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Low-level Ordnance Neutralization Using the ASLD System™

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This article outlines the benefits of using a new system of low-level mine neutralization. Some of the advantages of the A-Systems Landmine Destroyer System include effectiveness, easy transport, safety and minimal damage to environment. The author gives an overview of the System, describing its components, processes and field results.

Humanitarian demining (i.e., the removal of landmines, unexploded ordnance and improvised explosive devices from civilian-occupied territory) has numerous constraints that are not imposed on the military during combat operations. These issues range from the concern for collateral damage to the infrastructure to the logistical problems involved in getting demining equipment and personnel to a remote location. While the military is concerned neither with 100-percent removal of ordnance within an area nor with the residual debris from exploded ordnance, the humanitarian deminer must address all of these matters.

The A-Systems Landmine Destroyer (ASLD) System is designed to be used by the humanitarian deminer to destroy anti-personnel and anti-tank landmines, UXO and IEDs *in situ* through low-level neutralization by deflagration (burning the explosives). This approach reduces the danger and possible collateral damage to personnel and infrastructure compared to neutralization with explosives. In addition, ASLD typically leaves metal ordnance cases relatively intact, facilitating the removal of debris and permitting an efficient quality evaluation of the area once the demining has been completed.

ASLD System

The ASLD System is composed of three major components:

1. The transmitter
2. The receiver
3. The cartridge

The transmitter and receiver enclosures are lightweight, rugged boxes measuring 10.9 centimeters (4.3 inches) x 8.1 centimeters (3.2 inches) x 3.8 centimeters (1.5 inches). The transmitter weighs 320 grams (11 ounces) with battery. The receiver weighs 300 grams (10.6 ounces) with battery. The Type 200 cartridge measures 23 centimeters (9.0 inches) long x 3 centimeters (1.16 inches) in diameter and weighs 400 grams (14 ounces).

The ASLD System is battery-powered using field-replaceable 9-volt batteries available around the world. The typical receiver battery life is three months of operation. The typical transmitter battery life is one year. Both the transmitter and receiver are reusable, but the cartridge is consumed during the deflagration. The ASLD System is effective against landmines, UXO and IEDs with cases fabricated from metal including

steel and many plastics.

ASLD System components (shown with a six-inch [15-centimeter] scale for reference). *All photos courtesy of Floyd Artrip*

ASLD transmitter. The transmitter is a lightweight, rugged unit that sends commands to the receiver using a coded infrared beam. The transmitter is equipped with a monoscope for aiming the laser at the receiver. The monoscope is also used for observing the receiver indicator LEDs to verify the mode of operation. Transmitter operation is extremely simple with one LED indicator and two push-button controls for arming and firing the cartridge.

ASLD receiver. The receiver has two push buttons. LEDs prompt the deminer on the status of the receiver. After initial setup, the receiver is ready to detect the coded infrared beam from the transmitter at a standoff range up to 600 meters (650 yards).

ASLD cartridge. The cartridge is placed next to the target, connected to the receiver and triggered remotely using the transmitter to neutralize the target. The Type 200 cartridge is shown in the photo on the right. Type 75 and 300 cartridges are also available and have been tested against various models of landmines. Other cartridges are under development. Also shown is the cable that connects the cartridge to the receiver. Future underwater-rated cartridges are planned for underwater and wet-location operations.

Operation

The ASLD System uses line-of-sight between the command point selected by the deminer and each of the ASLD receivers. This range permits the deminer to observe the entire area and determine when it is safe to trigger each cartridge in turn. For locations not in line-of-sight, extension wires up to 300 meters (328 yards) long can be added. In this case, the ASLD receiver must still be visible from the command point. For safety purposes another deminer will need to be located in sight of the target with communications to the primary deminer.

Placing the receiver and cartridge. The receiver is placed in a protected location near the target in line-of-sight to the command point. This placement protects the receiver should the target explode during the operation. The cartridge is placed in a shallow trench in the ground adjacent to the target ordnance. The optimum position is near the lower edge of the target, pointed away from the trigger mechanism. This positioning permits the cartridge to burn through the casing, igniting the explosives, which then burn off before the trigger detonates from the heat. Because the trigger can detonate at any time during this process, the command point is selected to ensure deminer safety in the event the target goes high order[1] at any phase of the deflagration.

Connecting and arming the receiver. A short ASLD cable (included with the cartridge) is attached between the cartridge and the receiver. No longer does the deminer need to carry large spools of wire to and from the field. Operation of the ASLD receiver is very simple. The receiver has only two push buttons for operation. When the receiver is turned on, it performs a self test. Then the deminer selects a walk-away delay safety period. The receiver begins the countdown to when it will accept the remote fire command from the ASLD transmitter. The LEDs prompt the deminer on the status mode of the receiver at all times. For safety purposes, pressing the on/off button at any time during the operation turns the receiver off. Only after the walk-away delay safety period has elapsed will the receiver accept remote commands to neutralize the target.

Deflagrating the mine. When the deminer has completed placing and arming the receiver/cartridges for the day's shots, the next step is to move to the command point, which is a safe distance from all the targets and within line-of-sight of all of the receivers. After verifying that the range is clear, the deminer aims the transmitter at the first receiver and presses the charge button to arm that receiver. The armed (red) LED begins to flash. After a 30-second delay, the armed LED illuminates continuously, indicating the final safety delay has timed out.

When the deminer has determined conditions are safe, pressing the fire button triggers the cartridge to initiate the deflagration action for that target. Each receiver/cartridge is triggered individually in turn, permitting the deminer to verify that each target piece of ordnance has been burned. The deminer selects the next target by simply aiming the transmitter at it and repeating the charge and fire sequence. No electrical connections are necessary to switch targets.

Advantages of the ASLD System

Safety. Safety of the ASLD System begins with the design of the cartridge. Until attached to the receiver, the ASLD cartridge components are very difficult to ignite and are non-explosive. The igniter utilizes patented iron whiskers.[2] The burn charge uses thermite.[3] These characteristics make shipping and handling of the cartridges much safer than other landmine neutralization systems. The laser beam from the transmitter is eye-safe (Food and Drug Administration Class 1[4]). No high voltages are used anywhere in the System.

The ASLD System offers numerous built-in safety advantages for the deminers that enhance their personal safety plus the safety of nearby civilians, animals and infrastructure. First, the very nature of deflagration (low-order neutralization[5]) minimizes the possibility of collateral damage or injury as compared with explosive demolition techniques. For most cases, the ordnance is neutralized with little or no resultant explosion. Even if the ordnance were to go high order, people and animals are protected, because the deminer can verify the area is clear prior to triggering the cartridge. Second, the ASLD System has built-in safeties to prevent triggering the cartridge until the area is clear. The deminer can use the transmitter to switch between the ready and armed modes whenever necessary. Third, the deminer can safely stand off up to 600 meters (650 yards) away and watch the entire area before triggering a cartridge.

Ease of use. The System's ease of use begins with its transport to the minefield. Based on typical case size, shipments meet the Small Quantity Exception of 49 Code of Federal Regulations 173-4.[6] This classification along with the Department of Transportation rating of 4.1[7] means the cartridges can be easily shipped as non-hazardous cargo with minimal shipping delays through most freight carriers.

All components of the ASLD System are designed for simplicity and ease of use. The cartridge requires no tools for connecting it to the receiver. All connections and controls are easily manipulated while wearing heavy gloves. A transmitter plus enough receivers and cartridges for a typical day's operation can easily be carried in a backpack.

Placement of the cartridge only requires a shallow indentation on the ground adjacent to the ordnance. If the ground is very hard or frozen, a rock may be placed on top of the cartridge to prevent the thrust of the molten metal from pushing the cartridge away from the ordnance when the cartridge is triggered.

Flexibility. The ASLD System offers the deminer wide flexibility for neutralizing landmines, UXO and IEDs. The ASLD cartridge can penetrate and neutralize ordnance with steel cases and most plastic-cased mines. The Thermite burns at a very hot temperature, which ensures that it will ignite most explosives including TNT.

Field Test Results

The following tests demonstrate the effectiveness of low-level neutralization by deflagration using the ASLD System. The ASLD cartridges were field-tested against armed anti-personnel and anti-tank landmines at Fort A.P. Hill under the direction of Dr. Divyakant Patel, Physical Scientist of the United States Army Research, Development and Engineering Command's Humanitarian Demining Research and Development Program, and John Fasulo, U.S. Army demolitions expert at Fort A.P. Hill. These tests were part of a humanitarian-demining equipment evaluation contract. Additional penetration tests against steel plates were conducted at A-Systems, Incorporated headquarters in Charlottesville, Virginia. The first test demonstrates the ability of the ASLD cartridge to penetrate a steel plate.

Tests against steel plates. The photo to the right shows the hole created by an ASLD Type 200 cartridge against a steel test plate. Tests have confirmed the ASLD cartridge can penetrate a steel plate up to 6.3 millimeters (1/4 inch) thick. In this photo, the cartridge has created hole a 1.9 centimeters

(3/4 inch) in diameter. The ASLD cartridge was placed on the back side (outside) of the plate. Some of the molten iron that has cooled and hardened on the front side (inside) of the plate is visible below the hole. During an actual deflagration process, the molten iron would burn through the case of the ordnance, igniting the explosives. The gases from the burning explosives would vent through the opening, avoiding an explosion.

Penetration tests against steel plates.

Tests against plastic anti-personnel landmines. The second photo to the right shows the remains of an armed SPM-1 plastic AP landmine after deflagration using an ASLD Type 75 cartridge. The mine burned for more than five minutes, ending with a small explosion of the trigger. Only charred residue was left of the mine. The steel plates in the photo were used to hold the ASLD cartridge and the mine in position. This test was performed during a rain storm at Fort A.P. Hill. This is significant because some demining equipment is not suitable for use in wet conditions; however, the rain did not disrupt the ASLD tests.

AP mine remains after deflagration.

Tests against wooden anti-tank landmines. The third photo down to the right shows the results of a test of an ASLD Type 400 cartridge against a wooden AT landmine at Fort A.P. Hill. The molten iron burned through the first layer of wood and charred the second layer, discoloring the TNT. This test demonstrated that the ASLD cartridge does not burn long enough to completely penetrate wooden mines and set the explosive on fire.

Tests against metal anti-tank landmines. The fourth photo down to the right shows an armed, steel-cased AT landmine burning after being ignited by two ASLD Type 200 cartridges. Experience has shown that placing two cartridges on opposite sides of the larger mines results in more of the explosives being consumed before the trigger detonates. The AT mine to the right burned for nine minutes before exploding. The explosion was likely due to the mine trigger exploding from the heat generated by the burning explosive charge. This test was performed during a rain storm at Fort A.P. Hill.

Remains of a wooden anti-tank landmine.

After burning for nine minutes the AT mine trigger exploded, shattering the mine and scattering the unburned remainder of the main explosive charge. The explosion appeared to have been confined to the trigger mechanism. The mine-case fragments consisted of several large metal pieces, which were easily gathered and removed from the test area. The unburned explosives consisted of several large chunks that could be gathered and removed or else left to quickly neutralize upon exposure to the environment. There was no resulting crater from the explosion. If this operation had taken place in a real environment, there would likely not have been any damage to the surroundings or personnel. This test was conducted at Fort A.P. Hill during a rain storm.

A comparison was made between this test and a typical high-order test against this same type of AT mine using an explosive charge. The resultant explosion for that test left a crater in the hard ground big enough to hold a large office desk.

Tests of the ASLD System's ability to trigger blasting caps. The final series of tests of the ASLD System at Fort

A.P. Hill consisted of using the ASLD transmitter and receiver to trigger blasting caps instead of the ASLD cartridge. These tests demonstrated the ability of the ASLD System to remotely trigger typical blasting caps.

Two tests were successfully conducted. The ASLD System reliably triggered the blasting caps demonstrating the ability to use this type of trigger remotely without the need for long runs of wires. These tests were successfully performed during a rain storm.

A steel-cased anti-tank mine burning.

Conclusion

In situ mine destruction through low-level neutralization by deflagration is viable against many types of ordnance. The ASLD System demonstrated the ability to neutralize armed steel and plastic-cased landmines. It was not successful against wooden-cased ordnance.

The results for plastic-cased mines were mixed. Field testing revealed ASLD cartridges are very effective against some plastic mines. The force of the stream of molten metal is not enough to dislodge or push a partially-buried plastic mine away from the ASLD cartridge. For these plastic mines the results compare favorably with tests of the steel-cased mines. Small plastic mines resting loosely on the surface of the ground tend to be pushed away by the cartridge thrust with little or no resultant damage.

Anti-tank mine remains after the deflagration.

The ASLD System demonstrated the ability to remotely trigger blasting caps for other applications.

The ASLD System provides the deminer with a method for safely removing landmines, UXO and IEDs in civilian areas with minimum collateral damage and residual debris. The ASLD System, including the cartridges, is easily and inexpensively transported to remote locations due to the exemption from hazardous-material shipping regulations. Quality inspection of the area after deflagration with the ASLD System is simplified due the small amount of debris created and the absence of long wire runs from the command point to the ordnance.

Biography

Floyd Artrip holds engineering degrees from the University of Virginia and The George Washington University. Prior to founding A-Systems in 1975, Artrip was employed in industry, where he developed diverse products ranging from controls for unmanned anti-submarine helicopters to submarine periscopes and from shipboard navigation radar to electronic countermeasures against radar fire-control systems. While managing A-Systems, Artrip has continued to develop a broad range of products including two-way radio controls, medical devices and power supplies. Mr. Artrip holds two patents.

Endnotes

1. A high-order neutralization occurs when the mine explodes, creating a crater and putting personnel in danger. The uncontrolled explosion scatters fragments across the area.
2. *Iron whiskers* are patented polycrystalline iron fibers also known as "Schladitz Whiskers" after their inventor, Hermann Schladitz. These whiskers, named for their remarkable similarity to human whiskers, are one of the key features of the ASLD System's technology. These whiskers are rated as non-flammable and non-explosive, which makes them easy to transport. When ignited, they burn at a high enough

temperature to ignite the thermite charge in the cartridge.

3. Thermite is a chemical mixture of two powders, aluminum and iron oxide. When heated to a high temperature there is a chemical reaction resulting from the oxygen moving from the iron to the aluminum. This generates heat, up to 4,500 degrees Fahrenheit (2,482 degrees Celsius). The molten iron at this temperature will burn through the case of the landmine, igniting the charge inside. Because the thermite requires such a high temperature to ignite, it is rated as non-flammable and non-explosive, making for easy transportation.
4. Food and Drug Administration Class 1 certification ensures that a laser is unconditionally eye-safe with no perceived risks.
5. Low-order neutralization occurs when the mine detonates by burning with little or no explosion, crater, or danger to personnel. Low-order neutralization leaves the metal components of the mine in one location.
6. Quantity Exception of 49 Code of Federal Regulations 173-4 certification ensures that all requirements are met for shipping and packaging hazardous materials in the United States. Definition derived from http://frwebgate.access.gpo.gov/cgi-bin/multidb.cgi?WAISdbName=cfr+Code+of+Federal+Regulations+%28current+data%29&WAISqueryRule=%28%24WAISqueryString%29&WAISqueryString=49cfr173&WAIStemplate=multidb_results.html&Submit.=Submit&WrapperTemplate=cfr_wrapper2.html&WAISmaxHits=120. Accessed 3 May 2007.
7. The Department of Transportation rating ensures that the ASLD System adheres to safety regulations regarding its transport.

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