimuth lock is in line with the back level							
e. close and lock the grooved coupling clamp and engage safety spring							Fail if TU not mounted correctly.

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
f. ensure the traversing unit is securely mounted							Fail if TU not mounted correctly.
g. turn traversing unit from side to side until it locks into place;							
h. check the 2W1P1 connector on the coil cord for damage and cleanliness;							
i. check trigger operation to ensure the trigger returns to its original position							
j. check the bridge clamp operation							
k. check the electrical connector							
l. check arming lever operation							

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
3. **MOUNTING THE OPTICAL SIGHT (OSS)** a. release the sight locking latch by placing it in the down position							
b. align the sight mounting bracket with the boresighting plate on the traversing unit							
c. raise the sight locking latch until the lock engages							
d. ensure the OSS is securely mounted							Fail if sight not mounted correctly.
f. ensure the reticle light is off							
g. rotate focus ring to +3							
h. check humidity indicator							

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
4. **INSTALLING THE LAUNCH TUBE** a. raise the forward end of the launch tube and slide the mounting lugs into the horizontal hooks on the trunnion							
b. lift the launch tube latch and lower the launch tube until the locating pin is engaged							
c. secure the launch tube in position by closing the latch							
d. check launch tube latch to ensure it is engaging the launch tube and remains locked							

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
e. ensure launch tube is secure and free of dirt, missile wires and foreign matter							
5. **INSTALLING THE BATTERY ASSEMBLY IN THE MISSILE GUIDANCE SET (MGS)** a. remove the cover from MGS							
b. remove the protective cap from the battery assembly connector and place it on the storage connector							
c. align the rails of the battery assembly with the battery guides of the MGS							
d. allow the battery assembly to slide into the battery compartment under control							

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
e. apply pressure to the top of the battery assembly and ensure it is flush with the top of the MGS							
f. turn and tighten all turn-lock fasteners							
6. **CONNECTING THE TRAVERSING UNIT TO MGS** a. position the MGS to the right of the down hill leg							
b. align the colour guides on the 2W1P1 connector and the MGS J1 connector							
c. engage the connector with a minimum of force							

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
d. tighten the locking nut until the red mark on the MGS J1 connector cannot be seen							Fail if J1 not connected to MGS correctly.
7. **MOUNTING THE THERMAL IMAGERY (TI) SIGHT** a. remove TI sight from field handling case							
b. place coarse collimation control in proper position							
c. move latch handle toward rear of TI sight							
d. align and seat TI sight on top of the optical sight							
e. move latch handle forward to secure TI sight							

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
f. ensure TI sight is secure							Fail if not secure.
g. remove and inspect post-amplifier cable and connect to TI sight ensuring cable is clear of bridge clamp							Fail if PA cable not connected.
8. **INSTALLING BATTERIES INTO THE BATTERY POWER CONDITIONER AND CONNECTING TO TI SIGHT** a. remove the battery cover							
b. place two non-rechargeable lithium batteries into the power condition, ensuring the connectors are aligned							

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
c. replace the cover and secure the spring locks							
d. connect battery power conditioner cable to TI sight, set circuit breaker switch to ON							
e. turn TI sight On/Off/Stby switch to ON							
f. remove front lens cover and set field-of-view (FOV) switch on NFOV (Narrow Field of View)							
9. **WEAPON SELF-TEST** a. ensure TI sight On/Off/Stby switch is ON, FOV is on NFOV and set focusing ring of the OSS to +3							

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
b. lock system down, ensuring the arming lever is down and there is no missile in the launch tube							
c. push up and hold self-test switch and monitor weapon self test ensuring the OSS is boresighted							Fail if not boresighted correctly.
d. release TEST/ OPERATE switch and close cover							
e. check the operation of the reticle light in the OSS. In order to facilitate the check during daylight, the front lens of the sight should be covered.							
10. **BORESIGHT COLLIMATION** a. secure boresight collimator to TI sight							

	ASSEMBLES			DISASSEMBLES			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
b. connect power cable to 3J1 and J4 connectors							
c. carry out boresight collimation							Fail if collimation not done correctly.
d. disconnect and stow boresight collimator							

PART III
GENERAL REMARKS

_____
Instructor's Signature

ANNEX D
PERFORMANCE OBJECTIVE
LOAD AND UNLOAD THE TOW 2

PART I

STUDENT'S NAME_____

DATE _____

This is a PASS/FAIL test

Automatic Fail for violation IAW Remarks Column

Fail if there are 10 or more minor infractions

PART II

	IE	E	VE	REMARKS
LOADING 1. **Actions of No. 2**. Upon hearing the command LOAD or LOAD 2B from the No. 1, the No. 2:				
a. ensures the Elevation and Azimuth friction locks are engaged and the weapon is locked down;				.
b. ensures the trigger cover is down;				Fail if not done
c. ensures the thermal imagery (TI) sight On/Off/Stby switch is ON;				
d. operates selectable filter to reset/clear position;				
e. ensures WFOV(Wide Field of View) is selected;				

	IE	E	VE	REMARKS
f. ensures both sight covers are off;				
g. repeats the command LOAD or LOAD 2B; and				
h. remains in firing position and observes arcs of fire.				
2. **Actions of No. 3**. Upon hearing the command LOAD or LOAD 2B from the No. 2, the No. 3:				
a. repeats the command LOAD or LOAD 2B;				
b. raises the bridge clamp and inspects the launch tube;				
c. visually inspects the specified encased missiles;				
d. checks the humidity indicators;				
e. removes the forward handling ring and clamp and inspects the diaphragm;				
f. removes and retains the electrical connector cap;				
g. with electrical connector upwards, aligns the indexing lugs of the encased missile with the indexing slots of the launch tube, slides the encased missile forward and down until the missile is fully seated; and				Fail if wrong missile is loaded.
h. lowers the bridge clamp (apply pressure with the right hand while locking it with the left).				
3. **Actions of No. 2**. Once the No. 3 has locked the bridge clamp, the No. 2 reports READY.				

	IE	E	VE	REMARKS
TARGET ENGAGEMENT				
1. **Actions of No. 2**. Upon hearing the command TARGET or a fire control order from the No. 1, the No. 2:				
a. repeats the command TARGET; and				
b. ensures the TI sight is on WFOV.				
2. **Actions of No. 3**. Upon hearing the command TARGET from the No. 2, the No. 3:				
a. checks the backblast danger area and reports BACKBLAST; and				Safety violation.
b. observes the backblast danger area ensuring it remains safe until the missile is fired.				Safety violation.
3. **Actions of No. 2**. Upon hearing BACKBLAST from the No. 3, the No. 2:				
a. disengages the azimuth and elevation brake and locks;				
b. rough aligns the weapon to the direction of the target while repeating the target indication;				
c. searches for and places the crosshairs on the target;				
d. switches the TI sight to NFOV (Narrow Field of View), focuses and adjusts the sight picture; and				Fails if the TI sight is not set to NFOV.
e. reports ON.				
4. **Actions of No. 3**. Upon hearing ON from the No. 2, the No. 3:				

	IE	E	VE	REMARKS
a. repeats ON; and				
b. raises the arming lever and reports, ARMED.				
5. **Actions of No. 2**. Upon hearing ARMED from the No. 3, the No. 2:				
a. raises the trigger cover; and				
b. awaits further orders from No. 1 or engages the target as per fire control orders.				
MISSILE NOT FIRED CEASE TRACKING UNLOAD				
1. **Actions of No. 2**. Upon hearing the command CEASE TRACKING UNLOAD from the No. 1, the No. 2:				
a. lowers the trigger cover;				Safety violation.
b. repeats CEASE TRACKING UNLOAD; and				
c. continues to observe the arcs of fire.				
2. **Actions of No. 3**. Upon hearing the command CEASE TRACKING UNLOAD from the No. 2, the No.3:				
a. repeats, CEASE TRACKING, UNLOAD; and				
b. lowers the arming lever and reports, DISARMED.				Safety violation.
3. **Actions of No. 2**. Upon hearing DISARMED from the No. 3, the No. 2:				
a. ensures the trigger cover is lowered;				
b. engages the elevation lock and brake;				

	IE	E	VE	REMARKS
c. engages the azimuth lock;				
d. locks the weapon system down;				
e. places TI sight On/Off/Stby switch to Stby;				
f. places the TI sight to WFOV;				
g. replaces the TI sight cover; and				
h. remains in firing position and observes the arcs of fire.				
4. **Actions of No. 3**. When the weapon system has been locked down, the No. 3:				
a. unlocks and raises the bridge clamp;				
b. removes the encased missile from the launch tube;				
c. inspects the launch tube, closes the bridge clamp and reports LAUNCH TUBE CLEAR;				
d. replaces the forward handling ring and clamp;				
e. replaces the electrical connector cap;				
f. secures the encased missile; and				
g. remains in position observing the arcs of fire and awaits further orders from the No. 2.				
5. **Actions of No. 2**. Upon hearing LAUNCH TUBE CLEAR from the No. 3, the No. 2:				
a. reports ALL CLEAR; and				

	IE	E	VE	REMARKS
b. remains in firing position observing the arcs of fire and awaits further orders from the No. 1.				
CEASE TRACKING				
1. **Actions of No. 2**. Upon hearing the command CEASE TRACKING from the No. 1, the No. 2:				
a. lowers the trigger cover;				Safety violation.
b. repeats CEASE TRACKING; and				
c. remains in firing position.				
2. **Actions of No. 3**. Upon hearing CEASE TRACKING from the No. 2, the No. 3:				
a. repeats CEASE TRACKING;				
b. lowers the arming lever and reports DISARMED; and				Safety violation.
c. remains in position observing the arcs of fire and awaits further orders from the No. 2.				
3. **Actions of No. 2**. Upon hearing DISARMED from the No. 3, the No. 2:				
a. ensures the trigger cover is lowered;				
b. places the TI sight to WFOV ;				
c. reports DISARMED, READY; and				
d. remains in firing position observing the arcs of fire while awaiting further orders.				

	IE	E	VE	REMARKS
MISSILE HAS BEEN FIRED CEASE TRACKING UNLOAD				
1. **Actions of No. 2**. Upon hearing CEASE TRACKING UNLOAD from the No.1, the No. 2:				
a. lowers the trigger cover;				Safety Violation.
b. engages the elevation lock and brake;				
c. engages the azimuth lock;				
d. locks the weapon system down;				
e. repeats CEASE TRACKING, UNLOAD;				
f. turns the TI On/Off/Stby switch to Stby;				
g. places the sight to WFOV;				
h. replaces the TI sight cover; and				
i. remains in firing position and observes the arcs of fire.				
2. **Actions of No. 3**. Upon hearing the command CEASE TRACKING UNLOAD from the No. 2, the No. 3:				
a. repeats CEASE TRACKING, UNLOAD;				
b. unlocks and raises the bridge clamp;				
c. removes the empty missile container from the launch tube;				
d. inspects the launch tube and closes the bridge clamp;				
e. reports LAUNCH TUBE CLEAR; and				
f. remains in position observing the arcs of fire and awaits further orders from No. 2.				

	IE	E	VE	REMARKS
3. **Actions of No. 2**. Upon hearing LAUNCH TUBE CLEAR from the No. 3, the No.2:				
a. reports ALL CLEAR;				
b. remains in position observing the arcs of fire and awaits further orders from No. 1.				
CEASE TRACKING LOAD				
1. **Actions of No. 2**. Upon hearing CEASE TRACKING LOAD from the No. 1, the No. 2:				
a. lowers the trigger cover;				Safety violation.
b. engages the elevation lock and brake;				
c. engages the azimuth lock;				
d. locks the weapon system down;				
e. repeats CEASE TRACKING LOAD; and				
f. remains in position and observes arcs of fire.				
2. **Actions of No. 3**. Upon hearing CEASE TRACKING LOAD from the No. 2, the No. 3:				
a. repeats CEASE TRACKING LOAD;				
b. unlocks and raises the bridge clamp;				
c. removes the empty missile container and inspects the launch tubes; and				
d. without orders, prepares and loads another missile.				

PART III
GENERAL REMARKS

_____

Instructor's Signature

ANNEX E
PERFORMANCE OBJECTIVE
MISFIRE DRILLS ON THE TOW 2

PART I

STUDENT'S NAME _____

DATE _____

This is a PASS/FAIL test

Automatic Fail for violations IAW Remarks Column

Fail if there are 7 or more minor infractions

PART II

	IE	E	VE	REMARKS
MISFIRE DRILLS				
1. **Actions of No. 2**. The following are the actions of the No. 2 when a misfire occurs:				
a. alerts the crew by reporting MISFIRE; and				
b. continues tracking for one minute.				Fail if not done.
2. **Actions of No. 3**. Upon hearing MISFIRE from the No. 2, the No. 3:				
a. repeats MISFIRE;				

	IE	E	VE	REMARKS
b. initiates a missile guidance set (MGS) self-test for good batteries and if the batteries fail replaces them;				Fail if not done.
c. ensures the coil cord is properly secured to the MGS and ensures the bridge clamp locking lever is secure and the arming lever is fully raised;				
d. after the 1 minute wait, disconnects the coil cord and lowers the arming lever; and				Fail if not done.
e. connects the coil cord to the MGS, raises the arming lever (ensuring the back blasts danger area is clear) and reports ARMED.				
3. **Actions of No. 2**. Upon hearing ARMED from the No. 3, the No. 2:				
a. fires the weapon;				
b. if it still fails to fire a second time, the No. 2 reports MISFIRE TWO; and				Fail if not done.
c. continues tracking for 1 minute, counting aloud.				
4. **Actions of No. 3**. Upon hearing MISFIRE TWO from the No. 2, the No. 3:				
a. repeats MISFIRE TWO;				

	IE	E	VE	REMARKS
b. continues to observe the backblast danger area;				
c. counts aloud with the No. 2 for 1 minute;				
d. after 1 minute is completed, disconnects the coil cord; and				
e. lowers the arming leaver and reports DISARMED.				
5. **Actions of No. 2**. Upon hearing DISARMED from the No. 3, the No. 2:				
a. repeats DISARMED;				
b. lowers the trigger cover;				
c. locks the system with the crosshairs on target; and				
d. stands clear (30 minutes).				Fail if not done.
6. **Actions of No. 3**. After the 30 minute waiting period:				
a. unloads the missile, keeping it pointed down range; and				
b. places it in a safe place away from troops and equipment (200 m) or in a dud pit.				

PART III
GENERAL REMARKS

Instructor's Signature

ANNEX F
AIRLIFT OF ANTI-ARMOUR PLATOON

1. The take-off (T/O) weight of the CH-146 helicopter is 10 500 lbs. (4772.7 kg). The weight of the aircraft itself with a crew of three is estimated at 7000 lbs. (3181.8 kg) which leaves 3500 lbs. (1590.9 kg) for fuel and cargo. With a full load, the maximum permissible load, whether interior or exterior, has been determined at 2300 lbs. (1045.4 kg). The following are weights used in determining loading capacities of the TOW 2 and its crew.

HELICOPTER LOADING AND PLANNING

COMPONENTS	WEIGHT	
	LBS	KG
Tripod	22	10
Traversing Unit	58	26.3
Launch Tube	11	5
Optical Sight with Protective Bag	31.9	14.5
Thermal Imagery Sight with Protective Case	29.3	13.3
Collimator with Protective Case	19	8.6
Battery Power Conditioner with Batteries	15.5	7
Spare Lithium Batteries in Carrying Case	8.5	3.9
Missile Guidance Set with Battery	58.5	26.5
Total TOW 2 without Missile	253.2	115.1
Missile BGM-71E	61.8	28.1
Total Weight with one Missile	315	143.2

Table 2-F-1: TOW 2 Component Weight

PERSONNEL & EQUIPMENT (1 X DETACHMENT)	WEIGHT	
	LBS	KG
Total TOW 2 without missile	253.2	115.1
Total Detachment personnel without rucksack (4 X 200 lbs.)	800	363.6
First Line Missile, BGM-71E (10 X 28.1 kg)	618	281
Total Weight for Detachment	1671.2	759.7
Total Weight for Detachment including Rucksack (4 X 50 lbs. rucksack)	1871.2	850.5
Total Weight for Detachment including Rucksack and Toboggan (10 person tent group = 300 lbs.)	2171.2	986.7

Table 2-F-2: Personnel & Equipment (1 x Detachment)

2. Consideration should be given to use a four-person detachment with four additional infantrymen to carry the extra missiles.

3. The following is a recommended planning table for an airmobile operation. Where the number of missiles shown is less than the basic load, it is the maximum amount that can be carried by a TOW 2 detachment and/or the maximum amount within weight limitations for the helicopter. The planning table is a guide based on a full, fuel load and aircraft crew of three. Data for a platoon is based on a platoons equipment with eight TOWs.

SERIAL	SIZE OF SUB-UNIT	TOTAL WEIGHT LESS MISSILES (KG)	NO. OF AC	NO. OF MISSILE	TOTAL WEIGHT (KG)	REMARKS
1	One detachment only	479	1	2	535	No rucksacks
2	One detachment only	479	1	10	760	No rucksacks
3	One detachment only	570	1	2	627	With rucksacks
4	One detachment + 4 infantrymen	842	1	6	1009	No rucksacks
5	One detachment only	706	1	2	763	With rucksacks & one toboggan
6	One detachment only	751	1	6	923	With two toboggans
7	One section (2 X 4 person detachments)	958	1	2	1015	No rucksacks
8	One section (2 X 4 person detachments)	1412	2	4	1524	With rucksacks & two toboggans
9	Platoon (4 person detachments)	3832	4	8	4057	No rucksacks
10	Platoon (8 person detachments)	6736	8	48	8085	No rucksacks
11	Platoon (4 person detachments)	5648	8	16	6098	8 toboggans & rucksack

Table 2-F-3: Variations of Detachments

4. Reducing the amount of fuel in the aircraft will result in the ability to carry greater weight. It is possible to put more equipment in the aircraft if the resulting loss of flight time and range is acceptable. As an indication, reducing the weight of fuel from

1352 lb. (614.5 kg) to 600 lb. (272.7 kg), permits an extra 700 lb. (318.8 kg) of cargo to be carried, for a total of 3000 lb. (1363.6 kg). In this example, the endurance of the aircraft drops from two hours of flight to only one hour, and the radius of action from about 100 Nautical Miles (185 km) to about 25 Nautical Miles (46.3 km), depending on wind conditions.

CHAPTER 3
BV 2063 (TOW)

LESSON 1
BV 2063 (TOW) CARRIER MOUNTING KIT

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following on the BV 2063:

   a. general description;

   b. weapon's mount and system's components stowage locations; and

   c. other BV 2063 components.

2. **Timing**. One 40-minute period.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. Carrier BV 2063 (TOW);

   b. TOW 2 complete; and

   c. a pointer.

5. **Preparation**. Prior to the lesson:

   a. park the Carrier, BV 2063 (TOW), in a suitable location; and

   b. check the TOW 2 components and leave them mounted on the vehicle.

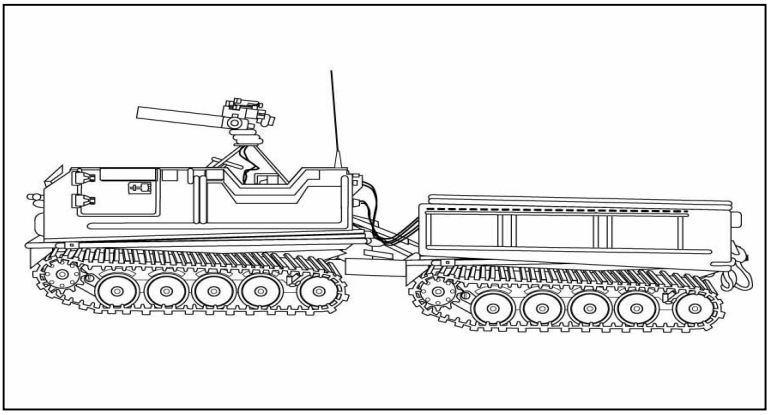


Figure 3-1-1: Carrier, Tracked, Articulated BV 2063 (TOW) Tactical Configuration

Figure 3-1-2: Helicopter Lifting Shackles

Figure 3-1-3: Weapon Mount

Figure 3-1-4: MGS Power Conditioner and TI Sight Power Conditioner

CONDUCT OF THE LESSON

6. **Safety Precautions**. Normal.

7. **Review**. Review the names of the various TOW 2 components.

8. **Introduction**. This lesson provides the operator with a general description of the Carrier BV 2063 (TOW).

9. The Carrier, Tracked, Articulated, Amphibious, (TOW), BV 2063 (or Carrier BV 2063) is a special military vehicle designed for use as an all-terrain, mobile weapon platform, specifically configured to carry a TOW 2. It can travel on and off roads under almost all conditions and in all climatic extremes. In particular, its large track area permits the carrier to travel over deep snow and soft ground conditions, which are impassable to almost all tracked and wheeled vehicles. It is also amphibious, being propelled in the water by its four tracks. The carrier is shown in Figure 3-1-1.

10. The carrier consists of two track-driven cars, which are coupled together by a central articulated steering assembly. Steering is accomplished using hydraulic cylinders, which turn the cars relative to each other.

11. The front car contains the power pack (engine and transmission), a transfer case and brake and steering systems. A front-mounted differential transmits power to the track through the drive sprockets. The front car also houses a TOW 2 mount, TOW 2 weapon, the carrier radios and the crew.

12. The rear car houses the fuel tank, the ammunition rack and acts as a stowage compartment for most of the on-board equipment, including portions of the front car which are removed in tactical situations. Helicopter lifting shackles are mounted on the rear car at each corner (see Figure 3-1-2). Lifting braces and shackles for the front car are also secured to the top of the rear car. The rear car tracks are powered by a second differential mounted at the front of the rear car.

13. Confirm by questions.

WEAPON MOUNT AND COMPONENTS

14. **Weapon Mount** (Figure 3-1-3). The BV 2063 as a TOW

missile carrier is equipped with a weapon mountand a secondary hydraulic system. The electrically-driven hydraulic pump supplies pressure for the operation of the weapon mount elevation cylinder and the front car stabilization cylinders. The weapon mount elevation control switch, on the left-hand side of the weapon mount, is activated by pressing up to raise the mount and down to lower the mount. When the mount reaches the desired height, the stabilizer bar may be secured in position by rotating the locking handle clockwise and raising the mount until it locks. This locks the mount to the desired height for sighting, firing and guiding the missile. When lowering the mount, the locking device on the stabilizer bar is automatically released.

15. The BV 2063 Carrier is equipped with the TOW 2 and numerous support items. The stowage locations given in the following component descriptions are those used when the carrier is in the tactical configuration (see Figure 3-1-1):

a. **Coiled Cord Vehicle Extension Assembly**. The W2 coiled cord extension assembly is used to extend the length of the cable between the traversing unit and the missile guidance system (MGS). The extension is required when the weapon system is vehicle mounted.

b. **MGS Power Conditioner**. The MGS power conditioner adapts the power output of the vehicle to the power requirements of the MGS. The MGS power conditioner is placed in the MGS and connected to the vehicle power supply at the 24 V dc power outlet located below the MGS mounting bracket (see Figure 3-1-4).

c. **Thermal Imagery (TI) Sight Vehicle Power Conditioner**. The TI sight vehicle power conditioner tailors the vehicle power output to the power requirements of the TI sight. It is used in place of the portable TI sight battery power conditioner, when the weapon system is vehicle mounted. The vehicle power conditioner is secured to the back of the driver's seat (see Figure 3-1-4).

OTHER BV 2063 COMPONENTS

16. The stowage, locations and operations of the other vehicle components of the Carrier BV 2063 (TOW) are as follows:

a. **Helicopter Lifting Shackles**. The helicopter lifting shackles for the rear car are already mounted in the correct location for lifting; however, the front car lifting shackles are part of the front car support braces, and they must be installed on the front car to facilitate lifting.

b. **Windshields**. Mounted in a bracket, on the rear of the partitioning wall between stowage compartments 2 and 3, the windshields may be reached through the right rear hatch (R3) when stowed.

c. **Tarpaulin**. The tarpaulin is rolled and laid on the floor of stowage compartment R3 with the remainder of the vehicle EIS less the driver's tools.

d. **Roof Braces (Tarpaulin Superstructure)**. Normally mounted to support the tarpaulin, the roof braces are stowed in the rear car when the tarpaulin is removed. Secured with an elastic cord in a bracket on the interior front wall of the rear car, the roof braces may be reached through the left front hatch (L1).

e. **Radio Equipment**. The front car is equipped with two radio mounts, stacked one above the other on the right side behind the No. 1 seat. Access to the radios is from the rear. The radios should be covered during inclement weather.

17. Confirm by questions and practice.

STABILIZATION AND TILT SYSTEMS

18. The Carrier BV 2063 was designed as a TOW carrier. For best firing results, the gun platform (the front car) should be both stable and level. To achieve a stable and level platform, the carrier has a tilt mechanism and a stabilization system consisting of the following components:

a. **Tilt Cylinder Indicator Light**. This indicator light glows to indicate the tilt cylinder control lever is not in the Driving Position. It reminds the driver to shift the tilt cylinder control lever before the carrier is driven off.

b. **Stabilization Cylinders Indicator Light**. This indicator light glows to indicate the stabilization cylinders are not fully retracted. The carrier must not be moved if this light is on; as the stabilization legs must be fully retracted or serious damage to the carrier may result.

c. **Stabilization Cylinder Control Switch**. This switch controls the operation of the stabilization cylinders. The switch is pressed ON and OFF. When the switch is pressed and cocked to the ON position the electrically driven hydraulic pump is activated, and hydraulic pressure is directed by means of the magnetic/hydraulic control valve to the stabilization cylinders. The cylinder pistons with footplates, are forced down and compress the track until the track contacts the top of the road wheels. As soon as either cylinder moves from the fully retracted (UP) position, the switch must be locked in the OFF position. The pump starts again and the magnetic/hydraulic control valve directs pressure to raise the stabilization cylinders. When both cylinders are fully retracted, the indicator light goes out. To shut the pump off, return the switch to the centre position.

WARNING

The cylinder retraction safeguard described here does not instantaneously retract the cylinders; some time must elapse. Serious damage may be caused if the vehicle is operated with the stabilization cylinders in any position other than fully retracted; therefore the carrier must never be moved with the stabilization indicator lights on.

NOTE

A safeguard is built into the stabilization system to help ensure that the operator does not drive off while the stabilization cylinders are down. If the transmission gear shift/selector lever is moved out of neutral (N) while the cylinders are not in the fully retracted position, a switch, mounted on the transmission gear shift/selector lever, automatically activates the pump to retract the stabilization cylinders.

d. **Tilt Control Lever**. The tilt cylinder control lever is located under the driver's seat and a decal detailing its operation will be found on the left engine access cover next to the driver's right leg. This lever manually operates a spool valve in the steering/tilt hydraulic system and a red warning light on the driver's control panel.

WARNING

The carrier must never be driven when the tilt control lever indicator light is on. In the two operating positions, the steering hydraulic circuits are isolated and no steering action is possible.

NOTE

When the control lever is in the DRIVING POSITION, the tilt cylinder acts as an additional damping cylinder and the steering system functions normally. In the BLOCKED position, the carrier is hydraulically locked in whatever angle of tilt existed between the cars when the lever was shifted, and the steering system remains functional. With the control lever in either of the tilt positions, the tilt cylinder extends or retracts until it reaches its limit of travel position or the DRIVING POSITION. In the DRIVING POSITION, the control lever releases the hydraulic pressure on both sides of the tilt cylinder piston, allowing the carrier angle to normalize. When in either of the tilting positions, the steering system will not function.

19. Confirm by questions.

CONCLUSION

20. Take questions from class on the entire lesson.

21. Confirm by questions.

22. **Summary**. To include the following:

    a. the importance of knowing the stowage location of the TOW 2 components in the carrier BV 2063 (TOW); and

    b. announce the next lesson.

LESSON 2
ASSEMBLY, DISASSEMBLY AND STOWAGE OF TOW 2 COMPONENTS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following :

   a. assembly of the TOW 2 components in the BV 2063;

   b. disassembly of the TOW 2 components; and

   c. stowage of the TOW 2 components.

2. **Timings**. One 40-minute period.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. BV 2063 vehicle complete with TOW 2;

   b. six missile simulation rounds/dummy missiles; and

   c. hand-out on storage locations one per student.

5. **Preparation**. Prior to the start of the period:

   a. have the vehicle parked in suitable location;

   b. check the equipment; and

   c. check the hand-outs.

6. **Miscellaneous**. Class is hands on and should be taught by demonstrations.

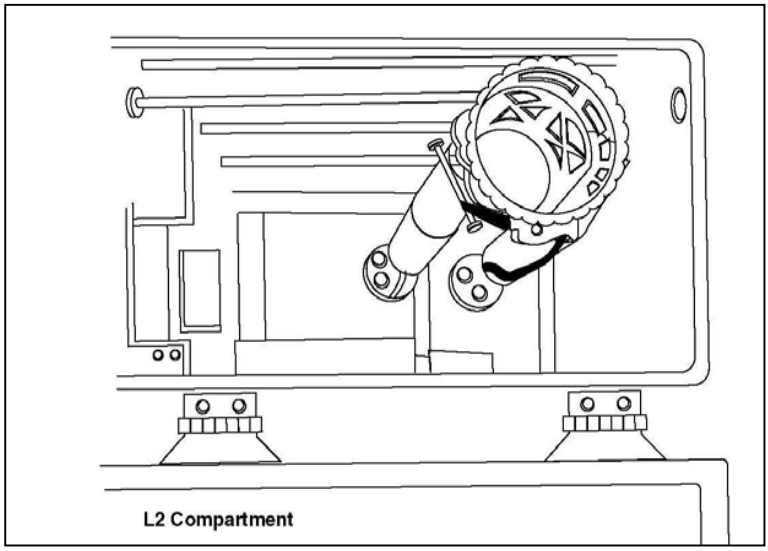


Figure 3-2-1: Tripod Stowage Location

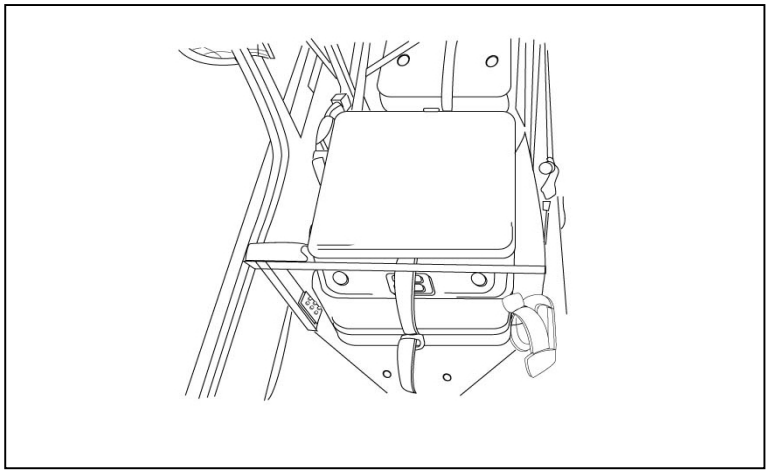


Figure 3-2-2: Collimator Stowage Location

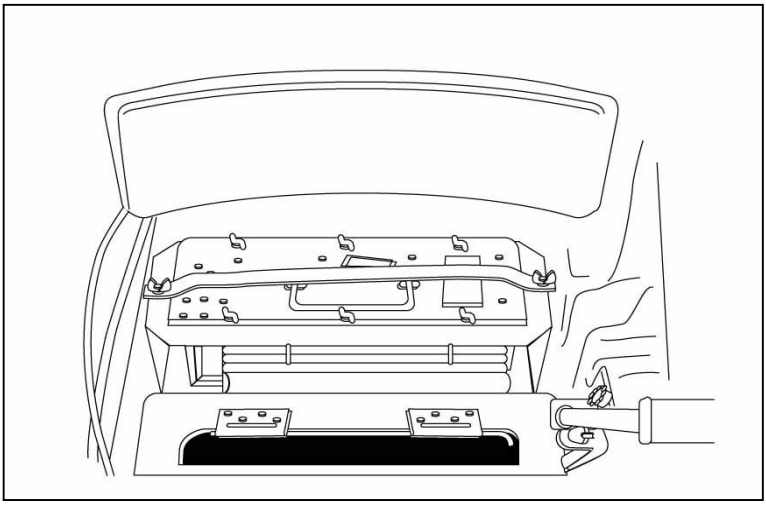


Figure 3-2-3: Spare Battery Stowage Location

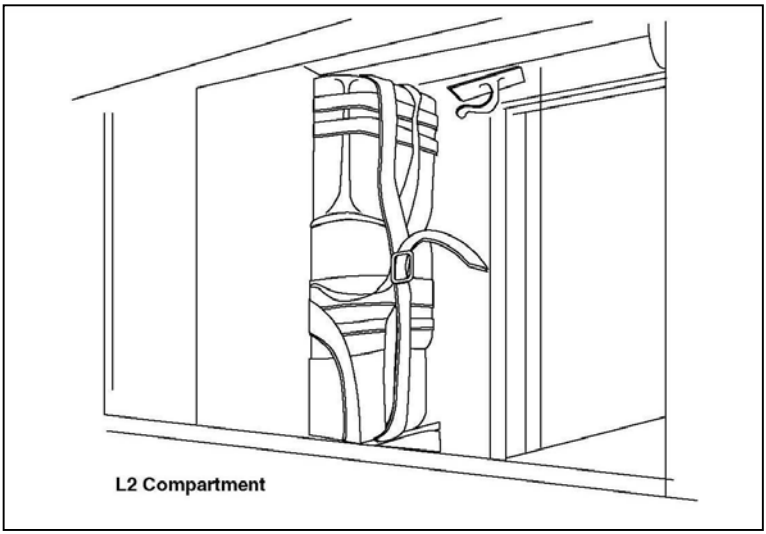


Figure 3-2-4: Power Conditioner and Battery Pack

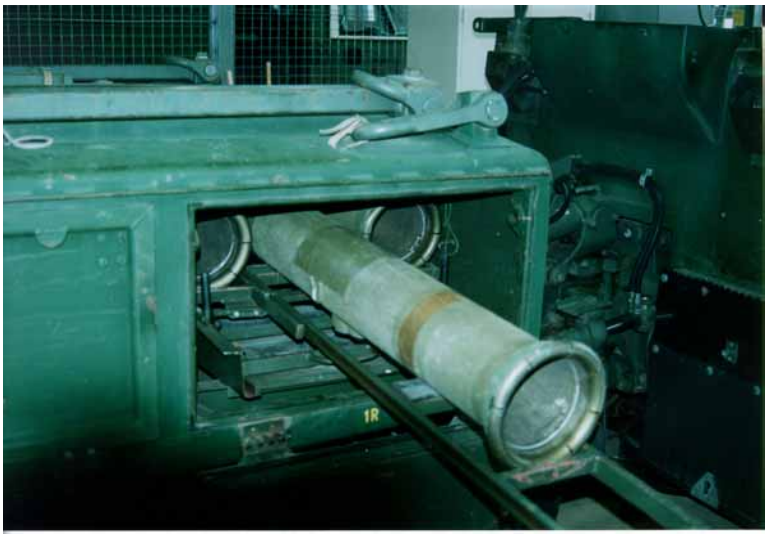


Figure 3-2-5: Encased Missiles Stowage Location

CONDUCT OF THE LESSON

7. **Review**. Review the components of the BV 2063.

8. **Introduction**. Stripping and assembly of the TOW 2 components should never be done against time. The TOW 2 components in the BV 2063 are the same as the ground mount and may be dismounted or mounted depending on the operation.

ASSEMBLY OF THE TOW 2

9. **Mounting the Traversing Unit (TU)**. The TU is mounted in the following sequence with assistance:

a. Ensure vehicle power is turned ON.

b. Raise and lock the weapon mount.

c. Unlock the coupling clamp.

d. Extend the coil cord from its stored position.

e. Pass the coil cord through the weapon mount.

f. Place the TU into the weapon mount.

g. Lock the coupling clamp ensuring azimuth lock is in between the red arrows.

h. Ensure the TU is properly secured.

i. Turn TU from side to side until it locks into place.

j. Inspect coil cord and attach it to the coil cord vehicle extension assembly.

k. Check the trigger operation by lifting the cover and depressing the trigger. Ensure the spring returns the trigger to the original position and close the cover.

l. Check the bridge clamp operation to ensure it locks onto the trunnion.

m. Check the electrical connector by raising the bridge clamp and arming the lever. Push the sleeve of the connector up and inspect the connector for damage and dirt.

n. Check operation of the bridge clamp locking lever (two successive clicks should be heard when the lever is being raised or lowered).

o. Check the operation of the arming lever. When the bridge clamp locking lever is locked, the arming lever should remain up when raised and go down on its own when the bridge clamp is unlocked.

10. **Mounting the Optical Sight**. The optical sight must be handled with care as it is a precision device and has fragile electro-optical components. It is mounted as follows:

a. release the sight locking latch by placing it in the down position;

b. align the sight mounting bracket with the boresighting plate on the TU;

c. raise the optical sight locking latch until the lock engages;

d. physically ensure that the optical sight is securely mounted;

e. ensure the reticle light is off;

f. rotate the focus ring to +3; and

g. check the humidity indicator.

11. **Installing the Launch Tube**. Installing the launch tube is done in the following sequence:

a. raise the forward end of the launch tube and slide the mounting lugs into the horizontal hooks of the trunnion;

b. lift the launch tube latch and lower the launch tube until the locating pin is engaged;

c. secure the launch tube in position by closing the latch;

d. check launch tube latch to ensure it is engaging the launch tube and remains locked; and

e. ensure launch tube is securely attached to the trunnion and is free of dirt, missile wire and foreign matter.

12. **Installing the MGS Power Conditioner in the Missile Guidance Set (MGS)**. The MGS power conditioner is installed in the MGS in the following sequence:

a. remove the cover from the MGS;

b. remove the protective cap from the MGS power conditioner connector;

c. align the rails of the MGS power conditioner with the battery guides of the MGS;

d. allow the MGS power conditioner to slide into the battery compartment under control;

e. apply pressure on the top of the MGS power conditioner and ensure it is flush with the top of the MGS; and

f. turn and tighten all turn-lock fasteners.

13. **Installing the MGS**. The MGS is installed into the gunners seat assembly as follows:

a. ensure the MGS power conditioner is OFF;

b. place the MGS on the MGS mounting tray with the MGS power conditioner towards the drivers seat;

c. secure the MGS with the mounting wires over the carrying handles;

d. ensure there is a J1 connector adapter attached to the W2 cable and secure the W2 cable to the J1 connector by aligning the yellow coloured index line with the yellow coloured mating line next to the J1 connector on the MGS;

e. turn the locking nut in a clockwise direction until the red mark on the J1 adapter cannot be seen;

f. secure the MGS power conditioner cable to the MGS power conditioner by aligning the lug in the cable connector to the groove in the MGS power conditioner connection;

g. turn the locking nut in a clockwise direction until the cable is fully seated;

h. turn ON the MGS battery power conditioner; and

i. stow the MGS cover in the R3 compartment.

14. **Mounting the Thermal Imagery (TI) Sight**. The TI sight must be handled with care as it is a precision device and has fragile electro-optic components. It is mounted as follows:

a. Remove the TI sight from the field handling case.

b. Place the coarse collimation control knob in position one (forward position). Some TI sights require that the coarse collimation control be placed in position two. This is easy to verify, when collimation is impossible in position one, it must be done in position two.

c. Move latch handle towards rear of TI sight.

d. Align and seat the TI sight on top of the optical sight.

e. Move latch handle forward to secure TI sight.

f. Ensure that the TI sight is secure.

g. Remove and inspect post amplifier cable and connect it to the TI sight by aligning the yellow lines.

CAUTION

Keep post amplifier cable clear of the bridge clamp.

h. Connect the TI vehicle power conditioner to the TI sight and ensure the vehicle power conditioner is turned on.

i. Turn the TI sight On/Off/Stby switch to ON.

j. Ensure the TI sight is set to NFOV (Narrow Field of View).

k. Remove front lens cover.

l. Stow and strap the protective field case under the radio trays.

15. A system self test is conducted after assembly.

16. Confirm by practice.

DISASSEMBLY OF THE TOW 2

17. Disassembly of the components is done in the reverse order.

18. Confirm by practice.

STOWAGE OF THE TOW 2 COMPONENTS

19. The remaining TOW 2 components are stored in the BV 2063 for ease of mounting and dismounting. The remaining components and their stowage arrangements are:

a. **Tripod**. The tripod is stowed and strapped in the L2 compartment of the rear car (see Figure 3-2-1);

b. **Collimator**. The collimator is stowed and strapped in its protective case under the crew commander's seat (see Figure 3-2-2);

c. **Batteries (Spares)**. There are two battery assemblies provided for use with the MGS when the weapon system is ground mounted, or when the MGS power conditioner has failed or is not available. One battery is stowed in a bracket in the front car behind the backrest of the loader’s seat (see Figure 3-2-3). The second battery is stowed

in a bracket on the front wall of the L2 compartment of the rear car, and is accessed through the left intermediate hatch;

d. **TI Sight Battery Power Conditioner and Spare Battery Pack**. The TI sight battery power conditioner powers the TI sight. The vehicle power conditioner, and spare battery pack (consisting of two lithium batteries), are stowed and strapped together in a bracket located on the rear wall of the R2 compartment (see Figure 3-2-4); and

e. **Encased Missiles**. (TOW Ammunition). The ammunition is stowed in a double-tier rack in the front compartment of the rear car and is reached through the right front hatch (R1) (see Figure 3-2-5). There are two missiles on the bottom tier and three on the top.

WARNING

Ensure hands and fingers are not between the top and bottom racks, of the ammunition storage compartment as serious injury could result.

20. To easily secure the missiles into the top rack two soldiers are required, however one soldier can do the task if necessary. The encased missiles are stored in the following manner:

a. The first soldier opens the R1 hatch cover and the second soldier opens the L1 hatch cover.

b. The top rack is lowered by pulling back on both vertical locking handles.

c. Using the left hand unlock the slide mechanism locking device.

d. Using the right hand pull the slide mechanism outward to its full extent.

e. Place the missile nose outwards onto the slide mechanism, ensuring the handling ring is forward of the first slide mechanism cross brace.

f. Push the slide mechanism inwards until it locks into position.

g. With assistance from the second soldier, balance the slide mechanism so the missile is not touching the top of the compartment and roll the missile left or right until seated in the bracket.

h. Repeat sub-paragraphs c. through g. to load the second missile.

i. Repeat sub-paragraphs c. through f. to load the centre missile on the top rack.

j. Secure the three missiles in the top rack, by using a quick jerk to raise the rack until both vertical locking devices engage. This will ensure that the missiles are secured between the top rack and the retaining device.

k. Release the locking device on the bottom rack.

l. Grasp the handle and pull the bottom rack completely outwards.

m. Place two missiles nose outward in the bottom rack.

n. Fasten the two missile retaining straps.

o. Pull outward on the lower rack release latch.

p. Apply pressure on the lower rack Royal release latch while pushing the bottom rack inward, until the lower rack passes the detent.

q. Fully seat the lower rack ensuring the locking

device engages.

r. Close the R1 and L1 hatch covers.

21. If only one soldier is available the L1 hatch is not opened.

22. Unloading of the missile stowage compartment is done in the reverse order as loading. To unload the missile stowage racks the bottom rack must be unloaded first.

23. Confirm by questions and practice.

CONCLUSION

24. Take questions from the class.

25. Confirm by practice.

26. Pack kit.

27. **Summary**. To include the following :

a. explain that proper storing of equipment will lead to easier access and better control of equipment; and

b. announce the next lesson.

LESSON 3
BV 2063 (TOW) CONFIGURATIONS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following:

   a. vehicle configurations;

   b. preparing the vehicle configurations;

   c. preparing the vehicle for firing; and

   d. preparing the vehicle after firing.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instruction period.

4. **Stores**. The following stores and equipment are required:

   a. vehicle with complete TOW 2 system, and

   b. hand-out on the teaching points one per student.

5. **Preparation**. Check out the vehicle and hand-outs.

6. **Miscellaneous**. Have students receive as much hands-on experience as possible. It is recommended there be eight students per vehicle.

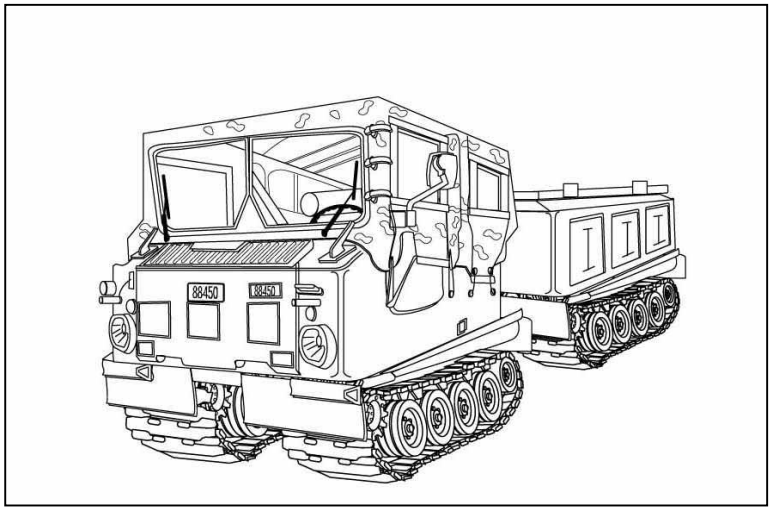


Figure 3-3-1: BV 2063 Administrative Configuration

Figure 3-3-2: BV 2063 Tactical Configuration

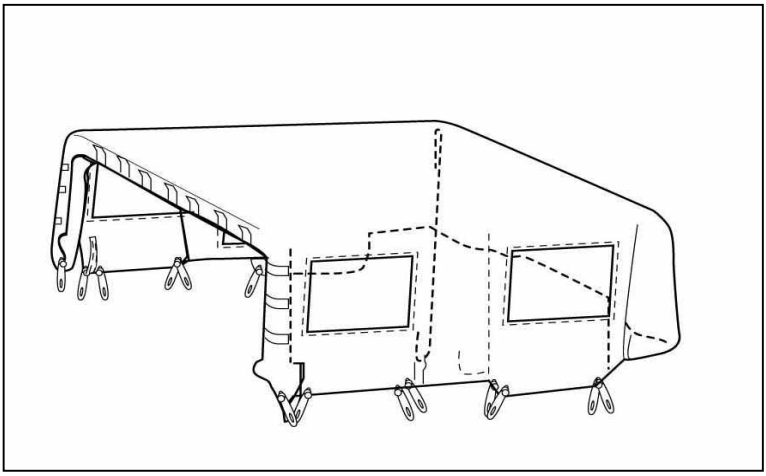


Figure 3-3-3: Tarpaulin Removal

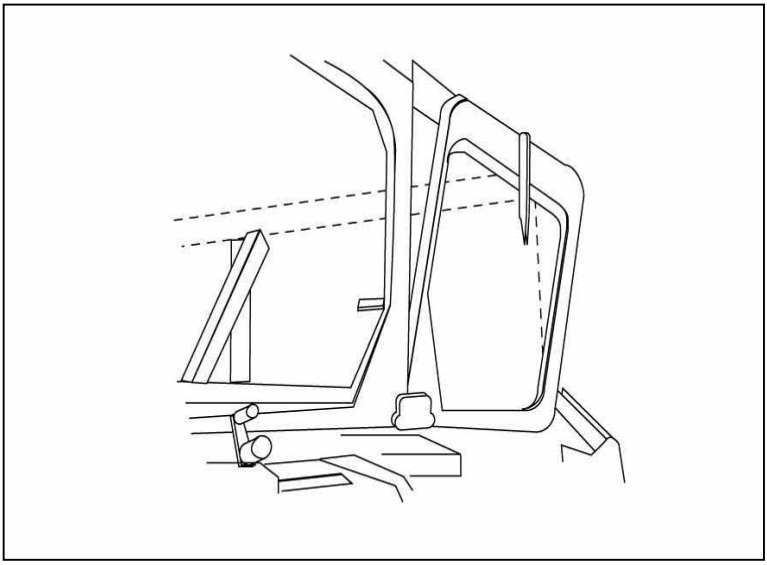


Figure 3-3-4: Windshield Removal

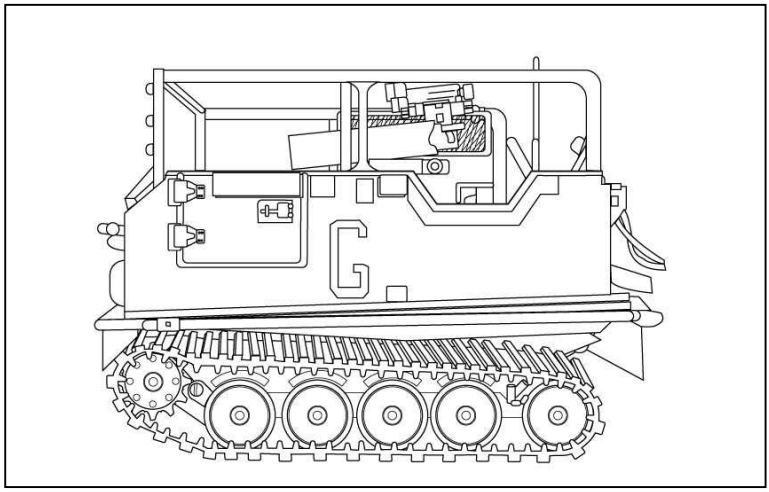


Figure 3-3-5: Tactical Zone Travelling Configuration

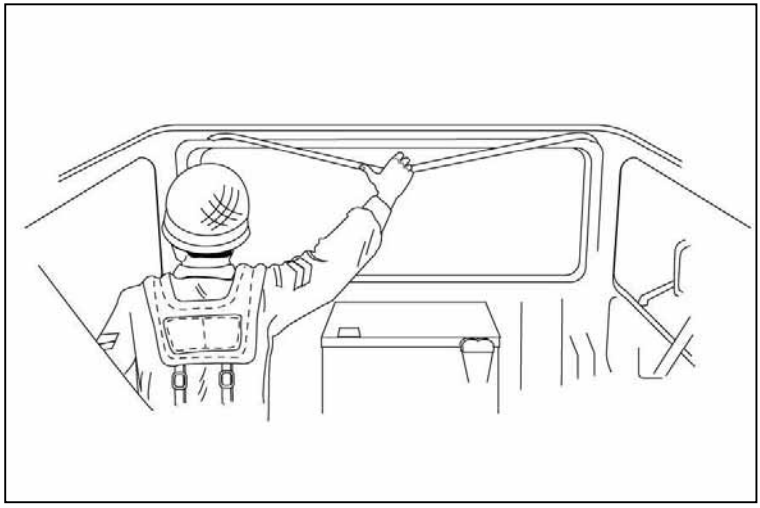


Figure 3-3-6: Lowering the Windshield Frame

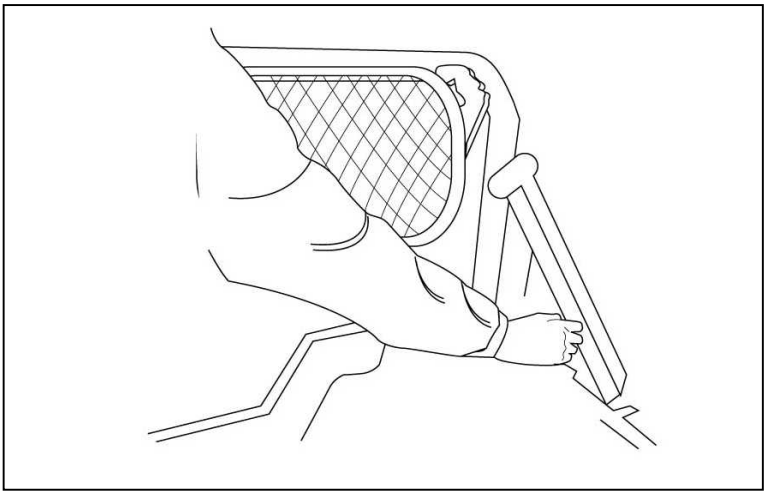


Figure 3-3-7: Lowering the Side Superstructures

CONDUCT OF THE LESSON

7. **Safety Precautions**. Normal.

8. **Review**. Review the stowage, location and operation of other vehicle components.

9. **Introduction**. The Carrier BV 2063 (TOW) has two configurations, administrative and tactical.

VEHICLE CONFIGURATIONS

10. **Administrative Configuration**. This is used for administrative purposes, when not in enemy contact (see Figure 3-3-1). This configuration includes:

a. removable tarpaulin installed;

b. superstructure cross-braces installed;

c. roll-over bars locked up;

d. windshields installed; and

e. weapon system fully assembled (unloaded) and locked down.

11. **Tactical Configuration**. The weapon system is at the READY state. This configuration is used when enemy contact is imminent. It ensures that the weapon can be put into action quickly (see Figure 3-3-2).

PREPARING THE VEHICLE FOR CONFIGURATION CHANGE

12. **Conversation to Tactical Configuration**. The carrier is converted from its administrative configuration to its tactical configuration, as follows:

a. **Tarpaulin Removal**. To remove the tarpaulin (see Figure 3-3-3), proceed as follows:

(1) unhook the elastic cord tie-downs securing the tarpaulin and flaps to the sides of the carrier;

(2) lift straps from all securing eyes around the carrier;

(3) fold side and doors over the roof section;

(4) fold the back over the roof section;

(5) fold the front 1/3 of the tarp back;

(6) fold the middle 1/3 over the rear;

(7) fold in half from driver side to passenger side; and

(8) remove the tarpaulin from the roof and place it on the ground.

b. **Windshield Removal**. To remove the windshields (see Figure 3-3-4), proceed as follows:

(1) Remove windshield wiper arms from drive crank and fold below the base of the windshields.

(2) Remove the spring clips securing both windshields.

(3) Both windshields are removed at the same time.

(4) Pull out on top of the windshields until they are clear of mounting pins.

(5) Lift up on the windshields until they are free of the securing lugs on the bottom of the frame.

(6) Place the windshields upright (frame to frame) with the centre of the windshields' frame facing the hatch against the front wall of the R3 compartment. They are secured in position with a spring loaded latch on the roof and a metal brace on the floor of the compartment.

(7) Place the tarpaulin on the floor of the R1 compartment.

c. **Superstructure (Roll Bars)**. To lower the superstructure proceed as follows:

NOTE

One end of the roof braces is looped while the other end is bent at approximately 90 degrees. First remove the bent end.

(1) remove the roof braces starting at the front and stow against the front wall of R1 compartment;

NOTE

At this point, the carrier is in the Tactical Zone Travelling Configuration (see Figure 3-3-5), which gives the crew the protection of the roll bars; however, with the completion of these steps, the carrier can be quickly converted to the full Tactical Configuration.

(2) pull on the cord thereby activating the release of the windshield frame latches (see Figure 3-3-6);

(3) push out on the frame as far as possible, release and let fall under control;

WARNING

Handle the heavy roll bars with care, as damage or injury could result from carelessness. Ensure that the carrier doors are closed and that there is sufficient room on both sides of the carrier to lower the superstructure. Lower bars under control.

(4) pull on the wire cord releasing latch of the rear support brace and disconnect the brace from the side bar (see Figure 3-3-7);

(5) pull the side bar outward and down until it rests against the car body; and

(6) repeat steps (4) and (5) for other side bar.

NOTE

Right side bar has a hinged step attached, which should be folded and secured in the raised position (flush with the body) for travelling.

13. Confirm by questions and practice.

14. **Conversion to Administrative Configuration**. To return to the covered administrative configuration (see Figure 3-3-1) from the tactical configuration (see Figure 3-3-2) the reverse sequence is performed.

WARNING

The outer door flap elastic cord tie-downs must not be secured when there are personnel in the carrier.

15. Confirm by questions and practice.

PREPARING THE CARRIER FOR WEAPON FIRING

16. To prepare the carrier for firing the weapon, proceed as follows:

a. Position the carrier in the desired location with the transmission in neutral (N) and the parking brake applied.

b. Using the tilt cylinder, level the front car; when accomplished, move the tilt control lever to the BLOCKED position. The tilt cylinder warning indicator light should come on.

c. Activate the stabilization cylinders by moving the control switch on the driver's panel to the ON position, until the foot plates press the track firmly

against the top of the road wheels on both sides of the car. Move the control switch to the centre position. The stabilization system warning indicator light should come on.

d. Activate the weapon mount elevation control switch and raise the mount to the desired height. When the mount reaches the desired height, the stabilizer bar should be secured in position by rotating the locking handle clockwise and raising the mount until it locks. When lowering the mount, the locking device on the stabilizer bar is automatically released.

NOTE

If the elevation cylinder fails to raise the weapon mount at this time, use the manually operated emergency weapon mount jack.

17. Confirm by questions and practice.

PREPARATION FOR MOVING FROM A FIRING POINT

18. To prepare the vehicle for moving from a firing point, proceed as follows:

a. Start the engine.

b. Lock the weapon system down.

c. Ensure the lens covers are replaced and cover the system with the protective bag.

d. Raise the loader's platform and secure for travelling.

e. Lower the weapon mount.

f. Retract the stabilization cylinders by moving the control switch to the OFF position, until the

stabilization cylinder indicator light goes out, indicating that both stabilization cylinders are fully retracted. Then move the control switch to the centre position.

g. Using the tilt cylinder control lever, release the controlled angle and place the lever in the DRIVING POSITION. The tilt cylinder indicator light should go out.

h. Release the parking brake and move the carrier from its position.

19. Confirm by questions and practice.

CONCLUSION

20. Take questions from the class on the entire lesson.

21. Confirm lesson by practice.

22. Pass out hand-outs.

23. **Summary**. To include the following:

a. reiterate all warnings pertaining to this lesson; and

b. announce the next lesson on this subject.

LESSON 4
BV 2063 (TOW) DETACHMENT DRILLS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following drills:

   a. load;

   b. target engagement;

   c. cease tracking;

   d. disengagement; and

   e. malfunction.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. BV 2063 tactical configuration;

   b. TOW 2 complete;

   c. missile simulation round/dummy missile container;

   d. carrying straps; and

   e. hand-outs on drills, one per student.

5. **Preparation**. Prior to the start of the first period:

   a. put the vehicle in the tactical configuration and park it in a suitable location with the TOW 2 mounted;

b. verify the equipment; and

c. check the hand-outs.

6. **Miscellaneous:**

a. give an explanation and demonstration by talking the students through the drills; and

b. divide the class into four-person detachments for a competition.

CONDUCT OF THE LESSON

7. **Safety Precaution**. Normal.

8. **Review**. Review the two vehicle configurations.

9. **Introduction**. The drills described below apply to the tactical configuration.

LOAD

10. Prior to loading a self-test and collimation will have been completed already.

11. **Action of the No. 2**. The No. 1 using the command LOAD or LOAD 2B initiates loading drills. Upon hearing the command, the No. 2:

a. ensures the weapon mount is raised and locked;

b. ensures the elevation and azimuth friction locks are engaged and the weapon is locked down;

c. ensures the trigger cover is lowered;

d. ensures the thermal imagery (TI) sight On/Off/Stby switch is ON;

e. sets the selectable filter to the Reset/Clear position;

f. ensures the WFOV (Wide Field of View) is selected;

g. ensures both sight covers are off;

h. repeats the command LOAD or LOAD 2B; and

i. remains in his firing position and observe his arcs of fire.

12. **Action of the No. 4**. Upon hearing the command LOAD or LOAD 2B from the No. 1, the No. 4:

a. repeats the command LOAD or LOAD 2B;

b. removes the specified encased missile from the racks and places it with the warhead towards the rear of the vehicle on the loader's platform;

c. visually inspects the specified encased missile;

d. checks the humidity indicator;

e. removes the forward handling ring and clamp and inspects the diaphragm;

f. removes and retains the electrical connector cap; and

g. waits to pass the encased missile to the No. 3.

13. **Action of the No. 3.** Upon hearing the word of command LOAD or LOAD 2B from the No. 2, the No. 3:

a. repeats the word of command;

b. raises the bridge clamp and inspects the launch tube;

c. turns and receives the encased missile from the No. 4;

d. upon receiving the encased missile turns toward the front of the vehicle;

e. with the electrical connector upwards, aligns the indexing lugs of the encased missile with the indexing slots of the launch tube and slides the encased missile forward and down until the missile is fully seated; and

f. lowers the bridge clamp and applies pressure with the left hand while locking it with the right hand.

14. **Action of the No. 2**. Once the No. 3 has locked the bridge clamp the No. 2 reports READY.

ENGAGEMENT DRILLS

15. The aim of an engagement drill is to bring the vehicle in its tactical configuration (weapon system loaded) into a firing position. Travelling between firing positions the weapon system is at the READY state and its hydraulic mount in the DOWN position.

16. Once the vehicle is in the firing position the No. 4 engages the tilt cylinder as required, engages the stabilizers and exits the vehicle to prepare missiles. The No. 1 exits the vehicle, takes up a position of observation and designates arcs to the No. 2. The No. 2 raises the weapon mount and observes the arcs. The No. 3 assists the No. 2 in the observation of the arcs of fire.

17. **Action of the No. 2**. To engage a target from the mounted position the word of command is TARGET or a fire control order given by the No. 1 who initiates all actions of the No. 2. Upon hearing the command, the No. 2:

a. repeats the command TARGET; and

b. ensures the TI sight is set to WFOV.

18. **Actions of the No. 4**. All actions of the No. 4 are initiated by the command TARGET given by the No. 1. Upon hearing the command the No. 4 ensures the missile racks hatch R1 is closed, takes up a position to the right of the loaders platform or in line with the traversing unit (TU) and remains there throughout the target engagement.

19. **Actions of the No. 3**. Upon hearing the command TARGET from the No. 2, the No. 3:

a. ensures the No. 4 is beside the loader's platform or in line with the TU;

b. checks the backblast area and reports BACKBLAST; and

c. observes the backblast danger area ensuring it remains safe until the missile is fired.

20. **Actions of the No. 2**. Upon hearing BACKBLAST from the No. 3, the No. 2 :

a. disengages the azimuth and elevation brake and lock;

b. rough aligns the weapon to the direction of the target while repeating the target indication;

c. searches for and aligns the cross-hairs on the target;

d. switches the TI sight to NFOV (Narrow Field of View), focuses and adjusts the sight picture; and

e. reports, ON.

21. **Actions of the No. 3**. Upon hearing ON from the No. 2, the No. 3:

a. Repeats ON; and

b. Raises the arming lever and reports ARMED.

22. **Actions of the No. 2**. Upon hearing ARMED from the No. 3, the No. 2:

a. raises the trigger cover; and

b. awaits further orders from the No. 1 or engages the target as per fire control orders.

23. Confirm by practice.

CEASE TRACKING AND CEASE TRACKING UNLOAD

24. The command CEASE TRACKING will be employed when the target being engaged is either destroyed or can no longer be engaged. The command CEASE TRACKING UNLOAD will be employed when there is no requirement to load the weapon.

MISSILE NOT FIRED—CEASE TRACKING UNLOAD

25. **Action of the No. 2**. The command CEASE TRACKING UNLOAD will be given by the No. 1. Upon hearing the command, the No. 2:

a. lowers the trigger cover;

b. repeats CEASE TRACKING UNLOAD; and

c. continues to observe the arcs of fire.

26. **Actions of the No. 3**. Upon hearing CEASE TRACKING UNLOAD from the No. 2, the No. 3:

a. repeats CEASE TRACKING UNLOAD; and

b. lowers the arming lever and reports, DISARMED.

27. **Actions of the No. 2**. Upon hearing DISARMED from the No. 3, the No. 2:

a. ensures the trigger cover is lowered;

b. engages the elevation lock and brake;

c. engages the azimuth lock;

d. locks the weapon system down;

e. places the TI On/Off/Stby switch to STBY;

f. places the TI sight to WFOV;

g. replaces the TI sight cover; and

h. remains in the firing position and observes arcs of fire.

28. **Actions of the No. 3**. When the weapon system has been locked down, the No. 3:

a. unlocks and raises the bridge clamp;

b. removes the encased missile from the launch tube;

c. passes the encased missile to the No. 4;

d. inspects the launch tube, closes the bridge clamp and reports LAUNCH TUBE CLEAR; and

e. remains in position observing the arcs of fire and awaits further orders from the No. 2.

29. **Actions of the No. 4**. Upon receiving the encased missile from the No. 3, the No. 4:

a. replaces the forward handling ring and clamp;

b. replaces the electrical connector cap;

c. secures the encased missile; and

d. remains in position observing the arcs of fire and awaits further orders from the No. 1.

30. **Actions of the No. 2**. Upon hearing LAUNCH TUBE CLEAR from the No. 3, the No. 2:

a. reports ALL CLEAR; and

b. remains in the firing position observing arcs of fire and awaits further orders from the No. 1.

MISSILE NOT FIRED—CEASE TRACKING

31. **Action of the No. 2**. The No. 1 will give the command CEASE TRACKING. Upon hearing the command, the No. 2:

a. lowers the trigger cover;

b. repeats CEASE TRACKING; and

c. remains in the firing position.

32. **Actions of the No. 3**. Upon hearing the command CEASE TRACKING from the No. 2, the No. 3:

a. repeats CEASE TRACKING;

b. lowers the arming lever;

c. reports DISARMED; and

d. remains in position observing arcs of fire, while awaiting further orders.

33. **Actions of the No. 2**. Upon hearing DISARMED from the No. 3, the No. 2:

a. ensures the trigger cover is lowered;

b. places the TI sight to WFOV and reports DISARMED, READY; and

c. remains in the firing position observing arcs of fire, while awaiting further orders.

34. Confirm by practice.

MISSILE FIRED—CEASE TRACKING UNLOAD

35. **Actions of the No. 2**. The command CEASE TRACKING UNLOAD will be given by the No. 1. Upon hearing the command, the No. 2:

a. lowers the trigger cover;

b. engages the elevation lock and brake;

c. engages the azimuth lock;

d. locks the weapon system down;

e. repeats CEASE TRACKING UNLOAD;

f. places the TI sight On/Off/Stby switch to STBY;

g. places the TI sight to WFOV;

h. replaces the TI sight cover; and

i. remains in the firing position and observes arcs of fire.

36. **Actions of the No. 3**. Upon hearing CEASE TRACKING UNLOAD from the No. 2, the No. 3:

a. repeats CEASE TRACKING UNLOAD;

b. unlocks and raises the bridge clamp;

c. removes the empty missile container from the launch tube;

d. passes the empty missile container to the No. 4;

e. inspects the launch tube and closes the bridge clamp;

f. reports LAUNCH TUBE CLEAR; and

g. remains in position observing the arcs of fire and awaits further orders from No. 2.

37. **Actions of the No. 4**. Upon receiving the empty missile container from the No. 3, the No. 4:

a. discards the empty missile container; and

b. remains in position observing the arcs of fire and awaits further orders from the No. 1.

38. **Actions of the No. 2**. Upon hearing LAUNCH TUBE CLEAR from the No. 3, the No. 2:

a. reports ALL CLEAR;

b. returns the TI sight setting to WFOV; and

c. remains in the firing position observing the arcs of fire and awaits further instructions from No. 1.

MISSILE FIRED—CEASE TRACKING LOAD

39. **Actions of the No. 2**. The No. 1 will give the command CEASE TRACKING LOAD. Upon hearing the command, the No. 2:

a. lowers the trigger cover;

b. engages the elevation lock and brake;

c. engages the azimuth lock;

d. locks the weapon system down;

e. repeats CEASE TRACKING LOAD; and

f. remains in the fire position and observes arcs of fire.

40. **Actions of the No. 3**. Upon hearing the command CEASE TRACKING LOAD from the No. 2, the No. 3:

a. repeats CEASE TRACKING LOAD;

b. unlocks and raises the bridge clamp;

c. removes the empty missile container;

d. passes the empty missile container to the No. 4;

e. inspects the launch tube; and

f. receives another missile from the No. 4 and loads it.

41. **Actions of the No. 4**. Upon hearing CEASE TRACKING LOAD from the No. 1, the No. 4:

a. removes an encased missile from the R1 compartment;

b. places the missile on the loader's platform with warhead facing the rear of the vehicle and prepares the missile for loading;

c. receives the empty missile container from the No. 3;

d. passes the new encased missile to the No. 3; and

e. discards the empty missile container.

42. Confirm by practice.

DISENGAGEMENT DRILL

43. In order to move out of the firing position the words of command are CEASE TRACKING or CEASE TRACKING LOAD, PREPARE TO MOVE. The detachment then proceeds in the following sequence:

a. **Actions of the No. 1**. The No. 1, after issuing the command, resumes his position in the co-driver's seat and supervises the move.

b. **Actions of the No. 2**. Upon hearing the command CEASE TRACKING LOAD, PREPARE TO MOVE, the No. 2:

(1) repeats CEASE TRACKING LOAD, PREPARE TO MOVE;

(2) carries on normal cease tracking load drill;

(3) reports READY when the No. 3 has loaded another encased missile; and

(4) lowers the hydraulic mount.

c. **Actions of the No. 3**. Upon hearing the command CEASE TRACKING LOAD, PREPARE TO MOVE, the No. 3:

(1) repeats CEASE TRACKING LOAD, PREPARE TO MOVE;

(2) carries on normal cease tracking load drill;

(3) accepts a missile from the No. 4 and loads its; and

(4) raises the loader's platform.

d. **Actions of the No. 4**. Upon hearing the command CEASE TRACKING LOAD, PREPARE TO MOVE, the No. 4:

(1) hands up an encased missile to the No. 3 (if the missile has been fired);

(2) closes the R1 compartment;

(3) returns to the driver's seat and retracts the stabilization cylinders;

(4) disengages the tilt cylinder and the parking brake; and

(5) prepares to move.

44. Confirm by practice.

MALFUNCTION DRILLS

45. Malfunction drills are conducted the same as with the ground mount with the following exceptions:

a. Once the 30 minute wait is observed the No. 3 remounts the vehicle and the No. 4 moves to the side of the vehicle where the dud pit is located.

b. The No. 3:

(1) lowers the weapon mount to waist height;

(2) raises the bridge clamp;

(3) ensuring the missile is horizontal and pointed down range, lifts the missile out of the launch tube; and

(4) passes the missile to the No. 4 who is facing the vehicle;

c. The No. 4 :

(1) carefully steps back and lowers the missile to the ground;

(2) steps over the missile, turns around and picks the missile up; and

(3) carries the missile to the dud pit.

46. Confirm by practice.

CONCLUSION

47. Take questions from the class on the entire lesson.

48. Confirm lesson by practice.

49. Pass out hand-outs.

50. **Summary**. To include the following:

a. the importance of performing the detachment drills until they become second nature; and

b. announce the next lesson.

LESSON 5
BV 2063 (TOW) MOUNT/DISMOUNT DRILLS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following drills:

   a. load;

   b. engagement (Mounted Action); and

   c. disengagement.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. BV 2063 in the tactical configuration;

   b. TOW 2 complete;

   c. missile simulation round/dummy missile container;

   d. carrying straps; and

   e. hand-outs on drills, one per student.

5. **Preparation**. Before commencement of the first period:

   a. put the vehicle in the tactical configuration and park it in a suitable location with the TOW 2 mounted;

   b. check the equipment; and

   c. check the hand-outs.

6. **Miscellaneous**:

a. give an explanation and demonstration by talking the students through the drills; and

b. divide the class into four-person detachments for ease of learning.

CONDUCT OF THE LESSON

7. **Safety Precaution**. Normal.

8. **Review**. Review the two vehicle configurations.

9. **Introduction**. The drills described below apply to the tactical configuration.

10. The word of command to mount is MOUNT, PREPARE TO MOVE. On this command, the detachment completes the stripping, if necessary, and carries the components as described in Lesson 8, Chapter 2. The crew approaches the vehicle from the rear in the following order No. 1, 3, 2 and 4.

11. **Actions of the No. 1**. Upon arriving at the rear of the vehicle, the No. 1:

a. places the tripod, spare battery case and the radio at the rear of the vehicle;

b. moves to the loader's platform;

c. drops the loader's platform;

d. removes the optical sight (OSS) from the protective bag; and

e. places the OSS on the loader's platform.

12. **Actions of the No. 2**. While the No. 1 is placing the equipment behind the vehicle, the No. 2:

a. leaves the launch tube standing up by the loader's platform;

b. turns vehicle power on;

c. secures the missile guidance set (MGS) on its stowage mount, removes its cover and exchanges the battery assembly for the MGS power conditioner;

d. raises the weapon mount; and

e. remains in the vehicle.

13. **Actions of the No. 3**. While the No. 1 is placing the equipment behind the vehicle, the No. 3:

a. places the traversing unit on the loader's platform;

b. places the collimator on the crew commander's seat; and

c. mounts the vehicle.

14. **Actions of the No. 4**. The No. 4 remains outside the vehicle and performs the following actions:

a. places the encased missile (if carried) on the ground beside the R1 compartment of the rear car;

b. places the thermal imagery (TI) sight power conditioner on the ground beside the R2 compartment;

c. places the TI sight beside the launch tube;

d. takes MGS cover off the back of the vehicle;

e. stows and secures all equipment; and

f. mounts the vehicle.

15. Once the No. 2 has mounted the MGS the following occurs:

a. the No. 1 passes the traversing unit (TU) to the No. 3;

b. the No. 3, with the assistance of the No. 2, mounts the TU;

c. once the TU is mounted the No. 1 passes the OSS to the No.3;

d. the No. 3 passes the OSS to the No. 2;

e. the No. 2 mounts the OSS;

f. as the No. 2 is mounting OSS the No. 1 passes the launch tube to the No. 3;

g. the No. 3 mounts the launch tube;

h. as the No. 3 is mounting the launch tube, the No. 1 removes the TI sight from its protective case;

i. the No. 1 passes the TI sight to the No. 3;

j. the No. 3 passes the TI sight to the No. 2;

k. the No. 2 mounts the TI sight;

l. as the No. 2 is mounting the TI sight the No. 1 passes the TI sight protective case to the No. 3 or places it on the loader's platform;

m. once the No. 1 has passed the TI sight protective case to the No.3, the No. 1 removes the boresight collimator and supervises boresight collimation;

n. once the No. 2 has mounted the TI sight, the No. 2 connects the MGS; and

o. the No. 3 stows and secures the TI sight protective case.

16. Once the No. 2 has reported CHECKOUT PROCEDURE

COMPLETE, the No. 1 can order the weapon to be loaded. When completed the No. 2 reports READY.

17. Confirm by questions and practice.

DISMOUNTING DRILLS

18. The word of command to dismount the TOW 2 system from the BV 2063 is CEASE TRACKING, UNLOAD, DISMOUNT. Once the cease tracking and unload drills are complete the ALL CLEAR is given by the No. 2, the hydraulic mount is lowered to the DOWN position. The dismount is performed in the reversed sequence of the mount; the crew members handling the same weapon system components with the exception of the No. 4 who is responsible for laying the equipment on the ground in order.

19. Confirm by practice.

CONCLUSION

20. Take questions from the class on the entire lesson.

21. Confirm lesson by practice.

22. Pass out hand-outs.

23. **Summary**. To include the following:

    a. the importance of performing the detachment drills until they become second nature; and

    b. announce the next lesson.

LESSON 6
BV 2063 (TOW) RIGGING FOR AIRMOBILE OPS

INSTRUCTOR'S NOTES

1. **Aim**. To teach how to rig the BV 2063 for airmobile operations to include the following:

   a. preparation of the BV 2063; and

   b. rigging the lifting points.

2. **Timing**. One 40-minute period.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. BV 2063 in the tactical configuration;

   b. TOW 2 complete;

   c. missile simulation round/dummy missile container;

   d. lifting bars; and

   e. cross lifting bar.

5. **Preparation**. Before the period begins:

   a. put the vehicle in the tactical configuration and park it in a suitable location with the TOW 2 mounted; and

   b. check the equipment;

6. **Miscellaneous**.

   a. give an explanation and demonstration by talking the students through the drills; and

b. divide the class into four-person detachments for ease of learning.

Figure 3-6-1: BV 2063 Side and Front Lifting Bars

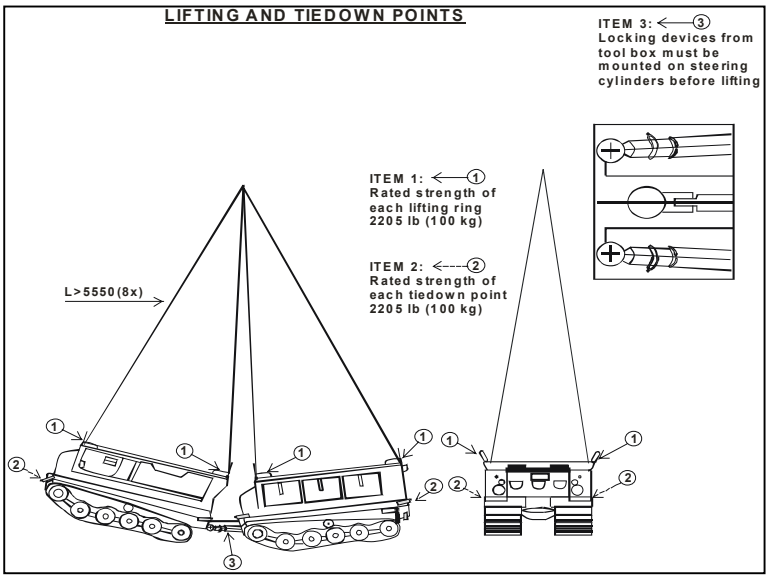


Figure 3-6-2: BV 2063 Lifting Points and Sway Collars

CONDUCT OF THE LESSON

7. **Safety Precaution**. Normal.

8. **Review**. Review the two vehicle configurations.

9. **Introduction**. The BV 2063 has the capability to be airlifted by medium and heavy lift helicopters. When the vehicle is configured with the TOW 2 system it should be mounted and a full complement of ammunition should be stored in the rear car.

PREPERATION OF THE VEHICLE FOR AIRMOBILE OPERATIONS

10. Prior to rigging the vehicle the following must be done to the vehicle and equipment:

a. remove and stow the radio antennas;

b. unload and lower the weapon mount;

c. store any loose items in the R3 compartment;

d. secure and lock all the compartments except L1;

e. remove the four plastic mount covers from the front car;

f. unstrap the cross lift bar; and

g. unfasten the lift bars from the top of the rear car using the wrench spanner and a 36 mm socket.

RIGGING THE LIFTING POINTS

11. To rig the vehicle for lifting, use the following sequence:

a. align the cross lifting bar over the front two lifting brackets;

b. align the two side lifting bar with the flat end over the cross lifting bar and the end with the extensions over the rear mounting brackets (see Figure 3-6-1);

c. tighten all bolts into the mounting brackets;

d. attach the anti sway-collars over the steering cylinders (see Figure 3-6-2);

e. place the plastic mount covers in the tool roll; and

f. secure the tool roll and all remaining kit in the L1 compartment.

12. To bring the vehicle to the tactical configuration reverse the sequence.

13. Confirm by practice.

CONCLUSION

14. Take questions from the class on the entire lesson.

15. Confirm lesson by practice.

16. **Summary**. To include the following:

a. the importance of performing the detachment drills until they become second nature; and

b. announce the next lesson.

LESSON 7
BV 2063 (TOW) MAINTENANCE

INSTRUCTOR'S NOTES

1. **Aim**. To teach maintenance of the BV 2063 to include:

    a. general maintenance procedures;

    b. daily and periodically preventive maintenance; and

    c. operations under extreme conditions.

2. **Timing**. One 40-minute period.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores are required:

    a. multi media projector;

    b. slides on the main teaching points; and

    c. hand-outs one per student.

5. **Preparation**. Prior to the start of the period:

    a. Prepare the classroom; and

    b. Check the slides, OHP and hand-outs.

CONDUCT OF THE LESSON

6. **Review**. Name the parts of the BV 2063(TOW).

7. **Introduction**. This lesson describes the checkpoints and services to be performed by the crew.

8. A good crew shall, in addition to operating the vehicle

under different conditions, also ensure that it is in the best possible technical condition.

9. When a fault or defect occurs in a vehicle part or system, that component shall not be used until the maintenance personnel approve its use.

GENERAL MAINTENANCE PROCEDURES

10. General maintenance procedures that are the crew's responsibility include the following:

a. **Cleanliness**. Dirt, grease, oil and debris only get in the way and may conceal a problem and create a potential safety hazard. Use cleaning solvent sparingly on all metal surfaces. Use soap and water when cleaning rubber and plastic materials.

WARNING

Cleaning solvents are flammable and give off harmful vapours. Use solvents in a well-ventilated area. Avoid prolonged breathing of solvent vapours and skin contact with cleaning solvents. Do not smoke in areas where solvents are being used.

b. **Tightness of Bolts, Nuts and Screws**. Check all bolts, nuts and screws for obvious looseness, and that none are missing. Check for chipped paint, bare metal or rust around bolt heads. If a bolt, nut or screw is loose, report it to maintenance.

c. **Inspection of Welds**. Look for loose or chipped paint, rust and gaps where parts are welded together. If a bad weld is found, report it to maintenance.

d. **Inspection of Electrical Wires and Connectors**. Look for cracked or broken insulation or bare wires on electric cables and loose or broken

connectors. Tighten loose connectors and report damaged cables to maintenance.

e. **Inspection of Hoses and Fluid Lines**. Look for damage and leaks. Ensure that clamps and fittings are tight. Wet spots indicate leaks, as do stains around a fitting or connector. If a leak comes from a loose fitting or connector, tighten it. If something is broken or worn report it to maintenance.

f. **Fluid Leakage Control**. It is necessary to know how fluid leakage affects the vehicle. Following are definitions of the classes of leakage for determining vehicle status. Become familiar with them and REMEMBER—WHEN IN DOUBT, ASK YOUR SUPERVISOR.

11. Leakage definitions for crew/operator are as follows:

a. **Class I**. Seepage of fluid (as indicated by wetness of discoloration), but not sufficient to form drops.

b. **Class II**. Leakage of fluid great enough to form drops, but not enough to cause dripping from the item being checked/inspected.

c. **Class III**. Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

CAUTION

Equipment operation is permissible with minor leakage (Class I or II). Report all Class III leaks to your supervisor immediately. Of course, consideration must be given to the fluid capacity in the item or system being checked or inspected. When in doubt, notify your supervisor.

12. Confirm by questions.

DAILY AND PERIODICAL PREVENTIVE MAINTENANCE

13. Daily and periodical preventive maintenance inspection checklists are found in Annex A of this Chapter. They provide inspection points and maintenance operations for daily and periodical inspections.

14. **Batteries**. Battery maintenance is performed by first opening the battery cover, then proceeding as follows:

WARNING

Do not smoke or have an open flame nearby when checking batteries. Batteries emit gases that are highly explosive. Do not allow battery acit to come in contact with skin as serious burns can result.

a. Remove caps and check electrolyte level in all battery cells. Correct level is the lower edge of the filler hole. If necessary, fill cells with distilled water. Run engine 10-15 minutes to allow electrolyte and water to mix.

b. Visually check batteries for cracks or leaks in the casing and corrosion around the posts.

c. Clean the battery racks with water.

d. Check the cable and post clamp bolts and nuts for tightness. Tighten all loose hardware.

e. Close the battery box cover.

15. Confirm by questions.

OPERATION UNDER EXTREME CONDITIONS

16. Under extreme cold conditions particular attention must be paid to indicator lamps, condition of the turret hatch, loader and shield door gaskets, ease of operation of equipment and condition of batteries.

17. When operating equipment in extreme hot conditions, temperatures above 35 degrees Celsius, special attention must be given to the following:

a. batteries may overheat and boil dry;

b. batteries discharge quickly when not in use for extended periods;

c. lubricants lose viscosity and levels may require more frequent checking;

d. corrosion, pitting, fungus growth and paint blistering occur more frequently;

e. upholstery fabrics, rubber, plastics and tarpaulins tend to mildew and deteriorate more rapidly; and

f. moving parts must be kept clean, free of sand and lubricate frequently.

18. Confirm by questions.

CONCLUSION

19. Take questions from the class on the entire lesson.

20. Confirm by questions.

21. Pass out hand-outs on maintenance.

22. **Summary**: To include the following:

a. stress that general maintenance procedures are the responsibility of the entire crew and the importance of following the inspection checklists; and

b. give a forecast of the next lesson.

ANNEX A
BV 2063 (TOW) DAILY PREVENTIVE MAINTENANCE TABLE OF CHECKS AND SERVICES

B – BEFORE OPERATION **D – DURING OPERATION** **A – AFTER OPERATION**			
B	**D**	**A**	**PREVENTIVE MAINTENANCE CHECKS AND SERVICES**
			NOTE Perform WEEKLY(W) and BEFORE(B) checks if: a. the driver has not operated the vehicle in more than a week; or b. the driver is going to operate this vehicle for the first time.
			ITEM 1—EXTERIOR
x		x	a. Visually check front and rear carrier body for damage that would impair operations, such as fording and swimming.
x			b. Check under vehicle for fluid leaks.
			c. Check condition of the following:
x		x	(1) mirrors and mountings;
x		x	(2) windshield and mountings;
x		x	(3) windshield wiper arms and blades;
x		x	(4) door seals for damage that would impair operations, such as fording and swimming;
x		x	(5) rear car hatch cover seals;
x		x	(6) rear car hatch cover hinges and locks;
x			(7) fuel tank filler cap armoured cover;
x			(8) reflectors;

B – BEFORE OPERATION D – DURING OPERATION A – AFTER OPERATION			
B	**D**	**A**	**PREVENTIVE MAINTENANCE CHECKS AND SERVICES**
x			(9) pintle hook and towing eyes; and
x			(10) security and mountings of front car support braces on top of rear car.
x		x	d. Check operation of all exterior lights.
x			e. Remove plastic intake and exhaust covers if installed.
		x	f. Install plastic intake and exhaust covers.
			ITEM 2—SUSPENSION SYSTEM
x			a. Check for broken torsion springs by attempting to pry up on wheel arms.
x		x	b. Check road wheels, drive sprockets, tensioning wheels, support wheels and adjusting screws for damage, loose mountings, rubber separation and chunking of the road wheels.
x		x	c. Check tracks for correct sag, missing or damaged guide horns and through-cracks or tears in track band.
			NOTE Cracks located outside the guide horns are permissible. If you can see through the crack, the track is unserviceable.
			ITEM 3—STEERING HYDRAULIC FLUID TANK
x		x	Check fluid level. Correct level is between "MAX" and "MIN" marks. Add fluid as necessary.

B – BEFORE OPERATION

D – DURING OPERATION

A – AFTER OPERATION

B	D	A	PREVENTIVE MAINTENANCE CHECKS AND SERVICES
			ITEM 4—COOLING SYSTEM
			WARNING Do not remove expansion cap if temperature reads above 70°C(158°F). Hot engine coolant can cause serious burns.
x		x	a. Check coolant level. Coolant should be between the MIN and MAX marks. Add coolant as necessary.
x		x	b. Check the radiator compartment for fluid leaks and debris.
			ITEM 5—DIFFERENTIALS
		x	After swimming carrier, check differentials for water contamination. Water contamination causes oils to turn milk-like in colour. If water is found in differential, notify maintenance.
			ITEM 6—TRANSFER CASE
		x	After swimming carrier, check the transfer case for water contamination. Water contamination causes oils to turn milk-like in colour. If water is found in the transfer case, notify maintenance.
			ITEM 7—FUEL SYSTEM
x			a. Open drain tap on water trap; drain accumulated water.
x		x	b. Check inside front and rear car for leaks.
x		x	c. Check security of tank mountings.

B – BEFORE OPERATION D – DURING OPERATION A – AFTER OPERATION			
B	**D**	**A**	**PREVENTIVE MAINTENANCE CHECKS AND SERVICES**
			ITEM 8—POWER PACK COMPARTMENT
			CAUTION Do not overfill engine oil. Damage to engine may result if oil level is above full mark.
			NOTE Check oil level with engine off and the vehicle on level ground. If engine has been running, wait five minutes before checking level. If oil level is above the MIN mark when engine is COLD, DO NOT add oil. If level is below the MIN mark, add oil as necessary
			a. Remove engine hood and proceed as follows:
x		x	(1) Pull out engine oil dipstick; check oil level. Correct level is between marks.
x		x	(2) Check engine compartment for fluid leaks.
x		x	(3) Idle engine, with gear shift/selector lever in neutral (N), until the engine temperature is between 70°C and 90°C (158°F and 194°F). Pull out transmission oil dipstick; check oil level. Correct level is between marks.
			WARNING Carbon monoxide can be deadly.

B – BEFORE OPERATION D – DURING OPERATION A – AFTER OPERATION			
B	**D**	**A**	**PREVENTIVE MAINTENANCE CHECKS AND SERVICES**
x			(4) To prevent carbon monoxide poisoning, ensure that engine hood and cover seals are free of cracks and brakes.
x		x	**ITEM 9—WINDSHIELD WASHER** Check fluid level in windshield washer reservoir. Check reservoir for damage/leaks. Top up as required.
x			**ITEM 10—BRAKE MASTER CYLINDER** Check brake master cylinder reservoir, correct level is between MIN and MAX marks. If below MIN report to maintenance.
x			**ITEM 11—REAR CAR** Check inside rear car for evidence of water entering and fuel leaks.
			ITEM 12—INSTRUMENTS, WARNING INDICATORS AND CONTROLS a. Check operation of the following gauges:
x	x		(1) **Fuel level gauge—**should show fuel in tank.
x	x		(2) **Engine coolant temperature gauge—**should remain between 70°C and 95°C (158°F and 203°F) when engine is warmed up.
x	x		(3) **Tachometer—**should read 750 to 850 RPM at idle.

B – BEFORE OPERATION **D – DURING OPERATION** **A – AFTER OPERATION**			
B	**D**	**A**	**PREVENTIVE MAINTENANCE CHECKS AND SERVICES**
			b. Check warning lights for obvious damage. After starting engine, check operation of the following:
x	x		(1) Transmission oil temperature indicator light—should not be lit.
x	x		(2) Directional signal indicator light.
x			(3) Engine oil pressure indicator light—should go out once engine has started.
x	x		(4) Hydraulic brake circuits/parking brake indicator light—should go out when parking brake is released and should not light when service brake is applied.
	x		(5) High beam indicator light.
	x		(6) Speedometer.
x			(7) Bilge pump indicator light—If light does not come on when bilge pump is turned on, troubleshoot.
x			(8) Charging indicator light—If charging indicator remains lit when engine is running, notify maintenance.
x	x		(9) Tilt mechanism warning indicator light—If indicator lights when selector is in the DRIVING POSITION, or fails to light when selector is in any position other than the DRIVING POSITION, notify maintenance.

B – BEFORE OPERATION D – DURING OPERATION A – AFTER OPERATION			
B	**D**	**A**	**PREVENTIVE MAINTENANCE CHECKS AND SERVICES**
x	x		(10) Stabilization system warning indicator light—If indicator lights when stabilization cylinders are fully retracted or fails to light when cylinders are in any position other than the fully retracted position, notify maintenance.
x			c. Check operation of heater and heater fan.
x			d. Check operation of horn.
x			e. Check operation of windshield wipers and washer.
			ITEM 13—ENGINE
			Check engine for:
	x		a. Unusual noise or vibration.
	x		b. Excessive exhaust smoke.
	x		c. Rough idle.
	x		d. Hard starting.
	x		e. Lack of power.
			ITEM 14—STEERING
			Check steering for:
	x		a. Pulling to one side.
	x		b. Hard turning.
	x		c. Unusual noise while turning.
x		x	d. Packed snow, ice or debris in steering unit.
x	x	x	e. Operation of tilt mechanism in all selector positions.

B – BEFORE OPERATION

D – DURING OPERATION

A – AFTER OPERATION

B	D	A	PREVENTIVE MAINTENANCE CHECKS AND SERVICES
			ITEM 15—STABILIZATION SYSTEM
x		x	a. Check fluid level of stabilization system hydraulic reservoir. Correct level between MAX and MIN marks. Add fluid as necessary.
x	x	x	b. Check operation of stabilization cylinders.
x	x	x	c. Check operation of electrically-driven hydraulic pump.
	x		d. Check operation of stabilization cylinder's automatic release mechanism on transmission gear shift/stabilization cylinder foot plate.
x	x	x	e. Check operation of weapon mount elevating mechanism.
x		x	f. Check security of stabilization cylinder foot plate.
			ITEM 16—SERVICE BRAKES
			Check service brakes for:
	x		a. Vibration
	x		b. Unusual noise.
	x		c. Stopping ability.
			ITEM 17—TRANSMISSION
			Check transmission for:
	x		a. Slippage.
	x		b. Rough shifting.
	x		c. Unusual noise.

B – BEFORE OPERATION **D – DURING OPERATION** **A – AFTER OPERATION**			
B	**D**	**A**	**PREVENTIVE MAINTENANCE CHECKS AND SERVICES**
			ITEM 18—PARKING BRAKE
x			Check parking brake for proper operation.
			ITEM 19—WINCH
x			a. Check condition of external winch mount.
	x		b. Check remote control for proper operation.
	x		c. Inspect remote control and power cable for damage.
	x		d. Check winch for leaks and kinked, frayed or damaged cable.
			ITEM 20—COOLANT HEATER
	x		a. Check operation of circulating pump for engine coolant.
	x		b. Check hoses and connections for leaks and damage.
	x		c. Check engine coolant heater unit for leaks and damage.
	x		d. Check blowtorch for proper operation.
			ITEM 21—SECURITY OF LOAD
x	x	x	Check security of load.
			ITEM 22—ANTENNAE AND MOUNTS
x	x	x	Ensure that antennae and mounts are properly secured.
			ITEM 23—FIRE EXTINGUISHERS
x		x	a. Check that seal is intact.

B – BEFORE OPERATION D – DURING OPERATION A – AFTER OPERATION			
B	**D**	**A**	**PREVENTIVE MAINTENANCE CHECKS AND SERVICES**
x		x	b. Check security of extinguisher mount.

WEEKLY AND MONTHLY CHECKS AND SERVICES

1. Checks and services to be performed WEEKLY (W) and MONTHLY (M) are listed as follows:

PERIOD		PREVENTIVE MAINTENANCE CHECKS AND SERVICES
W	**M**	
		ITEM 1—EXTERIOR/INTERIOR FASTENINGS
	x	a. Inspect all fastening and locking devices as follows: (1) Hasps and locks. (2) Seat belts. (3) Pintle hook and towing attachments. (4) Tarpaulin tie-down points.
	x	b. Check operation of all attachments and mechanisms used to convert carrier from its non-tactical configuration.
		ITEM 2—BATTERIES
		WARNING Do not smoke or have an open flame nearby when checking batteries. Batteries emit gases that are very explosive. Injury to personnel my result. Do not allow battery acid to come in contact with skinas serious burns can result.
		a. Remove battery box cover, and proceed as follows:
x		(1) Check vent tubes for kinks or damage.

PERIOD		PREVENTIVE MAINTENANCE CHECKS AND SERVICES
W	M	
x		(2) Remove caps. Check electrolyte level in all battery cells. Correct level is the lower edge of the filler bore. If necessary, fill batteries with distilled water. Run engine for 10-15 minutes to allow electrolyte and water to mix.
x		(3) Visually check batteries for cracked or leaking casing and corrosion around the posts.
x		(4) Check the cable and post clamp bolts and nuts for tightness. Tighten all loose hardware.
x		(5) Check security of the battery temperature sensor and wiring.
		b. Replace battery box cover.
		ITEM 3—V-BELTS
x		a. Remove right side access cover. Check tension of V-belts for proper deflection; adjust if required, as follows:
		NOTE Measurement is taken midway between pulleys.
		(1) Fan and hydraulic pump 10mm (3/8 in);
		(2) Alternator 5mm (1/4 in);
		(3) Water pump 10mm (3/8 in); and
		(4) Check belts for cracks, frays and breaks.
		b. Replace access cover.
		ITEM 4—INTER-CAR CABLES AND LINES
x		a. Check cables for cracks, breaks and other damage.
x		b. Check fuel lines for damage, deterioration and leakage.

PERIOD		PREVENTIVE MAINTENANCE CHECKS AND SERVICES
W	M	
		ITEM 5—FIRE EXTINGUISHERS
x		a. Check that seal on fire extinguisher handle is intact.
x		b. Check that gauge shows full charge (if applicable).
x		c. Check for damage to handle or gauge (if applicable).
	x	d. Sign the control tag on the extinguisher.
		ITEM 6—SUSPENSION
	x	a. Clean and lubricate at all grease points.
	x	b. Visually inspect centre beam, track beams and leaf springs for security of fasteners and damage.
		ITEM 7—DIFFERENTIALS
x		a. Check oil level and fill as required.
x		b. Check for indication of water in oil. Water contamination causes oil to turn milk-like in colour.
		ITEM 8—FUEL TANK, CAP AND STRAINER
	x	a. Check fuel tank cap for missing or damaged gasket.
	x	b. Check fuel tank strainer for damage or debris.
		ITEM 9—WINCH
	x	a. Check remote control operation.
	x	b. Inspect remote control and power cable for damage.
		ITEM 10—ENGINE COOLANT HEATER
	x	a. Check operation of circulating pump for engine coolant heater.
	x	b. Check hoses and connections for leaks and damage.

PERIOD		PREVENTIVE MAINTENANCE CHECKS AND SERVICES
W	M	
	x	c. Check engine coolant heater unit for leaks and damage.
	x	d. Check blowtorch for proper operation.
		ITEM 11—FRONT CAR HEATER
		a. Open four fasteners, partially lift heater assembly cover at the rear and remove cover and proceed as follows:
	x	(1) Inspect heater core and hoses for leaks; and
	x	(2) Clean debris from heater as required.
		ITEM 12—BILGE PUMPS
	x	a. Check bilge pump screens for cleanliness.
	x	b. Check operation.
		ITEM 13—TRANSFER CASE
	x	a. Check oil level in transfer case; fill as required.
	x	b. Check oil level for indication of water in oil. Water contamination causes oil to turn milk-like in colour.
	x	c. Check condition of rubber bellows seal between transfer and brake unit to ensure vehicle is watertight.
		ITEM 14—ENGINE AIR CLEANER
	x	Inspect air cleaner; if dirty it requires changing, inform maintenance.
		ITEM 15—BLACKOUT LIGHTS
x		Install front blackout lights and test function of lights and control switch.

PERIOD		PREVENTIVE MAINTENANCE CHECKS AND SERVICES
W	M	
		ITEM 16—WEAPON MOUNT
	x	Check condition and lubricate weapon mount pivot bearings.
		ITEM 17—REAR CAR HATCH COVERS
	x	Check condition and lubricate hatch cover hinges and locking mechanism.

ANNEX B
PERFORMANCE OBJECTIVE
BV 2063 (TOW) MOUNTING/DISMOUNTING DRILLS

PART I

STUDENT'S NAME_____

INSTRUCTOR'S NAME_____

DATE_____

GRADING_____

PART II

	MOUNTING			DISMOUNTING			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
1. **ORDER OF MARCH AND EQUIPMENT CARRIED BY DETACHMENT** a. No. 1 carries the tripod, optical sight (OSS) and thermal imagery (TI) sight battery power conditioner spare battery pack;							

	MOUNTING			DISMOUNTING			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
b. No. 3 carries the traversing unit (TU) and boresight collimator in its protective case;							
c. No. 2 carries the missile guidance set (MGS) and launch tube; and							
d. No. 4 carries the encased missile, TI sight battery power conditioner and the TI sight in its protective case.							
2. **MOUNTING PREPERATION** a. **Actions of No. 1:**							
(1) places the tripod and spare battery case at rear of vehicle;							
(2) drops the loader's platform; and							
(3) places OSS on loader's platform.							
b. **Actions of No. 3**:							

	MOUNTING			DISMOUNTING			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
(1) places TU on loader's platform;							
(2) places collimator on crew commander's seat; and							
(3) mounts the vehicle.							
c. **Actions of No. 2**:							
(1) places launch tube by the loader's platform;							
(2) turns vehicle power ON;							
(3) secures the MGS and exchanges the battery assembly for the MGS power conditioner; and							
(4) raises the weapon mount and remains in vehicle.							
d. **Actions of No. 4**:							

	MOUNTING			DISMOUNTING			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
(1) places the encased missile by the R1 compartment;							
(2) places the TI sight power conditioner by R2 compartment;							
(3) places the TI sight by the launch tube;							
(4) takes the MGS cover off the back of the vehicle; and							
(5) stows and secures all equipment and mounts the vehicle;							
3. **MOUNTING**:							
a. No. 1 passes the TU to the No. 3;							
b. No. 3, with assistance of the No. 2, mounts the TU;							
c. No. 1 passes the OSS to the No. 3;							Fail if OSS is not properly secured

	MOUNTING			DISMOUNTING			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
d. No. 3 passes the OSS to the No. 2;							
e. No. 2 mounts the OSS;							
f. No. 1 passes the launch tube to the No. 3;							Fail if OSS sight is not properly secured
g. No. 3 mounts the launch tube;							
h. No. 1 passes the TI sight to the No. 3;							
i. No. 3 passes the TI sight to the No. 2;							
j. No. 2 mounts the TI sight;							Fail if TI is not properly boresighted
k. No. 1 passes the TI sight protective case to the No. 3;							
l. No. 2 connects the MGS;							
m. No. 3 stows and secures the TI sight protective case; and							
n. No. 2 and 3 complete a system check-out, self test and boresight/collimation.							Fail if not boresighted/ collimated correctly

	MOUNTING			DISMOUNTING			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
4. **DISMOUNTING DRILL** a. The word of command to dismount the TOW 2 from the BV 2063 is CEASE TRACKING, UNLOAD, DISMOUNT or DISMOUNT. The weapons mount is lowered and after the No. 2 gives ALL CLEAR. The crew dismounts in the opposite order, handling the same components with the exception of the No. 4, who is responsible for laying the equipment on the ground in the order of march.							

PART III
GENERAL REMARKS

_____

Instructor's Signature

ANNEX C
PERFORMANCE OBJECTIVE
BV 2063 (TOW) LOAD AND UNLOAD

PART I

STUDENT'S NAME_____

INSTRUCTOR'S NAME_____

DATE_____

GRADING_____

PART II

	IE	E	VE	REMARKS
LOADING 1. **General**. Prior to conducting a load, a system self-test is completed and collimation done if necessary.				
2. **Actions of No. 2**. Loading drills are initiated by the No. 1 commanding, LOAD or LOAD 2B. Upon hearing the command, the No. 2:				
a. ensures the weapon mount is raised and locked;				
b. ensures the elevation and azimuth friction locks are engaged and the weapons system is locked down;				.

	IE	E	VE	REMARKS
c. ensures the trigger cover is down;				
d. ensures the thermal imagery (TI) sight On/Off/Stby switch is set to ON;				Fail if not done
e. operates selectable filter switch to Reset/Clear position;				
f. ensures WFOV (Wide Field of Vision) is selected;				
g. ensures both sight covers are off;				
h. repeats the command LOAD or LOAD 2B; and				Fail if the wrong missile is ordered or loaded.
i. remains in firing position and observes arcs of fire.				
3. **Actions of No. 4**. The No. 4 upon hearing LOAD or LOAD 2B from the No. 1 will:				
a. repeats command LOAD or LOAD 2B;				
b. removes specified missile from the rack and place it with the nose towards the rear of the vehicle on the loader's platform;				
c. visually inspects the encased missile;				
d. checks the humidity indicators;				
e. removes the forward handling ring and clamp, and inspects the diaphragm;				

	IE	E	VE	REMARKS
f. removes and retains the electrical connector cap;				
g. waits to pass the encased missile to the No. 3.				
4. **Actions of No. 3**. All actions of the No. 3 are initiated by the command LOAD or LOAD 2B given by the No. 2. Upon hearing the command LOAD or LOAD 2B, the No. 3:				
a. repeats the command LOAD or LOAD 2B;				
b. raises the bridge clamp and inspects the launch tube;				
c. turns and receives the encased missile from the No. 4;				
d. upon receiving the encased missile will turn towards the front of the vehicle;				
e. with electrical connector upwards, aligns the indexing lugs of the encased missile with the indexing slots of the launch tube, slides the encased missile forward and down until the missile is fully seated; and				
f. lowers the bridge clamp (apply pressure with the left hand while locking it with the right hand).				
5. **Actions of No. 2**. Once the No. 3 has locked the bridge clamp, the No. 2 reports READY.				

	IE	E	VE	REMARKS
TARGET ENGAGEMENT 1. **Actions of No. 2**. All actions of the No. 2 will be initiated by the command TARGET or fire control order given by the No. 1. Upon hearing the command, the No. 2:				
a. repeats the command TARGET; and				
b. ensures the TI sight is on WFOV.				
2. **Action of No. 4**. All actions of the No. 4 are initiated by the command TARGET given by the No. 1. Upon hearing the command the No. 4 will:				
a. ensures the missile rack hatch R1 is closed; and				
b. takes up a position to the right of the loader's hatch or in line with the TU and remains there through out the target engagement.				
3. **Actions of No. 3**. All actions of the No. 3 are initiated by the command TARGET given by the No. 2. Upon hearing the command, the No. 3:				
a. ensures the No. 4 is beside the loader's platform or in line with the TU;				
b. checks the backblast danger area (BBDA) and report BACKBLAST; and				Fails if BBDA is not checked.
c. observes the backblast danger area until the missile is fired.				

	IE	E	VE	REMARKS
4. **Actions of No. 2**. Upon hearing BACKBLAST from the No. 3, the No. 2:				
a. disengages the azimuth and elevation brake locks;				
b. rough aligns the weapon to the direction of the target while repeating the target indication				
c. searches for and places the crosshairs on the target;				
d. switches the TI sight to NFOV, focuses and adjusts sight picture; and				Fails if the TI sight is not: ON, NFOV and focussed before firing.
e. reports ON.				
5. **Actions of No. 3**. Upon hearing ON from the No. 2, the No. 3:				
a. repeats ON; and				
b. raises the arming lever and reports, ARMED.				
6. **Actions of No. 2**. Upon hearing ARMED from the No. 3, the No. 2:				
a. raises the trigger cover; and				
b. awaits further orders from No. 1 or engages the target as per fire control orders.				
CEASE TRACKING 1. The command CEASE TRACKING LOAD is given by the No. 1 when the target being engaged is either destroyed or lost.				

	IE	E	VE	REMARKS
2. **Missile is fired**:				
a. **Actions of No. 2**:				
(1) lowers the trigger cover;				Fails if trigger cover is not lowered
(2) engages the elevation lock and brake;				
(3) engages the azimuth lock;				
(4) locks the weapon system down;				
(5) repeats CEASE TRACKING LOAD; and				
(6) remains in the fire position and observes the arcs of fire.				
b. Actions of No. 3:				
(1) repeats CEASE TRACKING LOAD;				
(2) unlocks and raises the bridge clamp;				
(3) removes the empty missile container;				
(4) passes the empty missile container to the No. 4;				

	IE	E	VE	REMARKS
(5) inspects the launch tube; and				
(6) loads another missile.				
c. **Action of No. 4**:				
(1) upon hearing CEASE TRACKING LOAD from the No. 1, the No. 4 removes an encased missile from the R1 compartment;				
(2) places the missile on the loader's platform with the warhead of the missile facing the rear of the vehicle and prepares the missile for loading;				
(3) receives the empty missile container from the No. 3;				
(4) passes the new encased missile to the No. 3; and				
(5) discards the empty missile container.				
3. **Missile has not been fired**:				
a. **Actions of No. 2**:				

	IE	E	VE	REMARKS
(1) upon hearing CEASE TRACKING from the No. 1, the No. 2 lowers the trigger cover;				Fails if trigger cover is not lowered
(2) repeats CEASE TRACKING; and				
(3) maintains firing position.				Fails if No 2 tries to lock down system
b. **Actions of No. 3**:				
(1) repeats, CEASE TRACKING;				
(2) lowers the arming lever and reports DISARMED; and				
(3) continues to observe the backblast danger area.				
c. **Actions of No. 2**:				
(1) upon hearing, DISARMED from the No. 3, the No. 2 ensures the trigger cover is lowered;				
(2) places the TI sight to WFOV and reports DISARMED, READY; and				

	IE	E	VE	REMARKS
(3) remains in firing position, observing the arcs of fire and awaiting further orders.				
d. **Action of No. 3**:				
(1) upon hearing READY from the No. 2, the No. 3 turns around; and				
(2) observes the arcs of fire and awaits further orders.				
CEASE TRACKING, UNLOAD 1. The command CEASE TRACKING, UNLOAD will be given by the No. 1 when there is no requirement to reload the weapon.				
2. **Missile has been fired**:				
a. **Actions of No. 2**:				
(1) lowers the trigger cover;				Fail if trigger cover is not lowered
(2) engages the elevation lock and brake;				
(3) engages the azimuth lock;				
(4) locks the weapon system down;				

	IE	E	VE	REMARKS
(5) repeats CEASE TRACKING, UNLOAD;				
(6) turns the TI On/Off/Stby switch to Stby;				
(7) places the sight to WFOV;				
(8) replaces the TI sight cover; and				
(9) remains in firing position and observes the arcs of fire.				
b. **Actions of No. 3**:				
(1) repeats CEASE TRACKING, UNLOAD;				
(2) unlocks and raises the bridge clamp;				
(3) removes the empty missile container from the launch tube;				
(4) passes the empty missile container to the No. 4;				
(5) inspects the launch tube and closes the bridge clamp;				
(6) reports LAUNCH TUBE CLEAR; and				

	IE	E	VE	REMARKS
(7) remains in position observing the arcs of fire and awaits further orders from the No. 1.				
c. **Actions of No. 4**:				
(1) upon receiving the empty missile container from the No. 3, the No. 4 discards the empty missile container; and				
(2) remains in position observing the arcs of fire and awaits further orders from the No. 1.				
3. **Missile has not been fired**:				
a. **Actions of No. 2**:				
(1) lowers the trigger cover;				Fail if trigger cover is not lowered
(2) repeats CEASE TRACKING, UNLOAD; and				
(3) maintains firing position.				
b. **Actions of No. 3**:				

	IE	E	VE	REMARKS
(1) repeats, CEASE TRACKING, UNLOAD; and				
(2) lowers the arming lever and reports, DISARMED.				
c. **Actions of No. 2**:				
(1) upon hearing DISARMED from the No. 3, the No. 2 ensures the trigger cover is lowered;				
(2) engages the elevation lock and brake;				
(3) engages the azimuth lock;				
(4) locks the weapon system down;				
(5) places TI sight On/Off/Stby switch to Stby;				
(6) places the TI sight to WFOV;				
(7) replaces the TI sight cover; and				
(8) remains in firing position and observes the arcs of fire.				
d. **Actions of No. 3**:				

	IE	E	VE	REMARKS
(1) when the weapon system has been locked down, the No. 3 unlocks and raises the bridge clamp;				
(2) removes the encased missile from the launch tube;				
(3) passes the encased missile to the No. 4;				
(4) inspects the launch tube, closes the bridge clamp and reports LAUNCH TUBE CLEAR; and				
(5) remains in position observing the arcs of fire and awaits further orders from the No. 1.				
e. **Actions of No. 4 upon receiving the encased missile from the No. 3**:				
(1) replaces the forward handling ring and clamp;				
(2) replaces the electrical connector cap;				
(3) secures the encased missile; and				

	IE	E	VE	REMARKS
(4) remains in position observing the arcs of fire and awaits further orders from the No. 1.				
e. **Actions of No. 2**:				
(1) upon hearing LAUNCH TUBE CLEAR from the No. 3, the No. 2 reports ALL CLEAR; and				
(2) remains in firing position observing the arcs of fire and awaits further orders from the No. 1.				

PART III
GENERAL REMARKS

_____
Instructor's Signature

ANNEX D
PERFORMANCE OBJECTIVE
MISFIRE DRILLS ON THE BV 2063 (TOW)

PART I

STUDENT'S NAME_____

INSTRUCTOR'S NAME_____

DATE_____

GRADING_____

PART II

MISFIRE DRILLS	IE	E	VE	REMARKS
1. **Actions of the No. 2**. The following are the actions of the No. 2 when a malfunction occurs:				
a. alerts the crew by reporting MISFIRE; and				
b. continues tracking for one minute.				Fail if there is no 1 minute wait.
2. **Actions of the No. 3**. Upon hearing MISFIRE from the No. 2, the No. 3:				

MISFIRE DRILLS	IE	E	VE	REMARKS
a. repeats MISFIRE;				
b. initiates a missile guidance set (MGS) self-test for good batteries and if the batteries fail, the No. 3 replaces them;				Fail if not done.
c. ensures the coil cord is properly secured to the MGS, the bridge clamp locking is secure and the arming lever is fully raised; and				
d. after the 1 minute wait, he lowers then raises the arming lever (ensuring the backblast is clear) and reports ARMED.				Fail if not done.
3. **Actions of the No. 2.** a. upon hearing ARMED from the No. 3, he refires the weapon; and				
b. if it fails to fire a second time, he reports MISFIRE TWO and continues tracking for 1 minute counting aloud.				Fail if not done.
4. **Actions of the No. 3**. Upon hearing MISFIRE TWO from No. 2, the No. 3:				

MISFIRE DRILLS	IE	E	VE	REMARKS
a. repeats MISFIRE TWO;				
b. continues to observe the backblast;				
c. disconnects the coil cord, while counting aloud with the No. 2 for 1 minute; and				
d. after 1 minute is complete, he lowers the arming lever and reports DISARMED.				
5. **Actions of the No. 2**. Upon hearing DISARMED from the No. 3, the No. 2:				
a. repeats DISARMED;				
b. lowers the trigger cover;				
c. locks the system with the crosshairs on target; and				
d. stands clear (30 minutes).				Fail if not done.
6. **Actions of the No. 3**. After the 30 minute waiting period the No. 3 remounts the vehicle and conducts the following:				
a. lowers the weapon mount to waist height;				

MISFIRE DRILLS	IE	E	VE	REMARKS
b. unloads the missile, keeping it pointed down range; and				
c. passes the missile to the No. 4.				
7. **Actions of the No. 4**. After the 30 minute waiting period the No. 4 moves to the side of the vehicle where the dud pit is located and conducts the following:				
a. facing the vehicle ensuring the missile is horizontal and pointed down range, receives the missile from the No. 3;				
b. steps back and lowers missile to the ground;				
c. steps over the missile, turns around and picks the missile up; and				
d. carries the missile to the dud pit with the missile continuing to point down range.				
NOTE During all range practices, a thirty-minute waiting period is observed after the weapon has been disarmed. All personnel will stand clear of the weapon.				

PART III
GENERAL REMARKS

_____

Instructor's Signature

CHAPTER 4
M113A2 TOW 2 UNDER ARMOUR (TUA) WEAPON SYSTEM

LESSON 1
DESCRIPTION AND FUNCTION

INSTRUCTOR'S NOTES

1. **Aim**. To teach the general description of the mechanical components of the TUA and the operation of the following:

   a. turret;

   b. launchers;

   c. secondary armaments;

   d. scales; and

   e. loader’s hatch.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. M113A2 TUA complete;

   b. charts on the arming mechanism and arming linkage;

   c. cut away chart of the TUA turret;

   d. a pointer; and

   e. hand-outs on technical data;

5. **Preparation**. Prior to starting the first period:

a. park the vehicle or trainer in a suitable location; and

b. check the training aids.

6. **Miscellaneous**. Give all students hands on instruction on all mechanical components covered. Remove the cover from the arming mechanism and operate the arming lever and release arm to demonstrate the mechanism of the arming linkage and safety arming mechanism. (On trainer only). At this stage the students are not expected to memorise all the names or technical data. The TUA technical data may be found in Annex B to this Chapter.

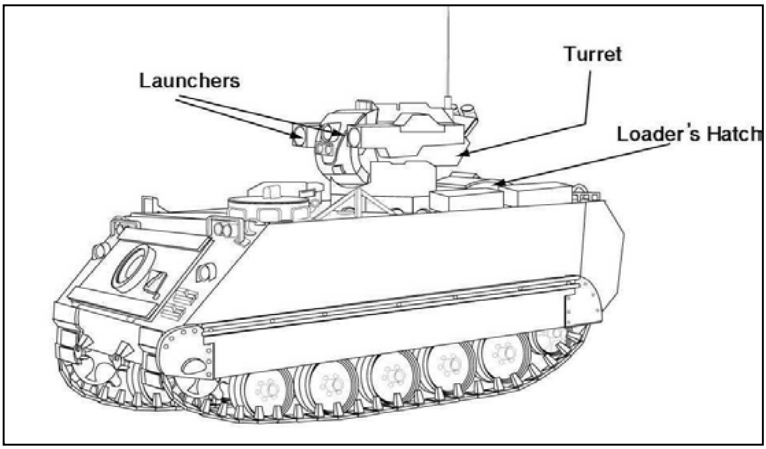


Figure 4-1-1: TUA

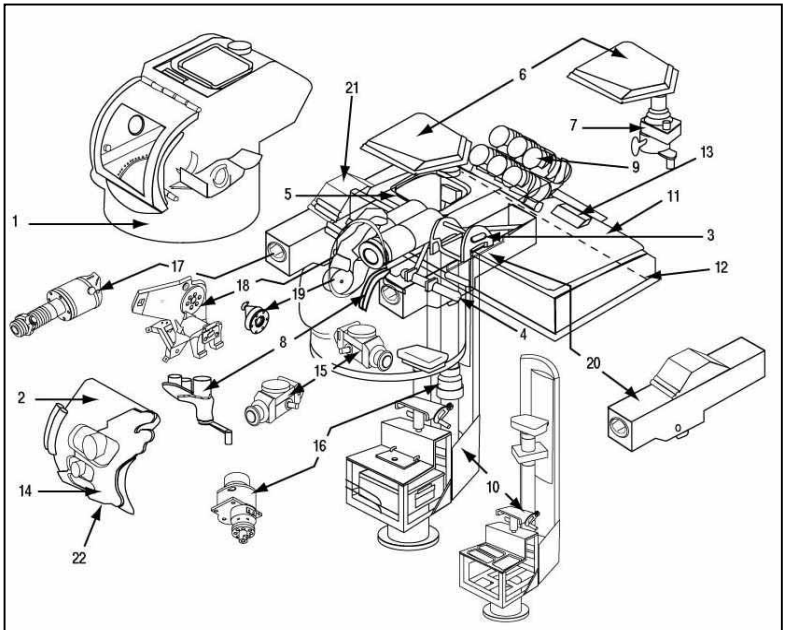


Figure 4-1-2: Front Shield Assembly

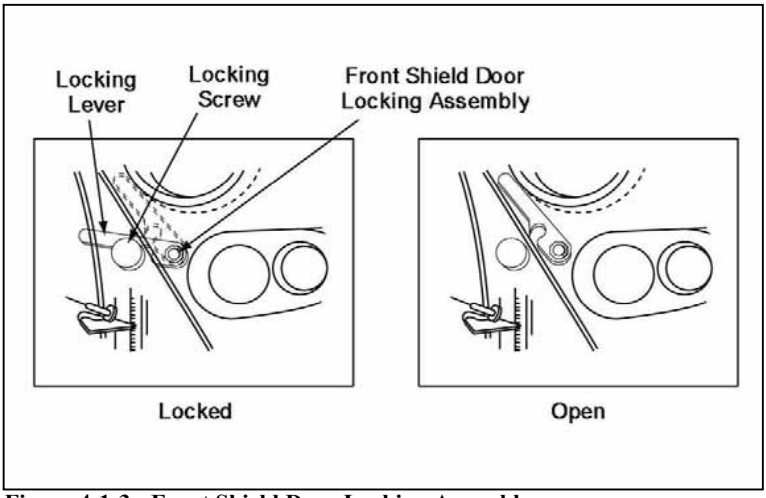


Figure 4-1-3: Front Shield Door Locking Assembly

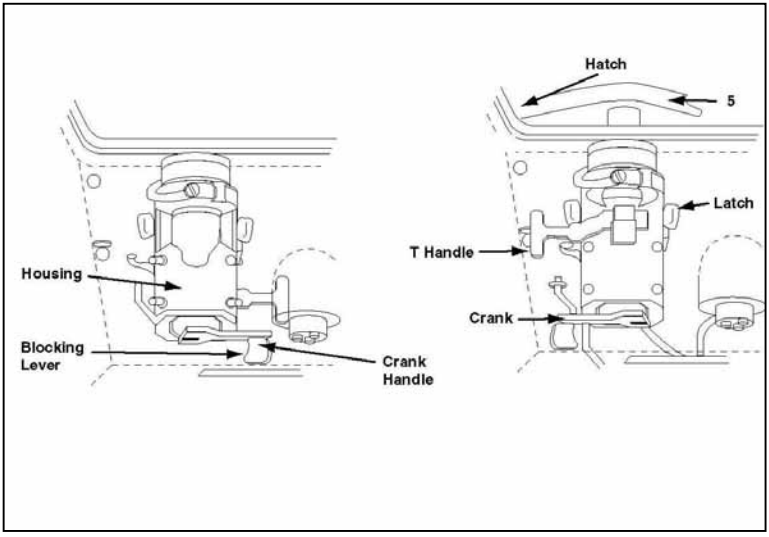


Figure 4-1-4: Turret Hatch

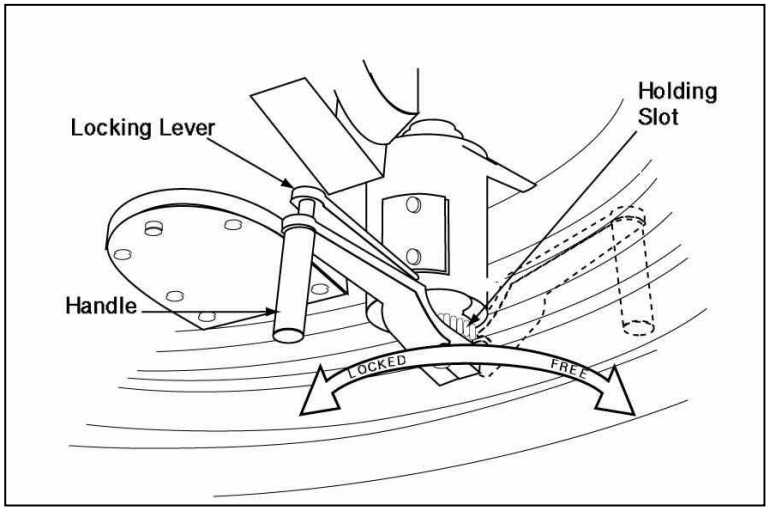


Figure 4-1-5: Turret/Shield Lock

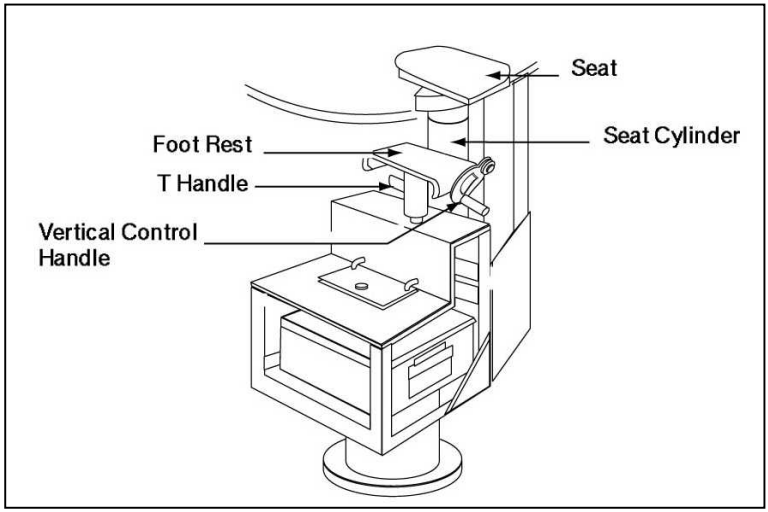


Figure 4-1-6: Gunner's Seat Assembly

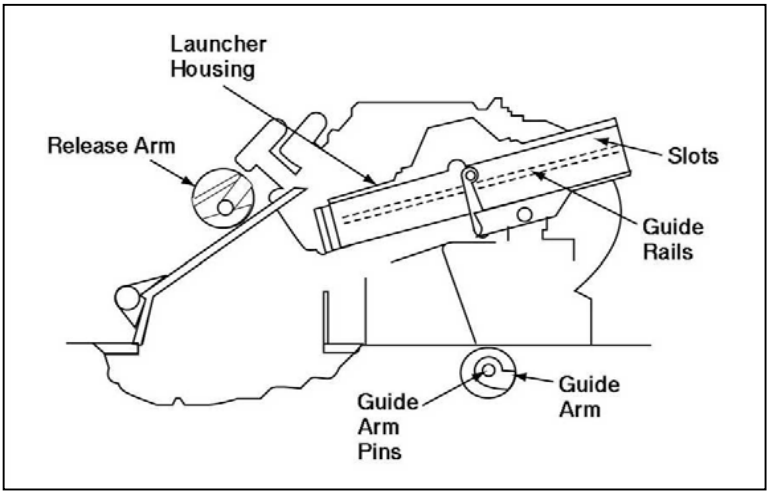


Figure 4-1-7: The Launcher

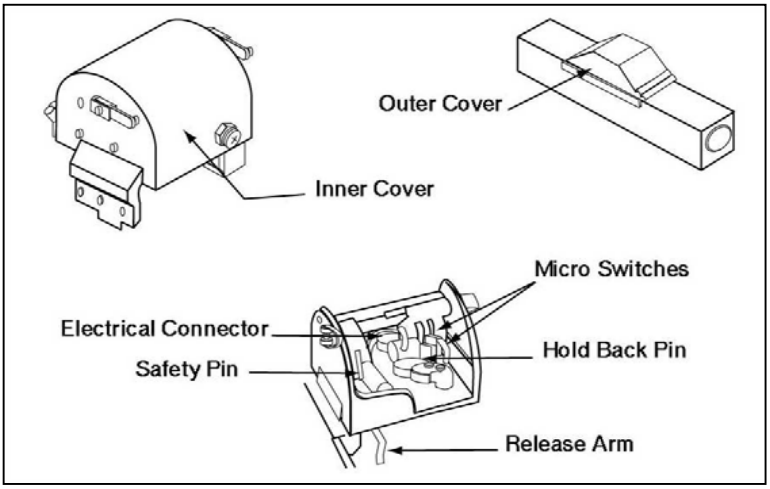


Figure 4-1-8: Arming Mechanisms

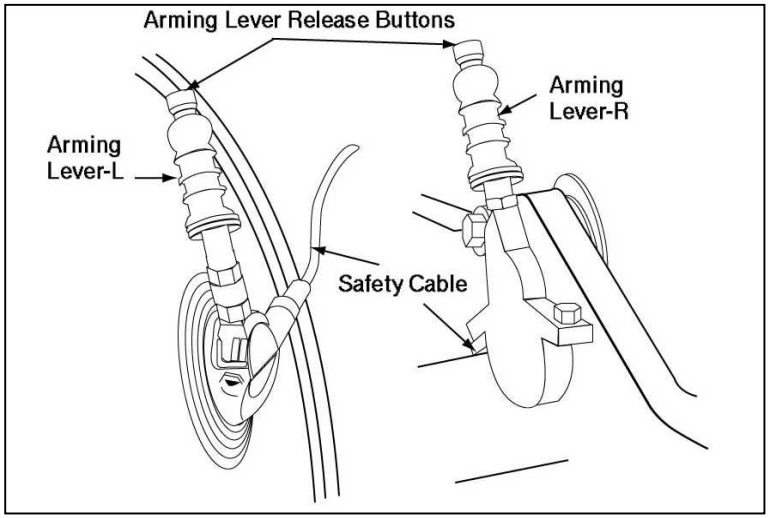


Figure 4-1-9: Arming Linkage

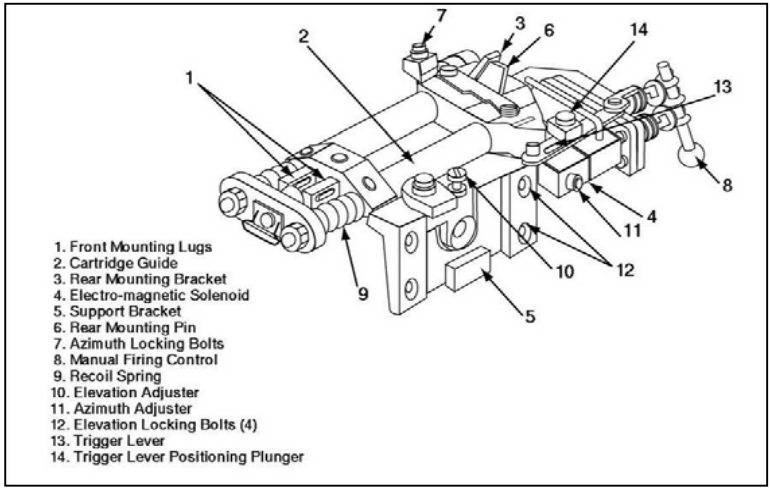


Figure 4-1-10: Coaxial Machine Gun Mount

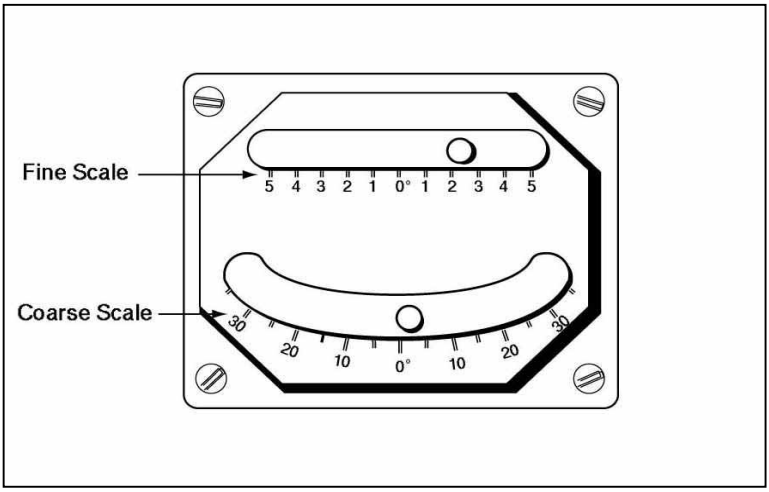


Figure 4-1-11: Inclinometer

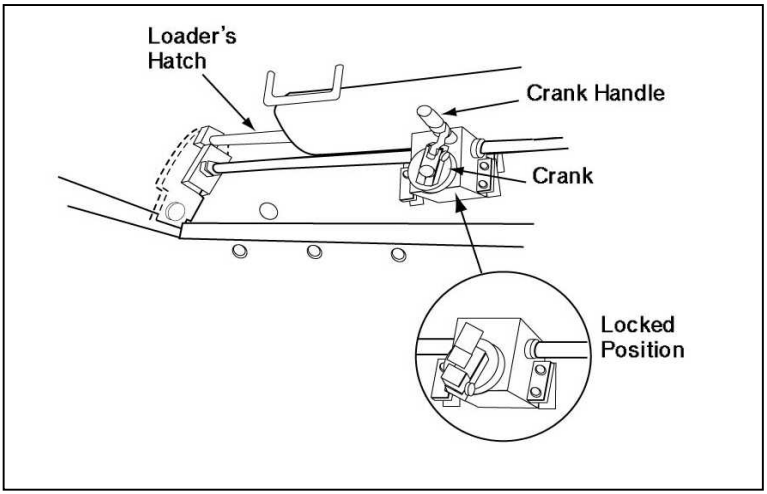


Figure 4-1-12: Loader's Hatch Assembly

CONDUCT OF THE LESSON

7. **Safety Precautions**. Heed all DANGER WARNINGS and CAUTIONS posted on components and vehicle.

8. **Review**. Review the characteristics of the TOW 2 system.

9. **Introduction**. This lesson provides the general description of the TOW (TUA) as well as a thorough knowledge of the location, description and function of the components and controls. These items are divided into two groups, mechanical and electrical. Lesson 1 comprises the mechanical group and Lesson 2 the electrical group.

GENERAL DESCRIPTION

10. The TUA is designed to provide protection for the missile system and operating personnel.

11. The weapon system, which is mounted on an M113A2, consists of an armoured rotating turret with two external mounted launchers (see Figure 4-1-1).

12. The system uses the same sighting and guidance units as the ground mounted TOW 2 Missile system.

13. The TOW 2 tripod mount, launch tube, sighting and guidance units, each of which are secured in the vehicle, can be quickly removed, assembled and used in the ground role, then returned to the vehicle for storage.

14. The weapon system can be easily stripped and stored inside the vehicle for transport on highways and in aircraft.

15. The loader's hatch provides protection for the loader and missiles during loading and unloading of the launchers.

TURRET COMPONENTS

16. **Turret Casing**. The turret casing is constructed of an armoured steel plate (Armox 500 S) that houses the sights and the mechanical and electrical components needed to launch and guide a missile to a target.

17. **Front Shield Assembly**. The front shield and door assembly (see Figure 4-1-2) is bolted to the elevation arm and the

front of the left and right launchers. Movement of the elevation arm is transferred to the front shield, which elevates and depresses the launchers. The front shield door provides ports for the optic sight (OSS) and thermal imagery (TI) sight. Opening and closing the door does not affect the sight settings. A sight protection unit is provided for the ports to protect the sights when not in use. The door can be closed and secured from inside the turret by using the front shield door locking assembly, which is composed of a locking lever and locking screw (Figure 4-1-3).

CAUTION

Use caution when traversing the turret with the shield door open, as it could contact the loaders hatch.

18. **Day and Night Sight Cover.** The day and night sight cover is located on the front of the shield door. To open the sight protection unit proceed as follows:

a. grasp the T handle with the right hand;

b. turn the T handle counter clockwise one quarter turn;

c. push T handle fully towards the front shield; and

d. turn T handle clockwise one quarter turn to the rear.

19. Close the sight protection unit in the reverse order.

20. **Turret Hatch**. The turret hatch provides overhead protection for the gunner. It may be raised to the half open position to provide an observation port or raised and rotated 3200 mils to become a possible exit or entry to the turret. A microswitch prevents the firing of the smoke grenades, when the hatch is in the half open or fully open position. The mircoswitch can be overridden by the override switch on the Smoke Grenade Control Box when the turret hatch is in the half open position. The operations of the turret hatch are detailed below:

a. To half open the turret hatch (see Figure 4-1-4) proceed as follows:

WARNING

1. Before moving the vehicle, ensure the turret hatch is locked in the half-open, fully open or closed position.

2. The gunner's head must be below the turret opening line when travelling

(1) grasp the crank handle and squeeze the lever to release the crank from the housing;

(2) rotate the crank clockwise approximately 10 turns to raise the hatch cover; and

(3) release the lever and lock the crank.

NOTE

The crank is locked in position when the clasp is engaged in a slot on the underside of the housing. It may be necessary to move the crank slightly to engage the clasp.

CAUTION

The T handle must be lowered into the slots on the mechanism housing to prevent rotation of the turret hatch cover when the hatch is fully or half open.

b. To fully open the turret hatch, proceed as follows:

(1) grasp the crank handle and squeeze the lever to release the crank from the housing;

(2) rotate the crank clockwise approximately

10 turns to raise the turret hatch cover;

(3) raise the latches to release the T handle and rotate the hatch cover 3200 mils by rotating the T handle to the left; and

NOTE

The hatch is locked in the fully open position when the T handle is lowered into the slot on the mechanism housing.

(4) rotate the crank counter-clockwise approximately one and a half turns until the crank stops. Release the lever to lock the crank.

c. To close the turret hatch proceed as follows:

(1) grasp the crank handle and squeeze the lever to release the crank from the housing;

(2) rotate the crank clockwise approximately one and a half turns to raise the T handle from the slot;

(3) release the lever and lock the crank;

(4) raise the latches and move the T handle to the right 3200 mils until the lever catch the T handle. The hatch cover is now in position over the hatch;

(5) rotate the crank counter-clockwise approximately 10 turns to lower the hatch cover; and

(6) lock the crank.

21. Confirm by practice.

22. **Turret/Shield Lock Assembly.** The turret/shield lock

assembly (Figure 4-1-5) is located below and to the right of the hand controller and is used to lock the turret and shield against movement when the vehicle is travelling or being transported. The shield lock is linked to the turret lock and operated by turning the crank on the turret lock. The turret locks in the 6100 azimuth position and the shield locks when fully depressed. To operate the turret/shield lock proceed as follows:

DANGER

Death or serious injury may result if the turret/shield lock is not applied when the vehicle is travelling.

NOTE

The system cannot fire if the turret/shield is locked.

a. To lock:

(1) depress the launchers to maximum depression and rotate the turret to the load position;

(2) push the locking lever down to disengage the lever from its holding slot; and

(3) pull the handle to the left until the lever enters the locking slot.

b. To unlock:

(1) push the locking lever down to disengage the lever from the locking slot; and

(2) push the handle to the right until the lever is engaged in the holding slot.

23. **Periscope**. The periscope provides forward observation for

the gunner.

24. **Gunner's Seat Assembly.** The gunner's seat assembly (see Figure 4-1-6) is bolted to and rotates with the turret casing. It can be adjustable for height and is fitted with a seat belt and an adjustable footrest. The base provides mounting space for the missile guidance set. To adjust the gunner's seat assembly for height proceed as follows:

a. push the seat down to the horizontal position against its spring;

b. sit on seat;

c. press down on vertical control handle with the left foot;

d. using the body weight, adjust the seat height to the correct viewing position with the eyepiece of the OSS or TI sight;

e. release the vertical control handle to lock the cylinder in position; and

f. pull the T handle and adjust the footrest to the desired position (one of six positions).

CAUTION

The gunner's seat cylinder is spring loaded. Do not step on the vertical control handle before sitting on the seat.

25. Confirm by practice.

LAUNCHER COMPONENTS

26. **Left and Right Launchers**. The left and right launchers (see Figure 4-1-7) are attached to the front shield and supported on the turret by the launcher shafts. Elevation and depression of the elevation arm is

transferred to the front door and shield, which rotates the launchers. The maximum elevation and depression arc is 533 mils, which is equal to 267 mils up and down from the 0 reference. The left and right launchers are identical in shape and operation. The launcher consists of the launcher housing, the launcher guide rails, slots, the guide lever, guide lever pins and release arm. The launcher housing provides light armoured protection for the missiles. The launcher guide rails and slots provide a support for the indexing lugs at the front end of the encased missile. The guide lever and guide lever pins support the encased missile while it is being pushed forward into the locked position. The release arm assists in unloading the launcher by unlocking the guide lever.

27. **Launcher Shafts**. The left launcher shaft and the right launcher shaft support the launchers in the turret casing. They are identical in shape and operation.

28. **Arming Mechanism**. The arming mechanisms (see Figure 4-1-8) are bolted at the top of the left and right hand launchers and contain the mechanism and switches needed to arm the missile and cut the guidance wires after missile launch. The arming mechanism consists of an outer cover, which provides light armoured protection to the mechanism. Under an inner cover there are two microswitches. The front microswitch controls wire cutting after the missile has been launched. The rear microswitch controls the arming of the missile. The electrical connector and the hold back pin are the same as on the basic TOW 2. The safety pin is a device, which works in conjunction with the release arm and guide lever. The safety pin prevents the missile from being armed unless the guide lever is fully seated forward and locked in position. The electrical cable carries all electrical signals to and from the missile.

29. The disarming sequence causes the wire cutting microswitch to energize and trigger the "MGS WIRE CUT" signal, when the missile FIRE signal has been initiated by arming the launch tube and pressing the trigger.

WARNING

If a MISFIRE condition arises, the launch tube must NOT BE DISARMED before:

a. the vehicle power condition has been switched OFF; and

b. if using the battery assembly, the missile guidance set (MGS) has been disconnected from the junction box by disconnecting the J1 plug.

30. **Arming Linkage (L and R).** The details of the left and right arming linkages are:

a. The right arming linkage (see Figure 4-1-9) consists of the arming lever, arming lever release button and components to arm/disarm the missiles. Pressing the right arming lever release button and rotating the right arming lever down to the armed position arms the right launcher.

b. The left arming linkage consists of the arming lever, arming lever release button, safety cable and components to arm/disarm the missiles. Pressing the left arming lever release button and rotating the left arming lever down to the armed position arms the left launcher. The safety cable ensures that only one launcher can be armed at a time.

31. Confirm by practice.

SECONDARY ARMAMENT COMPONENTS

32. **Coaxial Machine Gun Mount.** The coaxial machine gun (MG) mount is bolted to the right hand side of the right missile launcher (see Figure 4-1-10). The mount is adjustable for both azimuth and elevation for boresighting. When the MG C6 is mounted, it is fired electrically by means of an electro-magnetic solenoid activated by the No. 2 (gunner) from inside the turret. The

azimuth and elevation locking and adjusting nuts are loosened prior to placing the mount on the vehicle.

33. **Smoke Grenade Launchers.** Six smoke grenade launchers (see Figure 4-1-2) are mounted on the rear sloping surface of the turret. The firing switches are located in a control box mounted above and to the left of the hand controller. Operation of the smoke grenade launchers will be covered in Lesson 2.

34. Confirm by questions.

35. **Inclinometer.** The inclinometer (see Figure 4-1-11) is bolted on the inside of the turret to the left of the front shield and indicates the inclination angle of the vehicle. The fine scale indicates the inclination angle of the vehicle to the left or right from 0 to 5 degrees and the coarse scale indicates inclination angle from 0 to 35 degrees left or right.

NOTE

1. The maximum efficiency of the tracking system is obtained when the inclination of the vehicle is maintained at 0 degrees during the flight of the missile.

2. If the turret is inclined more than 10 degrees left or right, adequate tracking may be impossible.

36. **Elevation Scale.** The elevation scale is positioned on the left inside of the shield and its pointer is attached to the turret casing. The scale is graduated from –260 to +260 mils in 20 mil increments.

37. **Azimuth Scale**. The azimuth scale is attached to the hull of the vehicle with the numbers facing up towards the turret hatch and its pointer is attached to the front left side of the turret casing. The azimuth scale is graduated from 0 to 6400 mils in 50 mil increments. A double line indicates the load and collmination positions.

38. Confirm by questions.

LOADERS HATCH COMPONENTS

39. **Loader's Hatch Assembly**. The loader's hatch assembly is bolted to the top of the APC and provides protection for the loader and missiles during loading and unloading. The hatch is opened and closed from inside the vehicle. Two microswitches prevent the missiles from being fired when the hatch is open 10 mm at the front. A periscope permits observation to the rear of the vehicle. To open the loader's hatch (see Figure 4-1-2) proceed as follows:

a. rotate the turret to the load position;

b. pull the crank handle outward to the unlocked position;

c. turn the crank clockwise approximately five turns to fully open the loader's hatch; and

d. push the crank handle to the locked position. To close the loader's hatch reverse the above procedure.

DANGER

DO NOT attempt to open the loader's hatch before the turret is rotated to the loading position as indicated by the pointer on the azimuth scale.

WARNING

Turret will not operate with the loader's hatch open. Secure hatch before moving the vehicle.

NOTE

It may be necessary to move the crank slightly to lock the handle.

40. **Loader's Seat**. The loader's seat is located on the left side of the interior of the vehicle behind the gunner's seat assembly. Under the loader's seat are storage areas for the boresight/collimator, maps, vehicle documents and miscellaneous kit.

41. Confirm by practice.

CONCLUSION

42. Take questions from class on the entire lesson.

43. Confirm by questions.

44. **Summary**:

a. stress the importance of having a thorough knowledge of the location, description and function of the components and controls.

b. announce the next lesson.

LESSON 2
DESCRIPTION AND FUNCTION OF ELECTRICAL COMPONENTS AND CONTROLS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the description and function of the electrical components and controls of the TUA. The components are sub-divided into the following main teaching points:

   a. electrical components;

   b. turret drive units;

   c. electrical controllers; and

   d. limitation switches

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following equipment and stores are required:

   a. electrical path flow chart from 24 V power supply to the crew commander's control box and slip ring;

   b. electrical path flow chart of the circuits from the slip ring to remainder of the electrical components in turret;

   c. electrical path flow chart for the limitation switches;

   d. hand-outs on each electrical componentone per student; and

   e. a pointer.

5. **Preparation**. Prior to the commencement of the first period:

a. prepare the classroom; and

b. park the vehicle/trainer in a suitable location.

6. **Miscellaneous**. Periods to be given with the aid of charts in classroom then hands-on training in the vehicle.

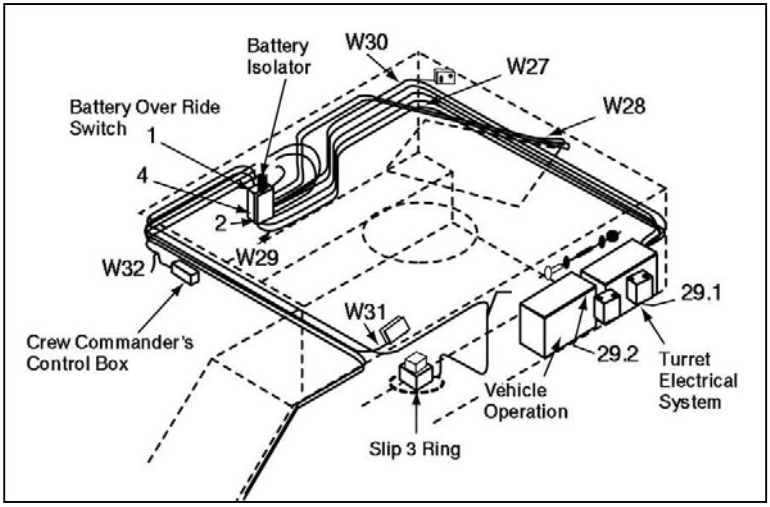


Figure 4-2-1: 24 Volt Power Supply

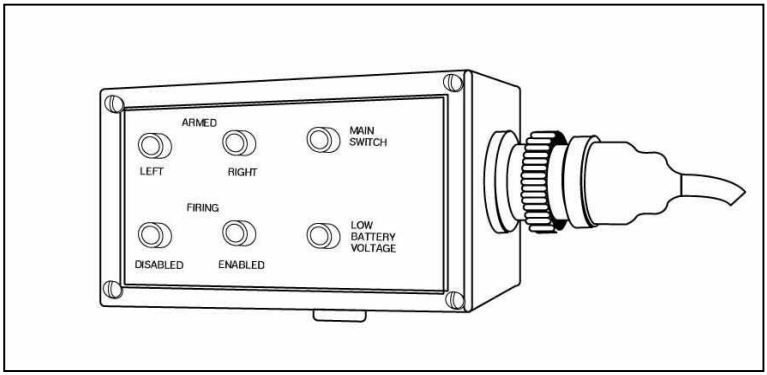
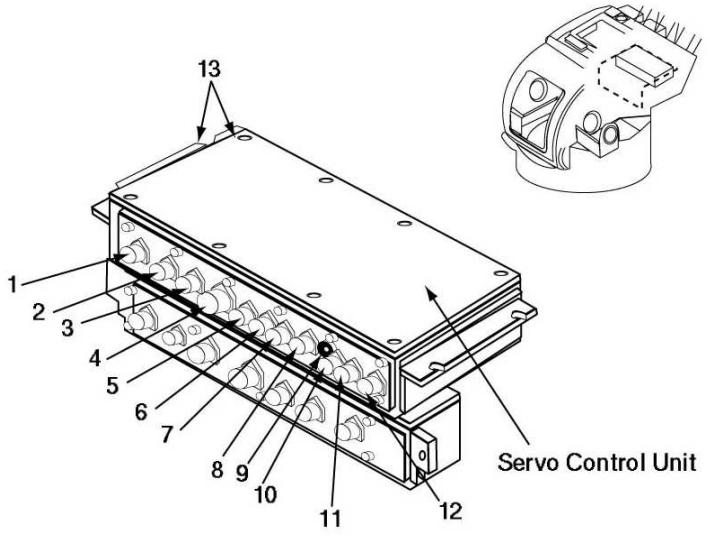


Figure 4-2-2: Crew Commanders Control Box



1. Elevation Drive Assembly - J28
2. Slip Ring - J42
3. Hand Controller - J26
4. Test - J23
5. Limitation Switch Turret - Hatch - J36
6. Smoke/Fragmentation Grenade Launcher Box Control Box - J37
7. Junction Box
8. Smoke/Fragmentation Grenade Launchers - J86
9. Turret Compartment Light - J32
10. Spare - J34
11. Limitation Switches - J27
12. Azimuth Drive Unit - J30
13. Fuses: F-3 CCTAS
    F-4 Interior Lights

Figure 4-2-3: Servo Amplifier

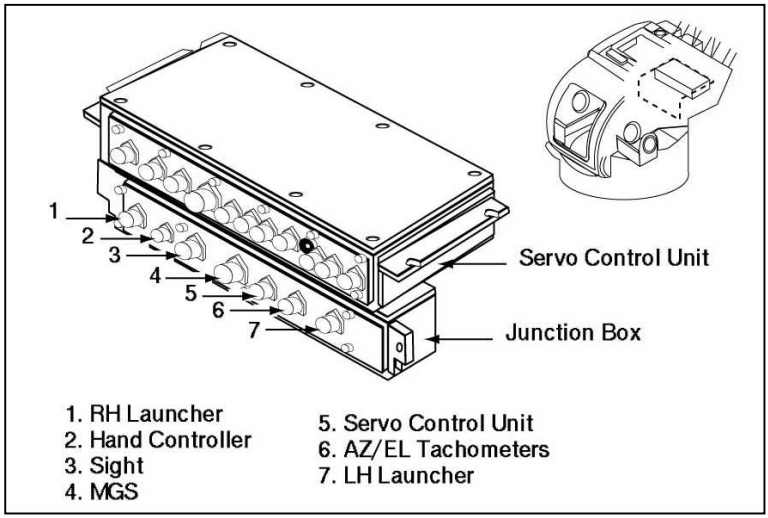


Figure 4-2-4: Junction Box

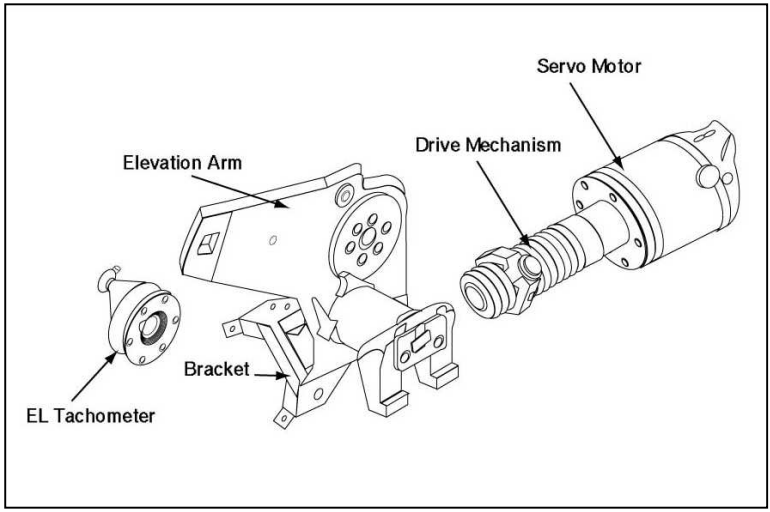


Figure 4-2-5: Elevation Drive Mechanism

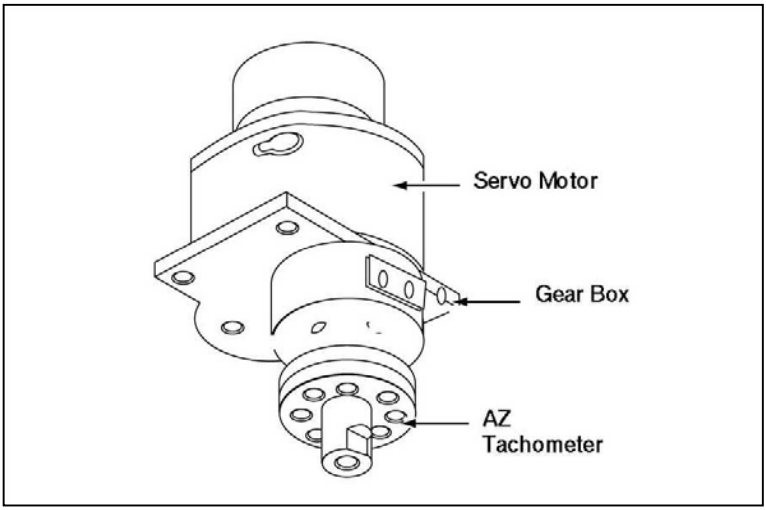


Figure 4-2-6: Azimuth Drive Assembly

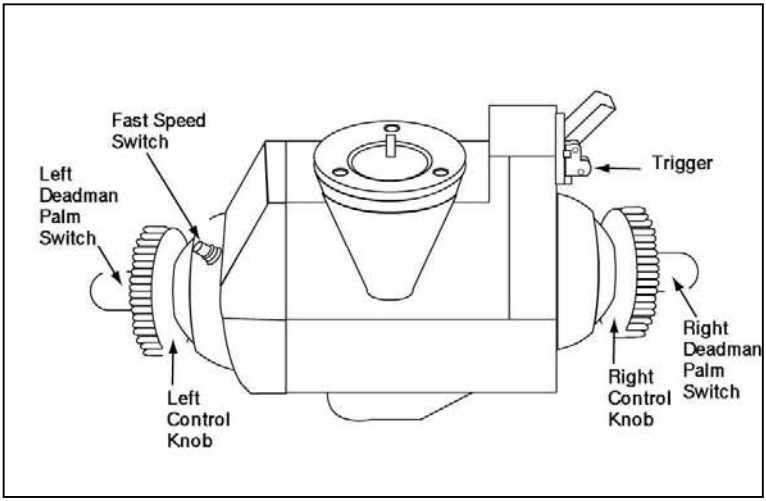


Figure 4-2-7: Hand Controller

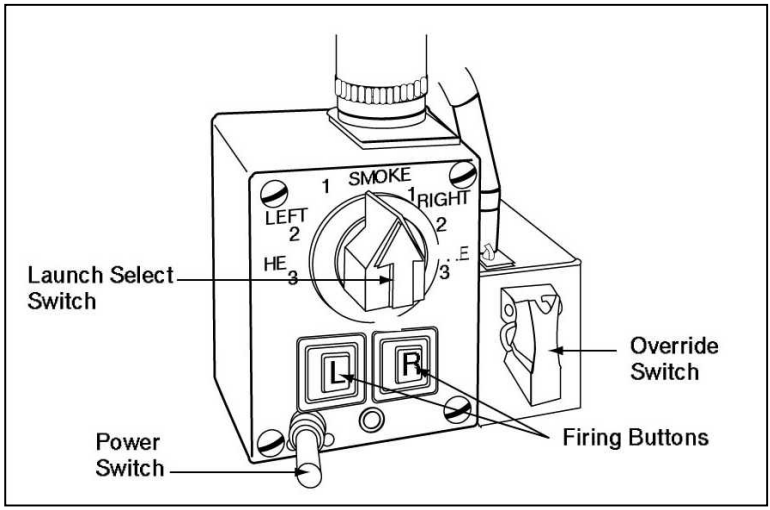


Figure 4-2-8: Smoke Fragmentation Grenade Control Box

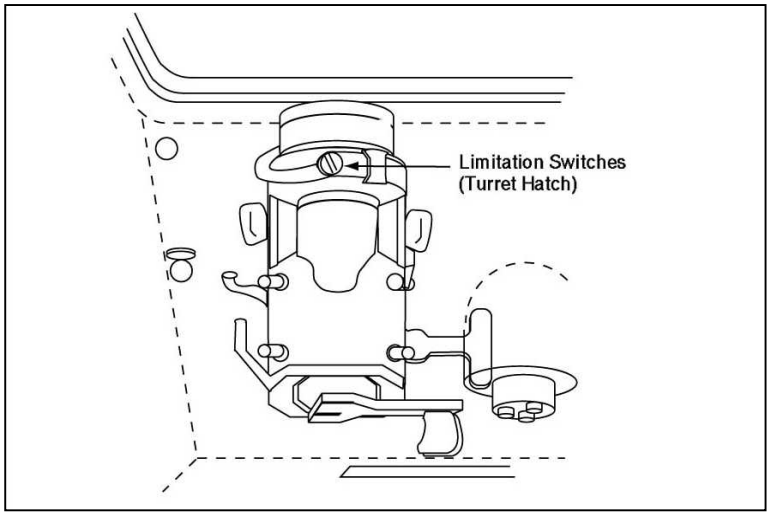


Figure 4-2-9: Limitation Switch (Turret Hatch)

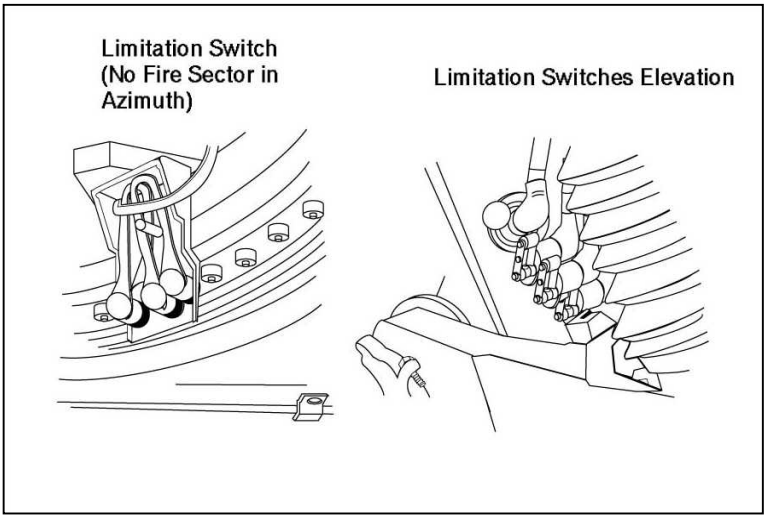


Figure 4-2-10: Limitation Switches (No Fire Sectors)

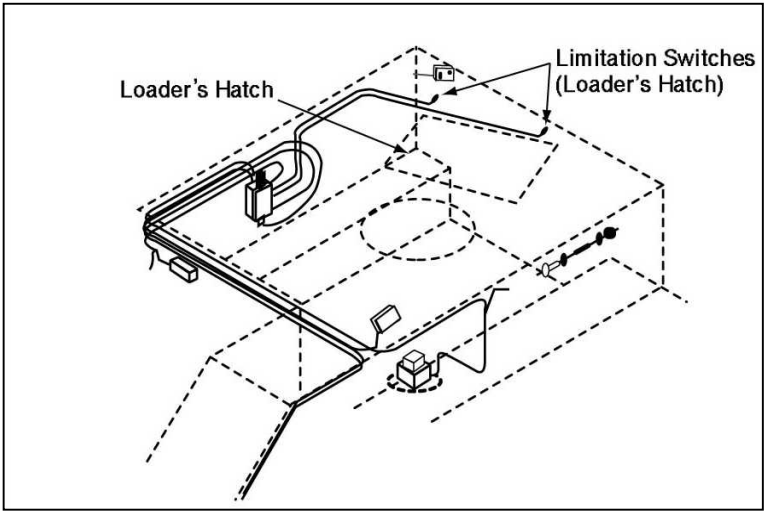


Figure 4-2-11: Limitation Switches (Loader's Hatch)

CONDUCT OF THE LESSON

7. **Safety Precautions**. Heed all DANGER WARNINGS and

CAUTIONS posted on components and the vehicle.

8. **Review**. Review the mechanical components and controls taught in the previous lesson.

9. **Introduction**. This lesson covers the electrical components and controls that pertain to the TUA.

ELETRICAL COMPONENTS

10. **24 Volt Power Supply.** The 24 V power supply (see Figure 4-2-1) is located in the boxes behind the loaders seat backrest and consists of four 12 V dc batteries. The rear two batteries are connected in series to supply 24 V dc to the turret electrical system and the internal lighting of the APC. The front two batteries supply 24 V dc for the vehicle operation.

NOTES

1. The turret batteries are not used to start the main engine.

2. When the low battery voltage indicator light on the crew commander's control box comes on, the vehicle must be started to allow recharging of the batteries.

11. **Master Control Panel.** The master control panel is located behind and to the right of the vehicle commander. A main circuit breaker, located on top of the box, controls power to the TUA weapon system. A second circuit breaker located on the bottom of the box, controls power to the crew compartment lights. The vehicle alternator, through a voltage activated relay, charges the turret batteries when the vehicle is running. The master control panel also has a battery over-ride switch, which may be used to start the vehicle if the vehicle batteries fail.

12. **Crew Commander's Control Box.** The crew commander's control box (see Figure 4-2-2) is located on the vehicle hull in front of the crew commander. The panel has red and green lamps which indicate the following:

a. Main Switch (Green)—main power to turret is on;

b. Armed Right (Green)—right launcher is armed;

c. Armed Left (Green)—left launcher is armed;

d. Firing Enabled (Green)—firing is enabled;

e. Firing Disabled (Red)—firing is disabled; and

f. Low Battery Voltage (Red)—battery power is low.

13. **Slip Ring Assembly.** The sling ring assembly is a rotary device that allows continuous electrical contact between the battery power supply and the turret electrical systems, as the turret is rotated. It is bolted to the floor of the M113 APC directly below the gunner's seat assembly.

14. **Missile Guidance Set (MGS) Conditioner.** The MGS power conditioner replaces the battery assembly in the TUA. The MGS power conditioner mounts into the MGS the same as the battery assembly and is connected to the vehicle power through a cable connected to the junction box through the slip ring assembly. The MGS power conditioner changes vehicle power to the power needed in the MGS. There is an On/Off switch located on the top of the MGS power conditioner.

15. Confirm by questions.

16. **Servo Amplifier.** The servo amplifier is bolted to two rails located behind the gunner. The unit contains two servo amplifiers that develop the currents to control the speed of the azimuth and elevation drive motors. It receives electrical power from the vehicle through the slip ring. This electrical power is distributed to various components in the turret (see Figure 4-2-3).

17. **Junction Box.** The junction box is located below the servo control unit behind the gunner. The box connects the signals between the various TUA weapon system components, much as the traversing unit does in the tripod mounted TOW 2 (see Figure 4-2-4).

18. **Night Sight Vehicle Power Conditioner.** The night sight

vehicle power conditioner is mounted behind the gunner above the servo amplifier and enables the night sight to operate from the vehicle power system in place of the battery power conditioner. It consists of two cables for hook-up and a power converter, which converts 24 V dc to 4.8 V dc and 16.5 V dc. There is an On/Off switch located on the side of the night sight vehicle power conditioner.

19. Confirm by questions.

TURRET DRIVE UNITS

20. **Elevation Drive Mechanism**. The elevation drive mechanism consists of a 24 V dc gear motor, coupled to a drive mechanism, which is connected between the turret and the elevation arm (see Figure 4-2-5). For maintenance and collimation, the drive mechanism can be manually operated by removing the plug at the front of the turret and inserting a screwdriver in the slot at the end of the roller screw.

21. **Elevation Tachometer Assembly**. The elevation tachometer (see Figure 4-2-5) is bolted on the right inside of the turret casing and is rotated by a link connected between the elevation arm and the tachometer lever. As the turret is elevated or depressed, the tachometer will detect any movement of the elevation arm. An electrical signal that is proportional to the movement of the turret is generated and sent to the MGS. The MGS then sends a corresponding signal to the missile to alter its course to the new elevation or line of sight.

22. **Azimuth Drive Assembly**. The azimuth drive assembly (see Figure 4-2-6) consists of a 24 V dc gear motor and tachometer. The gear motor engages the turret azimuth gear to traverse the turret. If the turret encounters any form of resistance that keeps it from traversing, a current limiter prevents gear motor burnout by limiting it to a force of 180 kg/m (equivalent to a current of 70 amps).

23. **Azimuth Tachometer**. The azimuth tachometer (see Figure 4-2-6) is bolted to the shaft of the azimuth gear motor. The gear motor drives the turret in azimuth. Movement of the turret in azimuth is detected by the tachometer and a signal that is

proportional to the speed of the turret is generated and sent to the MGS. The MGS will then send a corresponding signal to the missile, which will quickly alter its course to the new line of sight.

24. Confirm by questions.

ELECTRICAL CONTROLLERS

25. **Hand Controller**. The hand controller (see Figure 4-2-7) controls the elevation and azimuth movements of the turret and contains a left and right control knob, a fast speed switch, trigger with safety cover and two deadman palm switches. The traversing speed is 35 mils per second on normal speed and 157 mils per second on maximum speed.

NOTE

A palm switch must be depressed to activate the elevation and azimuth drive motors. Elevation is controlled by rotating the control knob forward and depression is controlled by rotating the control knob rearward. Slewing of the controller to the left or right traverses the turret. The fast speed switch accelerates rotation of the turret 4.5 times and elevation by 30 percent.

26. **Smoke Grenade Launcher Control Box**. The smoke grenade launcher control box (see Figure 4-2-8) is located to the left of the gunner, bolted to the turret casing centred between the gunner display panel and the gunner control box. The box consists of a power switch, power ON indicator light (red), launcher select switch and left and right bank firing buttons. The operation of the smoke grenades is described in Lesson 10 of this Chapter.

27. **Gunner Display Panel**. The gunner display panel is mounted to the turret casing to the left of the smoke grenade launcher control box. The gunner display panel has an LED digital display, load/collimation position switch and an auto-alignment switch. The gunner display panel will be explained in more detail in Lesson 7 of this Chapter.

28. **Gunner Control Box**. The gunner control box is mounted to the turret casing to the right of the smoke grenade launcher control box. The gunner control box allows the gunner to use either the main armament (TOW 2) or the secondary armament (C-6 co-axial machine gun). The gunner control box also has the smoke grenade override switch located at the top of the box.

29. Confirm by questions.

LIMITATION SWITCHES

30. **Limitation Switch (Turret Hatch).** A limitation switch (see Figure 4-2-9) is attached to the turret hatch operating mechanism to prevent launching of the smoke grenades when the turret hatch is in the half open and fully open position.

NOTE

When the turret hatch is in the half open position, the smoke grenade override switch on the gunner control box may override the limitation switch.

31. **Limitation Switches (No Fire Sectors)**. The six limitation switches (see Figure 4-2-10), three for elevation and three for azimuth, are part of the firing interlock system. These switches permit launching of a missile only when the turret/launchers are within a sector where launching is permitted. They do not hinder the movement of the turret. The elevation switches are attached to a bracket behind the elevation arm and are activated by an actuator on the elevation arm. The azimuth switches are attached to a bracket to the right of the azimuth drive and are activated by a raised rib section on the turret flange.

32. **Limitation Switches (Loader's Hatch)**. The two loader's hatch limitation switches (see Figure 4-2-11) are installed on either side at the rear of the loader's hatch frame and are activated by two levers attached to the hatch cover. The limitation switches are adjusted to prevent launching of the missiles when one or both switches are open, which occurs when the loader's hatch is raised more than 10 mm.

33. Confirm by questions:

CONCLUSION

34. Take questions from class on entire lesson.

35. Confirm by questions

36. Pass out hand-outs.

37. **Summary**. To include the following:

    a. stress the importance of knowing the location, description and function of the electrical components and controls; and

    b. announce the next lesson.

LESSON 3
ASSEMBLY/DISASSEMBLY AND STOWAGE OF TOW 2 COMPONENTS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the assembly and disassembly of TOW 2 components to include the following:

   a. assembly of TOW 2 components in the TUA;

   b. missile guidance set (MGS) self test;

   c. boresight/collimation

   d. storage of TOW 2 components; and

   e. disassembly of TOW 2 components.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. M113A2 TUA vehicle complete with TOW 2;

   b. ten missile simulation rounds/dummy missile; and

   c. hand-outs on storage locations

5. **Preparation**. Prior to the start of the first period:

   a. Park the vehicle/trainer in a suitable location;

   b. Verify the other equipment; and

   c. Check the hand-outs.

6. **Miscellaneous**. The class is hands on and should be taught by demonstrations.

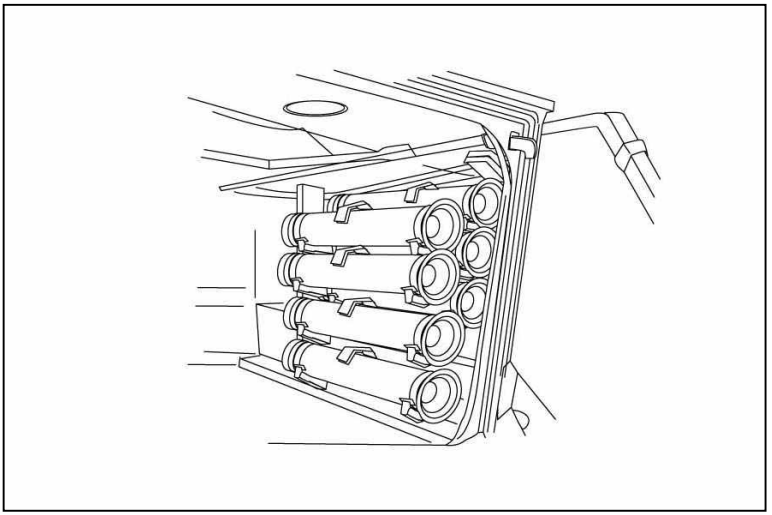


Figure 4-3-1: Storage Location of Missiles

CONDUCT OF THE LESSON

7. **Review**. Review the mechanical and electrical components of the TUA.

8. **Introduction**. Stripping and assembly of the TOW 2 components should never be done against time. The TOW 2 components in the TUA are the same as the ground mount and may be dismounted or mounted depending on the operation.

MGS

9. **Installing the MGS Power Conditioner in the MGS**. The MGS power conditioner is installed in the MGS in the following sequence:

a. remove the cover from the MGS;

b. remove the protective cap from the MGS power conditioner connector and place it on the storage connector;

c. align the rails of the MGS power conditioner with the battery guides of the MGS;

d. allow the MGS power conditioner to slide into the battery compartment under control;

e. apply pressure on the top of the MGS power conditioner and ensure it is flush with the top of the MGS; and

f. turn and tighten all turn-lock fasteners.

10. **Installing the MGS into the Gunner's Seat Assembly**. The MGS is installed into the gunner's seat assembly as follows:

a. Ensure that the main circuit breaker on the master control panel is in the OFF position.

b. Remove the gunner's seat assembly MGS stowage compartment cover by unfastening the clasps and lifting it up.

c. Using the MGS handles place the MGS with the MGS power conditioner installed into the MGS stowage compartment in the base of the gunner's seat assembly. Ensure the self test switch is towards the adjustable seat column and the handle towards the crew commander's cupola.

d. Ensure there is a J1 connector adapter attached to the W2 cable. Secure the W2 cable to the J1 connector by aligning the yellow coloured index line with the yellow coloured mating line on the MGS.

e. Turn the locking nut in a clockwise direction until the red mark on the J1 adapter cannot be seen.

f. Secure the MGS power conditioner cable to the MGS power conditioner by aligning the lug in the cable connector to the groove in the MGS power conditioner connection.

g. Turn the locking nut in a clockwise direction till the cable is fully seated.

h. Turn ON the MGS power conditioner.

i. Replace and secure the MGS stowage compartment cover.

11. **Mounting the Optical Sight System (OSS) in the TUA**. The installation of the OSS should be done by two persons and is conducted using the following procedure:

a. Turn ON the main circuit breaker on the master control panel.

b. One member climbs into the turret and elevates the launchers to 0 mils.

c. He opens the turret hatch to the fully open position.

d. Unlocks and opens the shield door.

e. The OSS and thermal imagery (TI) sight, in their protective cases, are placed on top of the vehicle. Then a second member climbs on top of the vehicle and waits for the member in the turret.

f. The member on top of the vehicle ensures that the sight locking latch on the OSS is in the down position.

g. After the OSS is lowered through the turret hatch with the sight lens first to the member in the turret, the outside member moves to the shield door.

h. With assistance from the member at the turret shield, the member in the turret aligns the sight mounting bracket with the lip on the elevation arm.

i. The member in the turret raises the sight-locking

latch ensuring that the OSS is securely fastened to the elevation arm.

j. He ensure the reticule light is off.

k. Rotates the focus ring to +3.

l. Checks the humidity indicator.

12. **Mounting the TI Sight in the TUA**. Once the OSS has been mounted the two members then mount the TI sight in the following manner :

a. the member outside the turret removes the TI sight from its protective case;

b. the coarse collimation control is placed in the proper position;

c. the latch handle is moved toward the rear of the TI sight;

d. the TI sight is passed to the member in the turret with the lens first and the mounting bracket downward;

e. the member in the turret aligns and seats the TI sight on top of the OSS;

f. the latch is moved forward to secure the TI sight;

g. he the ensures the TI sight is properly secured;

h. inspects the post amplifier cable in the turret and connects it to the TI sight by aligning the yellow lines;

i. connects the vehicle night sight power conditioner cable to the J1 connector on the TI sight;

j. turns on the vehicle power conditioner and ensures the TI sight is set to NFOV (Narrow Field of

View); and

k. turns the TI sight On/Off/Standby switch to ON.

13. **MGS Self Test in the TUA**. The MGS self test is performed by the crew in the same manner as for the basic TOW 2 except that the hand controller is used to slew the system. The test procedure is as follows:

a. the member in the turret unlocks the turret/shield lock;

b. the member in the vehicle lifts the door in the MGS stowage compartment cover and performs the self test;

c. with the assistance of the member in the vehicle, the member in the turret boresights the OSS to the MGS and slews the turret with the hand controller to confirm boresight; and

d. the member in the vehicle releases the Self Test Toggle and closes the cover.

14. **Boresight/Collimation in the TUA**. The crew through the front shield of the turret performs boresight/collimation. Boresight/Collimation is completed as follows:

NOTE

Troubleshooting for the MGS self test may be found in Annex A of Chapter 2.

a. the member outside the turret removes the boresight/collimator and attaches it to the TI sight through the front shield;

b. the member in the turret hooks up the boresight/collimator;

c. boresight/collimation is done the same as in the ground mount except that the member outside the turret may assist in adjusting the elevation and azimuth adjusting knobs on the boresight/collimator;

d. on completion of collimation, the crew removes the boresight /collimator and places it back in its stowage case;

e. the places the protective rubber sight covers on both sights; and

f. closes and secures the front shield.

15. Confirm by practice.

16. Disassembly of the components is done in the reverse order.

17. Confirm by practice.

18. The remaining TOW 2 components are stored in the TUA for easy mounting/dismounting.

19. **Traversing Unit (TU)**. The TU is stored as follows:

a. ensuring the coil cord is properly stored in the bottom of the TU, the TU is placed in the pedestal mount that is bolted to the floor located behind the driver;

b. secure the grooved coupling clamp; and

c. ensure the TU is properly secured in the mount.

20. **Collimator**. To store the boresight/collimator place the boresight/collimator case upright with the handle facing out in the open compartment of the loader's hatch.

21. **Launch Tube**. The launch tube is strapped into the mounts located on the roof of the hull above the vehicle batteries.

22. **Tripod**. The tripod is secured to the vehicle's hull above the battery box with the grooved coupling clamp to the rear of the vehicle.

23. **Missiles**. (see Figure 4-3-1) The 10 encased missiles are stowed on a rack directly across from the loader's seat. Each missile is secured in its rack by two nylon straps.

24. The TOW 2 tripod mount, launch tube and sighting and guidance units, which are secured in the vehicle, can be quickly removed, assembled and used in the ground role, then returned to the vehicle for storage.

25. The weapon system can be easily stripped and stored inside the vehicle for transport on highways and in aircraft.

26. The loader's hatch provides protection for the loader and missiles during loading and unloading of the launchers.

27. **TI Sight Case, Battery Power Conditioner, Spare Batteries and MGS Cover**. The TI sight case, battery power conditioner, spare batteries and MGS cover are all stowed in the stowage box number 2 on top of the vehicle.

NOTE

When stowing missiles in their racks, every second missile should be racked with the nose end to the rear of the vehicle. This enables the No. 3 (loader) to the load the left launcher.

28. Confirm by practice.

CONCLUSION

29. Take questions from the class.

30. Confirm by practice.

31. Pack kit.

32. **Summary**. To include the following:

    a. explain that proper storing of equipment will lead to easier access and better control of equipment; and

    b. announce the next lesson.

LESSON 4
CREW COMMANDERS TARGET ACQUISITION SYSTEM (CCTAS)

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following points on the CCTAS:

   a. description of the CCTAS components;

   b. installation/removal of crew commander's periscope; and

   c. operation of the CCTAS.

2. **Timing**. Three 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. TUA complete;

   b. OHP slide/chart of:

      (1) gunner's display panel; and

      (2) crew commander's periscope; and

   c. a pointer.

5. **Preparation**. Prior to the start of the first period:

   a. prepare the classroom;

   b. check the presentations, charts and lesson plan; and

   c. prepare the TUA and have it parked in a suitable location.

6. **Miscellaneous**. Description and operation should be taught in classroom; remainder is hands-on training in vehicle.

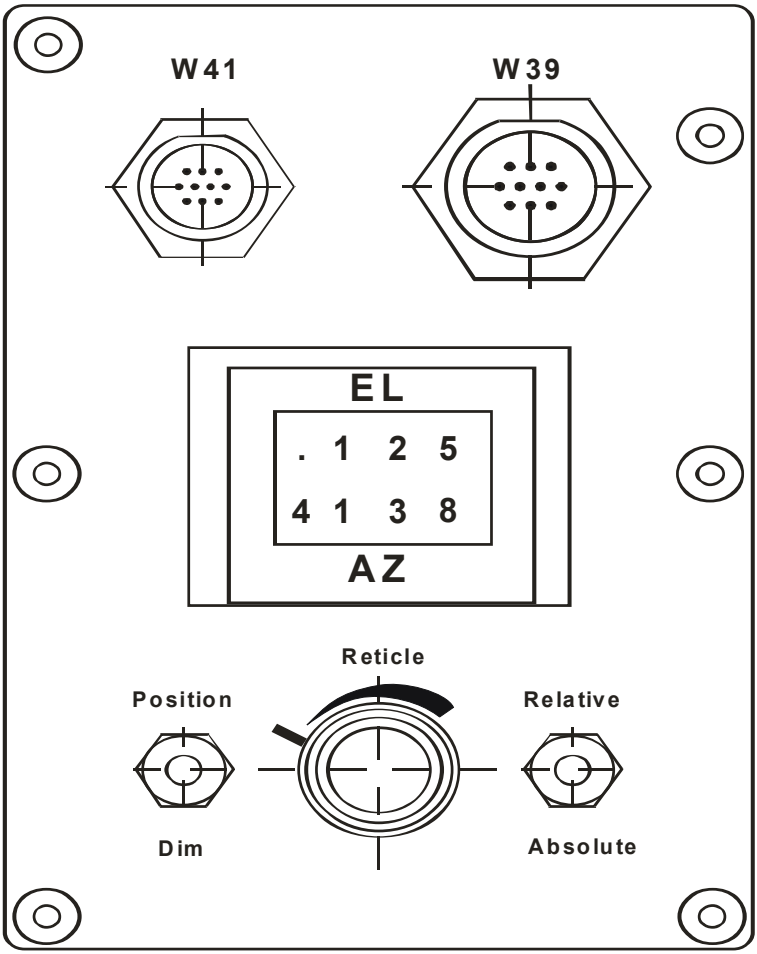


Figure 4-4-1: Gunner's Display Panel

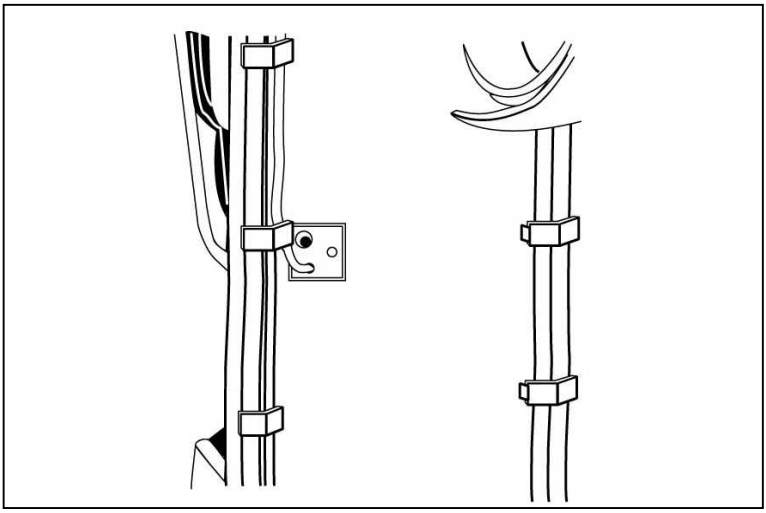


Figure 4-4-2: Loader's Ready Light

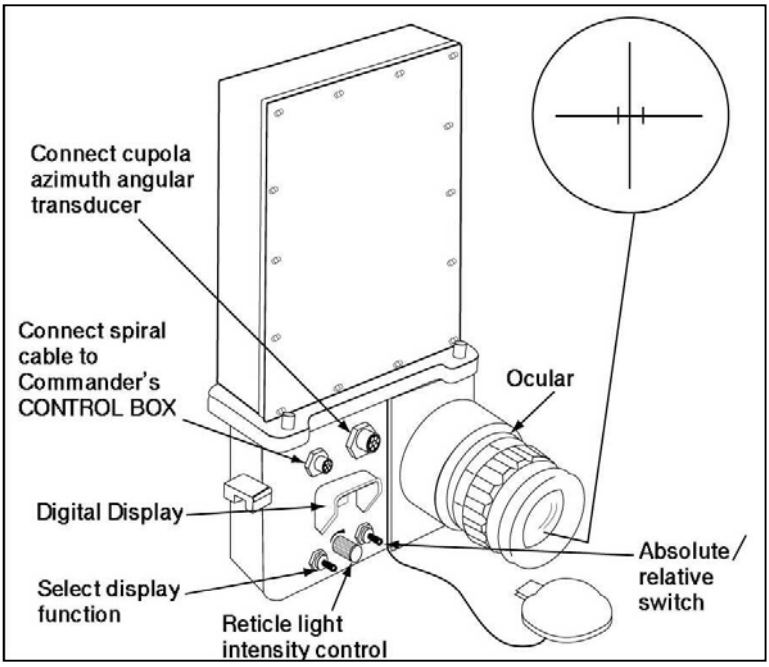


Figure 4-4-3: Crew Commander's Periscope

CONDUCT OF THE LESSON

7. **Safety Precautions**. Keep personnel and equipment clear of the rotating turret.

8. **Review**. Review the names of the electrical and mechanical components.

9. **Introduction**. The CCTAS is specially developed as an add-on to the TUA. It provides the detachment or section commander with an under-armour capacity to acquire targets and indicate them to the gunner. It is easily fitted to the TUA.

DESCRIPTION

10. The Key System Features are:

a. **Crew Commander's Periscope**. It is a specially designed optical instrument closely matching the capabilities of the TOW 2 Optical Sight (OSS).

b. **Automatic Align Facility**. The turret automatically aligns to the setting of the commander's periscope, when the gunner presses the alignment switch on the gunner’s display panel. The time saved compared to manual aligning is substantial and considerably increases the weapon's efficiency. While the gunner engages a target the commander may determine his next priority target and once the gunner has completed the first engagement, align to the next target the commander wants engaged.

c. **Digital Display**. Both the gunner and the commander have digital displays that show the azimuth and elevation settings of the turret and the cupola.

d. **Automatic Load and Collimation Positions**. These are achieved when the gunner presses a

switch.

11. **Gunner's Display Panel** (Figure 4-4-1). It is bolted to the turret casing to the left of the gunner. The gunner's display panel has a red LED display panel at the top of the box, a auto-alignment/dimmer switch to the left and a reload/collimation switch to the right.

12. **Loader's Ready Light** (Figure 4-4-2). The loader's ready light is mounted to the rear of the gunner's seat, so that it is easily visible to the loader when the turret is in the load position. The loader's ready light illuminates automatically when the turret is in the load position (correct azimuth and maximum elevation). This indicates to the loader that the turret is in the load position and the loader's hatch may be opened.

13. **Crew Commander's Periscope** (Figure 4-4-3). The crew commander's periscope is mounted in the crew commander's cupola. It consists of a 13 power magnification optical sight with stadia reticle lines, a rotating top mirror for setting the elevation of the field of view, an elevation lever and a periscope display panel. The periscope display panel consists of a red LED digital display panel, a position/dimmer switch to the left, an absolute/relative switch to the right and two electrical receptors above the display panel. There are two cupola turret handles mounted to assist in rotation of the cupola.

14. **Power Supply.** The power to the CCTAS is supplied from the servo amplifier. A nominal power of 24 V dc from the turret battery set is used and the details are:

a. supply voltage tolerance—16.0 V dc to 32.0 V dc;

b. supply current—gunner's display panel—0.4 Amps maximum; and

c. crew commander's periscope—0.4 Amps maximum.

15. **Angular Accuracy**. The optical sight diverges no more than +/-20 mils from the direction set by the periscope when the auto-alignment function is used. If the turret and the periscope are

adjusted perfectly parallel and there is no play in the gears, the maximum deviation will be +/-6.25 mils.

INSTALLATION AND REMOVAL OF THE CCTAS

16. The only component of the CCTAS that shall be installed or removed from the TUA by the crew will be the crew commander's periscope.

17. The crew commander's periscope is not considered a weapon system component but is valuable electro-optic equipment that must be appropriately secured.

18. The installation of the crew commander's periscope is done in the following manner:

a. ensure the main circuit breaker on the master control panel is off;

b. ensure the periscope locking lever is unlocked;

c. slide the crew commander’s periscope with the digital display towards the inside, two-thirds of the way in;

d. pull the two locking clamps out and fully seat the crew commander’s periscope home;

e. align the locking clamps with the stops on the crew commander’s periscope and lock it into place by pushing the locking levers all the way up;

f. ensure the crew commander’s periscope is secure;

g. connect the cable from the left electrical connector on the display panel to the connector at the bottom of the crew commander’s control box;

h. connect the cable from the crew commander’s cupola to the right electrical connector on the display panel;

i. ensure the crew commander's sight protection cover functions properly; and

j. ensure the eyepiece cover is secure.

19. Confirm by questions.

OPERATION

20. **Crew Commander's Periscope.** The elevation lever of the crew commander's periscope is located at the lower right side of the periscope. It is used to rotate the mirror inside the top end of the periscope in elevation. The scale is graduated in ±50 mil increments. This scale is not matched with the front shield elevation scale on the inside of the front shield.

21. The periscope display panel operates in the following manner:

a. The digital display's normal indication is a set of arrows. The purpose of the arrows is to help the commander align his periscope to the direction and elevation of the turret casing as quickly as possible. The direction and length of the arrows tells the commander which direction and how far to turn the cupola/elevation control;The display function switch is used for choosing the digital display's function (left hand switch on periscope display panel). Its operations are as follows:

(1) the switch lever is normally centred and will display the arrows in the digital display. It is spring-loaded both up and down;

(2) with the switch lever pressed up to POSITION, the display shows the elevation and azimuth setting of the periscope. Normally this relates to the vehicle's forward direction; and

(3) pressing the display function switch down to DIM repeatedly, dims the display gradually in five steps.

b. Reticle light dimmer adjusts the reticle illumination.

c. The ABSOLUTE/RELATIVE switch operates as follows:

(1) With the switch lever positioned down (ABSOLUTE), the system uses the vehicle forward direction and the vehicle horizontal plane as references for the azimuth and elevation displays.

(2) When the switch lever is set to RELATIVE, the display is zeroed out both in azimuth and elevation, so that the orientation the periscope happens to have at that moment becomes the new reference direction. The new reference value is automatically transferred to the gunner's display panel, so that both sets of displays are sychronized. This switch may be used to obtain a bearing in mils with reference to true north or a target reference point (TRP). The first step is to mark true north and TRPs on the detachment range card using the ABSOLUTE readings on the digital display. Later, when required, the No. 1 can align the periscope on true north or a TRP, press the position switch to RELATIVE and (using a few simple calculations if necessary) use this function to:

(a) determine the bearing of a target in mils for the purpose of calling indirect fire or helping to find its exact location on the map; and

(b) give a target indication to his gunner with reference to a TRP.

ALIGNMENT OF CCTAS TO GRID (NORTH)

22. CCTAS is aligned by following these steps:

a. One person walks out 50 metres on a bearing of 6400 mils.

b. Align the cross-hairs of the CCTAS on that person.

c. Zero the CCTAS using the "RELATIVE" setting.

d. Record the "ABSOLUTE" bearing for grid north;

e. Subsequent alignments can be done the same way in alternate and secondary positions. When moving from one position to another, these recorded bearings allow for a quick re-alignment.

f. Once the CCTAS has been properly aligned (which aligns the turret also), it can be used as a compass.

23. The CCTAS permits the detachment commander to greatly shorten his fire orders to the gunner. It changes next to nothing in the manner in which the section commander issues fire orders to the detachments. Detachment fire orders using the CCTAS are given using the primary method, described later. A number of back-up methods should be considered if part or all of the CCTAS becomes inoperable. This too will be described later.

24. The gunner display panel for the CCTAS operates in the following manner:

a. **Auto-Alignment Switch**. This switch is for the automatic alignment of the turret in relation to the crew commander's periscope. The switch is protected with a cover to prevent accidental

operation. The switch is spring loaded and must be held in the up position while the turret is automatically aligning. When pressed down, the switch doubles as a display intensity control. Pressing the switch repeatedly will dim the display in a five step cyclical fashion.

b. **Load/Collimation Position Switch**. This switch is protected with a cover to prevent accidental operation. The switch is pressed up to align the turret into the load position and pressed down to align the turret in the collimation position. The switch is spring-loaded in both directions and must be held in position while the turret is moving.

c. **Digital Display**. The digital red LED display shows the turret's azimuth and elevation in mils. The azimuth is indicated by the vehicle's forward direction as its zero point or relative direction that the crew commander assigns to the CCTAS.

25. Confirm by questions.

CONCLUSION

26. Take questions from class on the entire lesson.

27. Confirm by questions and practice.

28. **Summary**. To include the following:

a. the CCTAS improves overall system efficiency significantly by saving time. Saving time saves lives; and

b. announce the next lesson.

LESSON 5
COAXIAL MACHINE GUN MOUNT

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following:

    a. the general description of the coaxial machine gun mount;

    b. mounting/dismounting the C-6 MG; and

    c. boresighting the C-6 MG to the TOW optical sight.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

    a. M113A2 TUA complete with coaxial MG mount;

    b. TOW 2 weapon system;

    c. C-6 MG with right hand feed cover and feed tray;

    d. 7.62mm boresight insert rod;

    e. boresight optical head;

    f. tools including:

        (1) 13 mm wrench, and

        (2) 19 mm wrench.

    g. TUA boresighting board.

5. **Preparation**. Prior to the start of the first period:

    a. check the stores/equipment; and

    b. park the TUA in a suitable area allowing a clear, level distance of 40 metres in front for boresighting.

6. **Miscellaneous**. Ensure the C-6 MG is right hand feed.

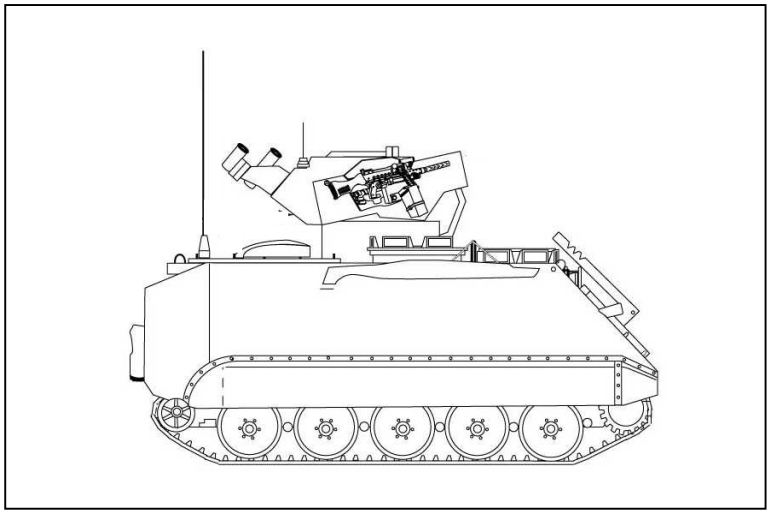


Figure 4-5-1: Location of Coaxial Machine Gun

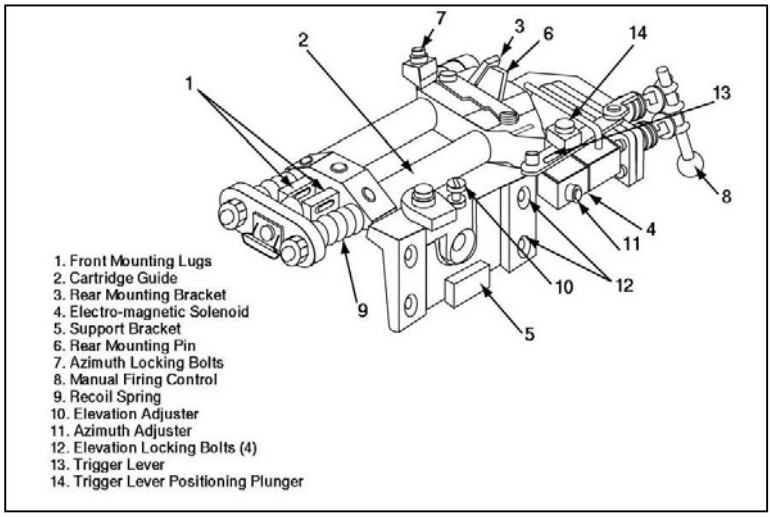


Figure 4-5-2: Parts of Coaxial MG Mount

CONDUCT OF THE LESSON

7. **Safety Precautions**. Carry out the normal safety precautions for the C-6 MG.

8. **Introduction**. The GPMG 7.62mm C6 is mounted coaxially to the right hand missile launcher and boresighted to the optical sight.

COAXIAL MACHINE-GUN MOUNT

9. The coaxial MG mount is bolted to the right hand side of the right missile launcher (see Figure 4-5-1). The mount is adjustable for both azimuth and elevation for boresighting. When the C6 is mounted, it is fired electrically by means of an electro-magnetic solenoid activated by the No. 2 from inside the turret. The azimuth and elevation adjusting nuts are loosened prior to placing the mount on the vehicle.

10. To fire the coaxial MG the No. 2 will ensure that the armament switch on the gunners control box is at the secondary armament position before pressing the trigger on the hand controller.

11. The coaxial mount consists of the component parts detailed in Figure 4-5-2.

TO MOUNT THE C-6 MACHINE GUN

12. To mount the C-6 machine gun:

a. assemble and perform safety precautions;

b. remove the rear mounting pin on the mount;

c. lift the trigger lever positioning plunger and move the trigger lever to the left;

d. lower the barrel and raise the butt;

e. ensure that the front mounting shoulders of the machine-gun are in front of the front mounting lugs on the mount;

f. lower the machine-gun and pull it to the rear;

g. ensure that the front mounting lugs are engaged and the rear mounting holes line up with the holes of the rear mounting bracket;

h. insert the rear mounting pin;

i. lift the trigger lever positioning plunger and move the trigger lever fully to the right; and

j. release the trigger lever-positioning plunger and ensure that the trigger lever is locked in position.

WARNING

When positioning the C-6 into the mount there must be a gap between the rear edge of the trigger lever and the front face of the trigger. This gap, however, must not exceed 3 mm. Failure to ensure this could result in stoppages or a "runaway gun" condition due to the trigger remaining too far back.

NOTE

For field expediency the tip of a flat screwdriver may be used to measure the gap.

TO DISMOUNT THE C-6 MACHINE GUN

13. To dismount the C-6 machine gun:

a. unload and clear the gun;

b. lift the trigger lever positioning plunger and move the trigger lever to the left;

c. remove the rear mounting pin;

d. lift the rear of the machine-gun and push it forward;

e. with the machine-gun clear of the front mounting lugs, remove the machine-gun;

f. replace the rear mounting pin;

g. lift the trigger lever positioning plunger and move the trigger lever fully to the right; and

h. release the trigger lever positioning plunger ensuring that the trigger lever is locked in position.

14. Confirm by practice.

BORESIGHTING THE C-6 MACHINE GUN

15. The C-6 machine gun barrel is boresighted to the optical sight system (OSS) mounted in the TUA. Boresighting is completed as follows:

a. Place the boresighting board as described in Annex K of this Chapter, 40 metres forward and level to the turret.

b. Place the boresight insert rod into the barrel of the C-6 and place the boresight optical head onto the boresight insert rod.

c. Place the cross-hairs of the OSS in the centre of the left aiming circle of the boresighting board and lock the turret.

d. Align the cross-hairs of the boresight optical head in the C-6 machine gun barrel with the right

aiming circle on the boresighting board by adjusting the coaxial mount as follows:

(1) Adjust azimuth using a 13 mm wrench to loosen the azimuth locking bolts and adjusting the azimuth adjuster as follows:

(a) move the mean point of impact (MPI) left by loosening the outside adjuster nut and tightening the inside adjuster nut;

(b) move the MPI right by loosening the inside adjuster nut and tightening the outside adjuster nut;

(c) ensure the inside and outside azimuth adjusting nuts are tightened; and

(d) ensure azimuth locking bolts are tightened.

(2) Adjust for elevation by using a 19-mm wrench to loosen the four elevation locking bolts. Use a 13 mm wrench to loosen the elevation adjusting nut and adjust for elevation as follows:

(a) move the MPI up by turning the elevation adjuster bolt clockwise;

(b) move the MPI down by turning the elevation adjuster bolt counter-clockwise;

(c) tighten the elevation adjuster locking nut; and

(d) tighten the elevation locking bolts.

NOTE

If no boresight kit is available, centralize the front sight of the C-6 and use the iron sight on the right aiming marker and proceed as taught.

CAUTION

Ensure that all the locking bolts are tight after each adjustment. Failure to do so will damage the threads of the locking bolts and adjusting nuts.

16. Confirm by practice.

CONCLUSION

17. Take questions from class on the entire lesson.

18. Confirm by practice.

19. **Summary**:

a. boresighting is carried out to obtain optimum accuracy at 500 m;

b. ensure the turret is locked when the OSS cross-hairs are on the OSS aiming point of the TUA boresighting board; and

c. give a forecast of the next lesson to be taught.

LESSON 6
TUA CHECK-OUT PROCEDURE

INSTRUCTOR'S NOTES

1. **Aim**. To teach the M113A2 TUA systems check-out procedures.

2. **Timing**. Four 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. M113A2 TUA trainer/vehicle complete with TOW 2 mounted; and

   b. hand-outs on systems check-out procedures, one per student.

5. **Preparation**. Prior to the commencement of the first period:

   a. Park the vehicle/trainer in a suitable location; and

   b. Check the equipment and hand-outs.

6. **Miscellaneous**. Practice by dividing class into four-person detachments.

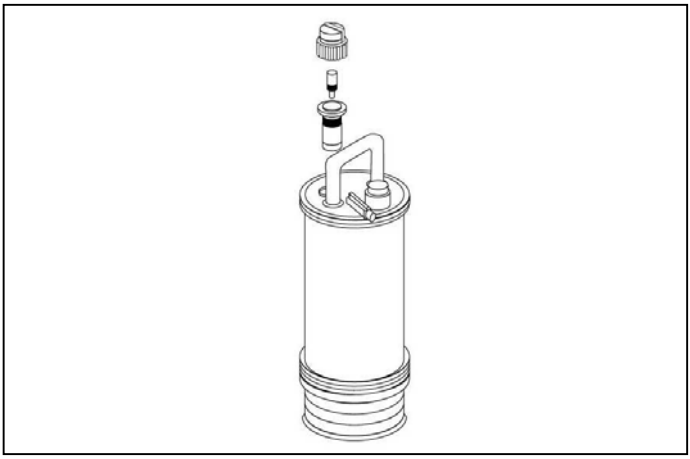


Figure 4-6-1: Smoke Grenade Launcher Tester

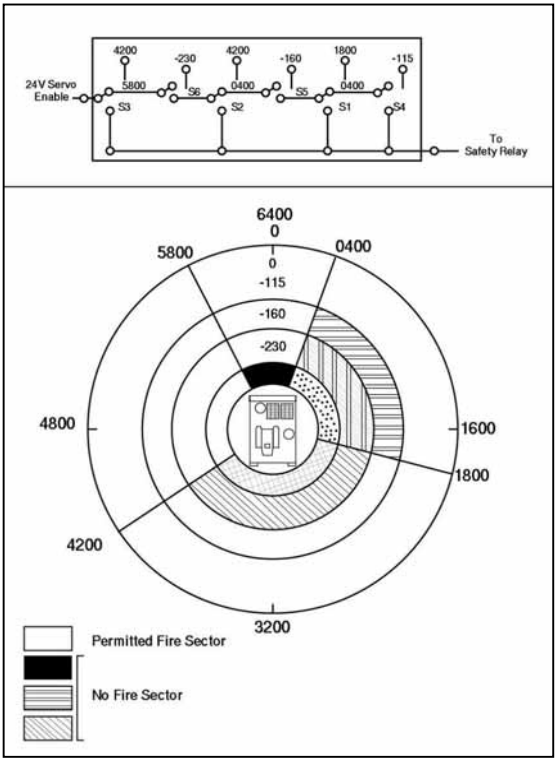


Figure 4-6-2: No Fire Sectors

CONDUCT OF THE LESSON

7. **Safety Precautions.** Heed all DANGER WARNINGS and CAUTIONS posted on the components and the vehicle. Keep personnel and equipment clear of the rotating turret.

8. **Review**. Review the strip and assemble drills on the TUA, MG and crew commanders target acquisition system (CCTAS).

9. The systems check-out procedure is conducted whenever the TOW 2 is mounted into the M113A2 TUA and as specified in the daily and periodical preventive maintenance. Before conducting the system check-out procedure the crew must verify that there are no missiles in the launchers, no smoke grenades in the grenade launchers and that safety precautions are conducted on the C-6 coaxial MG. The system check-out procedure includes:

a. CCTAS self-test check;

b. no fire sector check;

c. arming check;

d. load position check;

e. collimation position check;

f. smoke grenade launcher check; and

g. secondary armament check.

NOTE

Troubleshooting for the system check-out procedures will only consist of checking all visible electrical connection and circuit breakers and reporting faults to maintenance at the earliest opportunity.

10. The No. 1 initiates all checks. To begin the procedure the No. 1 uses the command, PREPARE FOR SYSTEM CHECK-OUT PROCEDURE. The remainder of the crew acknowledges by

answering in order No. 2 READY, No. 3 READY and No. 4 READY.

CCTAS SELF TEST

11. The CCTAS self-test is conducted to verify the target acquisition system. If an error occurs it is displayed on the commander's digital display panel as a number corresponding to a particular error. The error is reported to the technician at the earliest opportunity. A complete list of the error messages is contained in Annex J of this Chapter

12. The CCTAS self-test is conducted as follows:

a. The No. 1 gives the command CCTAS SELF TEST CHECK.

b. The No's 2, 3 and 4 repeat CCTAS SELF TEST CHECK.

c. The No. 2 prepares for the rotation of the turret by ensuring that his limbs, clothing and equipment do not get caught in the turret and then announces READY.

d. The No. 3 observes for obstructions around the base of turret.

e. The No. 4 observes for obstructions on the deck of the vehicle.

f. The No. 1 upon hearing READY from the No. 2:

(1) turns OFF the main circuit breaker on the master control panel;

(2) holds the position/dimmer switch on the commander's display panel in the UP position;

(3) turns ON the main circuit breaker on the

master control panel; and

(4) observes the digital display panel for error readings.

g. At this point the digital display panel reads TEST and the turret rotates at normal speed one complete revolution, during which it fully depresses, fully elevates and aligns to zero elevation and azimuth.

h. Once the test has started, the No. 1 may release the position/dimmer switch.

i. Once the turret is zeroed out the No. 1 verifies the direction arrows of the digital display panel and does the following:

(1) rotates the commander's cupola one complete non-stop turn in the direction of the azimuth arrows until the azimuth arrows match >|<; and

(2) slowly elevates and depresses the elevation lever, the LED display should read OK. The No. 1 then declares CCTAS SELF CHECK OK.

j. The No's. 2, 3 and 4 acknowledge by repeating CCTAS SELF TEST OK.

NO FIRE SECTOR CHECK

13. The no fire sector check is performed to check the fire limitations of the TUA (see figure 4-6-2).

14. The check is conducted as follows:

a. the No. 1 gives the command NO FIRE SECTOR CHECK and observes the disabled light on the crew commander's control box;

b. the No. 2 repeats NO FIRE SECTOR CHECK,

depresses the front shield to -115 mils on the elevation scale, rotates the turret to 0400 mils on the azimuth scale and reports SECTOR ONE;

c. the No. 2 rotates the turret clockwise to 1800 mils maintaining the –115 mils on the elevation scale and reports “1800”;

d. the No. 1 reports OK if the DISABLED light remained on during the entire rotation;

e. the No. 2 depresses the front shield to -160 mils on the elevation scale and rotates the turret back to 0400 mils on the azimuth scale and reports SECTOR TWO;

f. the No. 2 rotates the turret clockwise to 4200 mils maintaining the –160 mils on the elevation scale and reports “4200”;

g. the No. 1 reports OK if the DISABLED light remained on during the entire rotation;

h. the No. 2 depresses the front shield to -230 mils on the elevation scale, remains at 4200 mils on the azimuth scale and reports SECTOR THREE;

i. the No. 2 rotates the turret counter-clockwise to 5800 mils maintaining the –230 mils on the elevation scale and reports “5800”; and

j. the No. 1 reports OK if the DISABLED light remained on during the entire rotation and then gives the final report NO FIRE SECTOR CHECK OK.

15. Confirm by practice.

ARMING CHECK

16. The arming check is conducted to check the operation of

the arming linkage and the arming mechanism. The left or right missile arming light will illuminate on the commander's control box indicating that the mechanism is working and the arming limitation switch circuit has closed.

17. The arming check will be conducted as follows:

    a. the No. 1 gives the command ARMING CHECK and observes the crew commander's control box;

    b. the No. 2 repeats ARMING CHECK and arms the right launcher by pressing the release button on the right arming lever and pulling the arming lever down to the ARMED position;

    c. the No. 2 then reports, RIGHT LAUNCHER ARMED to the No. 1 and the No. 4;

    d. the No. 4 ensures that the electrical connector in the right launcher protrudes and reports OK;

    e. the No. 1 upon hearing OK from the No. 4 ensures the right arming light illuminates and reports OK;

    f. the No. 2 disarms the right launcher, arms the left launcher and reports LEFT LAUNCHER ARMED;

    g. the No. 4 ensures that the electrical connector in the left launcher is protruding and reports OK;

    h. the No. 1 ensures the left arming light illuminates, reports OK and gives the final report ARMING CHECK OK; and

    i. the No. 2 disarms the left launcher.

18. Confirm by practice.

LOAD POSITION CHECK

19. The load position check is conducted to test the limitation switches in the loader's hatch and the load/collimation switch on the gunner's display panel. When the turret is in the load position and the loader's hatch is open more than 10 mm, the limitation switch circuits are opened and there is no power to move the turret. The disabled light on the crew commander's control box will illuminate.

20. The load position check is conducted as follows:

a. The No. 1 gives the command LOAD POSITION CHECK.

b. The No. 2 repeats LOAD POSITION CHECK and rotates the turret to the load position, as indicated on the turret azimuth scale and elevates the front shield to +260 mils on the elevation scale. This should be done using the load/collimation position switch on the gunner's display box.

c. The No. 3 stands by for the turret to be rotated to the load position.

d. Once in the load position the No. 2 will report LOAD POSITION. The loader's ready light on the back of the gunner's seat assembly will illuminate to indicate to the No. 3 that the turret is in the load position.

e. The No. 3, once the turret is in the load position, opens the loader's hatch completely to ensure the loader's hatch opens freely, and that the turret is in the proper position. Having confirmed this he reports LOADER'S HATCH OPEN.

f. The No. 1, upon hearing LOADER'S HATCH OPEN, ensures the disabled light illuminates and reports DISABLED.

g. The No. 2, upon hearing DISABLED, attempts to

slew the turret. The turret should not move. The No. 2 then reports NO POWER.

h. The No. 3, upon hearing NO POWER from the No. 2, closes the loader's hatch and reports LOADER'S HATCH CLOSED and taps twice on the No. 2's leg.

i. The No's. 1 and 2 repeat LOADER'S HATCH CLOSED with the No. 1 ensuring the ENABLED light illuminates and declares ENABLED.

j. The No. 1 then gives the final report LOAD POSITION CHECK OK.

21. Confirm by practice.

COLLIMATION POSITION CHECK

22. The collimation position check ensures that the turret rotates to the collimation position. This position is used to collimate the system under contact when it is not advisable to use the front shield.

23. The collimation position check is conducted as follows:

a. The No. 1 gives the command COLLIMATION POSITION CHECK.

b. The No. 2 repeats COLLIMATION POSITION CHECK and rotates the turret to the collimation position 0, indicated on the elevation scale and 2970 on the azimuth scale. This should be done using the load/collimation position switch on the gunner's display panel. Once in the collimation position, the No. 2 reports COLLIMATION POSITION and opens the front shield door.

c. The No. 3, upon hearing COLLIMATION POSITION CHECK, removes the collimator from it's case. Once the No. 3 verifies that the turret is

in the collimation position, the No. 3 fully opens the loader's hatch, ensures the rubber caps are connected and the front shield opens properly.

d. The No. 3 assists in closing the front shield, closes the loader's hatch and reports LOADER'S HATCH CLOSED, then taps twice on the No. 2's leg.

e. The No. 2, once the front shield door is secured will rotate the turret to the 6400 mils position, ensure the launchers are in the horizontal position and report COLLIMATION POSITION CHECK OK to the No. 1.

f. The No. 1 acknowledges and reports COLLIMATION POSITION CHECK OK.

SMOKE GRENADE LAUNCHER CHECK

24. The smoke grenade launcher check is conducted before firing either smoke or fragmentation grenades and every time the systems check-out procedure is performed. The smoke grenade launcher tester (Figure 4-5-1) will be used to determine if the electrical impulses are being sent to the smoke grenade launcher. The smoke grenade launcher check is performed in the following manner:

a. The No. 1 orders, SMOKE GRENADE LAUNCHER CHECK.

b. The No. 2 repeats SMOKE GRENADE LAUNCHER CHECK, turns on the power to the smoke grenade launcher control box, closes the turret hatch completely, checks to see if red power light is on and opens the turret hatch to the half open position. The No.2 activates the smoke grenade launcher override switch on the gunner's control box and ensures that the red power light is on.

c. The No. 3, upon hearing SMOKE GRENADE LAUNCHER CHECK, picks up the smoke grenade launcher tester, climbs on top of the vehicle and places the tester in the left launcher of the bank closest to the turret and declares LEFT 1.

d. The No. 2 repeats LEFT 1, activating the override switch, places the selector to Smoke on the smoke grenade launcher control box and presses the left firing switch.

e. The No. 3, watchs the lights on the smoke grenade launcher tester waiting for the green light to illuminate. When the green light illuminates the No. 3 reports 1 OK and removes the tester from the left launcher.

f. The No. 2 and the No. 3 repeat the procedure to test the remaining left aiming launchers and the bank of right aiming launchers. The No. 2 keeps the override switch activated throughout.

g. The No. 3, after the smoke check, places the smoke grenade launcher tester back into the left launcher of the bank closest to the turret to test the fragmentation grenade switches and declares LEFT 1.

h. The No. 2 repeats LEFT 1, activates the override switch, places the selector switch to the left side on thenumber 1 position and presses the left firing switch.

i. The No. 3, when the red light on the smoke grenade launcher tester is lit, declares 1 OK and removes the smoke grenade launcher tester from the number 1 left aiming launcher.

j. The No. 2 and the No. 3 repeat this procedure to test the remaining left aiming launchers and the bank of right aiming launchers. The No. 2 keeps the override switch activated throughout and

changes the selector switch to each launcher in numerical order.

k. On completion of the smoke grenade launcher check, the No. 2 reports to the No. 1, SMOKE GRENADE LAUNCHER CHECK COMPLETE.

l. The No. 1 repeats SMOKE GRENADE LAUNCHER CHECK COMPLETE.

25. Confirm by practice.

SECONDARY ARMAMENT CHECK

26. The secondary armament check is conducted to check the operation of the electro-magnetic solenoid on the coaxial machine gun mount.

27. The secondary armament check is conducted as follows after normal C6 safety precautions:

a. the No. 1 cocks the C6, orders SECONDARY ARMAMENT CHECK and observes the actuation of the solenoid against the trigger of the C6;

b. the No. 2 repeats SECONDARY ARMAMENT CHECK, places the selector switch on the gunner's control box in the secondary armament position, reports FIRING and presses the trigger on the hand controller; and

c. the No. 1, upon hearing FIRING from the No. 2, ensures the solenoid actuates the C6 trigger and reports SECONDARY ARMAMENT CHECK OK, SYSTEMS CHECKOUT PROCEDURE COMPLETE

28. Confirm by practice.

CONCLUSION

29. Take questions from class on the entire lesson.

30. Confirm by questions.

31. Distribute the hand-outs.

32. **Summary**. To include the following:

    a. continuous practice using the system check-out procedure check-list; and

    b. a forecast of the next lesson.

LESSON 7
M113A2 TUA DETACHMENT DRILLS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following drills:

   a. loading;

   b. target engagement;

   c. cease tracking;

   d. disengagement; and

   e. cease tracking, unload.

2. **Timing**. Five 40-minute periods.

3. **Method**. A basic practical instructional period.

4. **Stores**. The following stores and equipment are required:

   a. M113A2 TUA vehicle/trainer with TOW 2 mounted;

   b. ten missile simulation rounds; and

   c. hand-outs on drills.

5. **Preparation**. Prior to the start of the first period:

   a. park the vehicle/trainer in a suitable location; and

   b. check the hand-outs.

6. **Miscellaneous**. Practice by dividing class into four-person detachments for competition..

CONDUCT OF THE LESSON

7. **Safety Precautions**. Heed all, DANGERS WARNINGS and CAUTIONS posted on components and the vehicle.

8. **Review**. Review the system checkout procedure.

LOADING DRILL

9. Prior to conducting the loading drills, a system checkout procedure is completed. Once the No. 1 reports CHECKOUT PROCEDURE COMPLETE, missiles may be ordered loaded. The commands for the loading drill are repeated as necessary:

a. the No. 1 gives the command LOAD or LOAD 2B;

b. upon hearing the command load from the No. 1, the No. 2:

(1) ensures the turret /shield lock assembly is unlocked;

(2) ensures the trigger cover is lowered;

(3) ensures that the arming levers are in the disarmed position;

(4) ensures the thermal imagery (TI) sight On/Off/Standby switch is "ON";

(5) operates the selectable filter to Reset/Clear position;

(6) ensures TI sight set to WFOV (Wide Field of View);

(7) ensures that the main armament switch is on (red light is illuminated);

(8) rotates the turret to the loading position, using the load position switch on the gunner's display panel or rotates the turret to the indicated marking on the azimuth scale while elevating the launchers fully; and

(9) repeats the command LOAD (or LOAD 2B) over the intercom;

c. the No. 3 upon hearing the command LOAD or LOAD 2B from the No.1 will proceed with normal preparation of the missile(s);

d. upon hearing the command LOAD or LOAD 2B from the No. 2, the No. 3:

(1) checks the loaders light;

(2) repeats the command LOAD or LOAD 2B;

(3) opens the loader's hatch and inspects the launcher(s) for protruding electrical connectors, damaged rails and foreign objects in the launcher(s);

(4) with the electrical connector upwards, aligns the indexing lugs of the encased missile with the guide rails of the launcher and pushes the encased missile forward and up, until the missile is fully forward;

(5) lowers the rear of the missile until it rests on the pins of the guide arms and pushes the missile forward until it locks in the forward position;

(6) ensures the missile is locked into position by pulling back on the missile;

(7) closes and locks the loader's hatch; and

(8) taps twice on the No. 2's leg to indicate that the loader's hatch is closed and that the turret can be rotated and reports BOTH or LEFT or RIGHT LAUNCHER(S) LOADED and which launcher has TOW 2B; and

e. the No. 2, once the No. 3 has reported the launchers loaded, lowers the launchers to the horizontal plane and reports READY.

10. Confirm by practice.

TARGET ENGAGEMENT DRILL (MOUNTED ACTION)

11. The crew commanders target acquisition system (CCTAS) permits the detachment commander to greatly shorten the fire control order to the gunner. Detachment fire control orders using the CCTAS are given using either the primary method or a number of back-up methods, which are required when part or all of the CCTAS becomes inoperable.

12. **Primary Method**. This is the fastest and most commonly used method. It follows the usual sequence of Alert, Indication and Executive command to fire. The Indication part is substantially abbreviated however, because of the CCTAS' ability to bring the gunner's reticle to within +/- 20 mils of the target. All that is then required is a short indication such as “TANK IN OPEN” or “TROOP OF TANKS, LEFT TANK.” There is no need for a complete target indication. An example of a fire control order would be “TARGET, ALIGN, TROOP OF TANKS IN THE OPEN LEFT HAND TANK, REPORT WHEN ON.”

13. **Alignment Function Breakdown**. If the automatic alignment function does not work properly, the gunner, after repeating TARGET replies GIVE DIRECTION AND ELEVATION to the No. 1. The No. 1 then presses up on the position switch on his periscope digital display panel, reads the display, gives the direction and elevation to the gunner and proceeds with the rest of the

procedure. An example of a fire control order would be “TARGET, DIRECTION ONE FOUR HUNDRED MILS, ELEVATION +125 MILS, COLUMN OF TANKS FRONT TANK, FIRE WHEN ON.”

14. **Commander's Periscope On but a Complete System Breakdown**. In this case, the fire control order is much the same as with an alignment breakdown, with one difference. The No. 1 reads the direction and elevation off the mechanical scales and pointers instead of the periscope digital display.

15. The aim of an engagement drill is to bring the vehicle in its READY state into a firing position and engage a target. To initiate a mounted action, the word of command is TARGET. The detachment proceeds in the following sequence:

a. The No. 1 directs the vehicle into a firing position, captures the target with the target acquisition system, prepares and issues a firing control order. If the CCTAS is not operational, the No. 1 issues a fire control order as detailed earlier in this lesson.

b. When the No. 1 gives the command TARGET, all actions are initiated by the No. 2 who:

(1) repeats the command TARGET;

(2) ensures the TI sight is on WFOV;

(3) checks that the main armament switch is on; and

(4) presses the automatic alignment switch and repeats the fire order or if the CCTAS is not operational, the No.2 rotates the turret according to the fire order given by the No. 1.

c. When the No. 3 hears the No. 2 repeat the command TARGET, the No. 3:

(1) checks the backblast danger area and reports BACKBLAST; and

(2) observes the backblast danger area until the missile is fired.

NOTE

The No. 3, observing through the loader's periscope, can only see a limited area directly in the back of the vehicle. If the system is firing to a side, then the No. 1 and/or the No. 4 should verify the backblast danger area. Peacetime regulations concerning the backblast area are given Chapter 2 Lesson 1.

d. Once in the general area of the indication the No. 2 will:

(1) search for the target in WFOV and place the crosshairs on the target;

(2) switch to NFOV (Narrow Field of View), focus and adjust the sight picture;

(3) acquire the target and report ON;

(4) arm the left or right launcher as required and report ARMING LEFT (or ARMING RIGHT); and

(5) raise the trigger cover.

e. The No. 1 upon hearing ON from the No. 2, ensures the proper launcher is armed by confirming the proper light on the crew commanders control box is illuminated and orders fire unless the No. 1 has already done so immediately after giving the target indication.

f. The No. 2 fires upon hearing the command FIRE. (If No. 1 orders FIRE WHEN READY immediately after giving his target indication, then the No. 2 fires right after raising the trigger cover).

NOTE

The No.1 must check the crew commander's control box to ensure the arming light is on. If the arming light does not illuminate it indicates that the microswitch in the arming mechanism is not properly closed. The guide arm not being seated fully forward and/or the safety pin not being seated properly normally cause this problem. To remedy the problem, lower the missile and reset it properly.

16. Confirm by practice.

CEASE TRACKING, CEASE TRACKING LOAD AND CEASE TRACKING UNLOAD

17. These commands are defined as:

a. **Cease Tracking**. Cease Tracking is the command used to disengage a target and continue to observe the Kill Zone or arcs of fire.

b. **Cease Tracking Load**. Cease Tracking Load is the command used to disengage a target and load missile(s) to ensure there is a full compliment of missiles in the launch tubes in preparation for other targets.

c. **Cease Tracking Unload**. Cease Tracking Unload is the command used to disengage a target and unload as there is no requirement to have the system in the ready state.

18. The command CEASE TRACKING is given by the No. 1 and is conducted as follows:

a. Upon hearing CEASE TRACKING from the No. 1, the No. 2:

(1) ensures the trigger cover is lowered;

(2) disarms the right or left launcher;

(3) switches the TI sight to WFOV;

(4) reports DISARMED, CEASE TRACKING, READY; and

(5) remains in a firing position, observes the arcs of fire and awaits further orders.

b. The No. 3 upon hearing READY from the No. 2, will stand down from the position of observation and await further orders.

19. The command CEASE TRACKING UNLOAD is given by the No. 1 and is conducted as follows:

a. Upon hearing the command CEASE TRACKING, UNLOAD, the No. 2:

(1) lowers the trigger cover;

(2) disarms the launcher;

(3) switches the TI sight to WFOV;

(4) switches the TI sight On/Off/Stby switch to OFF;

(5) rotates the turret to the load position;

(6) reports, DISARMED, CEASE TRACKING, UNLOAD; and

(7) closes the turret shield sight protection unit, remains in position and awaits further orders.

b. The No. 3, upon hearing the command CEASE TRACKING, UNLOAD from the No. 2:

(1) repeats CEASE TRACKING, UNLOAD;

(2) checks the loaders light to ensure it is illuminated;

(3) unlocks and raises the loader's hatch;

(4) pulls down and back on the release arm and removes the encased missile(s) from the launcher(s);

(5) inspects the launcher(s) and closes the loader's hatch;

(6) taps twice on the No. 2's leg and reports BOTH LAUNCHERS CLEAR;

(7) replaces the electrical connector, the forward handling ring of the encased missile(s) and returns the encased missile(s) to the stowage rack or discards the empty missile casings; and

(8) awaits further orders.

c. The No. 2, upon hearing CLEAR, rotates to the travel position and locks the turret/shield-locking lever.

20. The command CEASE TRACKING LOAD is giving by the No. 1 and is conducted as follows:

a. Upon receiving the command CEASE TRACKING LOAD from the No. 1, the No. 2:

(1) lowers the trigger cover;

(2) disarms the launcher;

(3) switches the TI sight to WFOV;

(4) rotates the turret to the load position; and

(5) reports DISARMED, LOAD.

b. The No. 3, upon receiving CEASE TRACKING LOAD from the No. 1:

(1) repeats CEASE TRACKING LOAD; and

(2) prepares the new encased missile(s) to be loaded;

c. The No. 3, upon receiving DISARMED LOAD from the No. 2:

(1) checks the loader's light to ensure it is illuminated;

(2) unlocks and raises the loader's hatch;

(3) pulls down and back on the release arm and removes the empty launch container(s) and inspects the launcher(s);

(4) without orders, prepares and loads a new encased missile(s);

(5) closes and locks the loader's hatch; and

(6) taps twice on the No. 2's leg and reports LEFT, RIGHT or BOTH LAUNCHER(S) LOADED.

d. The No. 2, upon hearing LEFT or RIGHT or BOTH LAUNCHER(S) LOADED:

(1) lowers the launchers to the horizontal plane;

(2) reports READY when completed; and

(3) observes arcs of fire while awaiting further orders.

21. Confirm by practice.

DISENGAGEMENT DRILL

22. To move out of the firing position the No. 1 orders CEASE TRACKING or CEASE TRACKING LOAD, PREPARE TO MOVE. The detachment then proceeds with the following sequence:

a. The No. 2, upon hearing the command CEASE TRACKING or CEASE TRACKING LOAD, PREPARE TO MOVE:

(1) repeats CEASE TRACKING or CEASE TRACKING LOAD, PREPARE TO MOVE;

(2) carries on the normal cease tracking or cease tracking load drill; and

(3) ensures that the turret is in the travelling position once the load is completed.

b. The No. 3, upon hearing the command CEASE TRACKING or CEASE TRACKING LOAD, PREPARE TO MOVE:

(1) repeats CEASE TRACKING or CEASE TRACKING LOAD, PREPARE TO MOVE; and

(2) conducts the normal cease tracking or cease tracking load drill.

NOTE

If possible, loading is done behind cover.

23. Confirm by practice.

CONCLUSION

24. Take questions from class on the entire lesson.

25. Confirm by questions/practice.

26. Distribute the hand-outs.

27. **Summary**:

    a. continuous practice and team works will perfect the drills and performance of the TUA crew; and

    b. announce the next lesson.

LESSON 8
OPERATIONS AFTER TRIGGER DEPRESSION

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following:

   a. the path of the launch signal;

   b. tracking by the gunner;

   c. the path of turret elevation/azimuth (EL/AZ) signals;

   d. the path of EL/AZ tachometer signals; and

   e. tracking by the Optical (OSS) and Thermal Imagery (TI) sights.

2. **Timing**. On 40-minute period.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores are required:

   a. OHP;

   b. OHP slides or charts on the electrical flow of each component;

   c. hand-outs on the electrical flow of each component, one per student; and

   d. a pointer.

5. **Preparation**. Prior to the commencement of the period:

   a. prepare the classroom; and

   b. check the OHP slides and hand-outs.

6. **Miscellaneous**. Use colour coded OHP flip slides or charts to distinguish between the different component signals.

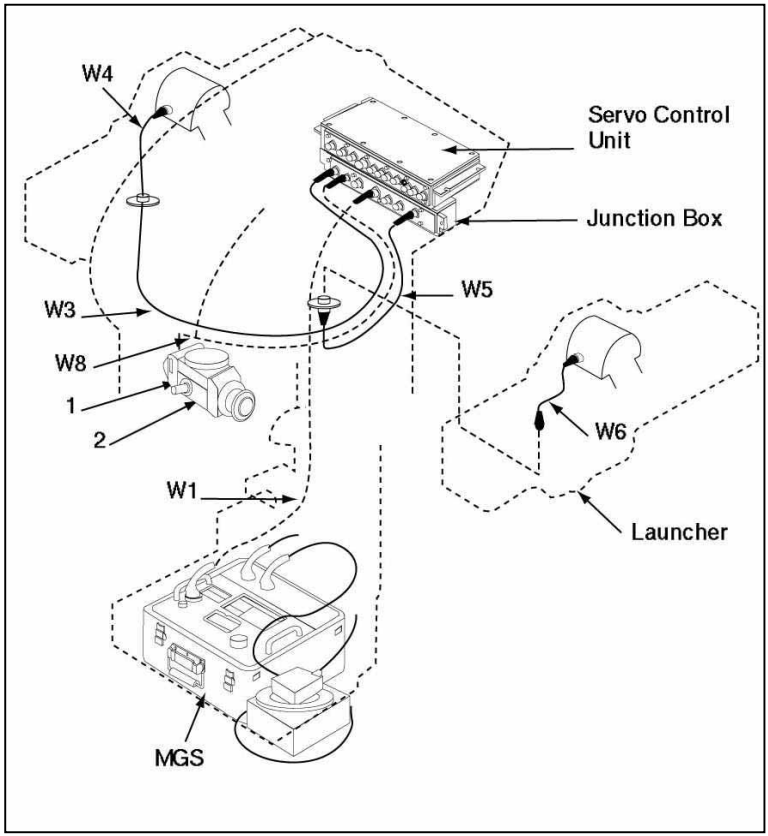


Figure 4-8-1: Launching Signal

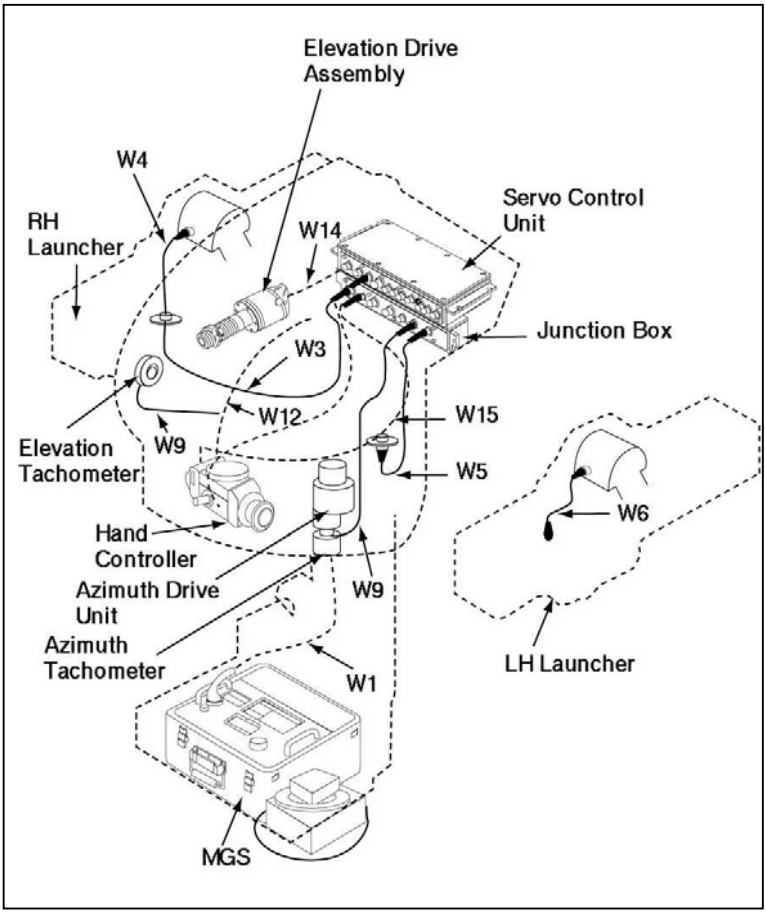


Figure 4-8-2: AZ/EL Tachometers Signals

CONDUCT OF THE LESSON

7. **Safety Precautions**. Nil.

8. **Review**. Review the various electrical and mechanical components and controls.

GENERAL

9. This lesson provides the description of the integrated action of the electrical and mechanical components after the trigger has been depressed.

LAUNCHING SIGNAL

10. Once the trigger (see Figure 4-8-1) has been depressed, and an electrical signal is sent from the hand controller through a cable into the junction box; then from the junction box the signal travels via cable to the missile guidance set (MGS) J1 connector. The MGS then sends the launching signal back to the junction box via cable. From the junction box the signal travels to the respective launcher left or right, whichever is armed.

11. Confirm by questions.

TRACKING BY GUNNER AFTER LAUNCH

12. After the missile has been launched, the gunner using the hand controller controls the tracking of the target. Slewing the hand controller to the left and right traverses the turret. Rotating the left and right control knobs forward depresses the front shield assembly and launchers, rotating to the rear will elevate them.

NOTE

One of the two deadman palm switches must be depressed to activate the gear motors. The gunner must at all times keep his hands on the hand controller even when firing at a static target, because this target may at any time start to move. This would cause the gunner to grab the hand controller. Even the most delicate activation of the deadman palm switch, causes movement of the turret resulting in an unsteady flight or loss of missile.

13. Confirm by questions.

TRAVERSING AND ELEVATION SIGNALS FOR TURRET

14. The traversing and elevating signals are sent from the hand controller to the servo amplifier via cable. The servo amplifier amplifies these signals so that they are proportional to the movement of the turret. Also, a built in filter ensures a certain degree of signal correction to ensure smoother tracking. The amplified signals are sent from the servo amplifier to the elevation drive mechanism and the azimuth drive assembly via cable.

15. Confirm by questions.

AZ/EL TACHOMETERS SIGNALS

16. The elevation and traversing movements of the turret are detected by the elevation tachometer assembly and azimuth tachometer (see Figure 4-8-2). The tachometers send a signal that is proportional to the movement of the turret and turret shield via cable to the junction box and then through cable to the MGS. The signals are computed by the MGS, corrections are send back from the MGS via cable to the junction box, then to the right or left launcher and from the launcher the corrections are sent to the launched missiles via the missile guidance wires.

17. Confirm by questions.

TRACKING BY SIGHTS SYSTEM

18. The optical sight and the TI sight track the missile in the same way as with other variants of the TOW 2. The signals that tell the MGS where the missile is in flight in relation to the line of sight, are sent via cable to the junction box and through the cable connected to the J1 of the MGS. The MGS computes the signals and sends the corrections to the missile as described in paragraph 16.

19. Confirm by questions.

CONCLUSION

20. Take questions from class on the entire lesson.

21. Confirm by questions.

22. Distribute the hand-outs.

23. **Summary**. To include the following:

    a. the importance of knowing how the system works; and

    b. announce the next lesson.

LESSON 9
M113A2 TUA MALFUNCTIONS DRILLS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following :

   a. types of malfunctions;

   b. misfire drill; and

   c. reporting procedures.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. TOW 2 System complete, one per three students;

   b. missile simulation round one per TOW 2; and

   c. hand-outs on drills one per student.

5. **Preparation**. Before the start of the first period:

   a. verify the equipment for serviceability; and

   b. check the hand-outs.

6. **Miscellaneous**. When confirming drills by practice, divide class into detachments for ease of learning.

CONDUCT OF THE LESSON

7. Safety Precaution. Normal.

8. **Review**. Review load and unload drills with the TOW.

9. **Introduction**. A malfunction is the failure of ammunition to function correctly when fired, or the unexpected functioning of explosive components during a test not intended to cause them to function.

MALFUNCTIONS

10. The following constitute a malfunction:

a. premature functioning during handling, maintenance, storage, transportation or deployment; and

b. during normal firing when there is:

(1) a failure to launch, either:

(a) a hang fire; or

(b) a misfire;

(2) an in-flight malfunctions, either:

(a) a dud; and

(b) an erratic flight.

WARNING

The crew must exercise extreme care to avoid injury from a delayed missile launch. A delayed launch usually occurs within one minute of pressing the trigger. However, it could occur as long as thirty minutes after pressing the trigger. Defective missiles (either fired or encased) must be disposed of only by Ammunition Technicians and must be reported in accordance with CFAO 71- 4.

MISFIRE DRILLS

NOTE

Whether pre-fire functions are heard or not, these drills shall apply.

11. The misfire drills is initiated by the No. 2 and is conducted in the following sequence:

a. The No. 2 alerts the crew by reporting MISFIRE and conducts the following drills:

(1) verifies the gunner's control box is on main armament;

(2) ensures proper launcher is armed; and

(3) maintains point of aim.

b. The No. 1, upon hearing MISFIRE from the No. 2:

(1) repeats MISFIRE;

(2) verifies the proper launcher is illuminated on the crew commander's control box; and

(3) reports LEFT OR RIGHT LAUNCHER ARMED.

c. The No. 3, upon hearing MISFIRE from the No. 2, repeats MISFIRE and continues to observe the backblast danger area.

d. The No. 2, upon hearing LEFT OR RIGHT LAUNCHER ARMED from the No. 1, will attempt to re-fire.

12. If the missile still fails to fire the No. 2 initiates the second

misfire drill as follows:

a. the No. 2 reports MISFIRE TWO and waits one minute;

b. the No. 1, upon hearing MISFIRE TWO from the No. 2, repeats MISFIRE 2;

c. the No. 3, upon hearing MISFIRE TWO from the No. 2:

(1) ensures that the missile guidance set (MGS) battery conditioner is ON and the power cable is properly secured;

(2) ensures the MGS J1 cable is properly secured;

(3) initiates an MGS self-test to ensure proper electrical flow and that the battery is functioning; and

(4) reports MGS PASS or FAIL; and

d. the No. 2, upon hearing MGS PASS will attempt to re-fire after the one minute wait.

13. If the missile still fails to fire the No.2 will initiate the third misfire drill and conduct the following:

a. the No. 2 reports MISFIRE THREE;

b. the No. 1 repeats MISFIRE THREE;

c. the No. 3, upon hearing MISFIRE THREE from the No. 2:

(1) switches the MGS power conditioner to OFF or disconnects the cable to the J1 connector if a battery assembly is being used; and

(2) reports POWER DISCONNECTED;

d. the No. 2, upon hearing POWER DISCONNECTED:

(1) lowers the trigger cover;

(2) disarms the launcher; and

(3) reports DISARMED;

e. the No. 3, upon hearing DISARMED from the No. 2:

(1) switches the MGS power conditioner to ON or connects the cable to the J1 connector if a battery assembly is being used; and

(2) reports POWER CONNECTED; and

f. the No. 2, upon hearing POWER CONNECTED:

(1) arms the left or right launcher; and

(2) presses the trigger and attempts to fire the missile.

14. If the missile still fails to fire, the No 2. initiates the fourth misfire drill and conducts the following actions:

a. the No. 2 reports MISFIRE FOUR and continues to track for one minute;

b. the No. 1 and 3 repeat MISFIRE FOUR and wait one minute;

c. after one minute, the No. 2 lowers the trigger cover and orders DISCONNECT POWER;

d. the No. 3, upon hearing DISCONNECT POWER:

(1) switches the MGS power conditioner to OFF or disconnects the cable to the J1 connector if a battery assembly is being used; and

(2) reports POWER DISCONNECTED;

e. the No. 2, upon hearing POWER DISCONNECTED from the No. 3:

(1) disarms the launcher;

(2) locks the turret/shield lock; and

(3) reports DISARMED;

f. the No. 1, upon hearing DISARMED from the No.2:

(1) waits 30 minutes;

(2) after 30 minutes, unloads the launcher by standing beside the launcher; and

(3) passes the encased missile to the No. 3 ensuring it is pointed down range at all times; and

g. after the 30 minute wait the No. 3, exits the vehicle from a safe location and staying as close to the vehicle as possible :

(1) moves to the location where the No. 1 will pass down the encased missile;

(2) faces the vehicle and receives the encased missile ensuring it is pointed down range at all times;

(3) steps back and lowers the encased missile to the ground;

(4) steps over the encased missile and turns about; and

(5) raises the missile and carries it a safe distance (200 m away or to a DUD PIT) ensuring that it is pointed in a safe direction at all times.

WARNING

Depending on the angle of the turret, the No. 1 and No. 3 will use either the crew commander's hatch or the combat door to exit.

NOTE

There is very little room for the No. 1 to manoeuvre for unloading the left launcher from the outside. There may be cases where the No. 4 will have to pivot the vehicle while the No. 2 counter rotates the turret to ensure the launcher is pointed down range. This would be done to assist the No. 1 by giving him sufficient room to unload.

15. Confirm by practice.

REPORTING PROCEDURES

16. In addition to the drills detailed above, the following reporting procedures apply:

a. If two consecutive malfunctions occur in the same launcher, that launcher is isolated. The missiles are disposed of on the authority of the Ammunition Technician, provided it is determined that the missiles are defective. The matter is referred to NDHQ by priority message outlining the action taken and requesting additional direction if required. The launching system is held for complete inspection by the second-line Fire

Control System (FCS) Technicians.

b. If two subsequent missile malfunctions occur from a different launcher, during the same firing practice, and the missile involved has the same lot number, carry out the procedures outlined in sub-paragraph a., suspend firing of missiles bearing the same lot number and seek NDHQ (DSSPM 4) direction by telephone.

c. If a malfunction occurs that may be attributed to the launching system, the weapon is isolated and tested by unit FCS Technicians. Back-up systems are made available to account for this possibility.

d. In the event of a wire break, once the missile has been fired; recover all available wire, particularly that portion on either side of the break, and send the wire to NDHQ, Attention: DSSPM 4.

e. Notwithstanding the special reporting provisions of this paragraph, all malfunctions are reported on the TOW Firing Report.

f. All malfunctions of the missile are reported in accordance with CFAO 71-4, Ammunition Accident, Incident, Defect and Malfunction Reports.

17. Confirm by questions.

CONCLUSION

18. Take questions from the class on the entire lesson.

19. Confirm by practice and questions.

20. Pack kit.

21. **Summary**. To include the following:

a. the importance of knowing the drills well enough so that they become second nature; and

b. a forecast of the next lesson on this subject.

LESSON 10
SMOKE GRENADE DISCHARGER OPERATION

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following:

   a. the loading of smoke grenades;

   b. the firing of smoke grenades; and

   c. smoke grenades misfire drills.

2. **Timing**. One 40-minute period.

3. **Method**. A basic practical instructional period.

4. **Stores**. The following stores and equipment are required:

   a. M113A2 TUA vehicle/trainer;

   b. six DUMMY smoke grenades; and

   c. hand-outs on drills.

5. **Preparation**. Before the start of the period:

   a. park the vehicle in a suitable location; and

   b. check the equipment and hand-outs.

6. **Miscellaneous**. Have each student act as the No. 2.

CONDUCT OF THE LESSON

7. **Safety Precautions**. Check to ensure you have DUMMY smoke grenades.

8. **Review**. Review smoke grenade safety and ammunition

accident prevention.

LOADING/UNLOADING OF SMOKE GRENADES

9. To load the smoke grenades:

   a. Ensure that the main switch on the grenade control box is OFF.

   b. To load the launcher, grip the grenade at the rubber cap and insert it into the launcher tube. Push the grenade all the way down to the detent. Make sure that the rubber lip snaps onto the launcher rim. After the grenade is properly loaded, make a final check by applying even pressure on the cap with the palm of your hand to ensure the grenade is properly seated.

10. To remove the grenade from the launcher, ensure that the main switch on the grenade control box is OFF. Use the fingertips of both hands and take hold of the grenade under the rim of the rubber cap. Pull steadily upwards. Remove the grenade from the launcher. Reinsert the safety pin with the pull wire.

FIRING OF SMOKE GRENADES

11. To fire the SMOKE grenades follow the procedure below:

   a. turn on the turret circuit breaker on the master control panel;

   b. turn on the main switch on the smoke grenade control box;

   c. traverse the turret so that it is facing upwind of the area to be covered;

   d. place the launcher select switch on the smoke position;

e. push the L (left firing) button to fire smoke from the upper bank; and

f. push the R (right firing) button to fire smoke from the lower bank.

NOTE

The smoke override switch must be held in the up position if the turret hatch is in the HALF OPEN position.

12. Confirm by questions and practice.

SMOKE GRENADE MISFIRE DRILL

13. The misfire drill on the smoke grenade is divided into three categories:

a. all smoke grenades in a bank fail to eject;

b. one smoke grenade in a bank fails to eject; and

c. a smoke grenade thrown by hand fails to ignite.

ALL SMOKE GRENADES IN A BANK FAIL TO EJECT

14. If all the smoke grenades in a bank fail to eject, the No. 2 will:

a. check that the selector switch on the smoke grenade control box is at SMOKE;

b. ensure that the On/Off switch on the smoke grenade control box is ON;

c. if the RED indicator light is not ON, check

(1) the top circuit breaker on the master control panel; and

(2) the 6.5 amp fuse on the grenade discharger control box;

d. attempt to fire the bank; and

e. if the grenades fail to eject:

(1) switch the On/Off switch to OFF;

(2) WAIT 10 MINUTES;

(3) UNLOAD;

(4) report the problem to a technician; and

(5) treat the grenades as MISFIRES until the technician has completed the test and determined the fault.

ONE SMOKE GRENADE IN A BANK FAILS TO EJECT

15. If one smoke grenade in a bank fails to eject the No. 2 will

a. switch the On/Off switch to OFF;

b. **wait 10 minutes**; and

c. either:

(1) reload the grenade in another tube and attempt to fire; or

(2) unload and throw by hand.

A SMOKE GRENADE THROWN BY HAND FAILS TO IGNITE

16. If a smoke grenade thrown by hand fails to ignite:

a. **wait 10 minutes**, and

b. dispose of the smoke grenade in accordance with CFTO C-74-050-005/MS-000 and Range Standing Orders.

MISFIRES

17. All misfires will be treated as duds and disposed of in accordance with CFTO C-74-050-005/MS-000, and Range Standing Orders.

18. Confirm by questions and practice.

CONCLUSION

19. Take questions from the class on the entire lesson.

20. Confirm by questions.

21. Pass out the hand-outs.

22. Summary:

a. stress that all misfires/duds are dangerous and must be destroyed by qualified personnel, and

b. give a preview of the next lesson.

LESSON 11
M113A2 TUA SECONDARY ARMAMENT DRILLS

INSTRUCTOR'S NOTES

1. **Aim.** To teach the following drills on the secondary armament:

   a. preparing the belt;

   b. load;

   c. unload;

   d. firing;

   e. make safe;

   f. clear gun;

   g. change barrel;

   h. immediate action/gas stoppages; and

   i. other stoppages.

2. **Timing**. Six 40-minute periods.

3. **Method**. A basic practical instructional period.

4. **Stores**. The following stores and equipment are required:

   a. C6 MG one per four soldiers;

   b. spare parts kit (to include right hand feed cover and feed tray);

   c. 50 rounds of 7.62mm dummy ammunition, belted;

   d. M113A2 TUA with TOW 2 weapon system mounted one per four soldiers; and

   e. hand-outs on the drills.

5. **Preparation**. Prior to the start of the first period:

   a. park the vehicle in a suitable location;

   b. check the equipment and hand-outs; and

   c. change MG to right hand feed.

6. **Miscellaneous**:

   a. practise by dividing the class into crews of four; and

   b. battery maintenance must be stressed in this lesson due to the high drain on the battery when the MG is fired.

CONDUCT OF THE LESSON

7. **Safety Precautions**. Normal C6 MG safety precautions. Ensure dummy ammunition is used.

8. **Review**. Review crew commanders target acquisition system (CCTAS) fire orders (if the CCTAS is used).

9. **Introduction**. A thorough knowledge of the actions to be carried out on receiving fire orders is imperative.

10. **Ammunition**. Links are only to be reused with dummy rounds. The ONLY exception to this rule is in battle. The ammunition is normally belted 4 ball and 1 tracer round. When the MG is configured for the right hand feed, the belt must be removed and reversed so that the single link is fed into the feed tray until the first round is against the cartridge stop, links uppermost.

NOTE

The Detachment Commander must ensure that the C6 MG is pointed in a safe direction when in the LOAD and UNLOAD position.

11. **The Load**. The sequence for loading the MG is:

a. The No. 1 gives the command, MG LOAD.

b. The No. 2 ensures the trigger cover is lowered and the main armament red light, on the gunner's control box is ON. The load/collimation switch is pressed upwards until the turret rotates to the load position, the launchers are depressed to the horizontal position and he repeats MG LOAD.

c. The No. 1- on hearing MG LOAD opens his hatch, places the ammunition box into the mount, ensures it is secure, opens the feed cover, places the belt in the feed tray, holds the belt in place and closes the feed cover. The No. 1 then reports MG LOADED.

12. **The Unload**. The sequence for unloading the MG is:

a. The No. 1 gives the command MG UNLOAD.

b. The No. 2 ensures the trigger cover is lowered, switches the gunner's control box to main armament, observes the red light, presses the load/collimation switch upwards until the turret rotates to the load position, depresses the launchers to the horizontal position and repeats MG UNLOAD.

c. The No. 1upon hearing MG UNLOAD, opens the hatch, cocks the gun, raises the feed cover, removes the belt, clears the feed tray, closes the feed cover, fires the action, removes the ammunition box and reports MG CLEAR.

13. Confirm by questions and practise.

14. **The Ready**. The MG is readied at the crew commander's discretion prior to a target engagement. The Ready is conducted in the following manner:

a. the No. 1 gives the order READY MG;

b. the No. 2 upon hearing READY MG, ensures that

the trigger cover is lowered, the gunner's control box is on main armament and presses the load/collimation switch upwards until the turret rotates to the load position;

c. the No. 1 when the turret has finish rotating and elevating to the load position cocks the MG ensuring the cocking lever is forward and reports MG READY; and

d. the No. 2 upon hearing MG READY, depresses the launchers to the horizontal position and awaits further orders.

15. **Make Safe**. When the target has been engaged and neutralized, the No. 1 will order STOP, MAKE SAFE. The sequence for the drill is:

a. The No. 1 gives the order STOP, MAKE SAFE.

b. The No. 2 repeats STOP, lowers the trigger cover, switches the gunner's control box to main armament and ensures it is engaged by observing the red light. He presses the load/collimation switch upwards until the turret rotates to the load position, depresses the launchers to the horizontal position and reports MAKE SAFE.

c. The No. 1 repeats MAKE SAFE, opens the hatch, cocks the gun, raises the feed cover and removes the belt then clears the feed tray. He then lowers the feed cover, hand fires the action using the manual firing lever, raises the feed cover, inserts a new belt, lowers the feed cover and reports MG LOADED.

WARNING

This MG load position should only be used in battle conditions since the MG may be pointed in an unsafe direction. During peace time and on ranges the MG will be pointed down range thus it may be necessary for the No. 1 to move out of his hatch to load and ready the gun.

16. Confirm by questions and practice.

17. **Firing Drill**. For TUA mounted C6, the order TARGET MG is used. The following drills are conducted:

a. The No. 1 gives the command TARGET MG ALIGN.

b. The No. 2 repeats TARGET MG ALIGN, presses the automatic alignment switch, repeats the fire order (if the CCTAS is not operational, the No.2 rotates the turret according to the fire order given by the No. 1). He then acquires the target, switches the secondary armament on the gunner's control box, raises the trigger cover and reports ON.

c. The No. 1 repeats ON and gives the executive FIRE.

d. The No. 2 engages the target.

NOTES

The normal length of burst is 20 rounds. This is necessary to ensure the gunner can observe the strike of the rounds on the ground. If short bursts are to used they will not be less than 10 rounds.

18. Confirm by questions and practice.

19. **Clear Gun**. For the TUA C6 coaxial MG, the clear gun

will only be used on conventional or field firing ranges.

a. on the order UNLOAD, CLEAR GUN, carry out the unload as described in paragraph 12; and

b. raise the feed cover and report MACHINE GUN CLEAR.

20. Confirm by questions and practice.

21. **Change Barrel**. For the TUA C6 coaxial MG, the CHANGE BARREL should be done out of contact. On the order CHANGE BARREL:

a. Complete the unload sequence as described in paragraph 12.

b. The No. 3 gives the No. 1 a cool barrel.

c. The No. 1 cocks the MG and replaces the barrel ensuring the gas regulator is set correctly. After allowing the working parts to go forward, he loads and cocks the MG to carry on firing or rotates the turret to the travel position for travelling.

d. The No. 1 after changing barrels gives the hot barrel to the No. 3 for cooling and storage.

NOTE

To avoid overheating, no gun is to fire more than 440 rounds (2 belts) continuously through the same barrel. Barrels are to be changed after every 440 rounds and not used again until hand cool.

22. Confirm by questions and practise.

23. **Immediate Action and Gas Stoppage Drill**. If the gun stops firing, it is imperative the crew knows how to remedy it with minimum loss of time.

24. **Immediate Action (IA)** If the MG stops or fails to fire:

a. The No. 2 reports MG MISFIRE, lowers the trigger cover, disarms the MG by switching the fire selector on the gunner's control box to main armament, observes to ensure that the Red Light is on, rotates to the load position and reports MG DISARMED.

b. The No. 4 upon hearing MG MISFIRE will move the vehicle out of the line of direct enemy fire.

c. The No. 1 repeats MG DISARMED, opens his hatch, cocks the MG, opens the feed cover, clears the feed tray, closes the feed cover and fires the action manually by engaging the manual firing control on the coaxial mount. A round may or may not be fired. He then loads, cocks the MG, closes the hatch and reports READY.

d. The No. 2 reports READY, switches the fire selector on the gunner's control box to secondary armament and observes the Yellow Light, depresses the launchers to the horizontal position and test fires the MG to ensure it is functioning properly.

e. The No. 1 upon hearing the MG functioning properly directs the vehicle into a fire position.

f. The No. 2 once in a fire position re-aims and fires.

25. Confirm by practise.

26. **Stoppage Remedied by Applying the IA**. The following stoppages will be remedied by applying the IA drill:

a. expended belt;

b. damaged rounds;

c. live round partly fed due to a damage link;

d. misfired round;

e. hard extraction; and

f. damaged link.

27. **MG Cannot be Cocked**. If the cocking handle cannot be pushed fully to the rear while applying the IA, a damaged link may be jamming the feed pawls. When the secondary armament is disarmed, the following action will be taken:

a. The No. 1 pushes the cocking handle as far back as possible, opens the feed cover, clears the feed tray, closes the cover and completes the cocking action. He then fires the action manually, loads, cocks the MG, closes the hatch and reports READY.

b. The No. 2 repeats READY, rearms the secondary armament, depresses the launchers to the horizontal position and test fires to ensure proper functioning of the MG.

c. The crew completes the IA.

28. Confirm by practise (assuming the MG can not be fully cocked).

29. **Gas Stoppage Drill**. After applying an IA, the MG fires a few rounds and again stops, this is caused by insufficient gas. The following action will be taken:

a. The No. 2 lowers the trigger cover, switches the fire selector switch to main armament, rotates to the load position and reports MG MISFIRE.

b. The No. 1 reports MG MISFIRE, raises the hatch and cocks the MG. He then adjusts the MG for more gas by turning the regulator clockwise 2 clicks. The hatch is then closed and he reports READY.

c. The No. 2 repeats READY, switches the fire selector to secondary armament, depresses the launchers to the horizontal position and test fires the MG.

d. The crew completes the IA.

NOTE

At the earliest opportunity the MG is to be unloaded, the barrel removed and the gas plug and block cleaned.

30. **Further Action**. If after carrying out the gas stoppage drill the stoppage re-occurs, then carry out the Change Barrel drill as taught and carry on firing. Clean and lubricate the gas affected parts as soon as possible.

31. Confirm by questions and practise.

32. **Other Stoppages**. Although stoppage caused by broken parts or obstructions are rare, the soldier must be able to recognise and remedy such cases quickly. The stoppages are taught in a set sequence but in reality they may occur in any order.

33. The words of command to practise the stoppage drills are outlined below (the actual drills are discussed in subsequent paragraphs):

a. GUN FIRING ALL RIGHT—GUN STOPS, after the IA has been carried out give GUN WON'T FIRE.

b. To signify why the GUN WON'T FIRE, report one of the following as appropriate:

(1) OBSTRUCTION IN THE BODY;

(2) EMPTY CASE IN THE CHAMBER;

(3) OBSTRUCTION IN THE BARREL; or

(4) SEPARATED CASE.

c. After completion of the corrective action, give OBSTRUCTION CLEAR—GUN FIRING ALL RIGHT.

d. Alternatively give, OBSTRUCTION CLEAR—GUN WON'T FIRE and indicate why by stating PRIMER NOT STRUCK/NOT PROPERLY STRUCK/ROUND WON'T EJECT or GUN WON'T COCK.

34. If after applying the IA drill the MG will not fire, conduct the other stoppages drills in the following manner:

a. Complete the unload sequence as previously taught.

b. The No. 1 cocks the MG again, opens the feed cover, raises the feed tray and inspects the interior of the receiver. Subsequent action will depend on what the No. 1 sees in the receiver:

(1) **Obstruction in the Body.** If the No. 1 sees an obstruction in the receiver, for example a jammed live round or empty case, he removes it by hand or if necessary, by using a tool from the cleaning kit. When the obstruction is cleared, the No. 1 inspects the chamber. If the chamber is clear or there is a live round present the No. 1 closes the feed-cover, with the MG pointed in a safe direction and fires the action manually (a round may be fired). Ensuring that the working parts are forward, he reloads, cocks the MG and carries on.

(2) **Empty Case in the Chamber.** If on the initial inspection or after removing an obstruction from receiver, the No. 1 sees an empty case in the chamber (caused by

a broken extractor or spring) he:

(a) closes the cover;

(b) fires the action manually;

(c) strips the guns, replaces the broken extractor or spring and re-assembles the gun;

(d) cocks the gun, fires the action manually, cocks the action again to ensure the empty case is extracted and again fires the action manually; and

(e) loads, cocks the MG and reports READY to the No. 2.

35. Confirm by practice.

36. **Obstruction in the Barrel or Separated Case**. If, on looking into the receiver and chamber of the MG there is no visible obstruction, the barrel should be removed and inspected for an obstruction or a separated case. The following action is taken depending on what is found:

a. **Obstruction**. The barrel is not to be used until the obstruction is removed. The No. 1 replaces it with the second barrel, allows the working parts to go forward, loads, cocks the gun and reports READY to the No. 2.

b. **Separated Case**. The No. 1 raises the feed tray and inserts the forward edge of the clearing plug into the chamber, pushes it as far forward as possible, using the handle, levers back on the clearing plug until it is clear of the chamber. He then checks to ensure that the separated case in on the clearing plug, allows the working parts to go forward and reports READY to the No. 2.

37. Confirm by practise.

38. **Damaged or Broken Parts.** If after carrying out the IA and stoppage drills, the MG still will not fire, complete the following action:

a. unload as taught;

b. the No. 1 strips and examines the MG and the ejected ammunition for the following signs which indicate damaged or broken parts:

(1) primer not struck (broken firing pin),

(2) primer not properly struck (weak main spring), or

(3) repeated failure to eject (broken ejector);

c. the No. 1 replaces the damaged or broken parts where applicable, loads and reports READY to the No. 2.

39. **Feed Pawl and Spring**. If after applying the IA and stoppage drills, the MG still fails to fire and the gun cannot be cocked, act as previously taught, but before loading, open the feed cover and examine the feed pawls and springs. If they are not working freely the No. 1 will do the following:

a. clean and oil the feed pawls and springs;

b. close the feed cover; and

c. load, cock, and report READY to the No. 2.

40. Confirm by practice.

41. **Runaway Gun**. A mechanical fault may cause the MG to fire after the trigger has been released. If this happens the following action must be performed immediately:

a. the No. 2 lowers trigger cover and switches to

main armament on the gunner's control box. If the cause is electrical this will remedy the problem;

b. if the cause is mechanical the No. 1 must twist the belt at the point of entry into the feed way, thus breaking the belt or jamming the feed; and

c. the No. 1 unloads, then loads, adjusts for more gas, cocks the gun and reports READY to the No. 2.

42. Confirm by practice.

CONCLUSION

43. Take questions from the class on the entire lesson.

44. Confirm by questions and practice.

45. Carry-out safety precautions.

46. Pack kit.

47. **Summary**:

a. remind the class that a stoppage drill is not complete until the weapon is firing again;

b. return all tools to the C6 MG cleaning kit immediately after use;

c. do not fire a damaged round; and

d. give a forecast of the next lesson.

LESSON 12
M113A2 TUA MOUNTING/DISMOUNTING DRILLS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the M113A2 TUA Mounting/Dismounting Drills.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. M113A2 TUA vehicle complete with TOW 2;

   b. ten missile simulation rounds/dummy missiles; and

   c. hand-outs on the drills one per student.

5. **Preparation**. Prior to the start of the first period:

   a. have the vehicle/trainer parked in a suitable location;

   b. check the equipment; and

   c. check the hand-outs.

6. **Miscellaneous**. Practice by dividing class into four person detachments.

CONDUCT OF THE LESSON

7. **Safety Precautions**. Heed all DANGER WARNING and CAUTION notices posted on components and the vehicle. Ensure that there are NO LIVE BLAST SIMULATORS present.

8. **Review**. Review the individual drills for carrying the TOW 2 dismounted.

M113A2 TUA MOUNTING DRILLS

9. When the vehicle is in its administrative configuration there are no missiles loaded into the launchers, the thermal imagery (TI) sight switch is OFF, the turret/shield is locked with the turret in the travelling position and the No. 2 is riding inside the vehicle on the loader's seat with the No. 3. This configuration is used for administrative purposes when the chance of contacting the enemy is remote. The drills described only apply to the tactical configuration when the vehicle is brought to the operational state.

10. Because of the restricted working area of a TUA, webbing is not worn inside the vehicle. When in MOPP 0 or MOPP 1 conditions, the gunner has the gas mask strapped across the chest.

11. During training and in operations, words of command are given using the vehicle intercom system when possible.

12. The mounting drill is used to install the TOW 2 into the M113A2 TUA in a quick and logical sequence. The word of command to install the TOW 2 in the M113A2 TUA is MOUNT, PREPARE TO MOVE. Upon hearing the command, the detachment completes the stripping, if necessary, and carries the components as described in Chapter 2 Lesson 8. The crew approaches the vehicle from the rear in order No. 1, No. 3, No. 2 and No. 4.

13. The detachment places their components on the ground and the following occurs:

a. The No. 4 moves inside the vehicle through the driver’s hatch, drops the ramp and then returns to the rear of the vehicle.

b. The No. 1 moves through the back ramp, opens the crew commander’s cupola and climbs on top of the vehicle.

c. The No. 3 places the traversing unit into its mount behind the driver engages the mounts grooved

coupling clamp and assists the No. 2 with the missile guidance set (MGS).

d. The No. 2, places the MGS at the right side of the slip ring, removes the MGS cover, installs the MGS power conditioner With the assistance of the No. 3, the No.2 installs the MGS and the No. 3 places the MGS cover on top of the vehicle.

e. The No. 2, once the MGS is installed and the MGS stowage compartment cover is properly secured will, move into the turret, open the turret hatch and the front shield.

f. The No. 3, once the MGS is secured will place the MGS cover on top of the vehicle through the crew commander's cupola and turn on the main circuit breaker on the master control box.

g. The No. 4, once at the rear of the vehicle, removes the optical sight system (OSS) and the TI sight from their protective cases. He then passes them to the No. 1 on top of the vehicle and then picks up the battery power conditioner and the spare battery and passes them to the No. 1 on top of the vehicle.

h. The No. 1, once the No. 2 is in the turret, passes the OSS and TI sight to No. 2, and assists in their installation.

i. The No. 2, with the assistance of the No. 1, installs the OSS and TI sight as taught.

j. The No. 3 stores the launch tube and the tripod in their respective mounts and starts loading the missiles into their stowage racks.

k. The No. 4, assists the No. 3, with the missiles.

l. The No. 1, once the TI sight is secure, stows the remaining components in their respective compartments as taught.

m. The No. 2, once the TI sight is hooked up, remains in turret and with assistance from the No. 3 conducts a MGS self test and OSS boresight.

n. The No. 2, once the MGS self test is complete, will with assistance from the No. 1, boresight/collimate the TI sight.

o. The No. 2, once the TI is boresight/collimated, will remain in his seat and await the System Check Out Procedure.

p. The No. 1, once the boresight/collimation is complete, will hand the boresight/collimator to the No.3 and move to his seat.

q. The No. 3 and the No. 4 carry on loading the missiles and miscellaneous kit. When completed, the No. 4 moves to the driver's compartment and the No. 3 sits on the loader's seat and they await further orders.

r. When all crew members are in their respective positions the No. 1 will initiate a System Check Out Procedure.

14. This completes the MOUNTING DRILL, for the M113A2 TUA.

15. Confirm by practice.

DISMOUNTING DRILL

16. The word of command to dismount the TOW 2 from the M113A2 TUA is CEASE TRACKING, and either UNLOAD, DISMOUNT, or DISMOUNT. After the No. 2 has locked the turret/shield in the travelling position, the No. 2 will give the ALL CLEAR. Then the dismount is performed in the reversed sequence of the (mount). The crew members handling the same weapon components with the exception of the No. 4, who is responsible for laying the equipment on the ground in the order of march.

17. Confirm by practice.

CONCLUSION

18. Take questions from class on the entire lesson.

19. Confirm by questions.

20. Pass out the hand-outs.

21. **Summary**. To include the following:

    a. with continuous practice the detachment drills become second nature and enable the crew to perform effectively and efficiently; and

    b. announce the next lesson.

LESSON 13
MAINTENANCE

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following maintenance procedures:

   a. general maintenance, and

   b. daily and periodically preventive maintenance.

2. **Timing**. One 40-minute period.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores are required:

   a. an OHP;

   b. OHP slides on general maintenance; and

   c. hand-outs one per student.

5. **Preparation**. Prior to the start of the period:

   a. prepare the classroom; and

   b. check the slides, OHP and hand-outs.

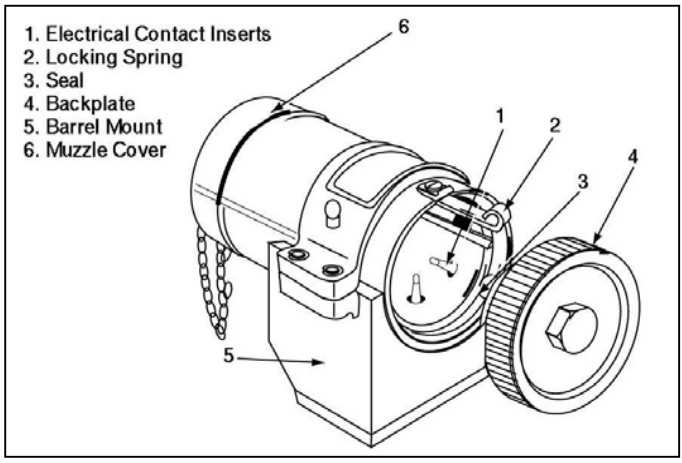


Figure 4-13-1: Smoke Grenade Launcher and Barrel

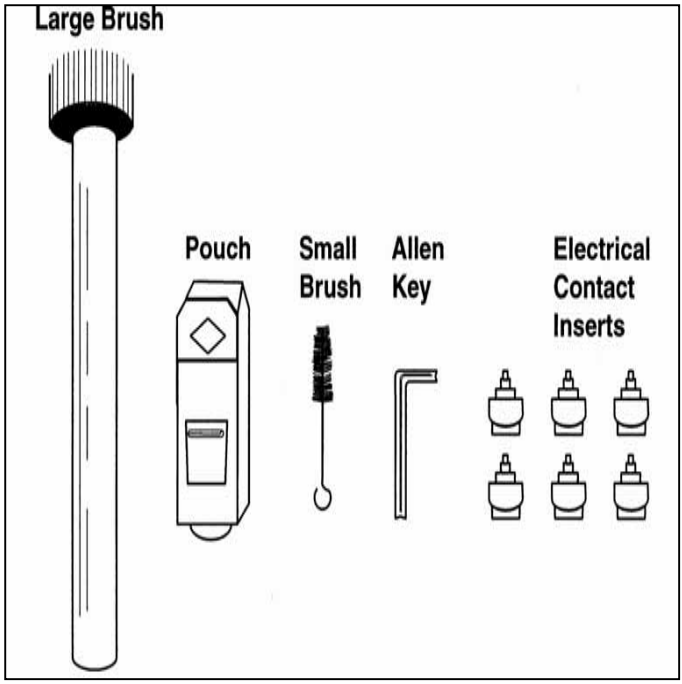


Figure 4-13-2: Smoke Grenade Launcher Accessories and Spare Parts

CONDUCT OF THE LESSON

6. **Review**. Have the students name the parts of the grenade launcher.

7. **Introduction**. This lesson describes the checkpoints and services to be performed by the crew.

8. A good crew shall, in addition to operating the vehicle under different conditions, also ensure that it is in the best possible technical condition.

9. When a fault or defect occurs in a vehicle part that part shall not be used until the maintenance staff approve its use.

WARNING

Cleaning solvents are flammable and give off harmful vapours. Use solvents in a well-ventilated area. Avoid prolonged breathing of solvent vapours and prolonged skin contact with cleaning solvents. Do not smoke in areas where solvents are being used.

WARNING

Before driving the vehicle, the turret hatch shall be locked in the open or closed position. The loader's hatch will be closed and locked. The turret/shield lock shall be applied.

CAUTION

Heed all CAUTION and WARNING decals posted throughout the vehicle.

GENERAL MAINTENANCE PROCEDURES

10. General maintenance procedures that are the crew's responsibility include the following:

a. **Cleanliness**. Dirt, grease, oil and debris only get in the way and may conceal a problem and create a potential safety hazard. Use cleaning solvent sparingly on all metal surfaces. Use soap and water when cleaning rubber and plastic materials.

b. **Tightness of Bolts, Nuts and Screws**. Check all bolts, nuts and screws for obvious looseness, and that none are missing. Check for chipped paint, bare metal or rust around bolt heads. If a bolt, nut or screw is loose, report it to maintenance.

c. **Inspection of Welds**. Look for loose or chipped paint, rust and gaps where parts are welded together. If a bad weld is found, report it to maintenance.

d. **Inspection of Electrical Wires and Connectors**. Look for cracked or broken insulation or bare wires on electric cables and loose or broken connectors. Tighten loose connectors and report damaged cables to maintenance.

11. Confirm by questions.

DAILY AND PERIODICAL PREVENTIVE MAINTENANCE

12. Daily and periodical preventive maintenance inspection check lists are found in Annex A of this Chapter. They provide inspection points and maintenance operations for daily and periodical inspections.

13. Preventive maintenance checks and services to be performed on a daily basis will include the following:

NOTE

Daily preventive maintenance and service checks are performed before, during and after vehicle operation and before, during and after firing the weapons systems

CAUTION

Do not use pressurised steam, water or air when cleaning the inside of the turret. This type of cleaning could cause ingress of humidity into the sighting units, servo motors, slip ring, electrical couplings and control boxes, which could cause corrosion. Do not use coarse grinding material to remove rust or scaling from unpainted surfaces.

a. Exterior:

(1) visually check the turret casing, launcher's and loader's hatches for damage, cracks in welds, paint chipping, rust spots and foreign objects that may obstruct movement of the turret;

(2) check conditions of the following:

(a) periscope, front shield access panel, and turret hatch gaskets;

(b) cleanliness of periscopes;

(c) ancillary stores stowage boxes;

(d) security of tools and equipment; and

(e) shield cover scraper and springs;

(3) check, clean and lubricate the smoke

grenade launchers;

(4) check the condition of antenna and mount; and

(5) check, clean and lubricate the secondary armament.

b. Interior:

(1) visually check all components for condition of paint, damage, rust spots, security and cleanliness;

(2) check the operation of the following:

(a) turret hatch locking mechanism;

(b) loader's hatch operating mechanism;

(c) turret/shield lock;

(d) gunner's seat and seat belt;

(e) open loader's hatch and inspect launchers for loose or missing parts;

(f) check operation of loader's hatch limitation-switches;

(g) check condition of loader's seat and seat belts;

(h) check condition of missile securing straps and brackets;

(i) check firing interlock circuits;

(j) inspect electrical cables for routing, signs of wear and loose connectors;

(k) check security of TOW 2 components; and

(l) inspect elevation mechanism rubber boots.

14. Confirm by questions.

BATTERIES

WARNING

Do not smoke or have an open flame nearby when checking batteries. Batteries emit gases that are highly explosive. Do not allow battery acid to come in contact with skin, as serious burns can result.

15. Open the battery cover, and proceed as follows:

a. Remove caps and check electrolyte level in all battery cells. The correct level is at the lower edge of the filler hole. If necessary, fill cells with distilled water, then run the engine 10-15 minutes to allow electrolyte and water to mix.

b. Visually check batteries for cracks or leaking casing and corrosion around the posts.

c. Clean battery racks with water.

d. Check cable and post clamp bolts and nuts for tightness. Tighten all loose hardware.

16. Close the battery box cover.

17. Confirm by questions.

SMOKE GRENADE LAUNCHERS

18. **General**. The smoke grenade launchers are tested and serviced before and after firing. Cleaning and lubrication should be carried out only with the recommended cleaning and lubricating materials. The inside of the barrels should be oiled immediately after firing, preferably when the barrel is still warm. The inside surface of the barrels sweat after firing, therefore, it is necessary to clean and oil the barrels every day for three days after firing (see Figure 4-13-1).

CLEANING

19. The barrels are cleaned as follows:

a. remove the muzzle cover and fasten it to the stud on top of the barrel clamp;

b. remove the backplate;

c. clean and oil the inside of the barrel with the cleaning brush;

d. replace the backplate and ensure that the locking spring is in the locking groove;

e. clean the exterior; and

f. replace the muzzle cover.

20. During monthly servicing, the following items must be cleaned and checked for security and serviceability:

a. clean the barrels and re-oil;

b. conduct the smoke grenade launcher check-out;

c. check the security of all electrical connections and components; and

d. check the electrical contact inserts for resilient mounting.

21. The accessories and spare parts for the smoke grenade launcher are detailed in (see Figure 4-13-2).

OPERATION UNDER EXTREME OR UNUSUAL CONDITIONS

22. Under extreme cold conditions particular attention must be paid to indicator lamps, condition of the turret hatch, loader and shield door gaskets, ease of operation of equipment and condition of the batteries.

23. When operating equipment in extreme hot conditions, temperatures above 35 degrees Celsius, special attention must be given to the following:

a. batteries may overheat and boil dry;

b. batteries discharge quickly when not in use for extended periods;

c. lubricants lose viscosity and levels may require more frequent checking;

d. corrosion, pitting, fungus growth and paint blistering occur more frequently;

e. upholstery fabrics, rubber, plastics and tarpaulins tend to mildew and deteriorate more rapidly; and

f. moving parts must be kept clean, free of sand and lubricate frequently.

24. Confirm by questions.

CONCLUSION

25. Take questions from the class on the entire lesson.

26. Confirm by questions.

27. Pass out the hand-outs on maintenance.

28. **Summary**: To include the following:

    a. stress that the general maintenance procedure is the responsibility of the entire crew and the importance of following the inspection checklists; and

    b. give a forecast of the next lesson.

ANNEX A
TUA PREVENTIVE MAINTENANCE INSPECTION CHECK LIST

INSPECTION CHECK LIST FOR THE COMMANDER (COMD)

B—BEFORE OPERATION
D—DURING OPERATION
A—AFTER OPERATION

B	D	A	CHECKS AND SERVICES
			ITEM 1—EXTERIOR
			WARNING Before driving the vehicle, the turret hatch will be locked in the open or closed position. The loader's hatch will be closed and locked. The turret and shield lock shall be applied.
x		x	a. Visually check the turret casing, launchers and loader's hatch for damage, cracks in welds, paint chipping, rust spots and foreign objects that may obstruct movement of the turret.
			b. Check condition of the following:
x		x	(1) Periscope, shield door, loader's and turret hatch gaskets.
x		x	(2) Cleanliness of periscopes.
x		x	(3) Ancillary stowage boxes.
x		x	(4) Gunner's and loader's seat cushions.
x	x	x	(5) Security of tools and equipment.
x		x	(6) Shield cover, scraper and springs.
x			c. Check, clean and lubricate the grenade launchers.
x		x	d. Check condition of antenna and mounts.

B—BEFORE OPERATION D—DURING OPERATION A—AFTER OPERATION			
B	**D**	**A**	**CHECKS AND SERVICES**
			ITEM 2—INTERIOR
x		x	a. Visually inspect all components for condition of paint damage, rust spots, security and cleanliness.
x		x	b. Check operation of the following: (1) Turret hatch operating mechanism. (2) Loader's hatch operating mechanism. (3) Turret/shield lock. (4) Gunner's seat, seat belt and foot rest.
x		x	c. Open loader's hatch and inspect launchers for loose or missing parts.
x		x	d. Check operation of loader's hatch microswitches by observing internal lighting (hatch open - lights go out).
x		x	e. Check firing interlock circuits by observing firing ¨Enabled¨ and ¨Disabled¨ lights on commander's control panel.
x		x	f. Inspect electrical cables for routing, signs of wear and loose connectors.
x		x	g. Check security of TOW II components stowage.
x		x	h. Check condition and installation of rubber boots on elevation mechanism.
x		x	i. Check turret hatch microswitch by observing the power-on light on the grenade launcher control box. (Hatch open, power-on light goes out).
x		x	j. Check operation of left and right launcher arming microswitches by observing lights on commander's control panel when arming levers are operated.

B—BEFORE OPERATION D—DURING OPERATION A—AFTER OPERATION			
B	**D**	**A**	**CHECKS AND SERVICES**
x			k. Inspect and clean azimuth and elevation scales.
x			l. Perform gunner's test.
		x	m. Inspect the loader's and turret hatches for leaking.

WEEKLY AND MONTHLY CHECKS AND SERVICES

PERIOD		CHECKS AND SERVICES
W	**M**	
		ITEM 1—EXTERIOR/FASTENINGS
	x	1. Inspect all fastening and locking devices as follows:
	x	a clasps and locks;
	x	b. seat belts; and
	x	c. securing straps for TOW II Components and missiles.
		ITEM 2—RAVERSE MOTOR/GEAR
x		a. Inspect motor casing for signs of oil leaks.
x		b. Inspect azimuth gear and motor gear for cleanliness. Clean, using a soft brush.
x		c. Verify the condition of gunner's and loader's seat cushions.
		ITEM 3—BATTERIES
		WARNING Do not smoke or have an open flame nearby when checking batteries. Batteries emit gases that are highly explosive. Do not allow battery acid to come into contact with skin, as serious burns can result.

PERIOD		CHECKS AND SERVICES
W	M	
	x	a. Open battery box cover, and proceed as follows: (1) Remove caps and check electrolyte level in all battery cells. Correct level is lower edge of filler hole. If necessary, fill cells with distilled water. Run engine 10-15 minutes to allow electrolyte and water to mix. (2) Visually check batteries for cracks or leaking casing and for corrosion around posts. (3) Clean battery racks with water. (4) Check cables and post clamp bolts and nuts for tightness. Tighten all loose hardware. b. Close battery box cover.

INTERVAL	ITEM NO.	IDENTIFICATION	ACTION	LUBRICANT	NUMBER OF POINTS
WEEKLY	1	**LOADER'S HATCH**			
		Operating Linkage	Lub	Molykote 321	10
		Cover Hinges	Lub	Molykote 321	2
		Gear Box	Check	Molykote 321	
	2	**STOWAGE BOXES**			

INTERVAL	ITEM NO.	IDENTIFICATION	ACTION	LUBRICANT	NUMBER OF POINTS
		Hinges	Lub	Molykote 321	3
		Hasps	Lub	Molykote 321	6
	3	**SHIELD**			
		Door Hinges	Lub	Molykote 321	2
		Door Lock	Lub	Molykote 321	1
MONTHLY	**1**	**GUNNER'S SEAT**			
		Hinge Pin	Lub	Molykote 321	
		Foot Rest	Lub	Molykote 321	
		Lock Pin	Lub	Molykote 321	
		Cover Hasp	Lub	Molykote 321	4
		Cover Hinge	Lub	Molykote 321	1
		Foot Pedal Linkage	Lub	Molykote 321	
	2	**LOADER'S SEAT**			
		Hinges	Lub	Molykote 321	1
	3	**BATTERIES**			
		Electrolyte	Check		
	4	**PERISCOPE**			
		Turret Hatch	Lub	Lub-o-seal	

INTERVAL	ITEM NO.	IDENTIFICATION	ACTION	LUBRICANT	NUMBER OF POINTS
		Loader's Hatch	Lub	Lub-o-seal	
		Shield Door	Lub	Lub-o-seal	
SEMI–ANNUALLY	1	**BATTERIES**			
		Posts and Clamps	Lightly lub	Petroleum Jelly 9150-00-250-0926	
	2	**TURRET HATCH**			
		Screw	Lightly lub	Tac 81	
		TURRET AND SHEILD LOCK			

ANNEX B
TECHNICAL DATA FOR TUA

1. TURRET

Length (Launchers Horizontal)	1755mm
Width	1050mm
Height (above vehicle)	1194mm
Height (above ground)	3023mm
Weight (less seat assembly)	780 kg
Traverse (continuous)	6400 mils
Drive	24 V dc Servo motor w/gear box
Speed (maximum)	157 mils/sec
Speed (tracking)	0 to 35 mils/sec
Material	Armoured Steel Plate (Armox 500S)
Thickness (front shield)	12mm
Thickness (sides)	8mm

2. LOADER'S HATCH

Length	780mm
Width	1213mm
Height (closed)	298mm
Operation	Gear box with crank (Torsion Bar assist)
Material	Armoured Steel Plate (Armox 500S)
Thickness	800mm

3. GUNNER'S SEAT ASSEMBLY

Weight	50 kg
Seat Adjustment	0 - 300mm
Operation	Spring Loaded Column
Rotation	6400 mils
Foot Rest Adjustment (6 position)	0 - 152mm

4. TURRET HATCH

Vertical opening	0 - 10 cm
Rotation	3200 mils
Mechanism	Crank and screw

5. TURRET/SHIELD LOCK

Type	Manual
Turret Lock	Sliding Gear
Shield Lock	Plunger

6. SIGHTING SYSTEM

Weights:	
Optical Sight	14.5 kg
TI Sight with case	14.3 kg (without case 10 kg)
Collimator with case	9.2 kg (without case 8.6 kg)

7. ELEVATION DRIVE ASSEMBLY

Type	Power
Drive	Electric Motor
Voltage	24 V dc
Elevation	533 mils

8. AZIMUTH DRIVE UNIT

Type	Power
Drive	Electric Motor
Voltage	24 V dc
Speed (maximum)	157 mils/sec
Azimuth	6400 mils

9. LAUNCHERS

Width	236mm
Material	Armoured Steelplate (Armox 500S)
Thickness	6mm
Elevation	355 mils

ANNEX C
DETAILED KIT LAYOUT FOR TUA

1. The following diagrams will show the suggested kit layout for storing equipment in and on the TUA vehicle.

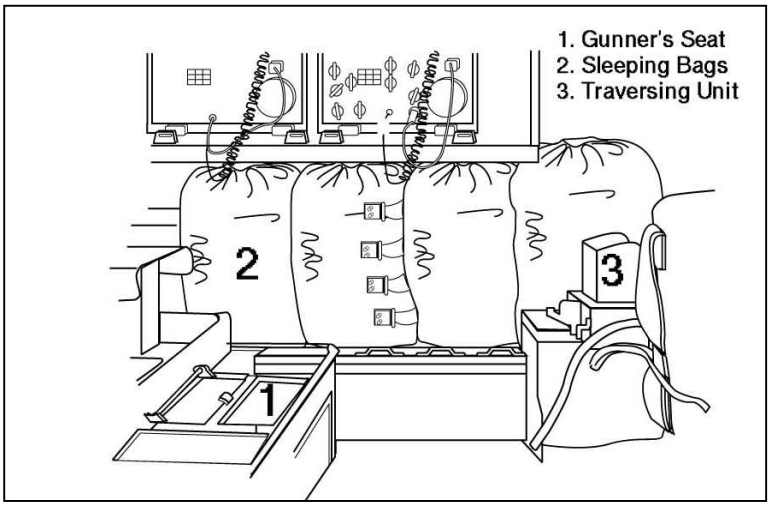


Figure 4-C-1: Sleeping Bag Stowage Location

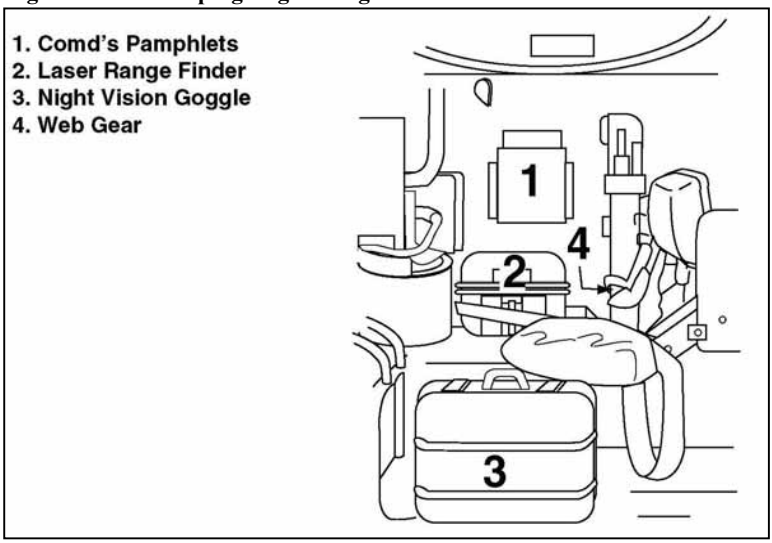


Figure 4-C-2: Kit Stowage Locations in Crew Commander's Area

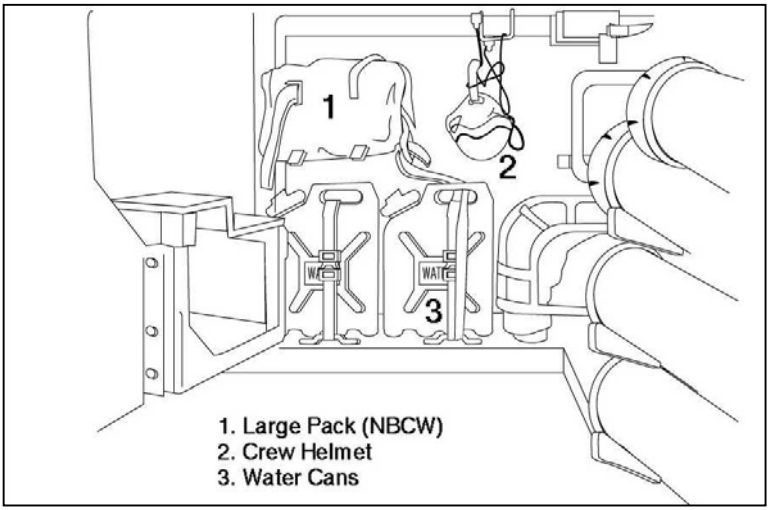


Figure 4-C–3: Kit Stowage Locations by Engine Panel

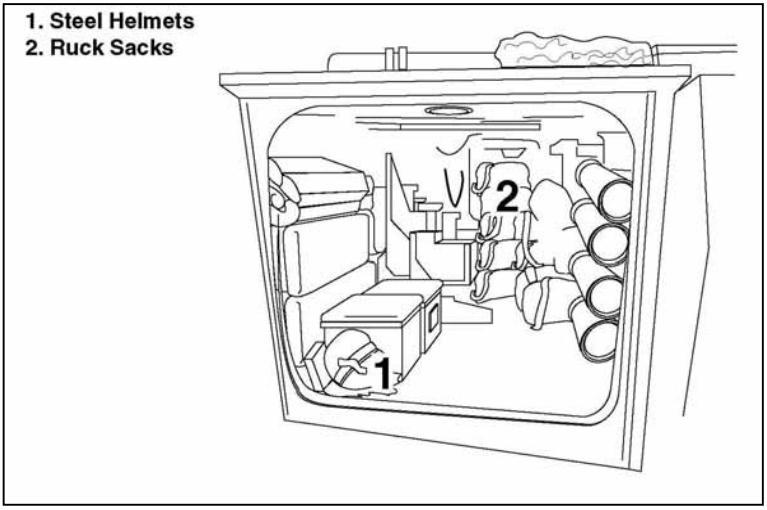


Figure 4-C-4: Kit Stowage Locations Interior of TUA

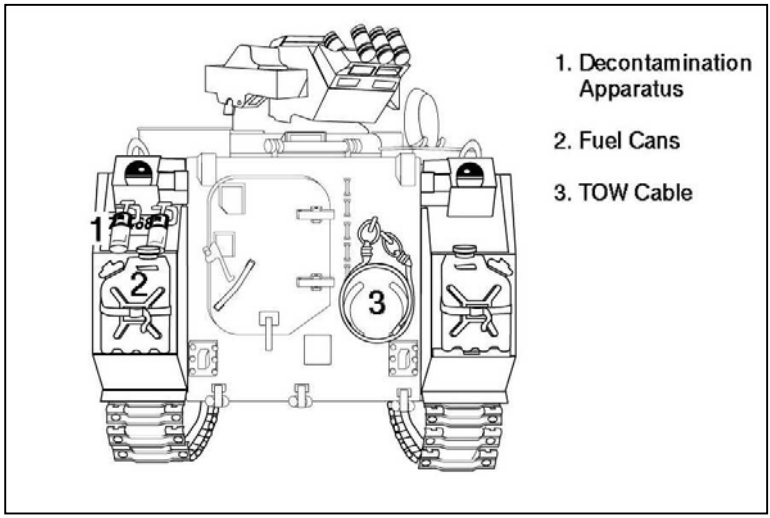


Figure 4-C-5: Rear of TUA (Exterior)

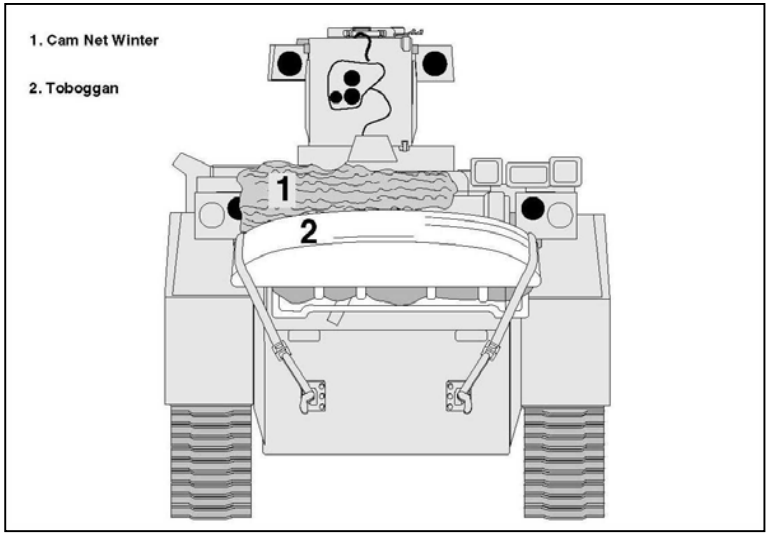


Figure 4-C-6: Front of TUA (Exterior)

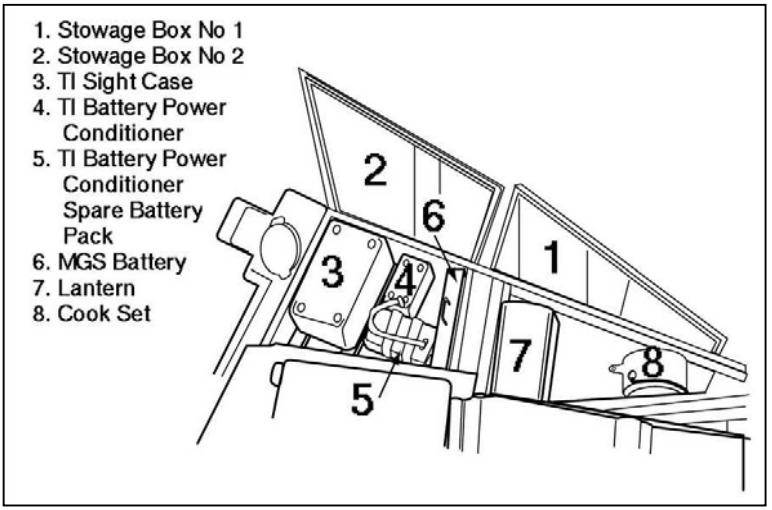


Figure 4-C-7: Stowage Box No. 1 and 2

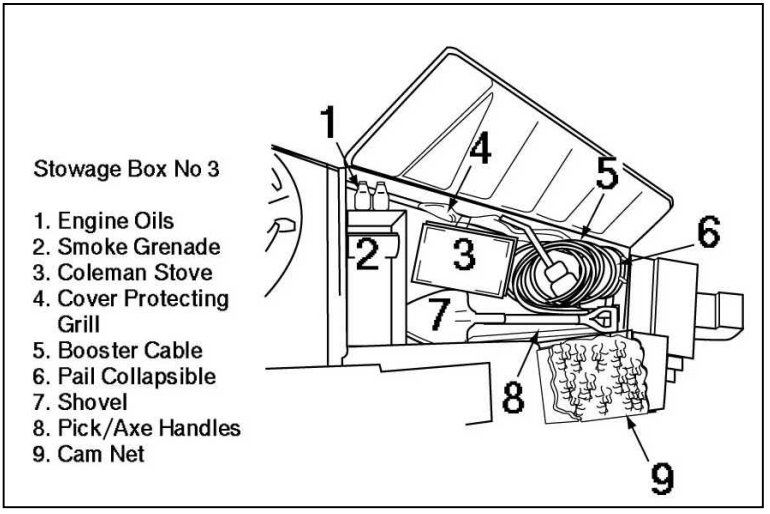


Figure 4-C-8: Stowage Box No. 3

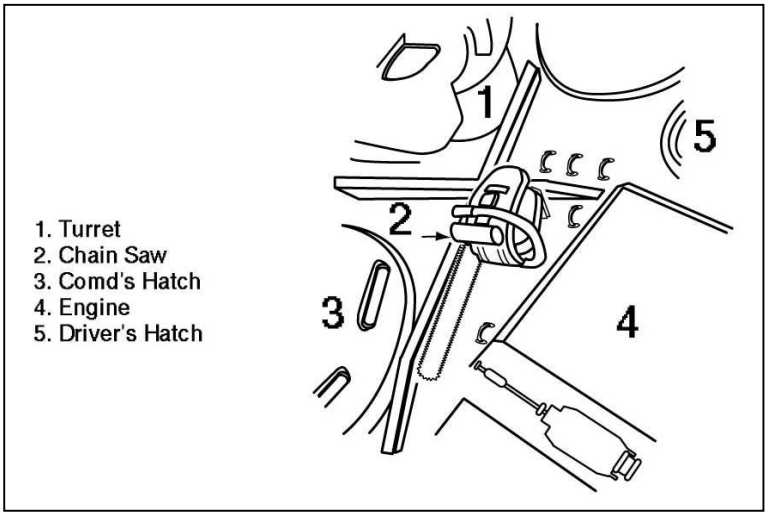


Figure 4-C-9: Chain Saw Stowage Location

ANNEX D
PERFORMANCE OBJECTIVE
M113A2 TUA MOUNTING/DISMOUNTING DRILLS

PART I

STUDENT'S

INSTRUCTOR'S NAME_____

DATE _____

GRADING_____

PART II

	MOUNTING			DISMOUNTING			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
1. **ORDER OF MARCH AND EQUIPMENT CARRIED BY DETACHMENT** a. No. 1 carries the tripod, optical sight (OSS) and thermal imagery (TI) sight battery power conditioner spare battery pack;							

	MOUNTING			DISMOUNTING			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
b. No. 3 carries the traversing unit (TU) and boresight collimator in its protective case;							
c. No. 2 carries the missile guidance set (MGS) and launch tube; and							
d. No. 4 carries the encased missile, TI sight battery power conditioner and the TI sight in its protective case.							
2. **MOUNTING DRILLMOUNTING** a. All detachment personnel will place their components on the ground. No. 4 moves inside the vehicle through the hatch, drops the ramp and then returns to the rear of the vehicle;							
b. No. 1 climbs on top of the vehicle through the crew commander's cupola;							
c. No. 3 places the TU into its mount and assists the No. 2 with the MGS;							Fail if TU is not properly secured in its mount.

	MOUNTING			DISMOUNTING			REMARKS
	IE	E	VE	IE	E	VE	
d. No. 2 places the MGS at the right side of the slip ring and conducts the following:							
(1) installs the MGS power conditioner;							
(2) installs the MGS into the gunner's seat assemble stowage compartment;							
(3) connects the J1 connector;							No. 2 fails if J1 is not properly installed
(4) connects the MGS power conditioner cable;							
(5) turns on the MGS power conditioner;							
e. No. 3 places the MGS cover on top of the vehicle through the crew commanders cupola and turns on the main circuit breaker;							

	MOUNTING			DISMOUNTING			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
f. No. 4 takes the OSS, TI sight, boresight/collimator, TI sight power conditioner, the spare battery case and passes them to the No. 1 on top of the vehicle.							
g. No. 1 passes the OSS to the No. 2 through the turret hatch ensuring that the locking latch is open;							
h. No. 2 correctly installs the OSS and ensures it is secured;							Fail if OSS is not properly secured
i. No. 2 ensures the OSS reticle light is off, the focus ring is at +3 and checks the humidity indicator;							
j. No. 1,with the locking latch to the rear, cover off and the coarse collimation control in the proper position, passes the TI sight to the No. 2;							

	MOUNTING			DISMOUNTING			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
k. No. 2 correctly installs the TI sight, ensures it is secured, turned ON and set to NFOV (Narrow Field of View);							Fail if TI sight is not properly secured
l. No. 3 stores the launch tube, the tripod and starts loading the missiles into their stowage racks;							
m. No. 4 assists No. 3 with the missiles and all miscellaneous kit;							
n. No. 1 stows all kit in the proper storage compartment;							
o. No. 2 and No. 3 conduct MGS Self Test and OSS boresight;							Fail if OSS is not properly boresighted
p. No. 1 and No. 2 conduct boresight/collimation of the TI sight;							Fail if not boresighted/ collimated correctly
q. No. 1 and No. 2 remove the boresight/ collimator, place the protective rubber caps on the sights and close and secure the front shield;							

	MOUNTING			DISMOUNTING			REMARKS
	IE	**E**	**VE**	**IE**	**E**	**VE**	
r. When complete, the No. 4 moves to the driver's compartment, the No. 3 sits on the loader's seat and they await further orders;							
s. No. 1 takes the seat in the crew commander's hatch and when all crewmembers are in their proper seats conducts a System Check Out Procedure.							
3. **DISMOUNTING DRILL** a. The word of command to dismount the TOW 2 from the M113A2 TUA is CEASE TRACKING, UNLOAD, DISMOUNT or DISMOUNT. After the No. 2 has locked the turret/shield in the travelling position No. 2 will give the ALL CLEAR. The crew dismounts in the same order, handling the same components with the exception of the No. 4, who is responsible for laying the equipment on the ground in the order of march.							
NOTE Fail if any part not mounted correctly.							

PART III
GENERAL REMARKS

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Instructor's Signature

ANNEX E
PERFORMANCE OBJECTIVE
M113A2 TUA SYSTEMS CHECK-OUT PROCEDURE

PART I

STUDENT'S NAME_____

INSTRUCTOR'S NAME_____

DATE_____

GRADING_____

PART II

	IE	E	VE	REMARKS
1. **CREW COMMANDERS TARGET ACQUISITION SYSTEM (CCTAS) SELF-TEST** a. No. 1 gives the command CCTAS SELF-TEST CHECK;				
b. No 2, 3 and 4 repeats CCTAS SELF-TEST CHECK;				

	IE	E	VE	REMARKS
c. No. 2 prepares for the rotation of the turret by ensuring that no limbs, clothing or equipment will get caught in the turret and reports READY;				
d. No. 3 observes for obstruction around base of turret;				
e. No. 4 observes for obstruction on the deck of the vehicle;				
f. No. 1 upon hearing READY from No. 2, will:				
(1) turn off the turret power;				
(2) hold the position/dimmer switch on the commander's display panel in the UP position;				
(3) turn on the turret power; and				
(4) observe the LED display for error readings.				
g. At this point the LED display will read TEST and the turret will rotate at normal speed on one complete turn, depress, elevate and then zero out. (launchers horizontal, azimuth at 0 mils);				

	IE	E	VE	REMARKS
h. Once the turret has zeroed out, the No. 1 will verify the direction arrows of the LED display by:				
(1) rotating the commmander's cupola one complete non-stop turn in the direction of the azimuth arrows until the azimuth arrows match, ie (</>); and				
(2) No. 1 slowly elevates and depresses the elevation lever and the LED display should read OK.				
i. No. 1 then reports CCTAS SELF-CHECK OK; and				
j. No's 2, 3 and 4 will acknowledge by repeating CCTAS SELF-TEST OK.				
2. **NO FIRE SECTOR CHECK** a. No. 1 gives the command NO FIRE SECTOR CHECK and observes the crew commander's control box;				
b. No. 2 repeats NO FIRE SECTOR CHECK, rotates the turret to 0400 mils on the azimuth scale, and 115 mils on the elevation scale and gives SECTOR ONE;				

	IE	E	VE	REMARKS
c. No. 2 then rotates the turret to 1800 mils and reports, “1800”;				
d. No. 1 reports OK if the DISABLED light remains on during the entire rotation;				
e. No. 2 rotates the turret to 0400 mils on the azimuth scale, and 160 mils on the elevation scale and reports SECTOR TWO;				
f. No. 2 then rotates the turret to 4200 mils and reports, “4200”;				
g. No. 1 reports OK if the DISABLED light remains on during the entire rotation;				
h. No. 2 depresses the front shield to 230 mils on the elevation scale and reports SECTOR THREE;				
i. No.2 rotates the turret to the LEFT to 5800 mils on the azimuth scale and reports “5800”; and				
j. No. 1 reports OK if the DISABLED light remains on during the entire rotation and finally reports NO FIRE SECTOR CHECK OK.				
3. **ARMING CHECK** a. No. 1 gives the command ARMING CHECK and observes the crew commander's control box;				

	IE	E	VE	REMARKS
b. No. 2 repeats ARMING CHECK, arms the right launcher and then reports RIGHT LAUNCHER ARMED to No. 4;				
c. No. 4 ensures the electrical connector in the right launcher is armed and reports OK;				
d. No. 1, upon hearing OK from the No. 4, checks right arming light and reports OK;				
e. No. 2 disarms the right launcher, arms the left and reports LEFT LAUNCHER ARMED;				
f. No. 4 ensures the electrical connector in the left launcher is armed and reports OK;				
g. No. 1, upon hearing OK from the No. 4, checks left arming light and reports ARMING CHECK OK; and				
h. No. 2 disarms the left launcher.				
4. **LOAD POSITION CHECK** a. No. 1 gives the command LOAD POSITION CHECK;				
b. No. 2 repeats LOAD POSITION CHECK, rotates the turret to the load position and reports LOAD POSITION;				

	IE	E	VE	REMARKS
c. No. 3 stands by for the turret to be rotated to the load position. Once No. 3 has identified that the turret is in the load position, No. 3 opens the loader's hatch more than 10mm and reports LOADER'S HATCH OPEN;				
d. No. 1, upon hearing LOADER'S HATCH OPEN, checks the disabled light which should be on and reports DISABLED;				
e. No. 2, upon hearing DISABLED, attempts to elevate and traverse the turret (the turret should not move) and reports NO POWER;				
f. No. 3, upon hearing NO POWER from No. 2, closes the loader's hatch, reports LOADER'S HATCH CLOSED and taps twice on No. 2's leg; and				
g. No's. 1 and 2 repeat LOADERS HATCH CLOSED, the No. 1 checks the ENABLED light which should be on and reports ENABLED, LOAD POSITION CHECK OK.				

	IE	E	VE	REMARKS
5. **COLLIMATION POSITION CHECK** a. No. 1 gives the command COLLIMATION POSITION CHECK;				
b. No. 2 repeats COLLIMATION POSITION CHECK, rotates the turret to the collimation position, reports COLLIMATION POSITION and opens the front shield;				
c. No. 3, upon hearing COLLIMATION POSITION from the No. 2, opens the loader's hatch, ensures the rubber caps are connected and the front shield opens properly;				
d. No. 3 assists in closing the front shield, closes the loader’s hatch, reports LOADER’S HATCH CLOSED and then taps the No. 2 on the leg;				
e. No. 2 rotates the turret to the 6400 mils position, elevates the front shield assembly until the launchers are in the horizontal position and reports COLLIMATION POSITION CHECK OK to the No. 1; and				
f. No. 1 acknowledges COLLIMATION POSITION CHECK OK.				

	IE	E	VE	REMARKS
6. **SMOKE GRENADE LAUNCHER CHECK** a. No. 1 gives the command SMOKE GRENADE LAUNCHER CHECK;				
b. No. 2 repeats SMOKE GRENADE LAUNCHER CHECK, turns on the power to the smoke grenade launcher control box, closes the turret hatch completely, checks to see if red light is on, opens it to the half open position and activates the smoke grenade launcher override switch. The power ON indicator light should come on;				
c. No. 3 upon hearing SMOKE GRENADE LAUNCHER CHECK from No. 2, picks-up the grenade launcher tester, climbs on top of the vehicle and places the tester in the number 1 left aiming launcher and reports LEFT 1;				
d. No. 2 repeats LEFT 1, and activating the override switch, places the selector on the control box to Smoke then presses the left firing switch;				
e. No. 3, when the green light of the grenade launcher test comes on, reports 1 OK and removes the tester from number 1 left aiming launcher;				

	IE	E	VE	REMARKS
f. No. 2 and No. 3 repeat the procedure to test the remaining left aiming launchers and the bank of right aiming launchers. The No. 2 keeps the override switch activated throughout;				
g. No. 3 after the smoke check, places the grenade tester back into the number 1 left aiming launcher to test the fragmentation grenade switches and gives LEFT 1;				
h. No. 2 repeats, LEFT 1, activates the override switch, places the selector switch to the left side on the number 1 position and presses the left firing switch;				
i. No. 3 when the RED LIGHT on the grenade tester comes on, reports 1 OK and removes the grenade tester from the number 1 left aiming launcher;				
j. The No. 2 and No. 3 repeat this procedure to test the remaining left aiming launchers and the bank of right aiming launchers. The No. 2 keeps the override switch activated throughout and changes the selector switch to each launcher in numerical order;				

	IE	E	VE	REMARKS
k. On completion of the smoke grenade launcher check, the No. 2 reports to the No. 1, SMOKE GRENADE LAUNCHER CHECK COMPLETE; and				
l. No. 1 repeats SMOKE GRENADE LAUNCHER CHECK COMPLETE.				
7. SECONDARY ARMAMENT CHECK a. No. 1 cocks the C6, gives the command SECONDARY ARMAMENT CHECK and observes the actuation of the solenoid against the trigger;				
b. No. 2 repeats SECONDARY ARMAMENT CHECK, places the selector switch on the gunner's control box in the secondary armament position, reports FIRING and presses the trigger on the hand controller; and				
c. No. 1 upon hearing FIRING from the No. 2 ensures the solenoid has actuated the trigger on the C6 and reports SECONDARY ARMAMENT CHECK OK, SYSTEM CHECKOUT PROCEDURE COMPLETE.				

PART III
GENERAL REMARKS

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Instructor's Signature

ANNEX F
PERFORMANCE OBJECTIVE
M113A2 TUA DETACHMENT DRILL-LOAD,
TARGET ENGAGEMENT, CEASE TRACKING,
DISENGAGEMENT AND CEASE TRACKING UNLOAD

PART I

STUDENT'S NAME_____

INSTRUCTOR'S NAME_____

DATE _____

GRADING_____

Any safety violation will result in failure of the PO for that crew position.

PART II

	IE	E	VE	REMARKS
1. **LOADING DRILL**: a. **Actions of the No. 1**. Gives the command LOAD or LOAD 2B.				
b. **Actions of the No. 2**. Upon hearing the command LOAD or LOAD 2B, the No. 2:				

	IE	E	VE	REMARKS
(1) ensures turret/shield lock assembly is unlocked;				
(2) ensures trigger cover is lowered;				Safety violation
(3) ensures arming levers are in disarmed position;				
(4) ensures the thermal imagery (TI) sight On/Off/Stby switch is ON, set to WFOV (Wide Field of View), and sets the operator's selectable filter to the Reset/Clear position;				
(5) ensures the main armament switch is ON;				Safety violation
(6) rotates the turret to the loading position; and				
(7) repeats the command LOAD or LOAD 2B over the intercom.				

	IE	E	VE	REMARKS
c. **Actions of the No. 3**. Upon hearing the command LOAD or LOAD 2B from the No. 1, the No. 3 proceeds with the normal preparation of the missile(s). Upon hearing the command LOAD or LOAD 2B from the No. 2, the No. 3:				
(1) checks the loader's light;				
(2) repeats the command LOAD or LOAD 2B;				
(3) opens the loader's hatch and inspects the launcher(s);				
(4) loads the missile(s) as ordered;				Fail if missile(s) are not loaded as ordered.
(5) ensures missile(s) are locked into position by pulling back on the missile(s);				
(6) closes and locks the loader's hatch; and				

	IE	E	VE	REMARKS
(7) taps twice on the No. 2's leg to indicate that the loader's hatch is closed and that the turret can be rotated reports BOTH or LEFT or RIGHT LAUNCHER(S) LOADED and reports which launcher has TOW 2B.				
d. **Actions of the No. 2**. Once the No. 3 has reported the launchers loaded, the No. 2 lowers the launchers on the horizontal plane and reports READY.				
2. **TARGET ENGAGEMENT DRILL**: a. **Actions of the No. 1**. Gives the command TARGET or a fire control order.				
b. **Actions of the No. 2**. Repeats the command TARGET and :				
(1) ensures the TI sight is on WFOV;				
(2) checks that the main armament switch is ON;				Safety violation if he does not check.

	IE	E	VE	REMARKS
(3) presses the automatic target indication switch and repeats fire order;				
(4) if there is no crew commanders target acquisition system (CCTAS) installed, the No. 2 rotates the turret according to the fire control order given by the No. 1.				
c. **Actions of the No. 3**. Upon hearing the command TARGET from the No. 2, the No. 3:				
(1) checks the back blast danger area and reports BACK BLAST;				Safety violation if back blast area not checked.
(2) observes the back blast danger area until the missile is fired.				Safety violation if he fails to continue to check the back blast area.
d. **Actions of the No. 2**. Once in the general area of the target, the No. 2:				
(1) searches for the target in WFOV, places the crosshairs on the target;				

	IE	E	VE	REMARKS
(2) switches to NFOV (Narrow Field of View), focuses and adjusts the sight picture;				Fail if the TI sight is not in NFOV .
(3) acquires the target and reports ON;				
(4) arms the left or right launcher as required and reports ARMING LEFT or ARMING RIGHT;				
(5) raises the trigger cover; and				
(6) upon hearing the command FIRE, the No. 2 fires. (If the No. 1 has already given the FIRE WHEN READY immediately after giving the target indication, then the No. 2 shall fire right after raising the trigger cover.)				
3. **CEASE TRACKING** a. **Actions of the No. 2**. Upon hearing the command CEASE TRACKING from the No. 1, the No. 2:				
(1) lowers the trigger cover;				Safety violation if cover not lowered.

	IE	E	VE	REMARKS
(2) disarms the launcher;				Safety violation if launcher not disarmed.
(3) switches the TI sight to WFOV;				
(4) reports DISARMED, CEASE TRACKING, READY; and				
(5) remains in a firing position, observes the arc of fire and awaits further orders.				
b. **Actions of the No. 3**. Upon hearing READY from the No. 2, the No. 3 stands down from the position of observation and awaits further orders.				
4. **CEASE TRACKING LOAD** a. **Actions of the No. 2**. Upon hearing the command CEASE TRACKING LOAD from the No. 1, the No. 2:				
(1) lowers the trigger cover;				Safety violation if cover is not lowered.
(2) disarms the launcher;				Safety violation if launcher is not disarmed
(3) switches to WFOV;				

	IE	E	VE	REMARKS
(4) rotates the turret to the load position; and				
(5) reports DISARMED, LOAD.				
b. **Actions of the No. 3**. Upon hearing CEASE TRACKING LOAD from the No. 1, the No. 3:				
(1) repeats CEASE TRACKING LOAD; and				
(2) prepares new encased missile(s) to be loaded.				
c. **Actions of the No. 3**. Upon hearing DISARMED, LOAD from the No. 2, the No. 3				
(1) checks the loader's light to ensure it is illuminated;				
(2) unlocks and raises the loader's hatch;				
(3) pulls down and back on the release arm and removes the empty launch container(s) and inspects the launcher(s);				
(4) loads a new encase missile(s);				Fail if wrong missile(s) are loaded.

	IE	E	VE	REMARKS
(5) closes and locks the loader's hatch; and				
(6) taps twice on the No. 2's leg and reports LEFT, RIGHT or BOTH LAUNCHER(S) LOADED.				
d. **Actions of the No. 2**. Upon hearing LEFT, RIGHT or BOTH LAUNCHER(s) LOADED:				
(1) lowers the launchers to the horizontal plane;				
(2) reports READY when completed; and				
(3) observes arcs of fire while awaiting further orders.				
5. **CEASE TRACKING UNLOAD** a. **Action of the No. 2**. Upon hearing CEASE TRACKING UNLOAD, the No. 2:				
(1) ensures trigger cover is lowered;				Safety violation if the cover is not lowered.
(2) disarms the launcher;				Safety violation if the launcher is not disarmed.
(3) switches the TI sight to WFOV;				

	IE	E	VE	REMARKS
(4) switches the TI sight On/Off/Stby switch to OFF;				
(5) rotates the turret to the load position;				
(6) reports DISARMED, CEASE TRACKING UNLOAD; and				
(7) closes the turret shield sight protection unit, remains in position and awaits further orders.				
b. **Actions of the No. 3**: Upon hearing CEASE TRACKING, UNLOAD:				
(1) repeats CEASE TRACKING UNLOAD;				
(2) checks the loader's light to ensure it is illuminated;				
(3) unlocks and raises the loader's hatch;				
(4) pulls down and back on the release arm, removes the empty launch container(s) and inspects the launcher(s);				

	IE	E	VE	REMARKS
(5) closes the loader's hatch;				
(6) taps twice on the No. 2's leg and reports BOTH LAUNCHERS CLEAR;				
(7) replaces the electrical connector and forward handling ring of the encased missile(s) and returns the encased missile(s) to the stowage rack or discards the empty missile(s) casings; and				
(8) awaits further orders.				
c. **Actions of the No. 2**. Upon hearing BOTH LAUNCHERS CLEAR:				
(1) rotates the turret to the travel position; and				
(2) locks the turret/shield locking lever.				

	IE	E	VE	REMARKS
6. **DISENGAGEMENT DRILL**: a. **Actions of No. 2**. Upon hearing the command CEASE TRACKING or CEASE TRACKING LOAD, PREPARE TO MOVE:				Any safety violation that occurs in the performance of the ordered drills will result in a failure.
(1) repeats CEASE TRACKING or CEASE TRACKING LOAD, PREPARE TO MOVE;				
(2) completes drill as ordered; and				
(3) rotates to the travel position.				
b. **Actions of No. 3**. Upon hearing the command CEASE TRACKING or CEASE TRACKING LOAD, PREPARE TO MOVE:				
(1) repeats CEASE TRACKING or CEASE TRACKING LOAD, PREPARE TO MOVE; and				
(2) completes the drill as ordered.				

PART III
GENERAL REMARKS

Instructor's Signature

ANNEX G
PERFORMANCE OBJECTIVE
M113A2 TUA MALFUNCTION DRILLS

PART I

STUDENT'S NAME _____

INSTRUCTOR'S NAME_____

DATE_____

GRADING _____

PART II

	IE	E	VE	REMARKS
1. **MISFIRE DRILL**: a. **Actions of the No. 2**. When a misfire occurs, the No 2: (1) reports MISFIRE;				
(2) ensures gunner's control box is on the main armament;				
(3) ensures proper launcher is armed; and				

	IE	E	VE	REMARKS
(4) maintains point of aim.				
b. **Actions of the No. 1**. Upon hearing MISFIRE:				
(1) repeats MISFIRE;				
(2) verifies the proper launcher is illuminated on the crew commander's control box; and				
(3) reports LEFT or RIGHT LAUNCHER ARMED.				
c. **Actions of the No. 3**. Upon hearing the command MISFIRE from the No. 2, the No. 3 repeats MISFIRE and continues to observe the back blast danger area; and				
d. **Actions of the No. 2**. Upon hearing LEFT OR RIGHT LAUNCHER ARMED from the No. 1, the No. 2 presses the trigger.				
2. **MISFIRE CONTINUES**:				
a. **Actions of the No. 2**. If the missile still fails to fire, the No. 2 reports MISFIRE TWO and waits one minute;				

	IE	E	VE	REMARKS
b. **Actions of the No. 1**. Upon hearing MISFIRE TWO from the No. 2, the No. 1 repeats MISFIRE TWO;				
c. **Actions of** the **No. 3**. Upon hearing MISFIRE TWO from the No. 2, the No. 3:				
(1) ensures the missile guidance set (MGS) battery conditioner is ON and the power cable is properly secured;				
(2) ensures the MGS J1 cable is properly secured;				
(3) initiates an MGS self-test to ensure proper electrical flow and that the battery passes; and				
(4) reports MGS PASS or FAIL.				
d. **Actions of the No. 2**. Upon hearing MGS PASS or FAIL from the No. 3, the No. 2 presses the trigger after the one minute wait.				

	IE	E	VE	REMARKS
3. **MISFIRE CONTINUES**: a. **Actions of the No. 2**. If the missile still fails to fire the No. 2 reports MISFIRE THREE;				
b. **Actions of the No. 1**. Upon hearing MISFIRE THREE from the No. 2, the No. 1 repeats MISFIRE THREE;				
c. **Actions of the No. 3**. Upon hearing MISFIRE THREE from the No. 2, the No. 3:				
(1) switches the MGS power conditioner to OFF or disconnects the cable to the J1 connector if a battery assembly is being used; and				
(2) reports POWER DISCONNECTED.				
d. **Actions of the No. 2**. Upon hearing POWER DISCONNECTED from the No. 3, the No. 2:				
(1) lowers the trigger cover;				
(2) disarms the launcher; and				

	IE	E	VE	REMARKS
(3) reports DISARMED.				
e. **Actions of the No. 3**. Upon hearing DISAMED from the No. 2, the No. 3:				
(1) switches the MGS power conditioner to ON or connects the cable to the J1 connector if a battery is being used; and				
(2) reports POWER CONNECTED.				
f. **Actions of the No. 2**. Upon hearing POWER CONNECTED from the No. 3, the No. 2:				
(1) arms the left or right launcher; and				
(2) presses the trigger and fires the missile.				
4. **MISFIRE CONTINUES**:				
a. **Actions of the No. 2**: If the missile still fails to fire the No. 2 reports MISFIRE FOUR and continues to track for one minute;				

	IE	E	VE	REMARKS
b. **Actions of the No. 1**. Upon hearing MISFIRE FOUR from the No. 2, the No. 1 repeats MISFIRE FOUR and waits one minute;				
c. **Actions of the No. 3**. Upon hearing MISFIRE FOUR from the No. 2, the No. 3 repeats MISFIRE FOUR and waits one minute;				
d. **Actions of the No. 2**. After waiting one minute the No. 2 lowers the trigger cover and orders DISCONNECT POWER;				
e. **Actions of the No. 3**. Upon hearing DISCONNECT POWER from the No. 2, the No. 3:				
(1) switches the MGS power conditioner to OFF or disconnects the cable to the J1 connector if a battery assembly is being used; and				
(2) reports POWER DISCONNECTED.				

	IE	E	VE	REMARKS
f. **Actions of the No. 2**. Upon hearing POWER DISCONNECTED from the No. 3, the No. 2:				
(1) disarms the launcher;				
(2) locks the turret/shield lock; and				
(3) reports DISARMED.				
g. **Actions of the No. 1**. Upon hearing DISARMED from the No. 2, the No. 1:				
(1) waits 30 minutes;				
(2) unloads the launcher by standing beside the launcher; and				
(3) passes the encased missile to the No. 3 ensuring it is pointed down range at all times.				
h. **Actions of the No. 3**. After waiting 30 minutes the No. 3:				
(1) stays as close to the vehicle as possible;				

	IE	E	VE	REMARKS
(2) moves to the location where the No. 1 will pass down the encased missile;				
(3) faces the vehicle and receives the encased missile ensuring it is pointed down range at all times;				
(4) steps back and lowers the encased missile to the ground;				
(5) steps over the encased missile and turns about; and				
(6) raises the missile and carries it a safe distance ensuring that it is pointed in a safe direction at all times.				

PART III
GENERAL REMARKS

Instructor's Signature

ANNEX H
PERFORMANCE OBJECTIVE
SMOKE GRENADE MISFIRE DRILLS

PART I

STUDENT'S NAME_____

INSTRUCTOR'S NAME _____

DATE _____

GRADING_____

PART II

	IE	E	VE	REMARKS
1. **ALL SMOKE GRENADES IN A BANK FAIL TO EJECT**: a. Actions of the No. 2:				
(1) checks the selector switch on the smoke grenade control box is set to SMOKE;				

	IE	E	VE	REMARKS
(2) ensures that the On/Off switch on the smoke grenade control box is ON;				
(3) if the RED indicator light is not ON checks:				
(a) the top circuit breaker on the battery isolator; and				
(b) the 6.5 amp fuse on the grenade launcher control box;				
(4) attempts to fire the bank; and				
(5) if the grenades fail to eject:				
(a) switches the On/Off switch to OFF;				
(b) WAITS 10 MINUTES;				
(c) unloads;				
(d) reports to a technician; and				

	IE	E	VE	REMARKS
(e) treats the grenades as MISFIRES until the technician has completed testing and determined the fault.				
2. **ONE SMOKE GRENADE IN A BANK FAILS TO EJECT**: a. Actions of the No. 2:				
(1) switches the On/Off switch to OFF:				
(2) WAITS 10 MINUTES; and				
(3) either:				
(a) loads the grenade in another tube and attempts to fire; or				
(b) unloads and throws by hand.				
3. **A SMOKE GRENADE THROWN BY HAND FAILS TO IGNITE**:				
a. WAIT 10 MINUTES; and				

	IE	E	VE	REMARKS
b. dispose of the smoke grenade in accordance with CFTO C-74-050-005/MS-000 and Range Standing Orders.				

PART III
GENERAL REMARKS

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Instructor's Signature

ANNEX I
PERFORMANCE OBJECTIVE
SECONDARY ARMAMENT DRILLS

PART I

STUDENT'S NAME _____

INSTRUCTOR'S NAME _____

DATE_____

GRADING _____

PART II

	IE	E	VE	REMARKS
1. **LOAD**: a. **Actions of No. 1**. The No. 1 gives the command MG LOAD;				
b. **Actions of No. 2**. Upon hearing the command MG LOAD, the No. 2:				
(1) ensures the trigger cover is lowered;				
(2) ensures the MG fire selector on the gunner's control box is OFF;				

	IE	E	VE	REMARKS
(3) rotates the turret to the load position;				
(4) depresses the launchers to the horizontal position; and				
(5) repeats MG LOAD.				
c. **Actions of No. 1**. Upon hearing the No.2 report MG LOAD, the No. 1:				
(1) places the ammunition box in the mount and secures it;				
(2) opens the feed cover;				
(3) places and holds the belt in the feed cover;				
(4) closes the feed cover; and				
(5) reports MG LOADED.				
2. **READY**: a. **Actions of No. 1**. The No. 1 gives the command READY MG;				
b. **Actions of No. 2**. Upon hearing the command READY MG, the No. 2:				

	IE	E	VE	REMARKS
(1) ensures trigger cover is lowered;				
(2) ensures gunners control box is on main armament;				
(3) rotates the turret to the load position; and				
(4) depresses the launchers to the horizontal position.				
c. **Actions of the No. 1**:				
(1) cocks the MG;				
(2) ensures the cocking handle is forward; and				
(3) reports MG READY.				
d. **Actions of the No. 2**:				
(1) repeats MG READY; and				
(2) awaits further orders.				
3. **FIRING DRILL:** a. **Actions of the No. 1**. The No. 1 gives the order TARGET MG ALIGN;				

	IE	E	VE	REMARKS
b. **Actions of No. 2**. Upon hearing the order TARGET MG ALIGN the No. 2:				
(1) repeats TARGET MG ALIGN;				
(2) aligns and acquires the target;				
(3) switches to secondary armament;				
(4) raises the trigger cover; and				
(5) reports ON.				
c. **Actions of the No. 1**. Gives executive FIRE; and				
d. **Actions of the No. 2**. Engages target.				
4. **MAKE SAFE**:				
a. **Actions of No. 1**. No. 1 gives the order STOP MAKE SAFE;				
b. **Actions of No. 2**. Upon hearing the order STOP MAKE SAFE, the No. 2:				
(1) repeats STOP;				
(2) lowers the trigger cover;				
(3) switches to main armament;				

	IE	E	VE	REMARKS
(4) rotates to the load position;				
(5) depresses the launchers to the horizontal position; and				
(6) reports MAKE SAFE.				
c. **Actions of the No. 1**:				
(1) repeats MAKE SAFE;				
(2) cocks the gun;				
(3) raises the feed cover;				
(4) removes the belt and clears the feed tray;				
(5) lowers the cover;				
(6) hand fires the action;				
(7) raises the feed cover;				
(8) inserts a new belt; and				
(9) lowers the feed cover and reports MG LOADED.				

	IE	E	VE	REMARKS
5. **IMMEDIATE ACTION (IA)**: a. **Actions of No. 2**. When there is a misfire, the No. 2:				
(1) reports MG MISFIRE;				
(2) lowers the trigger cover;				
(3) switches to main armament;				
(4) rotates to the load position;				
(5) depresses the launchers to the horizontal position; and				
(6) reports MG DISARMED.				
b. **Actions of the No. 4**. Moves the vehicle out of direct enemy fire;				
c. **Actions of the No. 1**:				
(1) repeats MG MISFIRE;				
(2) opens crew commander's hatch;				
(3) cocks the MG;				
(4) opens the feed cover;				

	IE	E	VE	REMARKS
(5) clears the feed tray;				
(6) hand fires the MG;				
(7) loads the MG;				
(8) cocks the MG; and				
(9) closes the crew commander's hatch and reports READY.				
d. **Actions of the No. 2**:				
(1) reports READY;				
(2) switches to secondary armament;				
(3) test fires the MG.				
e. **Actions of No. 1**. Directs the vehicle into a firing position; and				
f. **Actions of No. 2**. Re-aims and fires.				
6. **UNLOAD**: a. **Actions of the No. 1**. Gives the command UNLOAD;				
b. **Actions of the No. 2.** Upon hearing the command UNLOAD, the No. 2:				

	IE	E	VE	REMARKS
(1) ensures trigger cover is lowered;				
(2) switches to main armament;				
(3) rotates turret to load position;				
(4) depresses the launchers to the horizontal position; and				
(5) repeats UNLOAD.				
c. **Actions of the No. 1**:				
(1) opens crew commander's hatch;				
(2) cocks MG;				
(3) raises feed cover;				
(4) removes belt and clears feed tray;				
(5) closes feed cover;				
(6) hand fires action;				
(7) removes ammunition box; and				
(8) reports MG CLEAR.				

	IE	E	VE	REMARKS
7. **CHANGE BARREL**: a. **Actions of No. 1 and 2**. Complete the unload sequence as discussed in Section 6 above;				
b. **Actions of the No. 3**. Gives the No. 1 the cool barrel;				
c. Actions of the No. 1:				
(1) cocks the MG;				
(2) replaces the barrel ensuring the gas regulator is properly set;				
(3) allows moving parts to go forward;				
(4) loads;				
(5) readies; and				
(6) gives the hot barrel to the No. 3 for cooling and stowage.				
d. **Actions of the No. 2**. The No. 2 will re-arm, re-aim and fire if the situation dictates.				
8. **MG CAN NOT BE COCKED**: a. Actions of the No. 1:				

	IE	E	VE	REMARKS
(1) pushes cocking handle as far to the rear as possible;				
(2) holds cocking handle and opens feed cover;				
(3) removes belt and clears feed tray;				
(4) closes feed cover;				
(5) completes cocking; and				
(6) completes remainder of IA drill.				
b. **Actions of crew**. Completes IA drill.				
9. **GAS STOPPAGE DRILL**: a. **Actions of the No. 2**. If after applying the IA drill the MG fires a few rounds and stops the No. 2:				
(1) lowers the trigger cover;				
(2) switches to main armament;				
(3) rotates the turret to the load position; and				
(4) reports MG MISFIRE.				

	IE	E	VE	REMARKS
b. **Actions of the No. 1**:				
(1) repeats MG MISFIRE;				
(2) raises the hatch;				
(3) cocks the MG;				
(4) adjusts the regulator;				
(5) closes the hatch; and				
(6) reports READY.				
c. **Actions of the No. 2**:				
(1) repeats READY;				
(2) switches to secondary armament;				
(3) depresses the launchers to the horizontal position; and				
(4) test fires the MG.				
d. **Actions of Crew**. Complete the IA drills.				

PART III
GENERAL REMARKS

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Instructor's Signature

ANNEX J
CREW COMMANDERS TARGET ACQUISITION SYSTEM (CCTAS) ERROR MESSAGES

ERROR	TEST	DESCRIPTION
E#01	Start-up	AZ. encoder periscope absent/non responding
E#02	Start-up	EL. encoder periscope absent/non-responding
E#03	Start-up	AZ. encoder periscope absent/non-responding EL. encoder periscope absent/non-responding
E#04	Start-up	AZ. encoder turret absent/non-responding
E#05	Start-up	AZ. encoder periscope absent/non-responding AZ. encoder turret absent/non-responding
E#06	Start-up	EL. encoder periscope absent/non-responding AZ. encoder turret absent/non-responding
E#07	Start-up	AZ. encoder periscope absent/non-responding EL. encoder periscope absent/non-responding AZ. encoder turret absent/non-responding
E#08	Start-up	EL. encoder turret absent/non-responding
E#09	Start-up	AZ. encoder periscope absent/non-responding EL. encoder turret absent/non-responding

ERROR	TEST	DESCRIPTION
E#10	Start-up	EL. encoder periscope absent/non-responding EL. encoder turret absent/non-responding
E#11	Start-up	AZ. encoder periscope absent/non-responding EL. encoder periscope absent/non-responding EL. encoder turret absent/non-responding
E#12	Start-up	AZ. encoder turret absent/non-responding EL. encoder turret absent/non-responding
E#13	Start-up	AZ. encoder periscope absent/non-responding AZ. encoder turret absent/non-responding EL. encoder turret absent/non-responding
E#14	Start-up	EL. encoder periscope absent/non-responding AZ. encoder turret absent/non-responding EL. encoder turret absent/non-responding
E#15	Start-up	AZ. encoder periscope absent/non-responding EL. encoder periscope absent/non-responding AZ. encoder turret absent/non-responding EL. encoder turret absent/non-responding

ERROR	TEST	DESCRIPTION
E#18	Start-up	Communication error. No contact with gunner's control panel (GCP) established. (Timeout error: More than 3 seconds without any answer from GCP).
E#21	AZ CCW	Wrong telegram type received from GCP. (Telegram type should be 3).
E#28	AZ CCW	Turret does not move. (Timeout error: More than 3 seconds without answer from turret).
E#31	AZ CCW	Encoder segment missing. (Difference between two neighbouring sectors is more than one).
E#32	AZ CCW	Too large an encoder segment. (Timer exceeding 255).
E#33	AZ CCW	Too large an encoder segment. (Timer higher than 130).
E#34	AZ CCW	Too small an encoder segment. (Timer lower than 25).
E#35	AZ CCW	Wrong telegram type received from turret. (Telegram type should be 3).
E#38	AZ CCW	No motion in turret. (Timeout error: More than 3 seconds without answer from turret).
E#41	AZ CW	Wrong telegram type received from turret. (Telegram type should be 4).
E#48	AZ CW	No motion in turret. (Timeout error: More than 3 seconds without answer from turret).
E#51	AZ CW	Encoder segment missing. (Difference between two neighbouring sectors is more than one).

ERROR	TEST	DESCRIPTION
E#55	AZ CW	Wrong telegram type received from turret. (Telegram type should be 4).
E#58	AZ CW	No motion in turret. (Timeout error: More than 3 seconds without answer from turret).
E#61	EL DWN	Encoder segment missing. (Difference between two neighbouring sectors is more than one).
E#65	EL DWN	Wrong telegram type received from turret. (Telegram type should be 3).
E#68	EL DWN	No motion of launchers. (Timeout error: More than 3 seconds without answer from turret).
E#71	EL UP	Wrong telegram type received from turret. (Telegram type should be 6).
E#78	EL UP	No motion of launchers. (Timeout error: More than 3 seconds without answer from turret).
E#81	EL UP	Encoder segment missing. (Difference between two neighbouring sectors is more than one).
E#82	EL UP	Too large an encoder segment. (Timer higher than 255).
E#83	EL UP	Too large an encoder segment. (Timer higher than 190).
E#84	EL UP	Too large an encoder segment. (Timer lower than 35).
E#85	EL UP	Wrong telegram type received from turret. (Telegram type should be 6).

ERROR	TEST	DESCRIPTION
E#88	EL UP	No motion in turret. (Timeout error: More than 3 seconds without answer from turret).
E#90	AZ CW (per)	Timeout error. No motion of periscope in azimuth clockwise direction within 30 seconds.
E#91	AZ CW (per)	Encoder segment missing in azimuth periscope encoder. Difference between two neighbouring sectors is more than 1.
E#93	EL UP (per)	Timeout error. No motion of periscope in elevation upwards direction within 30 seconds.
E#95	EL UP (per)	Encoder segment missing in elevation periscope encoder. Difference between two neighbouring sectors is more than 1.
E#97	EL DWN (per)	Timeout error. No motion of periscope in elevation downwards direction within 30 seconds.
E#99	EL DWN (per)	Encoder segment missing in elevation periscope encoder. Difference between two neighbouring sectors is more than 1.

NOTE

There is also a (single) run-time error message: if the data transfer between the two microprocessors is interrupted, the affected display(s) will read IKKE DATA. This is Norwegian, and means NO DATA or communication error.

ANNEX K
SECONDARY ARMAMENT BORESIGHTING CHART

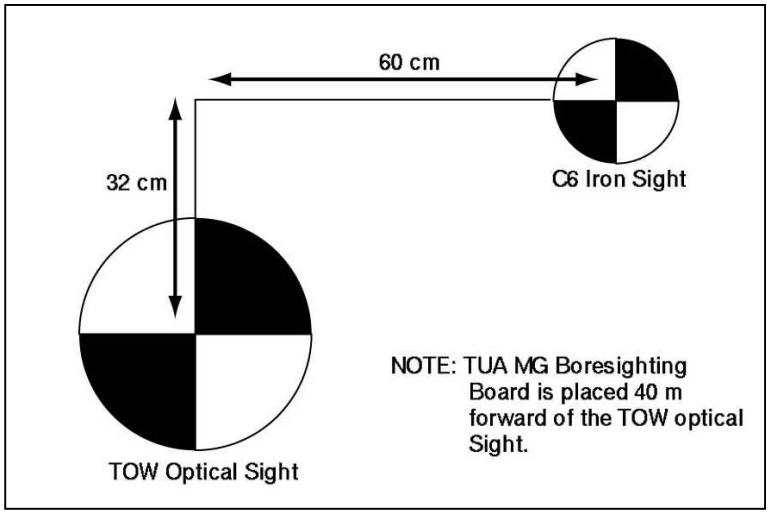

Figure 4-K-1: Secondary Armament Boresighting Chart

CHAPTER 5
TOW AMMUNITION

LESSON 1
TYPES OF MISSILES AND OPERATION OF THE TOW 2

INSTRUCTOR'S NOTES

1. **Aim**. To teach the operations of the TOW 2 to include:

   a. TOW 2 missile components and functions; and

   b. weapon system function (12 steps).

2. **Timing**. Three 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. multimedia projector;

   b. screen;

   c. slides on TOW 2 missile components;

   d. chart on TOW 2 missile components;

   e. hand-outs on TOW 2 missile components and functions;

   f. handouts on launching sequence; and

   g. TOW 2 ground mount complete.

5. **Preparation**. Prior to the start of the first period:

   a. set up the classroom; and

   b. check the slides, hand-outs and charts.

6. **Miscellaneous**. Use a cut-away model of the TOW 2 missile if available.

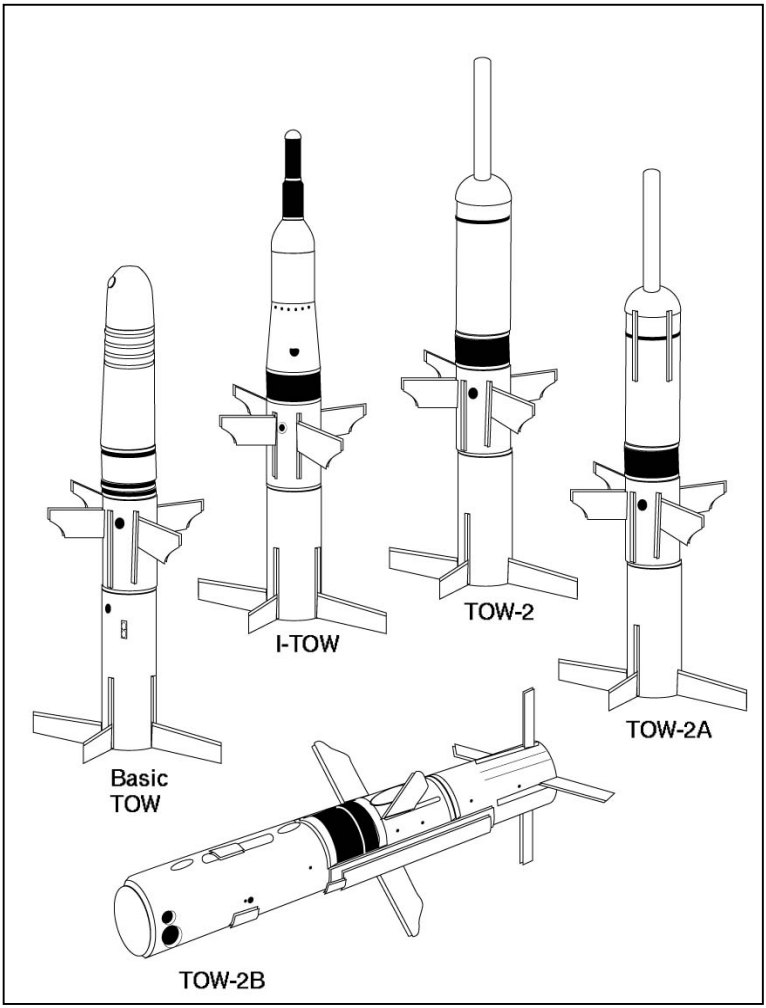

Figure 5-1-1: TOW Missile Types

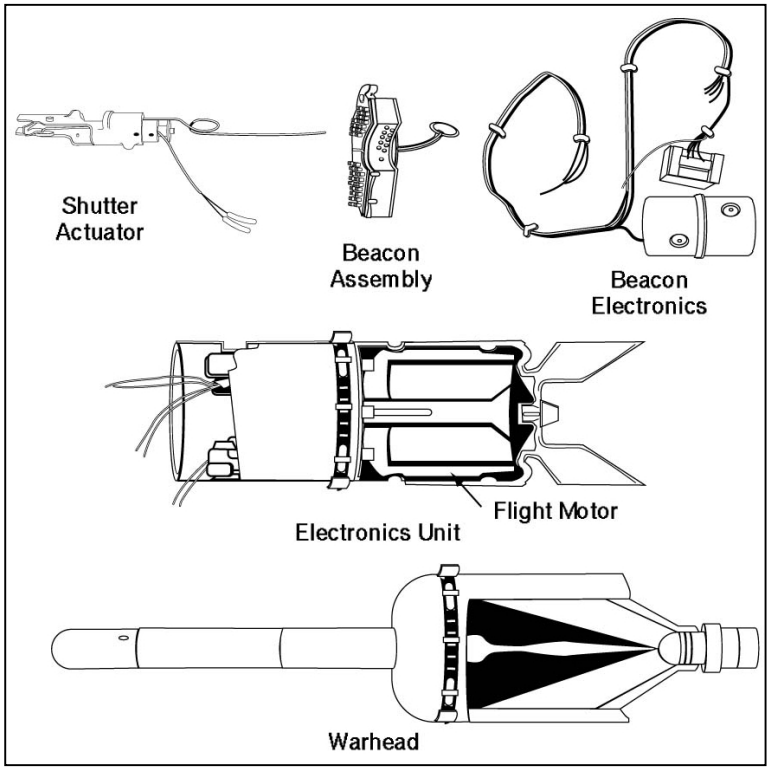

Figure 5-1-2: TOW Missile Components

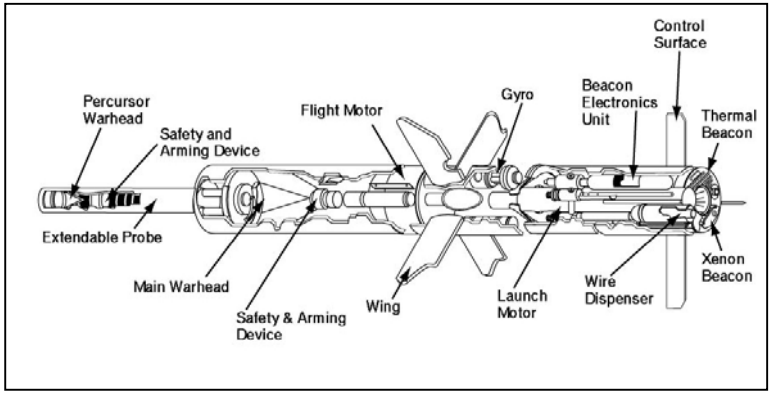

Figure 5-1-3: TOW 2A Missile Components

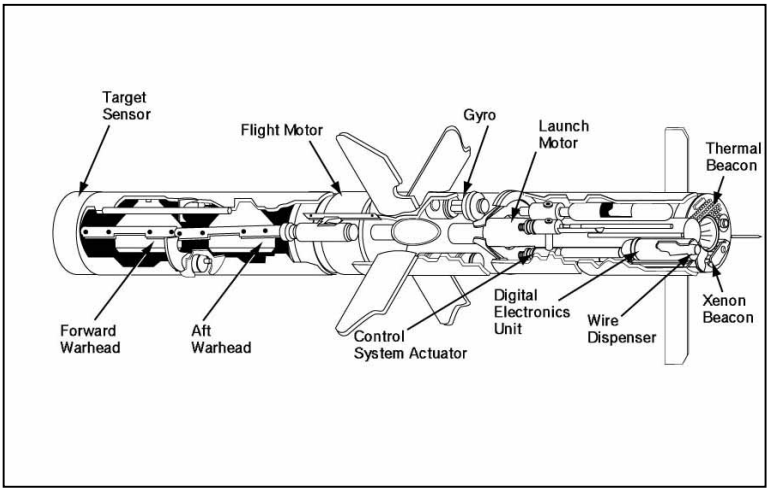

Figure 5-1-4: TOW 2B Missile Components

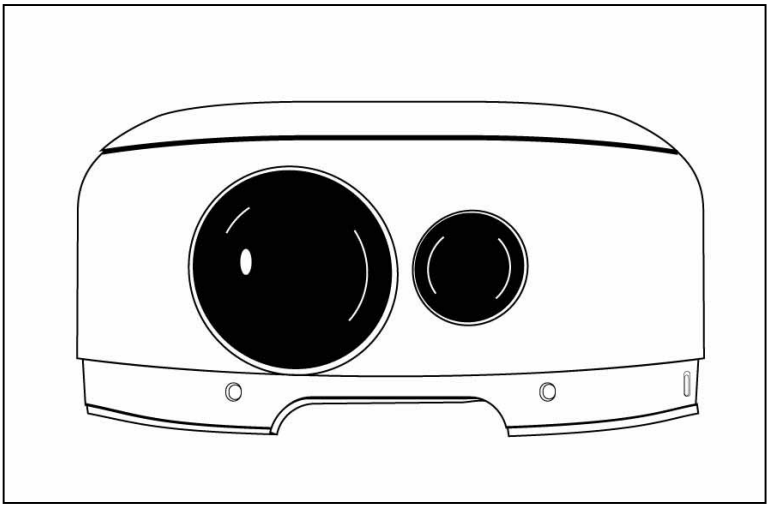

Figure 5-1-5: TOW 2B Sensor Assembly

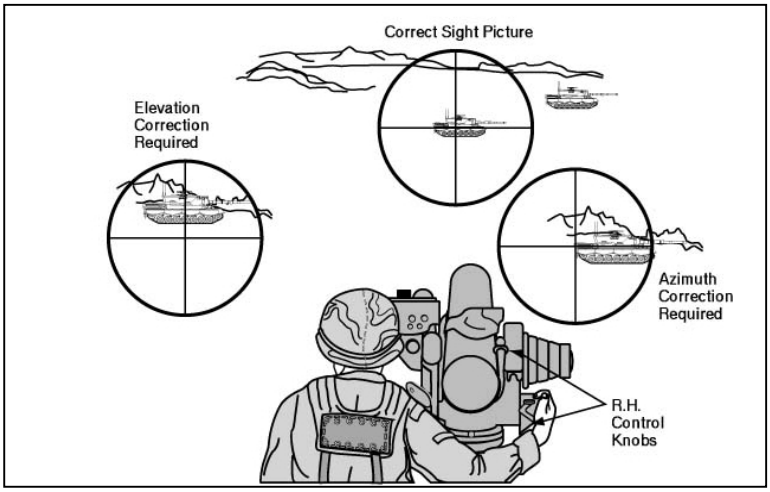

Figure 5-1-6: Gunners Correct Tracking Sight Picture

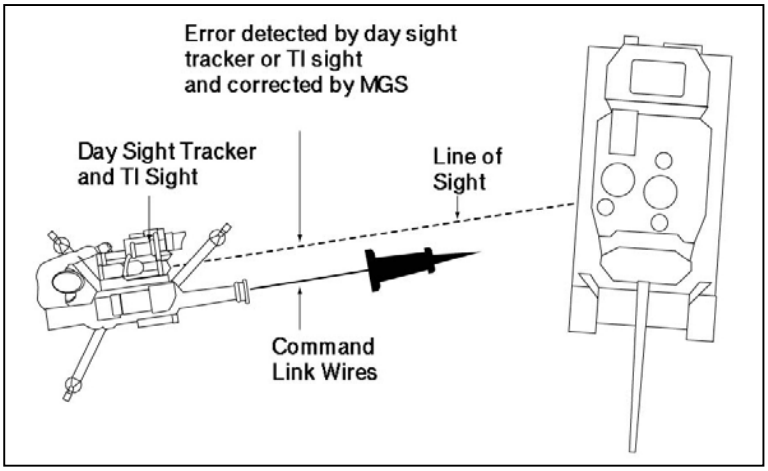

Figure 5-1-7: Guiding Missile to Target

CONDUCT OF THE LESSON

7. **Safety Precautions**. Nil.

8. **Review**. Review the description and functions of the major

components.

9. **Introduction**. To understand the TOW 2 operations there are certain operating procedures and weapon system functions that must be explained. These procedures and functions are detailed in the following paragraphs.

10. **TOW 2 Missile Components** (Figures 5-1-1 to 5-1-5). The following are the main components of the TOW 2 missile:

a. **Warhead**. The sub-assemblies of the warhead are:

(1) the main shaped charge;

(2) the crush switch;

(3) the extendable probe which can also contain an explosive charge and crush switch (TOW 2A); and

(4) sensor assembly (TOW 2B).

b. **Wings and Control Surfaces:**

(1) the wings provide aerodynamic stability and lift;

(2) the control surfaces control the attitude of the missile;

(3) the control surfaces are activated by a simple two-position actuators; and

(4) the electronics unit processes steering and stabilisation commands for the control surfaces.

c. **Propulsion System**. Consists of two components:

(1) **The Launch Motor**. Situated at the rear of the missile, it contains M7 propergol, a

solid fuel. The propellant charge is completely burned before the missile leaves the launch tube.

(2) **The Flight Motor**. Located close to the centre of gravity of the missile, it uses a solid combustible propellant (PNJ or GCV). The propellant burns completely in less than one second. It ignites approximately 7 metres in front of the launch tube and burns out when the missile is approximately 300 metres away.

d. **Command Link Wires**:

(1) Two command wires send the signals from the missile guidance set (MGS) to the missile. If one wire breaks, the correction signals pass via the other wire. The missile flight will be corrected but with reduced efficiency.

(2) The wires are located on two spools in the rear of the missile.

(3) There is at least 3750 metres of wire depending on the type of missile.

e. **Electronics Unit.** It processes steering and stabilisation commands for the control surfaces.

f. **Missile Batteries.** They provide the electrical power to:

(1) missile electronics;

(2) xenon source;

(3) thermal beacons; and

(4) solenoids.

NOTE

The batteries remain chemically inert until the electrolyte is melted by heat pellets, which are ignited when the trigger is pressed.

g. **Infrared Radiators**:

(1) All TOW missiles have a xenon source in the aft end for tracking by the optical sight sensor. The TOW 2, 2A and 2B have a thermal beacon for tracking by the night sight.

(2) Both provide guidance for missile flight by detecting the position of the missile compared to the line of sight.

h. **Xenon Beacon**:

(3) enables the MGS to discriminate between radiation from the xenon source and radiation from other sources, for example the sun, jammers, the target; and

(4) xenon source activated .08 seconds after launch.

i. **Thermal Beacon (Thermal Source):**

(1) The thermal beacon is mechanically shuttered. The MGS provides signals to open and close the shutter to identify the thermal beacon image.

(2) The thermal source is activated in the first 1.5 seconds delay before the missile is launched.

(3) It allows the missile to be guided in smoke, fog and darkness and when

electronic countermeasures are used against it.

j. **Gyroscope**:

(1) provides signals to the control surfaces to keep the missile stabilised during flight; and

(2) the gyroscope is started when the trigger is pressed.

k. **Launch Container**:

(1) The missile case is made of a fibreglass epoxy composite that provides a dry storage environment for the missile.

(2) It protects the missile during handling and acts as an extension of the launch tube to protect the gunner during launch.

(3) It contains a wire harness, which makes all electrical connections between the missile, the electrical connector of the traversing unit (TU) and a shear pin in its high position that keeps the missile in the launch container. Closing the bridge clamp forces the shear pin to a low position where it is sheared off by the thrust of the launch motor.

l. **Hold Back Pin.** The missile is held in place by a two position pin that suspends the missile securely during handling, When the bridge clamp is closed the pin is put in a position of low shear strength.

11. Confirm by questions.

12. **Operating Procedures and Weapon System Functioning**. The operating procedures and the TOW 2 component functioning are described in sequence in the following steps:

a. **Step 1—Performance of the Weapons System Checkout**.

b. **Step 2—Connecting the Weapon System to the Encased Missile**. After the missile has been loaded the No. 3 raises the arming lever on the bridge clamp which lowers the electrical connector, connecting the weapon system to the encased missile.

c. **Step 3—Acquiring and Tracking the Target**. The gunner looks through the thermal imagery (TI) sight and aligns the cross-hairs on the target by applying lateral force to the control knobs to position the cross-hairs in azimuth. Then the gunner rotates the control knobs to align the cross-hairs in elevation (see Figure 5-1-7).

d. **Step 4—Pressing the Trigger**. When the selected target is within range, the No. 2 raises the Trigger Cover and presses the trigger delivering a signal through the coiled cord to the MGS thus, activating the weapon system's electronics.

e. **Step 5—Activation of the Missile Batteries and Gyro**. The MGS generates a signal that is delivered through the coiled cord to the missile batteries to trigger the release of gas. This causes the missile's gyro to rotate and come up to speed.

f. **Step 6—Firing of the Launch Motor**. About 1.49 seconds after delivery of the trigger signal, the MGS generates the firing signal, which activates the missile's launch motor.

g. **Step 7—Launching of the Missile**. The missile launch motor propellant burns for approximately 0.05 seconds. It ejects the missile from the launch container and gives it sufficient momentum to be propelled more than 12 metres beyond the end of the launcher.

h. **Step 8—Extension of the Missile Wings and Control Surfaces**. As the missile leaves the end of the launcher, approximately 2 to 3 metres out, the wings and controls surfaces extend for in-flight control; at the same time the probe is mechanically extended. At this time, two switches (#2 and #4) in the flight motor ignition circuit close and complete the circuit to the flight motor and to the piston actuator in the safety and arming device. This completes the first stage of the Warhead Arming Sequence.

i. **Step 9—Initiation of Missile Control**. The thermal beacon and the xenon beacon on the missile are operating at this time. As the missile proceeds towards the target, the two command-link wires are dispensed from the internal wire dispensers.

j. **Step 10—Activation of the Flight Motor**. When the number 2 and 4 wings are fully extended, the 65 m/s delay relay is closed and allows the flight motor to be fired at about 6 metres from the launch tube.

k. **Step 11—Accomplishment of the Second Stage of Arming Sequence**. The safety arming device unlock function occurs due to the acceleration of the flight motor, between 14 and 19Gs acceleration. This occurs when the missile is 63 to 65 metres from the launch tube.

l. **Step 12—Guiding the Missile to the Target**. The No. 2 maintains the optical or thermal sight on the target using the control knobs. While the gunner does this, the signals from the optical and TI sight are sent to the MGS. The MGS uses the signals from the optical and TI sights, depending on the presence of fog, smoke, etc., and corrects the missile's direction of flight.

13. Confirm by questions.

14. **TOW 2B**:

a. **Flight Path**. The TOW 2B missile flies 2.25 metres above the line of sight (LOS). It takes the missile 200 metres to reach this flight profile.

b. **Arming**. TOW 2B arms at 100 to 200 metres downrange while all other TOW missiles arm at 65 metres.

c. **Sensing Height**. The maximum distance a TOW 2B can sense a target is 4.5 metres.

d. **Missile Weight**. TOW 2B weight is 29 kilograms or roughly 1 kilogram heavier than TOW 2A.

e. **Sensor Operation** (Figure 5-1-5):

(1) **Laser**. The TOW 2B uses a laser to measure the distance to the ground, this occurs every few inches during missile flight. This enables the missile to pick up a profile of the ground similar to a depth sounder on a boat. The height differential created by an AFV will satisfy one of the two sensors required to detonate the warhead. To achieve this, the missile computer runs four logic models or target profiles which are used for identification from any direction. They are as follows:

(a) MBT (warheads will fire into turret);

(b) APC (small or no turret);

(c) turret (dug in MBT, then back filled with earth so even from the top only the turret is visible); and

(d) smoke (if you can see a target

though the smoke so can the TOW 2B).

(2) **Magnetic Anomaly Detector (MAD)**. The second sensor array on the missile is a MAD, which senses disruptions in the earth's magnetic field created by large pieces of metal (AFVs). The MAD and the logic model described above must both agree that a target is present in order to fire the warheads. The target must be bigger than a Jeep. An ogive crush switch located around the nose of the warhead similar to the one employed on the TOW 2 and 2A missiles will detonate if the missile hits hard cover (minimum 1 cm of steel).

f. **Safety and Arming Device (SAD)**. This does not arm until .9 seconds into the missile's flight. During this time the SAD checks the crush switch for any damage. If damaged, the SAD will deactivate the crush switch which will prevent the possibly of an "air burst" when the missile arms. Before the SAD fires the main warheads, it fires a small charge to open a "window" for the main charges.

g. **Warheads**. The two TOW 2B warheads are 5 inch Explosively Formed Projectiles (EFP). The first projectile points down to the ground at 90 degrees while the second is offset 6 degrees from the first warhead. Both fire at the same time allowing the penetrators to impact a maximum of 1 metre apart. This gives TOW 2B a high probability of hitting ammunition, fuel or the crew.

h. **EFP and HEAT Warheads**. These are shaped charges, however EFP uses a shallow hemispherical cone. When the HE detonates in the warhead it transforms the cone into a solid slug or penetrator (like an APDS tank round). An EFP

penetrator travels at about 2000 m/s as opposed to a HEAT jet, which travels at about 8000 m/s. An EFP will not penetrate as much armour as a HEAT warhead (TOW 2B penetrates 230 mm whereas TOW 2A penetrates about 1200 mm).

i. **Training**. There is no extra training required to fire TOW 2B vice TOW 2A. THE GUNNER MUST MAINTAIN THE SAME POINT OF AIM AS WITH ALL OTHER TOW MISSILES. This is to avoid the gunner getting the Point of Aim (POA) mixed-up during combat. The POA for a TOW gunner is the same as a rifleman, centre of the visible mass. The gunner should also notice less launch obscuration due to the higher flight path of the TOW 2B missile.

j. **Firing TOW 2B**. The TI sight MUST BE ON and the RANGE FOCUS must be correct. This is due to the fact that the missile will fly out of the field of view (FOV) of the IR tracker when the day sight tracker switches from wide to narrow FOV at 2 seconds (1.76 seconds for all other TOW missiles). At this point, the Post Amplifier (PA) on the night sight will track the missile and then hand it back over to the IR tracker (if jamming is not present) as the missile moves back into the FOV. As with all TOW missiles the TI sight must be in focus to allow the PA to track the missile.

k. **ERA**. TOW 2B has been tested on the newest generation of ERA Granite and Pill Armour, neither of which could defeat the warhead's penetration. The warhead also produces much more shrapnel due to the steel casings. This gives TOW 2B more potential to inflict casualties on dismounted personnel near the target.

l. **Duds**. If a TOW 2B missile grounds out it will probably produce a dud. Markings are on the missile to indicate the direction of the warhead for destruction.

m. **Counter Measures**. During tests in the United States many different means were tried to deceive the TOW 2B such as:

(1) cam nets both on the MBT and domed over it;

(2) brush placed all over the vehicle;

(3) placing “space blankets” over the vehicle; and

(4) placing a laser in a position to jam the missile.

The results were conclusive in so far as the missile was not fooled in any of the above circumstances.

15. **Missile Selection**:

a. The TOW 2B should be used if:

(1) The target is partially to fully obscured or it is likely to move into a hull down position while the missile is airborne.

(2) There is doubt the direct attack missile (TOW 2A) is capable of penetrating the MBT (i.e. head on attack of an M-1, a Challenger, or a Leopard-2).

b. The TOW 2A should be used if:

(1) Friendly AFVs are in missile path. Do not fire TOW 2B over friendly vehicles as the missile will not differentiate between friend and foe.

(2) Target description does not justify the use of a TOW 2B missile (i.e. BTR-70 in the open).

CONCLUSION

16. Take questions from the class on the entire lesson.

17. Confirm by questions.

18. Pass out the hand-outs.

19. **Summary**. To include the following:

    a. the importance of knowing the operation and functions of the TOW 2 (the 12 steps); and

    b. forecast of the next lesson on this subject.

LESSON 2
TOW MISSILE AND BLAST SIMULATOR HANDLING AND STORAGE

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following details in regards to TOW ammunition components:

   a. TOW missile data;

   b. TOW missile markings;

   c. inspection and storage of TOW missiles; and

   d. inspection and storage of blast simulator.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following training aids are required:

   a. an OHP;

   b. OHP slides on the TOW encased missile data, colour coding and shipment and storage data; and

   c. hand-outs on the TOW encased missile data, colour coding and shipment and storage data.

5. **Preparation.** Prior to the start of the first period:

   a. Set-up the classroom.

   b. Check the slides, hand-outs and lesson plan.

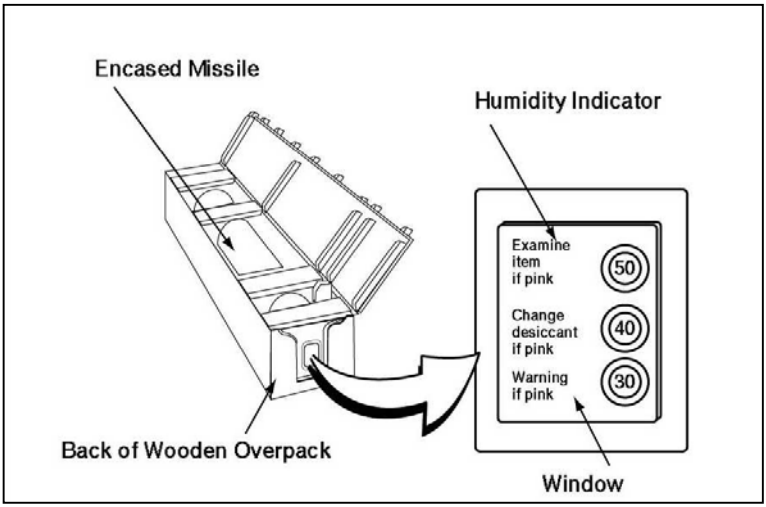

Figure 5-2-1: Wooden Overpack Shipping Container

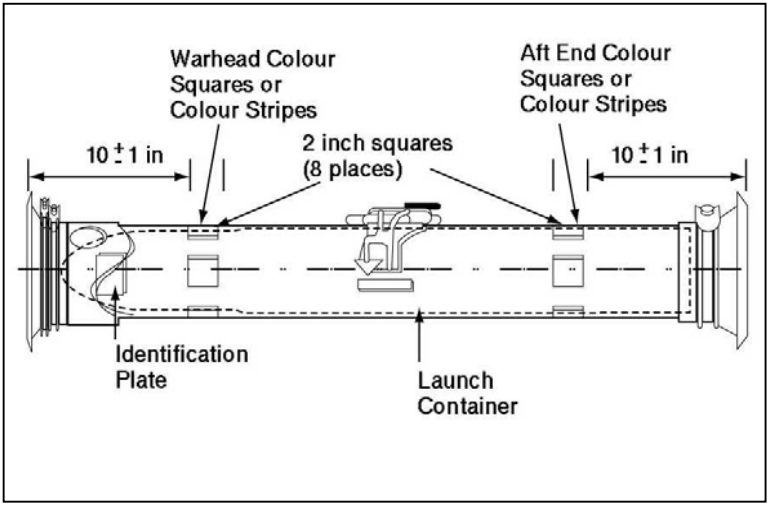

Figure 5-2-2: Location of TOW Encased Missile Identification Plate and Colour Codings

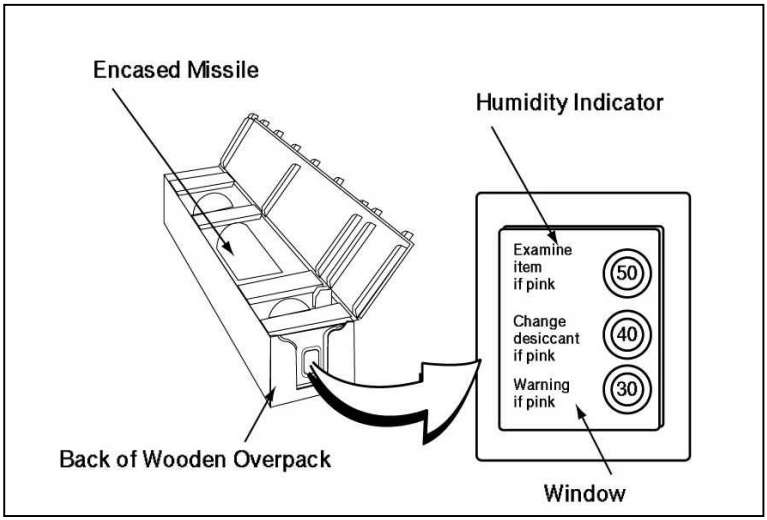

Figure 5-2-3: Step 2—Inspection Upon Receipt of TOW Missile Wooden Overpack Shipping Container

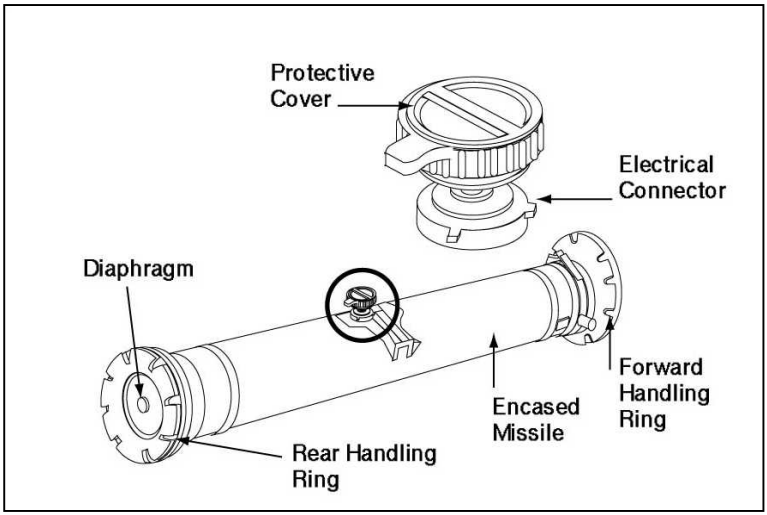

Figure 5-2-4: Step 4—Inspection Upon Receipt of TOW Missile Launch Container

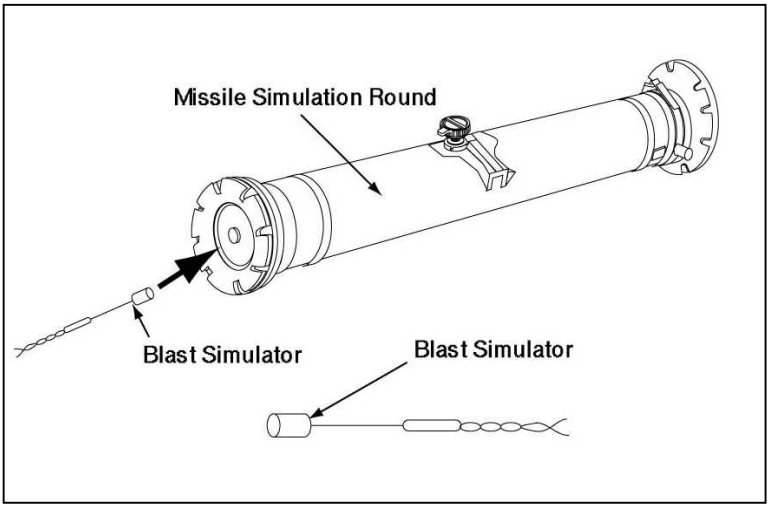

Figure 5-2-5: Blast Simulator

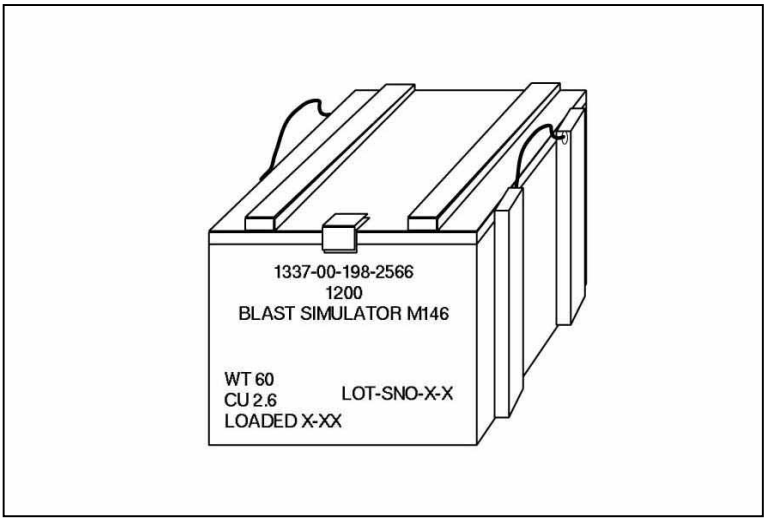

Figure 5-2-6: Blast Simulator Wooden Overpack

CONDUCT OF THE LESSON

6. **Safety Precaution**. NO LIVE ammunition in classroom.

7. **Review**. Review the functions of the missile components.

8. **Introduction**. The TOW missile is constantly being improved upon. At present, there are four types of operational missiles used by Canada. Instructions and precautions given in this lesson are intended specifically for the TOW encased missile, which is a complete round of ammunition. Refer to C-09-153-001/TS-000 for general information concerning handling and storage of ammunition. Observe the following precautions regarding the handling of the TOW encased missile:

a. Do not attempt to remove the missile from the launch container; and

b. Do not handle encased missile roughly or drop it. Damage may occur to motor propellant grain or other components and cause a failure at launch or in flight.

9. **TOW Encased Missile Colour Coding, Shipment and Storage Data**. The TOW encased missiles are normally shipped and stored in wooden overpacks (see Figure 5-2-1) to protect them from shocks caused by being shaken and/or dropped. The overpack contains the encased missile and padding around the missile. The launch container is part of the encased missile and provides protection for it. Take care in handling and moving the encased missile. The TOW encased missile colour coding, shipment and storage data are shown in Figure 5-2-2.

NOTE

The missile packed in the shipping container may or may not be in a moisture-proof bag.

10. Confirm by questions.

11. **Inspection Upon Receipt of TOW Missiles**. The inspection of the encased missile upon receipt by the user unit will be carried out in the following steps:

a. **Step 1**:

(1) Inspect the outside of the wooden overpack to make sure that it is not damaged in any way.

(2) The encased missile in the wooden overpack may be in a plastic bag. If it is in a bag, a humidity indicator is located in the bag and can be seen through the window in the back end of the wooden overpack. If the humidity indicator is blue, Step 1 is finished. If the humidity indicator is pink, remove the plastic bag and throw it away and take the encased missile back to the appropriate ammunition supply area (ASA) as soon as possible.

(3) If the encased missile is not in a plastic bag, the humidity indicator on the back end of the encased missile will be visible through the window in the rear of the wooden overpack. If the humidity indicator is blue, this inspection is finished, go to Step 2. If the humidity indicator is pink, take the encased missile back to the appropriate ammunition supply area (ASA) as soon as possible (see Figure 5-2-3).

b. **Step 2**:

(1) check the markings on the wooden overpack to be sure that the ammunition is identified correctly; and

(2) check the shipping papers to make sure that the ammunition received is what is on the shipping papers.

c. **Step 3**. Check the launch container for proper

markings, identification and colour coding.

d. **Step 4**:

(1) If the encased missile is in a plastic bag, open the bag and remove the missile. Throw away the bag.

CAUTION

Do not break the diaphragm on end of the encased missile. If moisture gets into the launch container, the missile can be damaged.

(2) Check the forward and rear handling rings on the encased missile to make sure they are not damaged (see Figure 5-2-5).

12. Confirm by questions.

13. **Missile Storage**. Missile storage and the regulations regarding the storage, handling and transportation of TOW ammunition are contained in the Explosive Safety Manuals, C-09-153-001/TS-000.

14. The materials used in the manufacture of the TOW missile are susceptible to deterioration by atmospheric conditions. The encased missile may be wrapped in a moisture-proof bag and shipped in a wooden box. The box is fitted with polystyrene pads which provide shock and vibration protection. The launcher container forms part of the encased missile and protects the missile after it is removed from the moisture-proof bag.

15. In the wooden box, the missiles are sufficiently protected to permit storage under the same conditions as other ammunition of a similar nature. In the field, missiles should be protected from the weather, in particular from temperatures below -54°C or above 68°C. Improvised shelters must be provided with whatever materials are available.

16. The self life of an encased missile is 20 years.

17. Confirm by questions.

18. **Temporary Field Storage (Missile)**. For temporary field storage of missiles, the storage area should provide the following facilities:

a. maximum protection against physical damages, deterioration and corrosion;

b. an ambient temperature of -54°C to 68°C;

c. level ground;

d. protection from the elements;

e. adequate drainage; and

f. ease of surveillance.

19. **Storage.** When placed into storage the following points should be considered:

a. the encased missiles are stored in their wooden containers;

b. prior to placing encased missiles in limited storage, an inspection will be performed;

c. encased missiles should be stored with the nose end pointed in the direction in which the missiles would pose the least threat in the event of an accident; and

d. for a semi-permanent storage area the ground (in a 15-metre radius) must be scraped clean.

20. Confirm by questions.

21. **Blast Simulator**. The blast simulator is the only ammunition used with the PGS. It is used with missile simulation rounds (MSR) to simulate the sound of a TOW missile being launched and is electrically fired. Because the sound and blast

effects can not be heard in the TUA, the blast simulator should only be used with the BV 2063 and the ground mount.

22. **Description.** The blast simulator is 1.6 cm long with two 45 cm wires connected to it. It is an explosive mixture made up of potassium perchlorate, aluminium and sulphur (see Figure 5-2-6).

23. **Explosive Content**. Blast simulators contain approx. 3 grams of explosive material.

24. **Handling.** Blast simulators are made to take bumping and jolting safely, and there should pose no problems under normal handling.

DANGER

1. Premature detonation of the Simulator Launch Antitank Guided Missile may be caused by nearby electro-static discharge or electromagnetic interference.

2. Do not use radios in the vicinity of the Simulator Launch Antitank Guided Missile.

3. Keep the two wires of the blast simulator in contact (twisted) with each other until inserted in the MSR .

25. **Overpack Service Upon Receipt**. The following will be checked upon receipt of a blast simulator overpack:

a. check overpack data markings and colour code to make sure the correct type of blast simulators have been received (see Figure 5-2-7);

b. check lead seals on the box to make sure they are not broken; and

c. check surface to make sure there is no holes or damage.

NOTE

1. Overpacks must not be opened until ready for use.

2. If damage or any other irregularities are found, return overpack to the ammunition supply area (ASA) as soon as possible and fill out the proper forms to report the problem. Refer A-GG-040-006/AG-002.

26. Confirm by questions.

CONCLUSION

27. Take questions from class on the entire lesson.

28. Confirm by questions.

29. Pass out the hand-outs.

30. **Summary**. To include the following:

    a. the importance of reporting any damaged ammunition;

    b. the importance of identifying the differences between each type of missile; and

    c. a forecast of the next lesson.

LESSON 3
LOAD/UNLOAD/MALFUNCTION DRILLS USING THE BLAST SIMULATOR

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following drills for the blast simulator:

    a. loading and unloading, and

    b. malfunction.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

    a. complete TOW system one per four students;

    b. dummy blast simulator one per TOW system;

    c. missile simulation round (MSR) one per TOW system; and

    d. hand-outs on the drills one per student.

5. **Preparation**. Check equipment and hand-outs.

6. **Miscellaneous**. Practice by dividing class into four-person detachments for ease of instruction.

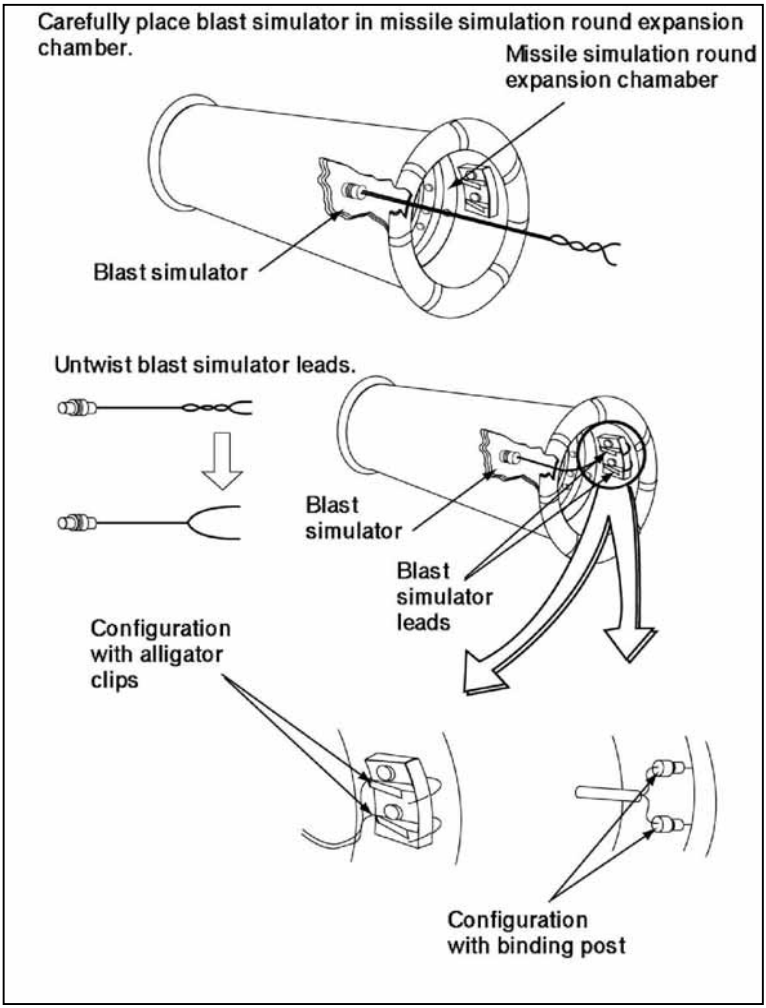

Figure 5-3-1: Blast Simulator Installed in Missile Simulation Round

CONDUCT OF THE LESSON

7. **Safety Precaution**. Before the start of each period the instructor:

a. must check all the dummy blast simulators; and

b. inspect all MSR.

8. **Review**. Review the load and unload drills with the missile.

9. **Loading the Blast Simulator**. Loading of the blast simulator is conducted in the following manner (see Figure 5-3-1):

a. unwrap the electrical leads from around the blast simulator and push it into the MSR expansion chamber; and

b. untwist the electrical leads and connect them to the two spring operated binding post connectors as follows:

(1) push the actuator of the spring operated connector inward, put the exposed metal end of a blast simulator lead into the slot and release the actuator;

(2) make sure the blast simulator lead is firmly attached to the connector by its exposed metal end; and

(3) repeat steps 1 and 2 using the other connector and the remaining electrical lead.

10. **Unloading a Fired Blast Simulator**. To unload a fired blast simulator proceed as follows:

a. disconnect the blast simulator electrical leads from the binding posts by pushing in on the post and withdrawing the leads; and

b. remove the blast simulator residue from the MSR expansion chamber.

WARNING

To avoid injury, the blast simulator leads shall be twisted together (shorted out) before removing a blast simulator from an MSR expansion chamber.

11. Confirm by practice.

12. **Unloading a Live Blast Simulator**. To unload an unfired blast simulator proceed as follows:

a. warn all personnel in the vicinity of the TOW, ensure the danger zone remains clear and the TOW launch tube is not moved from its aiming position;

b. disconnect the blast simulator electrical leads from the binding post by pushing in on the posts and withdrawing the leads; and

c. twist the blast simulator leads together and remove the blast simulator from the MSR expansion chamber.

WARNING

1. The blast simulator used in the operation of this equipment is a pyrotechnic device. The sound level produced by the blast simulator exceeds 140 decibels. To prevent hearing damage all personnel within 4 metres of the TOW must wear hearing protection.

2. Do not operate radio-transmitting equipment in the vicinity of a loaded blast simulator.

3. To avoid injury, the blast simulator leads shall be twisted together (shorted out) before removing the blast simulator from the MSR.

13. Confirm by practice.

14. **Blast Simulator Misfire Procedure**. If a blast simulator fails to fire during a mission sequence, when the mission is over proceed as follows:

a. warn all personnel in the vicinity of the TOW that a misfire has occurred and ensure the firing danger zone remains clear;

b. ensure the TOW launch tube is not moved from its aiming position;

c. ensure the blast simulator leads are not touching metal other than the binding posts;

d. press the TOW trigger and if the blast simulator does not fire wait three minutes;

e. disconnect the blast simulator electric leads from the MSR binding posts and withdraw the leads;

f. twist the leads together and remove the blast simulator from the MSR expansion chamber; and

g. dispose of the defective blast simulator in accordance with Range Standing Orders.

NOTE

If two misfire occur in sequence a first line system check of the equipment should be conducted.

15. Confirm by practice.

CONCLUSION

16. Take questions from class on the entire lesson.

17. Confirm the lesson by practice.

18. **Summary**. To include the following points:

a. the importance of following a proper sequence;

b. always treat the blast simulator the same as a missile; and

c. a forecast of the next lesson.

ANNEX A
MISSILE STORAGE TECHNICAL DATA

SERIAL	EQPT	TOW MISSILE	LOAD LIMIT LB/KG
1.	LSVW	10	
2.	MLVW	54	
3.	M-548	54	
4.	HLVW w/crane	192	
5.	HLVW w/o crane	240	

Table 5-A-1: Characteristics of Wheeled Vehicles

Nomenclature	Guided Missile, Surface Attack, BGM-71A, BGM-71A-1, BGM-71A-2, BGM-71A-3, BGM-71C, BGM-71C-1 or BGM-71D	Guided Missile, Practice (Inert Warhead, Live Motors) BTM-71A, BTM-71A-1, BTM-71A-2 and BTM-71A-3
NATO stock number (NSN)	1410-00-087-1521 (BGM-71A) 1410-01-007-2507 (BGM-71A-1) 1410-01-139-1512 (BGM-71A-2) 1410-01-181-6032 (GBM-71A-3) 1410-01-106-8514 (BGM-71C) 1410-01-180-6790 (BGM-71C-1) 1410-01-135-2092 (BGM-71D)	1410-00-087-1527 (BTM-71A) 1410-01-007-2508 (BTM-71A-1) 1410-01-137-9976 (BTM-71A-2) 1410-01-180-6791 (BTM-71A-3)
Part Number	10189999 (BGM-71A) 11500160 (BGM-71A-1) 13100906 (BGM-71A-2) 13100902 (BGM-71A-3) 13060893 (BGM-71C) 13100900 (BGM-71C-1) 19194422 (BGM-71D)	10190149 (BTM-71A) 11500162 (BTM-71A-1) 13100908 (BTM-71A-2) 13100904 (BTM-71A-3) 13100904 (BTM-71A-3)

Nomenclature	Guided Missile, Surface Attack, BGM-71A, BGM-71A-1, BGM-71A-2, BGM-71A-3, BGM-71C, BGM-71C-1 or BGM-71D	Guided Missile, Practice (Inert Warhead, Live Motors) BTM-71A, BTM-71A-1, BTM-71A-2 and BTM-71A-3
Basic Colour of encased missile	Olive drab	Olive drab
Colour of data markings on encased missile	White or yellow	White
Colour code marking on encased missile back end	Four 2-inch brown squares 90 degrees apart or 2-inch brown stripes	Four 2-inch brown squares 90 degrees apart or 2-inch brown stripes
Colour code marking on encased missile warhead end	Four 2-inch yellow squares 90 degrees apart or 2-inch yellow stripes	Four 2-inch blue squares 90 degrees apart or 2-inch blue stripes
Basic colour of wooden overpack container	Olive drab or unpainted	Olive drab or unpainted
Colour code marking on wooden overpack	Six black 4-inch squares, placed diagonally opposite on top, in upper left-hand corner on sides, and in upper right-hand corner on ends	Six blue 4-inch squares, placed diagonally opposite on top, in upper left-hand corner on sides, and in upper right-hand corner on ends
Colour of data marking on wooden overpack	White or black	White or black
Department of Transport (DOT) marking on wooden overpack	Rocket ammunition with explosive projectile	Rocket motor class A explosive
DOT hazard classification	Class A explosive	Class A explosive
Quantity-distance classification	1.1	1.1
Storage compatibility group	E	C
Storage temperature limit	-53.9 to +68.3 degrees C (-65 to +155 degrees F)	-53.9 to +68.3 degrees C (-65 to +155 degrees F)

Table 5-A-2: TOW Encased Missile Colour Coding, Shipment and Storage Data Chart

BLAST SIMULATOR XM-70

1. **Storage**. Blast simulators are stored in wooden overpacks as an ammunition item. See Table 5A-3 for overpack information.

2. **Packing**. Blast simulators are packed 25 in each cardboard box, four boxes in each barrier bag and 12 barrier bags in each wooden overpack.

NAME	BLAST SIMULATOR OVERPACK
NATO Stock Number (NSN)	1337-00-108-2566
Part Number	8035823
Colour of Overpack	Olive Drab or Unpainted
Overpack Data Marking Colour	White for Olive Drab, Black for Unpainted
Overpack DOTMarkings	–HIGH EXPLOSIVE DANGEROUS
DOT Hazard Classification	CLASS A EXPLOSIVE
Quantity—Distance Classification	7
Storage—ompatibility Group	Q

Table 5-A-3: Overpack Information

CHAPTER 6
THERMAL IMAGERY

LESSON 1
INFRARED TECHNOLOGY OVERVIEW

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following:

    a. thermal imager operations;

    b. environmental affects on thermal imager operations to include:

        (1) clear night performance;

        (2) target cues;

        (3) clutter

        (4) fog; and

        (5) snow;

    c. battlefield obscurants to include;

        (1) diesel fog;

        (2) white phosphorous (WP) smoke; and

        (3) impacting artillery;

    d. thermal imagery countermeasures.

2. **Timing**. Two 40-minute periods.

3. **Method**. A basic instructional period.

4. **Stores**. The following training aids are required:

a. an OHP; and

b. OHP slides.

5. **Preparation**. Prior to the start of the first period:

a. set up the classroom; and

b. check the OHP slides and lesson plan.

6. **Miscellaneous**. Nil.

CONDUCT OF THE LESSON

7. **Safety Precaution**. Normal.

8. **Review**. Review the parts of the thermal imagery (TI) sight.

9. **Introduction**. Thermal imagery allows a TOW gunner to detect, classify and recognise targets at long ranges both day and night. Thermal imagery out performs day optics during periods of adverse weather conditions and at night while maintaining a comparable capability to day optics during daylight operations.

OPERATION

10. Thermal Imaging is a process, which eliminates visible light and allows the observation of electro-magnetic energy in the infrared spectrum. Infrared (IR) energy is produced by a heat source thus it allows us to view any object, which is a source of heat. Early thermal imagers were incapable of detecting the minute thermal differences emitted by distant objects so a non-passive method of projecting thermal energy onto objects was created. This was done by filtering white light through a Germanium lens then using the filtered light to illuminate these objects. The Germanium lens, as seen on some of our older SMP vehicle light clusters, filtered out the white or visible light and only permitted the projection of the IR energy. The downfall of these systems was that the IR source illumination was visible to anyone else who possessed a thermal imager often compromising the location of the observer.

11. As thermal imagers evolved and became more sensitive this active method was no longer required. The Germanium lenses were now incorporated as filters within the thermal imagers with the imager being sensitive enough to detect and process the IR energy being directly emitted by the source.

12. Using the LAV III thermal imager (see Figure 6-1-1) as a model we will trace exactly how a thermal image is received, processed and displayed:

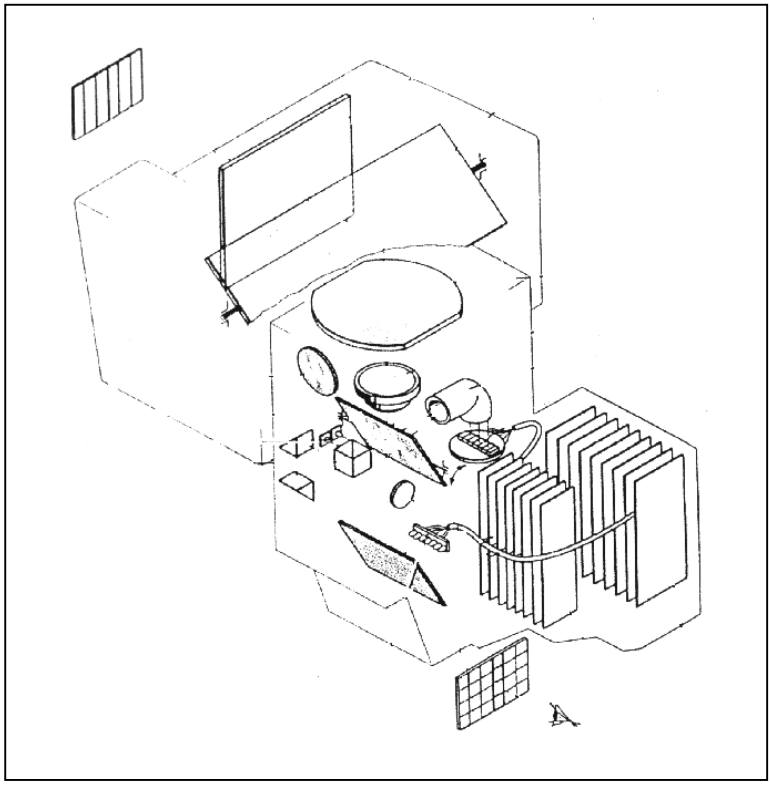

Figure 6-1-1: Schematic of Thermal Imager

a. The IR energy is projected by a Thermal Source.

b. The electromagnetic energy passes through the Thermal Window.

c. The electromagnetic energy is reflected off a Stabilised Mirror, which is stabilised in elevation by a gyro. The same mirror is used to stabilise the image for the day sight.

d. The electromagnetic energy then passes through the Germanium Frontline Lens and the visible light is filtered and the IR light is permitted to pass through.

e. The IR energy is then focused through either a Narrow Field of View (NFOV) or a Wide Field of View (WFOV) Prism System. These are mechanically selected and determine the apparent magnification of the object being viewed.

f. The magnified IR energy is then reflected off a Swinging Mirror. The mirror is swinging 30 times a second for every line being processed by the thermal imager. Thermal imagers all scan lines of images rather than the image as a whole.

g. The IR energy is then focused through the IR Objective Lens which focuses the energy onto the Detector Field.

h. The Detector Field is an electronic device that reacts similar to a film negative. It detects the IR energy and measures the thermal variations and converts the IR energy variations to digital signals. To detect the minute variations in the IR energy the Detector Field must be cooled to 80 Kelvin (0 Kelvin being absolute zero at – 273 degrees Celsius). This is accomplished using a cryogenic pump that compresses an inert gas creating extreme heat. When this gas is sprayed and expands it produces extreme cold. The cryogenic pump keeps re-circulating, compressing and then expanding the gas in the area of the detector field to create the extreme cold required to reach 80 Kelvin.

i. From the Detector Field the digital information is passed through a series of processors in the Pre-activator and the After-Activator which enhance and process the various lines of digital information.

j. From the After-Activator the digital information is sent to Light Diode Field which converts the digital signals for each line of video image to an visible spectrum image as determined by the processors. There is one diode for each line being processed.

k. The visible image is again reflected off the Fixed Mirror to the Swing Mirror where is it reflect to a Split Line of View Prism where the reticle images are superimposed on the visible image.

l. From this point the image is reflected off a series of mirrors and lens to the Viewing Aperture.

13. Confirm by questions.

SOURCES OF IR ENERGY

14. The four principal sources of IR energy in target signatures are listed below:

a. solar heating,

b. fuel combustion,

c. friction; and

d. thermal reflection.

15. **Solar Heat**. Solar heating effects occur mostly on the exterior surface of the body or hull of the targets. This type of heating highlights the target outline and overall shape of the external features. The outline of these features can provide helpful recognition cues to the gunner. The shape cues are usually similar to

the overall visible appearance of the target. These shape cues are recognizable out to medium and long ranges, depending on the IR sight resolution. Since the sides have more defined contours, the side view shapes are generally easier to recognize than the front views. The front view shapes tend to look like lumps. Unfortunately, solar heating as a source for these cues is highly variable, and solar-heated features as IR recognition cues are somewhat unreliable due to variances introduced by surface reflections, weather, atmospheric factors and solar heating changes during the course of the day. In addition to atmospheric variables and surface reflections, the solar heating rate is also affected by the object's ability to absorb sunlight. Generally, dark-colored objects are better absorbers of IR than the light coloured (white) ones.

16. **Fuel Combustion Heat**. Fuel combustion heat originates in operating engines, and is conducted to the surfaces of the surrounding engine compartment. Since engine compartment temperatures reach up to 200 degrees F, the surface of these compartments radiate highly visible features that can be detected through the IR sights, and provide gunners with very reliable cues. Personnel heaters usually operate by tapping engine heat and piping it into personnel spaces within the vehicle. After some time, the heated personnel space is visible in the IR sight. Likewise, engine muffler and exhaust features themselves do not appear highly defined on the IR display. Their outlines are diffuse and blob like. This aspect does not diminish their cue value, however, for the trained gunner can determine much information about the vehicle from these cues. These features are very hot and can be easily detected at extremely long ranges.

17. In addition, the gunner can deduce from the engine and exhaust cues whether the vehicle is a front-engine or rear engine vehicle. If the vehicle is maneuvering sufficiently, the gunner can determine on which vehicle facet the exhaust is located. This is important cue information. Also, if the detected hot spots are moving, the gunner will know that the object is probably a moving vehicle. Sometimes moving animals cause false target detection, usually though, animal signatures can be identified on the basis of their lower heat intensity.

18. To classify and identify IR images accurately, TOW gunners must ask themselves a series of questions about the target.

Among the questions they should ask themselves when long range targets are detected, are the following: Is the target moving?; Where is the engine located?; and Where is the exhaust located? The answers to these and similar questions will help gunners determine whether their targets merits further observation and identification.

19. **Frictional Heat**. Frictional heat is produced by the moving parts of vehicles. This heat is less intense than the high temperatures resulting from the engine combustion. Frictional heat is generated only when the vehicle is in motion. Frictional heating generates sufficient temperatures to provide long-range cues. However, these features usually appear at medium intensity in the thermal sight. The transport systems are the sources of most frictional cues. The track, road wheels, drive sprockets, support rollers, and shock absorbers are the frictionally heated features on the tracked vehicle. Wheeled vehicles generate frictional heat in the tires, shock absorbers, drive shafts, transmissions, axles and differentials, which are all good medium-to-long range detection and recognition cues. Frictionally heated feature cues can be used by the gunner at long range to detect the vehicle and classify it as wheeled or tracked. At medium to short ranges these cues can be used to identify the vehicle.

20. **Reflected Radiance**. Certain smooth, glossy surfaces such as vehicle windshields and glossy painted fenders can reflect IR radiation images impinging on them from other sources. Vehicle windshields, such as those of the trucks, often appear very dark because they reflect the low radiant temperatures of the cold night sky. Similarly, the fenders of the T-62 tank appear very dark due to this thermal reflectance of the cold sky. An overcast sky can cause warmer thermal reflections. The thermal radiance from a fire located next to a glossy painted APC could be reflected off the vehicle's flat side surfaces. Thermal reflections can produce some odd signature effects. The thermal imagery sight user should be aware of this phenomenon, but need not be overly concerned. Only very smooth glossy surfaces are subject to strong reflections. Generally, surface reflections are diffuse in nature and do not usually cause problems.

THERMODYNAMICS OF THE BATTLEFIELD BACKGOUNDS

21. Many of the natural and man made objects on a typical battlefield undergo continual temperature changes that follow important predictable trends. For example, natural background objects such as trees, grass, rocks and earth are heated passively through the absorption of solar energy. Even during overcast days some solar radiation is absorbed. Daily solar heating begins at sunrise, after midday, the sun declines and the background objects begin to cool. After sunset, the objects cool down to approach the temperature of the air. This daily two part heating and cooling cycle is called the diurnal cycle. Thus, an IR background is thermally dynamic.

22. During the diurnal cycle, individual background and target objects heat and cool at different rates. Larger dense objects such as medium sized rocks, tree timber and non-operating armoured targets heat and cool slowly. Lightweight objects, such as grass, tree leaves, bushes and the surface layer of the ground itself, heat and cool quickly. The heavy objects, such as rocks and armoured targets are said to have high thermal mass. Likewise, lightweight objects are said to have low thermal mass.

23. Sometimes the radiated temperature of the target reaches the temperature of the surrounding grass and leaves. Usually, however in sunny day cycles the target does not decrease in temperature to reach the night time background temperature before the sun rises again to restore the heat cycle. As the sun rises, the cool background warms up rapidly to exceed the target temperature. This point where the background temperature passes the target temperature is called diurnal crossover. When the morning crossover occurs, the IR displays the background as brighter than the target and a negative contrast target appears. When the afternoon crossover occurs, the target appears brighter than the background for a positive contrast target. The timing of these crossovers is greatly influenced by environmental factors. Thus, this discussion should only be thought of as a generalization of the diurnal and crossover concepts.

ENVIRONMENTAL EFFECTS

24. **Clear Night Performance**. Thermal imagery on a clear night will permit a gunner to detect targets at extremely long ranges. On a clear night it is common for the temperature of a target to far exceed the background temperatures of foliage and ground. The target heat transmits well through the clear night air and a target is detected which is of potential tactical importance (see Figure 6-1-1).

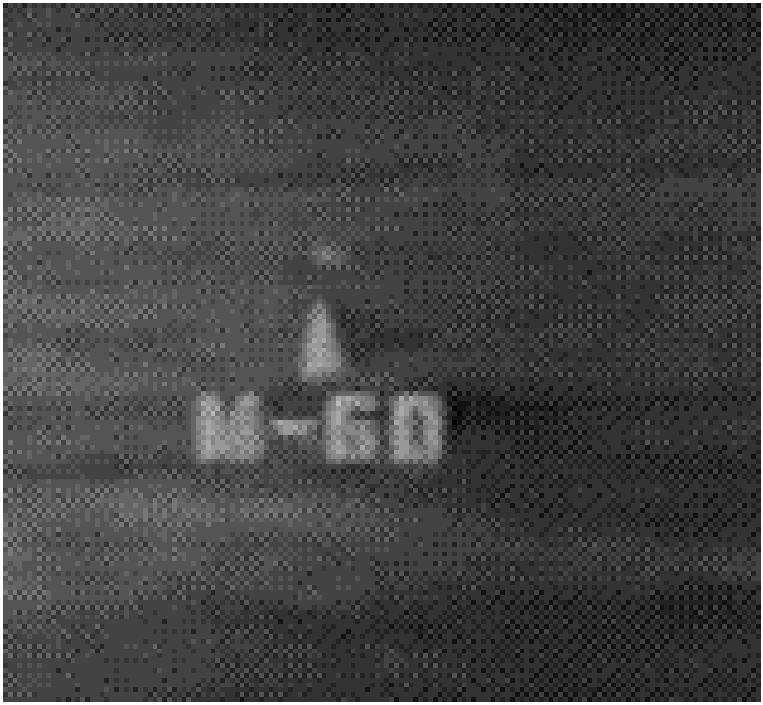

Figure 6-1-2: Tank at 3000 m on Clear Night

25. As the target to observer range decreases the target signature intensifies. The signature of the individual vehicle parts remains merged, even though the image is more distinct. At this range the target is still not recognisable as a tank (see Figure 6-1-2).

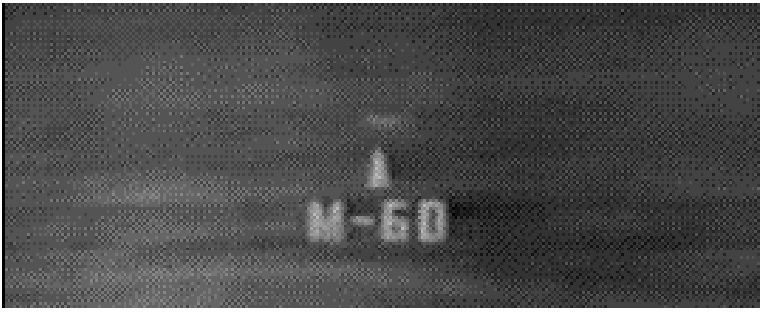

Figure 6-1-3: Tank at 2700 m on Clear Night

26. As the target draws closer (see Figure 6-1-3) the target features begin to emerge. At this range the hot vehicle tracks are perceptible. Faint traces of heat can be seen on the ground behind the vehicle. These are occasional muddy spots that were heated by the hot tracks as the vehicle passed through them.

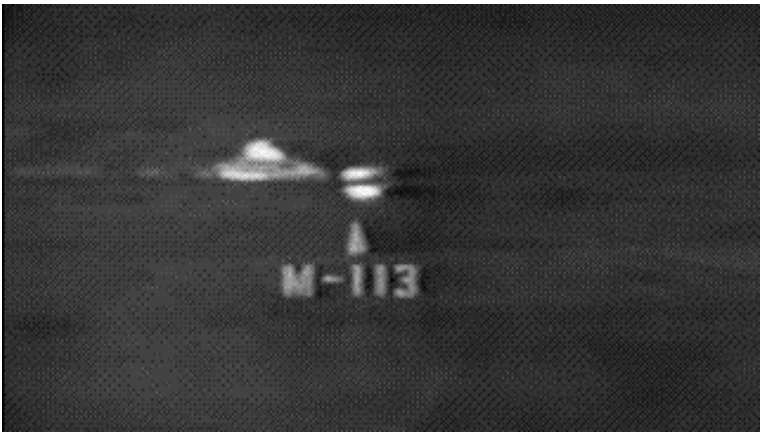

Figure 6-1-4: Tank and APC at 500 m on Clear Night

27. As the tank draws closer, the tracks and turret structure are distinct and the gunner can classify the target as a tank.

28. At close range (see Figure 6-1-4), in clear air, the thermal imager is capable of resolving the vehicle's detail. By becoming familiar with range signatures, a gunner can learn to recognise contacts at maximum tactical ranges.

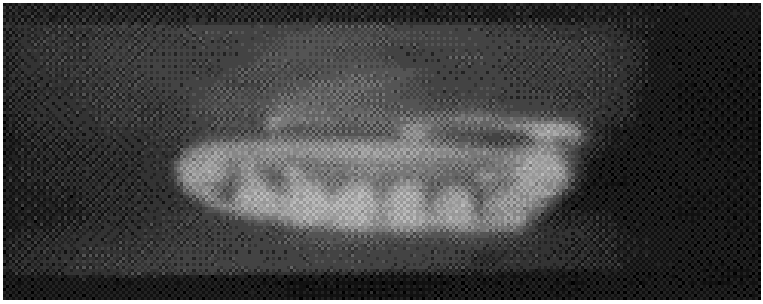

Figure 6-1-5: Tank at 300 m on Clear Night

29. **Target Cues**. Thermal cues are significantly different than visible cues. Note the predominant signature characteristics of the tank are its hot tracks and low profile of the vehicle (see Figure 6-1-4). Other features such as the hull and the turret can also be seen. The visibility of the track cues depends on how much the vehicle has been driven. Under combat conditions the vehicle's mantlet and barrel would be distinct cues if the armament had recently fired. Visibility could also depend on the amount of solar heat the vehicle has absorbed. Generally the tracks are more enduring and reliable cues.

30. Another reliable cue is the hot engine exhaust. In Figure 6-1-5 this is visible over the rear portion of the left track. Since the exhaust arrangement of a T62 and a T72 tank are similar, the same effect will be evident in the most Genforce Main Battle Tanks. Under low visibility or extended ranges the tracks and the exhaust may be all that is visible.

Figure 6-1-6: Side View of T-62 Showing Exhaust

31. Other dominant clues could be the location of personnel (see Figure 6-1-6). The spot in the centre of the left tank is the driver. These are not reliable cues in a tactical scenario. Also note the increase in the target signature caused by the personnel heater. The heater in the vehicle on the right is operating. It is obvious here that the operation of the heater increases the thermal detection and recognition of the vehicle as the ranges increase. It should also be recognised that an extended cooling off period would be required to reduce the thermal signature even after the heater has been turned off.

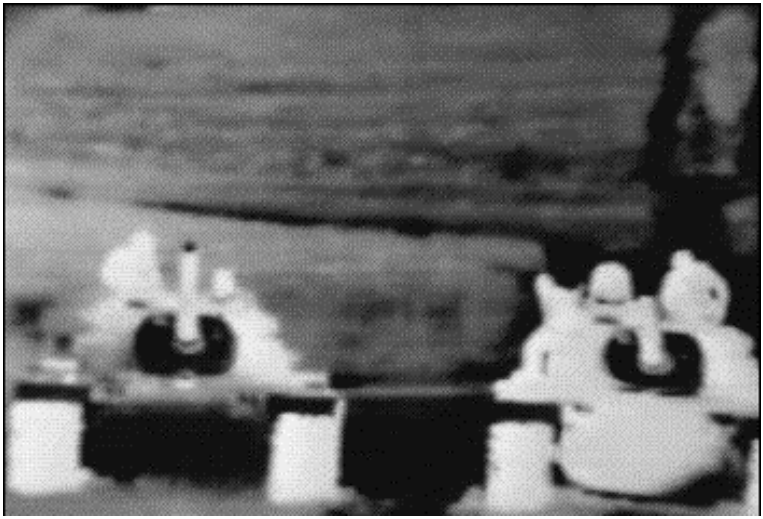

Figure 6-1-7: Personnel Location Thermal Signature

32. **Clutter**. Clutter is simply a term that describes the number of objects in the field of view that resemble targets. These could be warm rocks, patches of dirt, warm craters or any target-like feature. Clutter interferes with target acquisition procedures by increasing search time. This will increase the incidence of false contacts and decrease the detection range.

33. Low clutter represents an ideal target acquisition environment. Background features are suppressed providing high target contrast. In Figure 6-1-7 the target is easily detected at over 4000 metres. Even personnel are detectable at 2700 metres in a low clutter environment. Low clutter is very common in our North American climate and will occur normally under the following conditions:

a. overcast skies;

b. late at night;

c. following a rainy period; and

d. during light fog.

Figure 6-1-8: Target at 4000 m in Low Clutter Environment

34. High clutter makes acquisition of static targets very difficult. High clutter occurs predominantly in mid-afternoon on hot sunny days. In Figure 6-1-8 the three targets in the upper centre of the screen would probably be undetectable unless moving. Motion becomes a dominant cue for detection in a high clutter environment. Both the M60 and the M551 are detectable, but the M48 is still difficult to detect.

Figure 6-1-9: Tanks at 3700 m in High Clutter Environment

35. **Fog**. The severity of fog can be explained in terms of unaided eye visibility ranges. Light to moderate fogs provide visual sight ranges of greater than 1 kilometre. These fogs provide good target acquisition abilities and have no effect on thermal imager range capabilities. Heavy fog limits visual coverage to ranges less than 1 kilometre and imposes severe range limitations on thermal imagers.

36. Light to medium fog is shown in Figure 6-1-9with an M60 tank at 2100 metres in a 3/4 front view. Note the suppressed background and the high target contrast.

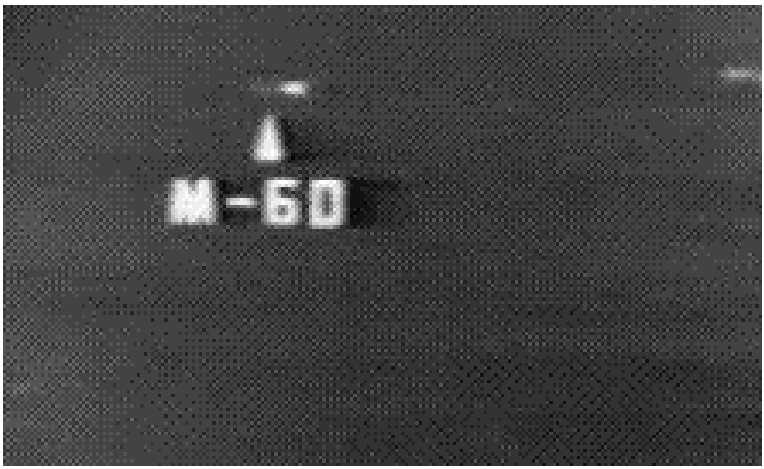

Figure 6-1-10: Tank in Light Fog at 2100 m

37. Figure 6-1-10 shows a tank at three ranges in heavy fog.

The dense fog tends to cool off both the target and the background and blocks transmission along the atmospheric path between the target and the thermal imager. The most common target cues, the tracks, are frequently suppressed under these conditions due to mud and the slow rates of travel. Under such conditions motor noise and radar may be the only cues available to the gunner. Targets tend to pop out of the fog at very close range. At 800 metres the target is no longer visible. If the advancing unit should pass an anti-tank position at close range it will expose a very hot rear view to the observer.

Figure 6-1-11: Tank in Heavy Fog at Various Ranges

38. The following ranges apply to the thermal imager in foggy conditions:

a. If visibility is under 500 metres, the thermal range will equal visual range.

b. If visibility is between 500 and 1000 metres then thermal range will be 1 1/2 to 2 times visual range. A visual range of 600 metres would translate to a thermal range of between 900 to 1200 metres.

c. A visual range over 1000 metres would provide full range thermal coverage and actually create ideal day thermal operating conditions due to the light fog masking the background heating effects and producing little or no clutter.

39. **Snow**. Fallen snow provides a unique background for target acquisition. A cold snow background usually allows a target to be presented in full outline as opposed to just the hot signature elements. Note that the only cool areas that exist are where snow has accumulated on the tracks.

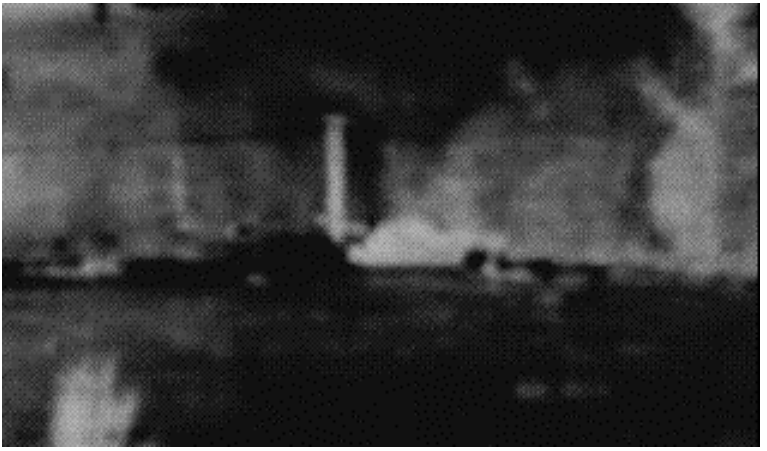

Figure 6-1-12: Tank in Snow at 500 m

40. When snow is falling or blowing it becomes as severe an obscurant as fog. At 800 metres the tank is almost totally obscured. In general falling snow reduces thermal detection to the visual range.

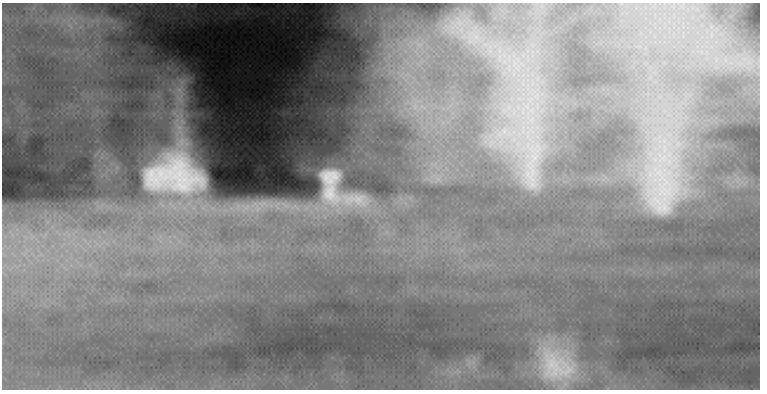

Figure 6-1-13: Tank in Falling Snow at 500 m

BATTLEFIELD OBSCURANTS

41. In a tactical environment the predominant obscurants are:

a. diesel fog

b. white phosphorous (WP) smoke; and

c. impacting artillery rounds.

42. Since the intensity of these obscurants is a tactical variable it is difficult to predict in advance the exact degradation in thermal performance. It is possible to demonstrate the degree of degradation for typically expected concentrations.

43. **Diesel Fog**. Diesel fog (see Figure 6-1-13) acts as a strong obscurant for the optical sight and direct vision, but is a weak obscurant for the thermal imager.

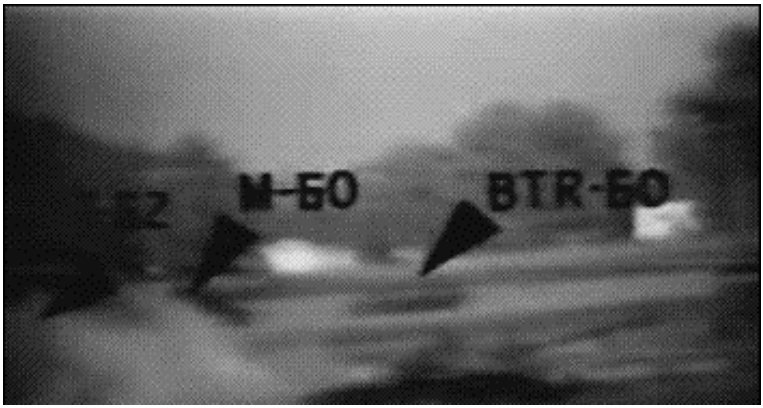

Figure 6-1-14: Example of Diesel Fog

44. **White Phosphorous (WP) Smoke**. WP smoke is a strong obscurant to the optical sight and other day optical devices, and a moderate obscurant for thermal. In high concentrations it is capable of temporarily defeating thermal. One of the unique features of WP smoke is its pyrotechnic effect, generated from its intense heat. Multiple rounds of WP smoke will prolong and intensify the obscuration effect. An M60 appears centre screen in this scene (Figure 6-1-14) as two bright hot tracks. Since there is no appreciable wind, the smoke rises vertically or billows, and as a result, the target is obscured only when a round lands directly between the target and the thermal imager.

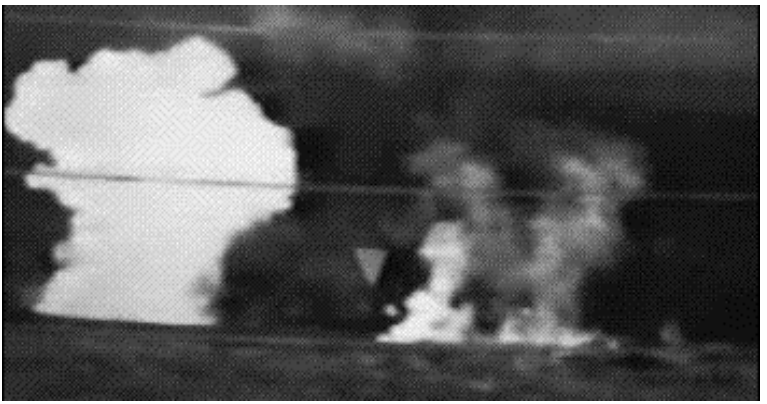

Figure 6-1-15: Example of WP (Tank under Triangle)

45. **Impacting Artillery**. Artillery explosions are common battlefield phenomena. The effect of the dust, smoke and debris from artillery is such that for the optical sight the wall of obscurants produced is almost impenetrable. Thermal disruption occurs primarily in the immediate area of the explosion resulting in temporary loss of contact with the target. Barrages falling near to or directly on a thermal imager obscure the target to a lesser extent than that of a barrage falling between the observer and the target.

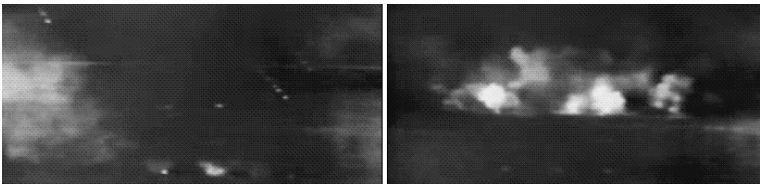

Figure 6-1-16: Effects of Artillery Barrage

46. In Figure 6-1-15 two M60 tanks are 2100 metres from the thermal imager. In the left image an artillery barrage impacts 100 metres from the thermal imager's position. Rounds landing on the side are evident by the flying hot shrapnel and clods of dirt. The target is only obscured when a round lands directly in the field of view. The obscuration is of a shorter time than encountered with WP. In the right image the barrage impacts 1000 metre from the thermal imager. The effects of flash and debris tend to obscure the target for a significantly longer period of time. This barrage and the previous one are of comparable intensity. They demonstrate that

thermal imagery performance is significantly better during close in artillery barrages.

DAY SIGNATURES VERSUS NIGHT SIGNATURES

47. Day thermal target signatures differ greatly from night signatures. This is especially true for sunny days and clear nights. It is less true for overcast or rainy days and nights. The source of the differences is primarily the solar heating effect. As noted above, solar heating generates target shape cues that persist in a helpful way into night operations. However, solar heating makes daytime IR target recognition troublesome.

48. The sun heats targets on warm days to relatively high temperatures. The outer hull does not always heat evenly due to shadowing. The IR reflections during the daytime can also provide spurious hot spots on the vehicle. Another problem in the daytime recognition is the daytime contrast reversal where the background features and other objects become hotter than targets. The negative target contrast combined with the many hot background objects increases scene clutter and target signature variation tremendously. This is especially troublesome from mid-morning through to mid-afternoon. The combination of shadows, reflections and uneven heating can make daytime IR target recognition very difficult and confusing. The many hot background clutter objects make long-range detection extremely hectic. Under these conditions, many hot spots are evident all over the gunner’s display. However, moving targets can be detected at long ranges during hot sunny days with IR. Without the motion, though, many false detections should be expected. Rainy day IR signatures are more consistent with expected target cues. As the rain cools the background, the targets tend to stand out conspicuously. Operating targets on rainy days usually exhibit positive contrast.

THERMAL IMAGERY COUNTERMEASURES

49. Modern AFV's are now starting to deploy thermal countermeasures such as those fitted to the T-90 tank. More information on new thermal imagery counter measures can be found in Anti-Armour Platoon in Battle.

CONCLUSION

50. Take questions from class on the entire lesson.

51. Confirm by questions.

52. **Summary**: To include the following:

    a. The importance of thermal imagers to enable the gunner to use their equipment to gain tactical advantages on the battlefield. Acknowledging battlefield obscurants and the effects of varying weather conditions will aid the commander and the user in knowing what to expect when using thermal imagers on the modern battlefield.

    b. A forecast of the next lesson.

LESSON 2
THERMAL SIGHT CONTROLS

INSTRUCTOR'S NOTES

1. **Aim**. To teach the following:

   a. thermal sight controls; and

   b. use of the Laser Jammer Filter.

2. **Timing**. One 40-minute period.

3. **Method**. A basic instructional period.

4. **Stores**. The following stores and equipment are required:

   a. TOW 2 ground mounted complete;

   b. an OHP; and

   c. a videotape covering TOW operator selectable filter operations.

5. **Preparation**. Prior to the start of the lesson:

   a. set up the classroom; and

   b. check the OHP slides, lesson plan and equipment.

6. **Miscellaneous**. This lesson deals with theory, principles and some hands-on practice; therefore be prepared to move the weapon system and class outside to apply some of the principles.

CONDUCT OF THE LESSON

7. **Safety Precautions**. Normal.

8. **Review**. Review the environmental and battlefield

obscurants as taught in the previous lesson.

9. **Introduction**. Thermal signatures are highly variable. Variations in solar heat, fuel combustion heat, frictional heat and thermal reflectivity affect infrared (IR) signatures and IR target recognition cues. In addition, some atmospheric conditions degrade IR signature performance, while others can actually enhance it. All possible combinations of these factors will not be addressed here, but the general trends in user controls will be discussed.

VIEWER CONTROL COMPENSATION FOR TARGET APPEARANCE VARIABLES

10. A thorough knowledge of the most effective control settings that can help compensate for these variables will greatly enhance the gunner's ability to detect and recognize the target .

IMAGE CONTROLS: CONTRAST, BRIGHTNESS, FOCUS AND IMAGE POLARITY

11. The TOW thermal sight has four controls that allow users to change the image in response to changes in environmental conditions and other variables, they are:

a. contrast;

b. brightness;

c. Field-of-View (FOV); and

d. Range Focus Knob.

12. **Contrast and Brightness Controls**. The following is general guidance for setting the image brightness and contrast controls. The settings given are for the indicated weather and gunner task conditions. Gunners should be encouraged to experiment with the controls. Experimentation will help the gunner better understand the effects of the image controls on the thermal image and thermal signatures, for example using the following settings:

a. **Brightness Low, Contrast Medium to High**. These are good settings for scanning an area in search of targets. Background clutter is suppressed. Only the hotter objects in the field of view will show up, cooler objects will not be visible. When a possible target has been found, brightness can be increased and contrast can be lowered gradually to reveal more thermal detail in the suspected target. Low brightness and medium-to-high settings are also good for IR operations in light fog and rain, or light dust conditions.

b. **Brightness Low to Medium, Contrast Medium**. This is the best overall setting for target detail. With medium contrast, brightness can be varied up and down to bring out features and determine which vehicle parts are the hottest. When brightness is lowered, the cooler parts such as tracks darken before hotter parts. Often very small changes in brightness can reveal much about vehicle detail. For example, road wheels can sometimes be seen at long range if this technique is used. This process is an example of thresholding out the cooler objects to get detail and thermal resolution in the hot features.

c. **Brightness Medium, Contrast Medium to High**. These settings work well in heavy fog or heavy dust when very little can be seen with the TOW. A high-gain setting increases the visual noise in the scene, but it also increases the apparent sensitivity of the sight. The image appears very grainy and is difficult to interpret. However, under the stated atmospheric conditions, this is the best picture that can be obtained. The settings are also good for searching a tree line in very wet conditions. These settings are sometimes useful with long-range targets (2500 metres and beyond). Beyond 2500 metres, small target images, such as the BRDM-2 front view, have so few resolvable features that only the best trained IR operator can see useful target detail. At these ranges the higher contrast setting will highlight the vehicle's

hull and overall silhouette. This will provide no internal detail, but at least it will help the target stand out from the background and will aid in target detection.

13. Confirm by questions and practice.

14. **Focus**. The IR image must be in crisp focus to obtain optimum target acquisition performance, this is done with:

a. **Eyepiece Focus**. The eyepiece focus should be adjusted first. The eyepiece focus is called the diopter adjustment, which allows most nearsighted operators to use the sight without their glasses. TOW gunners with simple nearsightedness can remove their glasses and adjust the eyepiece to provide clear focus. Gunners with an astigmatism must wear their glasses or do the best they can without them. Once trainees know their own diopter correction number, they can dial it on any diopter focus and feel secure that it is correct. As stated above, this diopter focus should be done first, otherwise confusion and loss of confidence in focussing ability may develop in the trainee. Correct diopter adjustment can usually be obtained by focussing the eyepiece such that the reticule appears focussed.

b. **Range Focus**. The second focus on the TOW sight is the range focus. It is made difficult only by the fact that IR heat energy diffuses on objects and does not usually give clear-cut straight lines on which to focus. Thus, the trainee must learn to go through focus again and again by adjusting the control back and forth through the region of best focus. This is most easily done when the IR is aimed at a prominent object. Once the region of best focus is determined, the trainee can experiment by focussing on different objects at different ranges.

15. **Field of View**. Wide field of view (WFOV) should be used

when searching the ground for targets. Once a hot spot has been seen the gunner would then switch to narrow field of view (NFOV), focus and adjust the brightness and contrast to achieve the best possible picture to recognize the target, and engage it if it is enemy.

16. Confirm by questions and practice.

17. **Laser Jammer Filter (Operator Selectable Filter)**. It is used to prevent laser jamming of the thermal imagery sight. There are 4 lens/filters (3 are filters and one is clear) that can be accessed by using the control toggle, located on the left side of the thermal sight. There are 3 positions: Neutral, Reset and Step. Step changes the filter to get the best picture when being jammed. Reset should be used when there is no jamming.

CONCLUSION

18. Take questions from class on the entire lesson.

19. Confirm by questions.

20. **Summary**. To include the following:

    a. the importance of having a clear, sharp thermal image to help identify targets; and

    b. a forecast of the next lesson.