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FIXOR: A New Approach to Neutralizing Landmines and UXO

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FIXOR: A New Approach to Neutralizing Landmines and UXO

Canada's MREL Specialty Explosive Products Limited introduces a new approach to neutralizing landmines and UXO.

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MREL Specialty Explosive Products Limited has developed FIXOR™, a new approach to neutralizing landmines and UXO. The product consists of two precursors: a flammable liquid in one plastic container and a totally inert powder in another. Neither of these precursors is classified as an explosive. Both precursors are approved for transport by land, sea, cargo and passenger airfreight. Before placement next to the UXO or landmine, they are mixed to form an explosive. A blasting cap or detonating cord causes initiation.

The detonation velocity and detonation pressure for the explosive mixture have been determined using experimental techniques and/or theoretical calculations. The use of FIXOR as an explosive neutralization device for landmines and UXO in humanitarian demining scenarios involved the evaluation of more than 75 field trials by MREL Specialty Explosive Products Limited at Canadian and American defense facilities and in an international venue (Kosovo). The trials demonstrated that FIXOR is effective against a wide variety of landmines and other munitions. The trials also confirmed that the product is much safer to handle and transport than conventional explosives.

Figure 1. FIXOR counter-force or "earmuff" attack configuration.

Introduction

Since 1984, the MREL Group of Companies has been conducting research on the effectiveness of explosive dusts, explosive foams, explosive liquids and shaped charges against landmines for eventual integration into minefield breaching and minefield-clearance systems.

In 1998, the explosives research efforts turned to development of a two-component (binary) explosive system. The goal was to use relatively inexpensive components that were not explosive and could be easily transported around the world by commercial airfreight with minimal logistics and at a low cost. In addition, the components would be easily mixed at the minefield to produce an explosive that could substitute for the more expensive plastic and block TNT explosives commonly used to destroy landmines and UXO. This technique is known as "blow in place" or BIP.

In November 1998, the research efforts resulted in the successful detonation of a binary explosive system. Further investigations have characterized and customized the system with the eventual goal of independent verification of its performance against landmines and UXO. Patents are pending.

This newly-developed binary explosive system has been termed FIXOR, an acronym for *F*ield-friendly, *I*nexpensive, une*X*ploded *O*rdnance *R*emover. Several test programs involving the use of FIXOR against a variety of landmines and UXO have been conducted.

There are always security concerns when explosives are transported and stored, and these concerns are intensified in peacekeeping operations where explosives could fall into the wrong hands.

FIXOR

FIXOR is a binary flammable liquid-based explosive kit that has been designed to complement or replace the use of purchased plastic explosives and block TNT as traditional demining and UXO explosive charges. As shown in Figure 1, FIXOR consists of two precursors: a flammable liquid (FIXOR Liquid, U.N. 2842, NSN 1375-21-920-4587) in one 500 ml plastic container and a totally inert powder (FIXOR Powder, NSN 1375-21-920-4638) in another 500 ml plastic container. Unlike binary nitromethane-based explosives, both FIXOR precursors are formally approved for transport by land, sea and commercial passenger airfreight.

In the country of use, FIXOR can be stored and transported as a flammable liquid and changed into an explosive by the deminer at the minefield when required. The precursors are mixed to form a Class 1.1D explosive (FIXOR Explosive, U.N. 0048) immediately prior to placement next to the UXO or landmine. Initiation and detonation of the FIXOR Explosive occurs by blasting cap or detonating cord. The goal of the FIXOR is to cause sympathetic detonation of the landmine or UXO immediately upon detonation of the FIXOR Explosive.

FIXOR precursors do not form an explosive until the contents of the two bottles are thoroughly mixed together. Therefore, if the contents of FIXOR precursors or FIXOR Explosive are spilled, they are not harmful to the deminer or to the environment. FIXOR Explosive is very safe to handle and deploy; however, it must be treated with respect since it is a detonator-sensitive explosive. After several hours of remaining unshaken, FIXOR will not detonate when fired by a detonator or by a detonating cord. This design makes FIXOR an unlikely candidate for misuse by hostile groups as a "booby-trap" or terrorist device. Unless FIXOR is re-shaken, it will only act as a flammable liquid.

FIXOR has been designed to integrate seamlessly with demining training methods and operating procedures in use throughout the world. FIXORs are easily and safely deployable by indigenous deminers and require no ongoing field technical support. They are also fully functional under all demining weather conditions. The diagram on this page (see Figure 2) is a schematic illustration of the procedure for making FIXOR Explosive at the clearance site.

Combination of FIXOR Products

When the liquid and powder components are combined as shown in Figure 2, the resulting mixture is a "cap-sensitive" explosive. The velocity of detonation (VOD) for this mixture was determined to be approximately 4300 m/s when placed in a plastic (PVC) tube with a 5 cm inner diameter. The VOD trace acquired using the continuous-resistance wire technique compares well with a calculated value of 4333 m/s, obtained using CHEETAH 2.0 with the BKWC library[1]. The estimated detonation pressure for this mixture is on the order of 40–44 kbar, using either CHEETAH 2.0 or a typical formula to estimate the pressure ($P = dD^2/4$, where d is formulation density and D is the velocity of detonation)[2]. In addition, air-blast measurements have been conducted. This method's results indicate that the TNT equivalency of FIXOR is of the order of 80–85 percent TNT. It should be noted that the use of other methods for this measurement would undoubtedly provide somewhat different results based on the differences in brisance that exist between TNT and FIXOR.

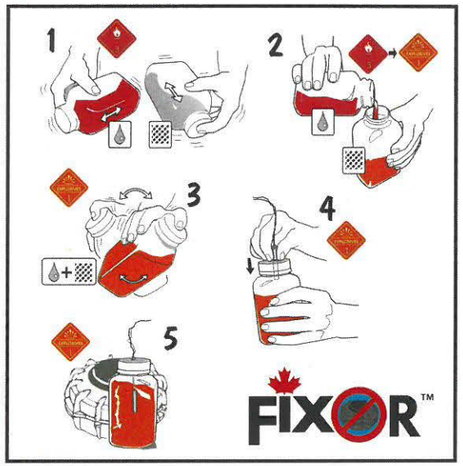

Figure 2 Schematic directions for the use of FIXOR.

Effectiveness of FIXOR Against Landmines and UXO

Three basic configurations for neutralization of landmines/ordnance can be utilized. These configurations allow increasing amounts of explosive power (shock) to be imparted to the target, depending on the hardness/toughness of the target casing.

Standard Attack Configuration

The standard attack configuration involves placement of one FIXOR adjacent to a target. This method is typically used for small, plastic-encased AP landmines. A #12 equivalent detonator (> 0.8 g PETN) or knotted detonating cord is used to initiate the FIXOR.

Counterforce or "Earmuff" Attack Configuration

The counterforce or "earmuff" attack configuration involves the placement of two FIXORs on opposite sides of a target. This configuration is typically used for larger AP mines and various plastic or thin steel-cased (but not hardened) AT landmines. Figure 1 shows this attack configuration against a TMA-5 landmine. Knotted detonating cord lines (or "sensitized detonating cord"—detonator double crimped on the cord end) are used for simultaneous initiation of the FIXORs. This method of initiation ensures simultaneous detonation of more than one

continued on page 112

Technical Characteristics of FIXOR

FIXOR Liquid

a) Color: red
b) NATO Stock Number: 1375-21-920-4587
c) Classification: Class 3 Flammable Liquid, U.N. 2842. Packing Group III
d) Health/Environmental Concerns: use in ventilated areas or outdoors, MSDS is available
e) Inner Packaging: 500 ml plastic bottle with removable plastic lid. L x W x H (inches): 3 x 2 ˜ x 6
f) Shelf life: indefinite
g) Settling: shake to remix before adding to FIXOR Powder
h) Outer Packaging: Complies with U.N. requirements for commercial air transport of flammable liquids. U.N. Approved 4GV/X22.7/S/99. 24 bottles per box
i) Box dimensions (inches): 23ʃ x 15 x 10¯
j) Gross weight per box: 30.9 lb.
k) Net weight of flammable liquid per box: 18.7 lb.

FIXOR Powder

a) Color: orange/white
b) NATO Stock Number: 1375-21-920-4638
c) Classification: inert powder
d) Health/Environmental concerns: none
e) Inner Packaging: 500 ml plastic bottle with removable plastic lid. Lid is prepared for detonator/detonating cord insertion. L x W x H (in inches): 3 x 2 ˜ x 6
f) Shelf life: indefinite
g) Settling: shake to loosen powder before adding FIXOR Liquid
h) Outer packaging: 24 bottles per box
i) Box dimensions (inches): 20 x 9ʃ x 6°
j) Gross weight per box: 5.6 lb

FIXOR Explosive

a) Color: orange
b) Classification: Class 1.1D explosive, Charges, demolition U.N. 0048
c) Net Explosive Weight: 0.9 lb.
d) Density: 0.9 g/cc
e) Velocity: 4,300 m/s (14,100 ft./sec.) based on testing to date
f) TNT Equivalency: approximately 80–85 percent by weight based on air-blast
g) Operational Temperature Range (tested): -20° to 110° F (-30° to 40° C)
h) Operational time: within two hours of mixing, or remix by shaking before detonating
i) Shelf life: indefinite
j) Initiation: ULI ("hangman") knotted 50 grain/ft. detonating cord or detonator (0.8 g PETN)

FIXOR

continued from page 87

FIXOR whereas some commercial "instantaneous" detonators have demonstrated initiation time scatter[3].

Focused Energy Attack Configuration

The focused energy attack configuration involves filling the FIXOR completely with FIXOR Explosive, which can enhance the performance of an individual FIXOR by "topping-up" the container with the explosive from another FIXOR. This action increases the net explosive weight from 400 g (0.9 lb.) to approximately 500 g (1.1 lb.) per FIXOR. One FIXOR can be used to top-up four other FIXORs by mixing five FIXORs and using one to fill up the other four. To enhance the performance of the topped-up FIXOR, point the bottom of FIXOR towards the target and use the shaped charge or Monroe effect from the bottom end of FIXOR. Two or more FIXORs can be used to focus the energy on hardened targets.

Neutralization of Targets

The following targets have been neutralized using selected variations of the above attack configurations:

AT Mines:	*AP Mines:*
M19	VS50
M21	M16
Mk 7	M18
TMA-5	PMA-1
TMA-3	PMA-2
PT-Mi-Ba III	PMA-3
	BLU-92/B

UXO:

M67 grenade, 81 mm HE mortar, 81 mm WP mortar, 40 mm HE round, BLU 97 submunition, LUU-II flare, MJU-7 flare, 76 mm recoilless rifle round, AIM 9 Gulf Sidewinder Seeker Head (copy), 105 mm Artillery Round, 155 mm Artillery Round, M1A2 Bangalore, 40 lb. Cratering Charge, Mk 82 500 lb. bomb

Suggested Standard Operating Procedures (SOP) for the neutralization of the above mines and UXO can be found at the website www.FIXOR.com. Users may submit their own successful SOPs/UXO neutralization techniques and photographs for inclusion on this site. FIXOR is currently being utilized in central and northeast Africa and in Southeast Asia.

Conclusions and Comments

After extensive trials, the MREL Group of Companies formed a number of conclusions about the use and effectiveness of FIXOR. These include the following:

- When using a detonating cord to initiate detonation of FIXOR, the end of the cord should be tied into a "Uli" knot (similar to a hangman's knot) with at least six turns in it to ensure detonation. The distance from the end of the detonator (or from the end of the Uli knot in the detonating cord) to the top of the FIXOR cap should be marked by the deminer at a length of nine cm to ensure proper placement inside FIXOR.
- When the simultaneous detonation of multiple FIXORs is required for a particular demining task, the deminer should not rely upon the timing accuracy of multiple electric or non-electric detonators—even if the detonators are "zero" delay detonators. It is preferable to use a piece of Uli-knotted detonating cord in each of the FIXORs and initiate the lengths of detonating cord simultaneously with one detonator. A "sensitized" detonating cord, which is comprised of an appropriate strength detonator crimped to the end of the cord, can also be used in place of a knotted detonating cord.
- When attacking larger, thick-walled UXO such as the 105 and 155 mm HE Artillery Rounds or a Mk 82 500 lb. bomb, additional FIXORs should be mixed and their explosive contents used to completely fill the FIXORs deployed against the UXO. This topping-up process provides up to 500 g of FIXOR explosive in a FIXOR as opposed to the standard 400 g and allows the FIXORs to be placed on their sides and detonated reliably.

Given these findings, MREL concluded that FIXOR is an effective method for neutralizing landmines and UXO in place that integrates seamlessly with current B/P procedures. When compared to conventional explosives, FIXOR has significantly less hazards and less logistical requirements during transport and storage. These factors add to its status as an effective measure against dangerous mines and UXO. ■

Figure 5 FIXOR liquid and FIXOR powder.

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* The FIXOR™ name is the sole property of MREL Specialty Explosive Products Limited.

*All photos courtesy of MREL.

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