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Demining Programme Office in the Falkland Islands – Exploitation 2015



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FALKLAND ISLANDS LANDMINE EXPLOITATION – MARCH 2015

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Background

The need for exploitation¹ was recognised early during the planning for mine clearance operations in the Falkland Islands. Little was known about the state of the mines some 30 years after the conflict, and it was considered important to understand the effects of ageing, along with the implications for issues such as appearance/recognition, functionality and detectability.

Exploitation was previously carried out during clearance Phases 1 and 3. This report outlines the work conducted during Phase 4a, where samples of the following mines were examined:

Type	Designation	Country of origin	Number examined/tested
Anti-personnel (AP)	P4B	Spain	50
	SB-33	Italy	16
Anti-tank (AT)	SB-81	Italy	12

Outline details of these mines are given in **Annex A**.

A total of 78 mines and fuzes were examined or tested, with 38 mines being fully disassembled. Work was carried out by Colin King (herinafter 'CK'), technical director of Fenix Insight Ltd, from 5 – 12 March 2015.

Aim

The aim of this report is to outline the findings from the exploitation work, with particular emphasis on:

- a. The general condition of the mines
- b. Their ability to function, either as designed, or by other mechanisms
- c. Significant changes in their characteristics that might affect detectability or sensitivity.

Preparation

Tools were fabricated in the UK to allow the machine-assembled casings of the SB-33 and SB-81 mines to be opened without inflicting unnecessary damage. A number of other specialist tools were taken to the Falklands, while others were bought or borrowed locally.

The process was mapped (see **Annex B**) and risk assessments were performed for the disassembly of each mine type; appropriate controls were emplaced for activities considered particularly hazardous.

Recovery of Mines

AP mines were recovered by BACTEC the Land Release Contractor (LRC) during clearance operations. P4B mines were defuzed and stored, ready for exploitation, in the holding area.

Defuzing SB-33 mines was considered potentially hazardous, since the detonator is extracted perpendicular to the firing pin; this means that the mine could function if the pin were embedded in the detonator – a

¹ The process of disassembling explosive ordnance in order to accurately characterise the munition.

situation that was later found to have occurred. SB-33 mines were therefore recovered and stored fully fuzed.

AT mines were located, identified and partially uncovered by the deminers, but left in place. CK photographed each mine in position before fully uncovering and lifting. The mines were then assessed to establish that it was safe to disarm them, and were defuzed inside the minefield.



SB-81 mines were located and partially exposed by deminers, then recovered by CK



AT mines were examined and then defuzed in the minefield. The condition of detonators was noted

Disassembly and examination

Exploitation was carried out in a remote area of the quarry at Pony Pass, adjacent to the site used for the destruction of mines by burning. Access to the area was controlled to minimise the risk during the disassembly process.



The APB was established in a disused section of the quarry at Pony Pass



Explosive storage was in the left hand container, with the APB to the right

Two Iso containers were positioned side-by-side. One was used for the storage of recovered mines and fuzes (the assemblies being safely separated from one another). The other container was converted for use as an Ammunition Processing Building (APB).



Storage of recovered mines



The APB was basic but functional

The following sequence of events was then followed (**Annex B**):

- a. External check of condition and photography
- b. Assessment of safety to disarm, where applicable
- c. Disarming by removal of the detonator
- d. Disassembly of mine casing
- e. Removal of internal components
- f. Examination and photography throughout
- g. Reassembly as a training aid, or set aside for destruction.

Explosive testing

The explosive testing of detonators was an important part of the Phase 4A exploitation work. No matter what the condition of the body, the fuze mechanism or the main charge, a mine is incapable of functioning as designed if the detonator is not serviceable.

A rig was improvised, in which a heavy steel girder could be lowered onto a mine fuze in order to actuate it. The firing pin was released onto the detonator and the outcome observed from a safe distance.

P4B fuzes, complete with detonators, were placed between two blocks for actuation. In order to test SB-33 and SB-81 detonators, SB-81 fuze mechanisms were reassembled and detonators attached; the assembly was then placed in an adapted SB-81 casing. The number of tests that could be conducted this way was limited because the fuze was destroyed each time a detonator functioned.



The explosive test rig used a rope and pulley to lower a girder onto the mine fuze



A P4B mine fuze placed on the test rig, ready for the girder to be lowered

OUTLINE OF FINDINGS

P4B

Origin

All mine bodies and fuze assemblies were produced in the same batch, namely 2-5-78 (1978 being the year of production).

There is no reason to expect any significant inconsistencies among the batch, therefore most of the differences observed are due to the effects of ageing.

Casing

A significant proportion of the fuze casings had hardened and cracked, with many partially disintegrated. The proportion of degraded fuzes recovered so far during Phase 4A is substantially greater than on previous phases.

The primary result of casing degradation is the exposure of the inner fuze cavity, leading to the ingress of water. This tends to have two significant effects:

- a. Corrosion of the striker spring
- b. Degradation of the detonator.

In examples where the top of the fuze casing had broken away, the striker spring and spacer were often missing altogether, leaving the mechanism incomplete. This means that the fuze could no longer function as designed.

In most instances, the lower section of the mine (containing the main charge) was in good condition.

Detectability

As in previous phases, no detection instrument has been considered reliable enough for use with buried P4B mines. Even when new, the striker spring (weighing just 0.14 g) is borderline for location using the current generation of detectors, while the foil covering the main charge is completely non-ferrous and makes little contribution to the detection signature. This has meant using primarily manual excavation to locate mines.

Any corrosion of the striker spring reduces its metallic mass and makes it even less detectable.



A range of degradation was present among P4B fuze casings



Many springs were corroded

Although it has little significance for conventional metal detection, the foil² which covers the explosive charge in the mine body may be significant for Ground Penetrating Radar (GPR).

GPR is now used in some instruments, combined with conventional metal detection, in order to identify anomalies in the ground. However, the fingers of broken foil - which are similar in size to the wavelength of the radar - may resonate to create a distinctive signal. GPR is an increasingly mainstream detection technique and might suitable for use against this mine type in future.

The foil is installed in the P4B body as a flat disc, but is broken when the fuze is fitted. In most cases, the foil ruptures in several places, creating 'fingers' that protrude into the fuze well. In some examples the foil remains virtually intact, while in others a portion is absent, but every P4B mine examined (including previous phases) has had some foil present.



Variations in the foil covering the main charge



View of the foils from the inside of the casing

Detonator functionality

Detonator function tests were performed on a number of fuzes recovered from four separate locations. Only complete fuzes, in good external condition, were selected for the test.

Of the 50 fuzes tested, only 16 (approximately one third) produced any explosive effect. The majority of these were recovered from a mine dump, where the packaging provided some measure of protection against the environment. Test results are shown in the table below:

Location	59S	59N	24	Mines dump
Number tested	10	10	10	20
Functioned	5	0	0	11
Failed	5	10	10	9

Out of those that exploded, the majority produced a weak effect that would probably fail to propagate to the main charge. In other words, actuation of mines in this category would be unlikely to cause injury.



Results from P4B detonator testing. The fuze on the left was one of the few that detonated fully; the one on the right barely had the energy to break the housing and would not have detonated the main charge

² The foil is an alloy of lead, tin and antimony

SB-33 and SB-81

Origin

The SB-33 (AP) and SB-81 (AT) were both produced by the former Italian manufacturer MISAR. They use similar designs and materials, and are often laid together in minefields; it therefore makes sense to consider them together.

The mines bear no significant markings, so it is not possible to confirm their date of manufacture or lot numbers. However, both types were produced in huge quantities and it is probable that all of the mines sold to Argentina, and subsequently laid in the Falkland Islands, originated from the same batches.

Casing

Almost all of the casings of the SB-33 and SB-81 mines examined were in excellent condition and showed little sign of deterioration.

As noted in previous phases, the rubber covers of the SB-33 mines were generally domed where prolonged exposure to water had caused the material to swell. Despite the rubber remaining intact, it appears that water eventually permeated, since most mines were moist inside.

Moisture was also present in most of the SB-81 mines, despite the integrity of the rubber pressure plate. The SB-81 fuze is actuated pneumatically, so the seal and flexibility of this plate are critical to its function; both aspects appeared to be unaffected in the mines examined³



The rubber domes on the SB-33 mines have swelled and allowed some moisture to enter



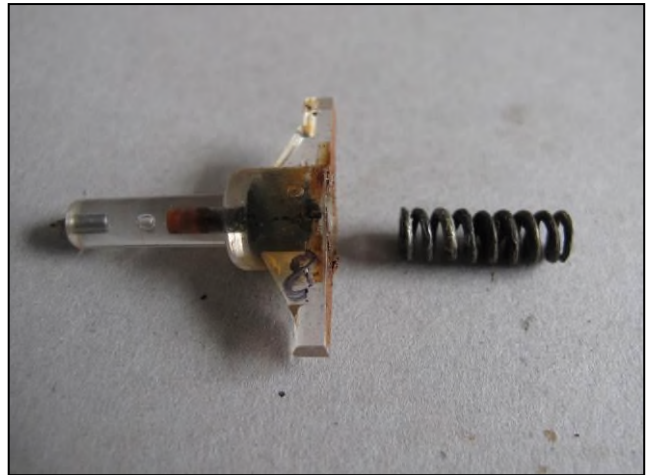
The pressure plates (right) of the SB-81 mines were in good condition; most were wet on the inside

Detectability

The primary detection signatures of the SB-33 and SB-81 come from their striker springs; these are made from magnetic steel and, when new, have masses of approximately 0.64 g and 0.86 g respectively. Other metallic components (such as stainless steel firing pins and aluminium detonator capsules) make little contribution to the signature.

Even where water had entered the mines, rusting of the striker springs was generally light and superficial. This means that the metal content of both mine types still remains well above the detection threshold.

³ Similar mines in hotter climates often have dry, cracked pressure plates that prevent them from operating.



Even when rusted, the steel springs had lost little of their original mass (SB-33 left, SB-81 right)

Main charges

Most of the SB-33 and SB-81 explosive charges were in excellent condition; some SB-33 charges and SB-81 boosters were damp, but most were assessed to be fully functional.

Detonator condition

The same type of detonator capsule is used in the SB-33 and SB-81. In both cases, the detonator is attached to a plug that seals the underside of the mine with a synthetic rubber O-ring. If this plug has not been tightened sufficiently then water will enter the mine. The front surface of the detonator incorporates the 'stab-receptor', which contains a pyrotechnic composition that is susceptible to damp.

Most detonators appeared to be in good condition; however, some had white crusting (probably aluminium oxide from the detonator capsule) while others had a brown gelatinous exudation from the stab receptor.



Detonators from the SB-81 mines, some of which show signs of deterioration

Detonator functionality

Detonators from SB-33 and SB-81 mines were tested by attaching them to a reassembled SB-81 fuze mechanism, from which the pneumatic actuation system had been removed. This assembly was then placed in an adapted SB-81 mine body, from which all explosive had been removed.

The limited number of fuzes available meant that only a relatively small number of detonators could be tested, since the fuze was destroyed if the detonator functioned. The results below have little statistical significance, but they do indicate that some detonators are fully functional and others are unserviceable, while some appear to be in a transitional state that results in incomplete detonation.

Mine type	SB-33	SB-81
Number tested	4	4
Full function	2	2
Partial function	1	1
Failed	1	1

The gradual decline of detonators within SB-33 mines was also apparent from mines that had failed to fully function when actuated. Of the 16 mines examined, 6 had the firing pin embedded in the detonator, which did not initiate.

The presence of the firing pin in the stab receptor of the detonator is a major and unexpected hazard, since further movement could cause initiation. During disarming, the detonator is withdrawn from the mine body at right angles to the firing pin, meaning that the two components scrape together. If the detonator is still active, this could initiate the mine in the hands of the deminer.



An SB-33 detonator plug removed to reveal the detonator still in position, impaled on the firing pin



An SB-33 disassembled, showing the pin in the fired position and a hole visible in the detonator

A further 4 mines were recovered with no detonator plugs present. It was initially assumed that these mines had been laid unarmed, without plugs, but examination showed that all had been actuated.

In each case, the detonator had exploded (ejecting the plug) but with insufficient force to initiate the main charge. The most likely explanation for this is deterioration of the detonators.



Several SB-33 mines had detonator plugs missing and were initially assumed to be unarmed



Examination revealed that the detonators had exploded, but failed to initiate the main charges

Additional tasks and deliverables

In addition to the main exploitation task, the following outcomes were achieved:

- Once disassembled, examined and tested, a number of mines were rebuilt, free from explosive (FFE). These are now available as training aids and test pieces for metal detection.
- One of each mine type was made into a sectioned model.
- The main charges extracted from the SB-81 mines were set aside for use as demolition charges.
- During clearance operations, an unknown type of AT mine was discovered. It was thought to have an inert filling but investigation showed that it contained a charge of TNT. The mine was later confirmed to be the Argentinian steel-cased copy of the US M1; this type was used in several minefields.
- The difference between the profile of an armed SB-33 and one that had been actuated was highlighted, and models made to illustrate both states.



A number of mines were reassembled, inert ('FFE')



Sectioned models were made for each mine type



SB-81 charge were retained for demolition



A 'new' mine type was identified



It is often possible to establish whether or not an SB-33 has been actuated by carefully feeling the position of the central plunger (through the rubber cover)

This inert model was produced - along with an actuated version - to illustrate the difference. The plunger is supported by a flexible ring so that it moves realistically, but cannot be actuated

Conclusions

The exploitation process was conducted successfully and without incident.

The work offered further insight into the condition of P4B, SB-33 and SB-81 mines, confirming that the samples examined showed more significant signs of deterioration than those seen on previous phases.

Specific conclusions and implications relating to the mines examined are summarised below (negative points shaded in red and positives in green):

Mine type	Conclusion	So what?
P4B	The metal content, which is close to the detection threshold when the mine is new, falls well below as the striker spring rusts	Conventional metal detection is unlikely to be reliable, regardless of enhancements to the technology
	Foil has been present in every mine examined (on this and previous phases)	Detection using GPR is a possibility
	Taking into account the number badly deteriorated or unserviceable, combined with those that produced a weak explosive effect, it is estimated that only 10 - 20% of P4B mines from these areas are still functional.	The risk of injury, should a mine be actuated accidentally, is relatively low.

SB-33	Out of 16 mines examined, 10 had been actuated but failed to detonate	This was unexpected and is currently unexplained
	It is not unusual for the mine to be found with the firing pin embedded in the detonator	It is potentially hazardous to defuze the mine in this state
SB-33 and SB-81	A proportion of detonators are non-functional or underpowered	The risks from remaining mines are declining
	Metal content remains fairly consistent, even in mines that have deteriorated	Metal detection is likely to remain a reliable option for the foreseeable future

Recommendations

It is recommended that:

- Trials are arranged to assess the feasibility of using GPR for the detection of the P4B.
- No attempt should be made to defuze SB-33 mines in the field.
- SB-33 mines should be recovered, fully fuzed, and demolished within the minefield. A special demolition procedure should be developed to ensure complete destruction.
- Scientific analysis should be conducted to investigate the changes occurring within the mine detonators, including the causes.
- The effects of ageing on recovered mines and other significant ordnance⁴ continue to be monitored in future phases.
- Further data are needed on the location and circumstances of recovered mines in order to understand the factors affecting their condition. All contractors and authorities involved in demining operations should consider ways to collect such data without impeding clearance work.



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⁴ Such as booby traps and BL-755 cluster munitions

Annex A – Mine types examined during Phase 4a



Designation: P4B
Type: Anti-personnel
Origin: Spain
Weight: 171 g
Diameter: 72 mm
Height: 43 mm
Explosive weight: 100 g
Explosive type: TNT/PETN
Operating pressure: 10 kg approx



Designation: SB-33
Type: Anti-personnel
Origin: Italy
Weight: 140 g
Diameter: 85 mm
Height: 30 mm
Explosive weight: 35 g
Explosive type: RDX/HMX
Operating pressure: 8 kg approx



Designation: SB-81
Type: Anti-tank
Origin: Italy
Weight: 3.3 kg
Diameter: 230 mm
Height: 90 mm
Explosive weight: 2.2 kg
Explosive type: TNT/RDX/HMX
Operating pressure: 150-310 kg

Annex B – Exploitation Process Map

