



TECHNICAL REPORT

Clearance of M16 anti-personnel mines in Chile

**Geneva March 2013
Erik Tollefsen, GICHD**



The Geneva International Centre for Humanitarian Demining (GICHD), an international expert organisation legally based in Switzerland as a non-profit foundation, works for the elimination of mines, explosive remnants of war and other explosive hazards, such as unsafe munitions stockpiles. The GICHD provides advice and capacity development support, undertakes applied research, disseminates knowledge and best practices and develops standards. In cooperation with its partners, the GICHD's work enables national and local authorities in affected countries to effectively and efficiently plan, coordinate, implement, monitor and evaluate safe mine action programmes, as well as to implement the Anti-Personnel Mine Ban Convention, the Convention on Cluster Munitions and other relevant instruments of international law. The GICHD follows the humanitarian principles of humanity, impartiality, neutrality and independence.

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ACKNOWLEDGEMENTS

The Geneva International Centre for Humanitarian Demining (GICHD) is grateful for having been invited to Chile to assist the government in fulfilling their obligations in line with Article 5 in the APMBC. The GICHD would like to direct a special thanks to the following individuals for their support during the mission:

Rear Admiral Kurt Hartung

Colonel Juan Orlando Mendoza

Captain (IM) Jorge Budge

Lieutenant Colonel Juan Pablo Godoy

Major Christian Zincker

Sgt Major Carlos Rivera

Acronyms

APMBC	Anti-Personnel Mine Ban Convention
CCW	Convention on Certain Conventional Weapons
DGPS	Differential Global Positioning System
CNAD	Chile's National Humanitarian Demining Commission
EOD	Explosive Ordnance Disposal
ERW	Explosive Remnants of War
GICHD	Geneva International Centre for Humanitarian Demining
GIS	Geographic Information System
GPS	Global Positioning System
HE	High Explosive
IMAS	International Mine Action Standards
IMSMA	Information Management System for Mine Action
MoD	Ministry of Defence (Defense)
MRE	Mine Risk Education
NGO	Non-Governmental Organization
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
SHA	Suspected Hazardous Area
SOP	Standard Operating Procedure
UN	United Nations
UXO	Unexploded Ordnance

Executive Summary

Following an invitation from Colonel Mendoza from CNAD the GICHD Director, Ambassador Stephan Husy, visited Chile from the 20th to 29th January 2012. The GICHD Director has visited Chile previously, last time focusing on the minefields in the north of the country. Accompanying the GICHD Director was Ms Aurora Martinez, the GICHD focal point for Spanish speaking countries and specialist on information management. Mr Erik Tollefsen, the GICHD advisor on EOD, stockpile destruction and technology was also invited to visit the mine action programme in Chile as a follow-on from the CNAD initiated assessment of ongoing clearance activities in 2009. Mr Tollefsen did not have an opportunity to visit Chilean Navy clearance operations on his initial assessment mission, so the January 2013 visit would allow him to provide technical advice to the Marines mine clearance organisation, should this be required.

This report responds to a request for advice on safe and efficient procedures for clearance of M16 bounding fragmentation type anti-personnel mines in a minefield in the Picton Islands.

The GICHD recommends the Chilean Navy revisits its procedures planned for the demining operation on the Picton Islands. The current procedures are exposing the operator to unnecessary risk as he/she will have to approach every single mine with an explosive disarmament method twice. The GICHD recommends that the Navy demining team develops SOPs based on the recommendations found in this report.



The visiting team and hosts about to board the Bell 412 SP helicopter following the visit to the 'Packsaddle' minefield at the Picton Islands in January 2013.

1. INTRODUCTION

1.1. GICHD SUPPORT TO CHILE

Following an invitation from Colonel Mendoza from CNAD (the National Humanitarian Demining Commission of Chile) the GICHD Director, Ambassador Stephan Husy, visited Chile from the 20th to 29th January 2012. The GICHD Director has visited Chile previously, last time focusing on the minefields in the north of the country. In addition to the field visit Ambassador Husy also had separate meetings with the Chilean Minister of Defence (H.E. Mr Rodrigo Hinzpeter), the MoD and the Army Engineering School. Accompanying the GICHD Director was Ms Aurora Martinez, the GICHD focal point for Spanish speaking countries and specialist on information management. Mr Erik Tollefsen, the GICHD advisor on EOD, stockpile destruction and technology was also invited to visit the mine action programme in Chile as a follow-on from the CNAD initiated assessment of ongoing clearance activities in 2009. Mr Tollefsen did not have an opportunity to visit Chilean Navy clearance operations on his initial assessment mission, so the January 2013 visit would allow him to provide technical advice to the Marines mine clearance organisation, should this be required.

This report responds to a request from CNAD for advice on safe and efficient procedures for clearance of M16 bounding fragmentation type anti-personnel mines in a minefield in the Picton Islands.

1.2. PICTON, LENNOX AND NUEVA

Picton, Lennox and Nueva is a group of three islands (and their islets) on the extreme south of South America, in the Chilean commune of Cabo de Hornos. They are divided between the Antártica Chilena Province, Magallanes and the Antártica Chilena Region. They lie east of Navarino Island and are separated from the Argentine part of Isla Grande de Tierra del Fuego in the north by the Beagle Channel.



Map of the southern part of South America.

1.3. BEAGLE CONFLICT

The Beagle conflict was a border dispute between Chile and Argentina over the possession of Picton, Lennox and Nueva islands and the scope of the maritime jurisdiction associated with those islands that brought the countries to the brink of war in 1978. The islands are strategically located off the southern edge of Tierra del Fuego and at the eastern end of the Beagle Channel. The Beagle channel, the Straits of Magellan and the Drake Passage are the only three waterways between the Pacific Ocean and the Atlantic Ocean in the southern hemisphere.

After refusing to abide by a binding international award giving the islands to Chile, the Argentine junta pushed the controversy to the brink of war in 1978 in order to produce a maritime boundary consistent with Argentine claims. The conflict had begun in 1904 with the first official Argentine claims over the islands that have always been under Chilean control. The conflict passed through several stages: since 1881 Chilean islands, since 1904 disputed islands, direct negotiations, submitted to a binding international tribunal, direct negotiations again, brinkmanship.

The conflict was resolved through papal mediation and since 1984 Argentina recognizes the islands as Chilean territory. The 1984 treaty resolves also several collateral issues of great importance, including navigation rights, sovereignty over other islands in the Fuegian Archipelago, delimitation of the Straits of Magellan, and maritime boundaries south to Cape Horn and beyond.

In order to protect its territory, the Chilean armed forces in 1981 laid minefields on three of the islands in southern Chile. Exact maps of the minefields from that time are available to the demining units which have to undertake clearance in accordance with Article 5 of the APMBC.

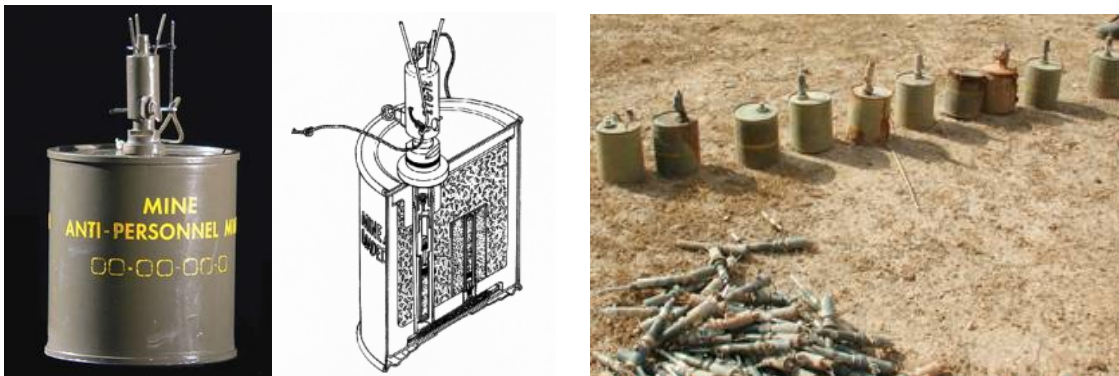


Captain (IM) Jorge Budge and Lieutenant Colonel Juan Pablo Godoy on board a Bell 412 SP helicopter en route to Picton Island.

2. THE M16 ANTI-PERSONNEL MINE

The M16 mine is a US made bounding anti-personnel mine which is designed to wound or kill by fragmentation. It was based on captured plans of the World War II era German S-mine and has similar performance. The mine consists of a cast iron body in a thin steel sleeve. A central fuse well on the top of the mine is normally fitted with a pronged M605 *pressure and tilt fuze*. Sufficient pressure on the prongs or tension on an attached tripwire causes the release of a striker. The freed striker is forced by the surrounding spring reasserting itself onto a percussion cap which ignites a short pyrotechnic delay. The purpose of this delay is to allow the victim to move off the top of the mine, to prevent its upward movement from being blocked. Once the delay has burned through, a 4.5-gram black powder charge is ignited, which launches the inner iron body of the mine up into the air (leaving behind the steel outer sleeve). The charge also ignites a second pair of pyrotechnic delays.

The mine rises to a height of 0.3 to 1.7 meters before one or both of the pyrotechnic delays detonates the main charge of the mine, which sprays high-velocity steel fragments 360° around the point of detonation. These metal fragments have an expected casualty radius of 27 meters for the M16 and M16A1 mines, and out to 30 meters for the M16A2 mine.



Images of M16 anti-personnel mines.

The M16 and M16A1 mines are similar; the M16A1 has redesigned detonators and boosters but remains largely the same. The M16A2 is considerably different, having an offset fuze well and only a single pyrotechnic delay element. This change reduces the weight of the mine considerably (2.83 kilogram) while allowing it to carry a slightly larger main charge (601 grams)

The mines were sold widely and copies were produced in several countries including Greece, India, South Korea and Turkey. They can be found in the employed in Angola, Cambodia, Chile, Cyprus, Eritrea, Ethiopia, Iran, Iraq, Korea, Lebanon, Laos, Malawi, Mozambique, Myanmar, Oman, Rwanda, Somalia, Thailand, Vietnam, the Western Sahara, and Zambia. The US retains stocks of M16A2 mines for use in any resumption of war in Korea.

2.1. HAZARDS

The M16 series of mines have a very high metal content and can be located visually as well as with prodders or metal detectors. They have no unusual hazards associated with them. On detonation the mine will bound and normally propel lethal fragmentation to a radius between 25 and 50 meters. The actual hazard radius for these types of mines averages out at 105 meters based on the following formula (cube root of explosive weight in kg x 2.2 x 100 meters) for safe fragmentation radius.

The M16 anti-personnel mine contains large amounts of metal, so is very easy to detect using a mine detector. However, it is important to note that the act of moving the detection head over the ground may strike the prongs and trigger the mine. Additionally, if long tripwires are fitted, the deminers might activate the mine before they have chance to find it.

3. DISCUSSON

3.1. NATIONAL STANDARDS

Chile's National Humanitarian Demining Commission (CNAD) has accredited a combination of blow in situ and RSP drills for its demining programme. Typically anti-vehicle mines (AVMs) are being neutralised, disarmed, lifted and removed for destruction, while smaller anti-personnel mines (APMs) are being blown in situ.

3.2. OBSERVATIONS

During the hosted visit to the Picton Islands a demonstration of planned mine clearance procedures was given by three deminers. The deminers were all equipped with the highest ballistic level personnel protection equipment (PPE) available in Chile. This is an ACE – Advanced Clearance Ensemble manufactured by Allen Vanguard (previously MED-ENG), a heavy type PPE compared with what other demining operations working with similar hazards are wearing. The demonstration area was located just outside the minefield with similar topographic and soil conditions as could be found inside the fenced off mined area. The demonstration gave a good display of the following demining components:

- **Command and control**
- **Demining marking system**
- **Lay-out of access line and working line**
- **Detection drill**
- **Low-order neutralization drill**
- **High-order demolition drill**
- **Medevac drill**



Images from the mine clearance demonstration at Picton Island.

The demonstration gave an example of the professionalism and expertise within the Chilean Marines demining unit. It also showed that the equipment and support functions at hand are of world class. The command and control of the site seemed tidy and adequate for a minefield of such type as the ones found on Picton Island. Two observations were, however, discussed as a result of the demonstration and the later brief and subsequent tour of the minefield in question (Packsaddle):

1. The planned use of the SAAB (former RUAG) SM EOD point focal charge raises some concern with the GICHD EOD specialist. Such an approach on every M16 mine will result in two explosive actions on each mine. Both explosive actions with their inherent hazards will result in a soak time (minimum 30 minutes following the low order attack and minimum 10 minutes following the high order attack). This will increase the risk to the operators and slow down the clearance operation. The cost element will not be discussed in this report. Annex III provides an alternative to the SM EOD charges that are no longer manufactured by SAAB.
2. Instead of a working lane directly approaching the mine rows, two separate access lanes were cleared and working lanes were cleared perpendicular to these. A quick estimate by the GICHD specialist identified that the area to be cleared could be reduced by 50% by choosing a more direct approach. This recommendation is based on the condition of the mines, the nature of the ground conditions (predominantly peat) and the positioning of the mines (no wash-outs).

3.3. COMBINATION OF FRAGMENTATION AND MINIMUM METAL ANTI-PERSONNEL MINES

In many countries (e.g. Iran, Iraq and Vietnam) variations of the M16 (M16A1 and M16A2) anti-personnel landmines have typically been used in combination with minimum metal anti-personnel landmines e.g. the US M14 (contains as little as 0.4 gr of metal) and Chinese Type 72. In such situations it is common to use Standing Operating Procedures (SOPs) describing a Render Safe Procedure (RSP) drill for disarming the mine for clearance operations in order to ensure safety and efficiency in the demining work lane. Blowing the bounding fragmentation mine in situ would spread many pieces of metal shrapnel which in turn would need to be investigated as a potential anti-personnel mine. Each investigation must be carried out with due diligence and therefore takes time. In many scenarios the pattern, number and exact location of

ANNEX I :

MINE NEUTRALISATION

1. When a tripwire is encountered follow it to both ends ensuring it is safe
2. Check the immediate ground for signs of boobytraps or anti-disturbance devices (if BT or AD are detected blow the mine in place) (not relevant for Picton Island)
3. Carefully remove soil from the top and sides to expose the fuze completely
4. If the mine appears to be undamaged and untampered with proceed (if not blow in place)
5. Carefully insert the original positive safety pin or a suitable piece of wire through the positive safety hole
6. Insert the original safety pin or similar wire through the hole opposite the release pin ring

After all safety pins are inserted, cut trip wires (if mine was set for tripwire actuation). NOTE - As with all mines the preferred method of removal is to blow in place.

DISARMING DRILLS

1. Once the neutralizing drill is complete the mine must be removed from the ground. Finish removing camouflage and loose soil to uncover upper and side surface of mine
2. From a safe position, run pulling rope to mine and secure rope or hook to the mine body without disturbing the mine (not relevant for Picton Island)
3. Return to safe position and pull mine so that it moves at least 1 meter from its hole, wait 30 minutes before returning to mine (not relevant for Picton Island)
4. Lift the mine from the ground
5. Unscrew the M605 combination pull/pressure fuze from the mine

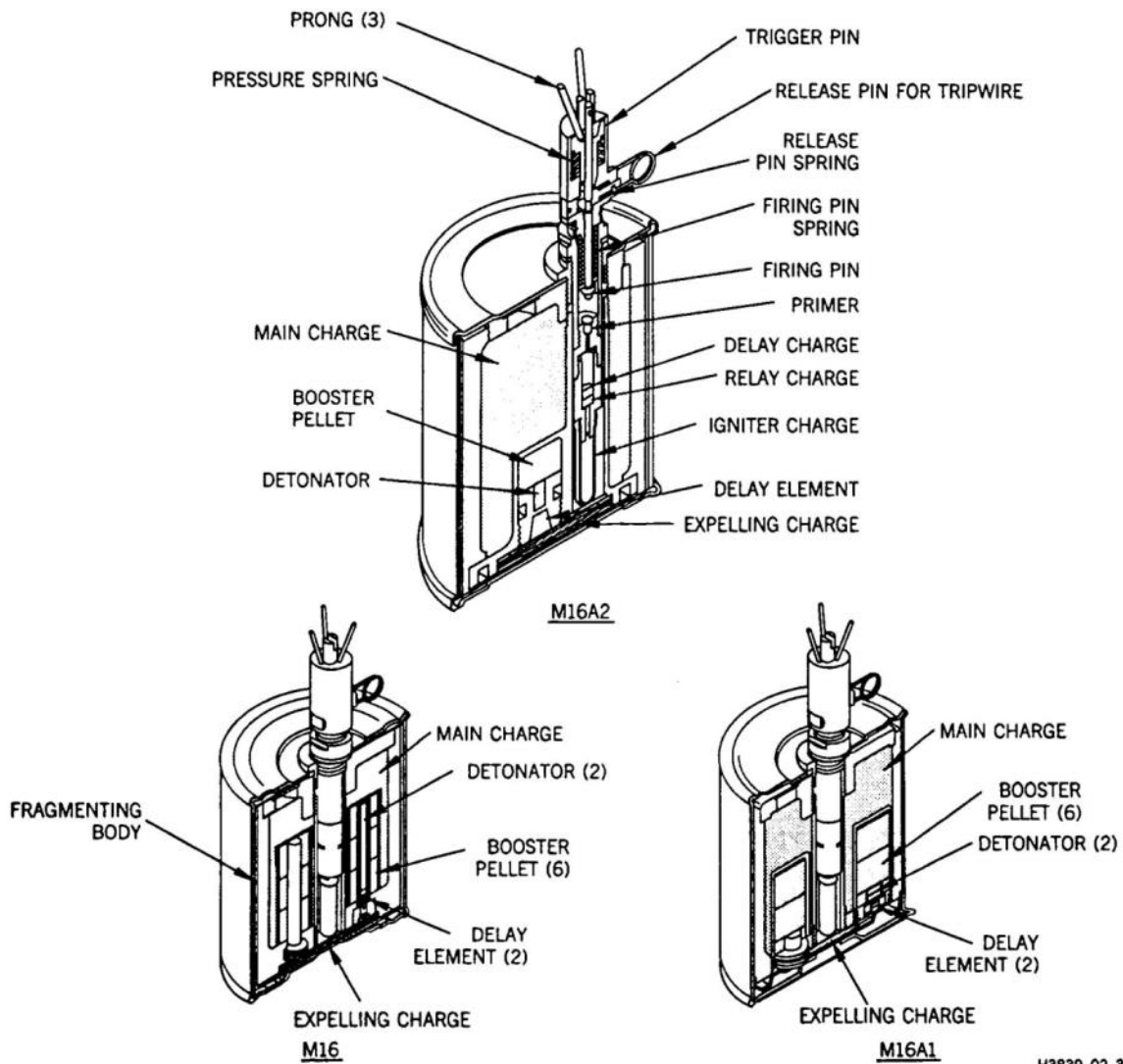
Store the components separately in preparation for future disposal.

DISPOSAL PROCEDURES

Whenever possible, M16 series bounding anti-personnel mine should be blown in situ using 2 x 0.25 kg explosive charges. Set up the charges on opposite sides of the mine body with an synchronised initiation to create an explosive crushing effect.

ANNEX II:

Schematic drawing of the M16 series anti-personnel mine.



H3839_02_3U

ANNEX III:

An alternative to the SM EOD point focal charge.



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