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Demining Programme Office in the Falkland Islands - Technical Support 2013

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EXPLOITATION OF ITEMS RECOVERED DURING DEMINING OPERATIONS: 2012/13

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Background

1. Exploitation[1] work was carried out on SB-33, SB-81 and P4B mines during Phase 1 of clearance operations; findings from this work are detailed in the ***2010 Falkland Islands Demining Programme Exploitation Report***.

2. Exploitation work was conducted on the following items:

   a. C3B anti-tank mines (***Figure 1***) recovered from SA064;
   b. An SB-33 anti-personnel mine (***Figure 2***) discovered outside the mine rows of SA064;
   c. Components of booby traps recovered from SA064.

3. Work was carried out by Colin King, technical director of Fenix Insight Ltd, from 19 – 22 March 2013.

4. The findings from this work were intended to assess the conditon of the ordnance in order to:

   a. Establish the general condition of the mines;
   b. Indicate their ability to function, either as designed, or by other mechanisms;
   c. Highlight significant changes in their characteristics that might effect detectability or sensitivity.

Figure 1
The Spanish C3B anti-tank mine

Figure 2
The Italian SB-33 anti-personnel mine

Aim

5. The aim of this report is to outline the findings from exploitation work provided within the Falkland Islands demining programme during the third phase of clearance.

Mine exploitation

C3B

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

6. Cracks were observed in the plastic casing of C3B mines recovered shortly after the 1982 conflict; it was therefore expected that mines remaining more than 30 years later would show substantial deterioration.

7. The deterioration of the plastic casing could be significant for the following reasons:

a. Cracks might allow water into the fuze housing, causing:

i. Rusting of the striker spring (with consequent reduction in detectability);

ii. Degradation of the ignition composition, with consequent inability to function.

b. The integrity of the fuze housing could be compromised, leading to a significant drop in operating pressure. This means that an affected mine might function under a load similar to that of an anti-personnel mine.

c. The break-up of the mine body might allow the main charge to disintegrate, eventually rendering the mine ineffective.

8. Findings from the exploitation of the C3B mines are at ***Annex A***.

SB-33

9. A solitary SB-33 anti-personnel mine was discovered in SA064, but located approximately 70 m from the nearest mine row.

10. The mine had sustained external damage to the casing and the detonator plug, but it’s internal condition was unknown.

11. The mine was set aside in the hope that exploitation might offer some explanation for its location and condition.

12. Findings from the exploitation of the SB-33 mine are at ***Annex B***.

Booby trap

13. Remnants of a booby trap were discovered towards the southern end of SA064. The components included the wooden stake, main charge, safety fuse and detonator. The firing device normally associated with such booby traps had not yet been located.

14. Detailed exploitation of the booby trap remnants was not deemed to be worthwhile, but comments are at ***Annex C***.

Creation of training aids

15. The 14 C3B mines recovered for exploitation were rendered inert, with all explosive components being sent for demolition. The bases of the inert mine casings were then marked with blue paint (the NATO colour code for inert munitions). The inert mines are shown in ***Figure 3***.

Figure 3
Inert mines for use as training aids and detection samples

16. Most of the inert mines contain the original metal content and can therefore be used for detection trials. The two mines with metal content removed were clearly marked and were retained for display purposes only.

17. One of the mines was sectioned to provide a training aid (***Figure 4***).

Figure 4
One of the C3B mines was sectioned to produce this training aid

Conclusions

18. The exploitation process was conducted successfully and without incident.

19. In particular, the work offered a detailed insight into the condition of the C3B mines and confirmed the most likely explanation for the location and position of the isolated SB-33. It also provided inert samples of C3B mines for use as detection samples and training aids.

20. Detailed conclusions relating to the items examined are included in the relevant annexes.

Recommendations

21. The provision of technical support services, including the exploitation of target mine types and the creation of inert samples, is recommended as a component of all future clearance contracts.

22. Exploitation activity may offer important information for future programmes on issues such as the overall condition, viability and detectability of target mines. This type of technical intelligence should be taken into account during the planning phases in order to allocate appropriate resources over a suitable

period; it is therefore recommended that exploitation work is considered prior to the detailed planning of clearance operations.

23. It is further recommended that there is a provision for additional technical support during a programme, if necessary. The isolated SB-33 mine illustrated one scenario where this was worthwhile; other scenarios might include detection anomalies, munitions in a particularly dangerous condition and technical aspects of accident investigation.

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April 2013

ANNEX A

EXPLOITATION OF THE C3B ANTI-TANK MINE

Background

1. The C3B (shown in ***Figure A1***) is a large and powerful anti-tank mine with the following specifcations quoted by the Spanish manufacturer, Explosivos Alavese (EXPAL) SA:

Weight	5.7 kg	Diameter	290 mm
Explosive weight	5 kg	Height	60 mm
Explosive type	TNT/RDX/Al (50/30/20)	Operating pressure	275 kg

Figure A1
The Spanish C3B anti-tank mine, shown here armed, with fuze fitted and safety cap to the left

2. The C3B uses a fuzing mechanism very similar to that of the P4B anti-personnel mine, protected by an additional plastic assembly to bring the operating pressure up to an acceptable level. Most of the components of the C3B are based on polystyrene plastic and are solvent-bonded together; this makes disassembly difficult and potentially dangerous. Components of the C3B are shown in ***Figure A2***.

3. Other than the aluminised explosive, the sole metallic content of the C3B is a steel spring weighing approximately 0.15 g. During Phase 1, it proved difficult to locate this spring reliably using any commercially-available detector.

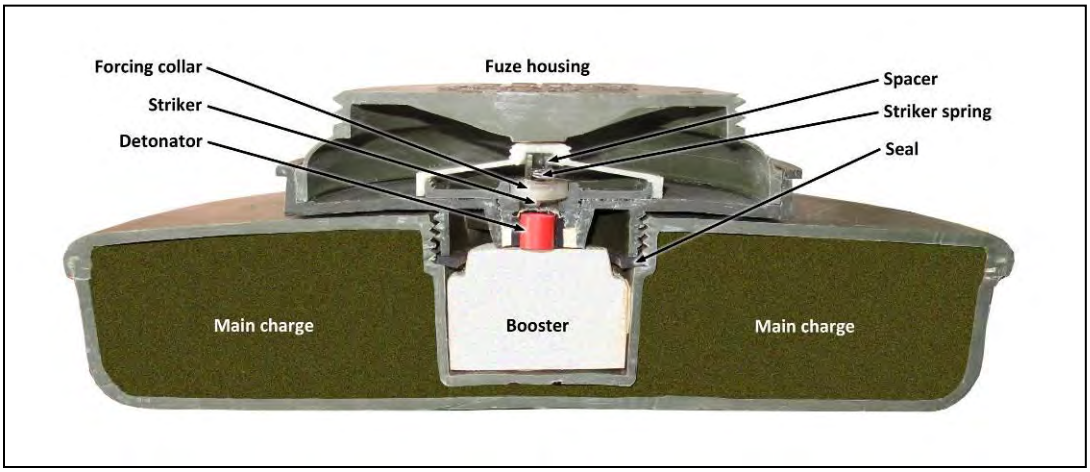

Figure A2
Components of the C3B

Methodology

4. Each of the 32 C3B mines located in SA064 was photographed in position and allocated a unique serial number. The mines were extracted from the ground and defuzed in the minefield. A sample of 14 mines were then selected and disassembled for examination.

5. All of the mines had been buried beneath peaty soil and vegetation, with depths typically around 100 mm. Mines from a variety of conditions were represented within the 14 chosen; some were extracted from firm ground while others were partially or completely submerged (see ***Figures A3 and A4***).

Figure A3

C3B in firm ground

Figure A4

Some mines were submerged

6. The mine bodies were opened and the main charge removed; the inside of the casing was then cleaned and examined for cracks.

7. The external and internal condition and constituency of the main charge was assessed before being set aside for demolition.

8. The webbing carrying handle (which is cast into the explosive) was cleaned and fastened back into position in the casing using adhesive. Previous examples had been re-assembled using metal rivets, which substantially increased the metallic signature of the mines; this means that they cannot be used as detection targets.

9. The solvent bond around the detonator was removed mechanically, the bond broken from around the thread of the detonator and the detonator unscrewed from the base of the fuze.

10. The bond around the shoulder of the external fuze housing was then broken, allowing the removal of the pressure plate and access to the fuze mechanism and striker spring. Some of the internal fuze housings could be opened by breaking the plastic bonds while others had to be cut.

11. All components were examined and photos were taken at every stage of disassembly.

12. A sample of five live fuzes, which had not been disassembled, were placed on a sandbag and subjected to pressure (well in excess of that normally required for initiation) using the bucket of an armoured excavator in order to assess the condition of the detonator.

13. The main observations from exploitation are illustrated and described below.

Exterior characteristics

Figure A5

The top surface (left) and underside (right) of the mine body with fuze removed. All of the mines recovered appeared to be in good condition superficially; however, every mine had cracks in the casing

Figure A6

Fine cracks in the casing allow the ingress of water; freezing then gradually extends the breaks

Figure A7

The top surface (left) and underside (right) of the fuze assembly. Most of the fuze bodies appeared to be undamaged and well sealed, yet almost all were wet inside

Fuze mechanism

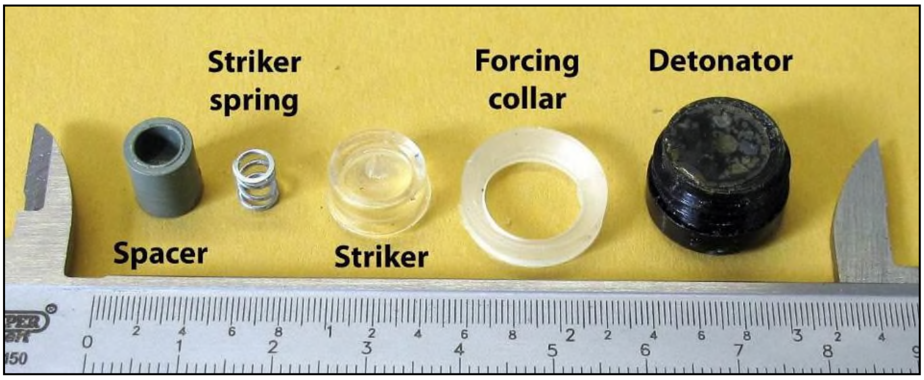

Figure A8
Components of the C3B fuze mechanism. Pressure applied to the top of the fuze forces the striker through a flexible 'forcing collar', which accelerates the striker into the detonator. The spring makes relatively little contribution to this effect

Figure A9
The sealed fuze assembly is very similar to that used in the P4B anti-personnel mine. Water was found inside almost all of these units

Figure A10
Due to corrosion, this striker Spring weighed only 0.09 g

Explosive components

Figure A11
Upper section of the casing removed to reveal the main charge; most were in good condition with little or no cracking or deterioration evident in the explosive. Although the inside of the plastic casing was wet, the cast filling contains very few voids

Figure A12
Booster pellets are composed of a pressed TNT/RDX (60/40) mixture and virtually all were in good condition. Despite the neoprene seal between the base of the fuze and the booster, all of the booster pockets contained water

Figure A13
The composition of the main charge is quoted as being TNT/RDX/aluminium (50/30/20) but, as shown here, the mixture is rarely homogenous. The aluminium content does not affect the detectability of the mine

Figure A14
The proportions of the constituents in the high explosive varied significantly; this sample contained no aluminium whatsoever. This is evidence that different material characteristics and specifications may be found within the same lot number

Figure A15
All of the C3B detonator assemblies examined were wet. The protective layer of clear plastic film over the stab receptor (right) did not provide an effective water-tight seal

Figure A16
Subjecting live fuzes to an operating load (>300 kg) using an excavator bucket did not produce any detonations. The most likely explanation is that the stab-receptive composition is no longer functional

Conclusions

14. All of the C3B mines recovered from SA064 appeared to be in good condition superficially, but all of the casings were cracked. The ingress and subsequent freezing of water is gradually causing the deterioration of the casings, but the effect is slow due to the small volumes of water and the flexibility of the plastic. The process is likely to accelerate as existing cracks enlarge and the plastic becomes more brittle.

15. The rate of deterioration has been slowed substantially by burial. Polystyrene is vulnerable to UV light and (according to observations made in the late 1980s) the casings of mines exposed to the sun had cracked badly within a year or two of exposure. Burial is also likely to reduce temperature gradients within the mines, minimising the expansion of explosive during hot weather and of water during freezing conditions.

16. There is little evidence of deterioration to the plastic of the fuze housing; it is therefore reasonable to expect that the operating pressure of most buried mines will still exceed 200 kg. However, mines that have been exposed to sunlight may be capable of functioning under far lower loads.

17. All fuze mechanisms appeared to be operational, despite the corrosion of some striker springs. Fuzes are likely to remain functional despite the deterioration of the striker spring.

18. The striker spring is the only metal component within the mine. The spring weighs less than 0.15 g when new and is positioned around 20 mm below the surface of the pressure plate; this makes its detectability marginal at best. If the striker spring is corroded, the metal content of the mine may be reduced or eliminated altogether, making it impossible to locate with a metal detector.

19. The explosive constituents of the main charge may vary, but this has little significance to the functionality of the mine. The booster and main charge remain intact while enclosed by the mine casing and solubility in ground water is low; the charges are therefore likely to remain viable for many years in buried mines.

20. Where C3B mines have been exposed to sunlight or have sustained mechanical damage to the casing, it is likely that the main charge and booster will gradually begin to crack and will eventually disintegrate.

21. Findings from the Ageing Study suggest that the primary explosive in the detonator is likely to remain viable for many years, being well protected by its plastic casing. However, the stab-receptive composition used to initiate the primary explosive is vulnerable to water and prolonged immersion appears to have rendered many of the detonator assemblies incapable of functioning as designed.

22. The ingress of water into the detonator is dependent on a number of factors and it is entirely possible that some remain capable of operating as designed. Those that cannot, but which still contain viable primary explosive, may be detonated by other influences, such as fire or impact.

ANNEX B

EXPLOITATION OF THE ISOLATED SB-33 ANTI-PERSONNEL MINE

Background

1. The SB-33 is a small anti-personnel mine with the following specifications (approximate):

Weight	140 g	Diameter	85 mm
Explosive weight	35 g	Height	30 mm
Explosive type	RDX/HMX (98/2)	Operating pressure	8 kg

2. The mine is extremely robust, with most of the components made from polycarbonate plastic; the fuzing mechanism is designed to be highly resistant to impact and shock. Some of the SB-33 mines recovered from SA064 are shown in ***Figure B1***.

Figure B1
SB-33 mines recovered from mine rows in SA064

3. The isolated mine found in SA064 (***Figure B2***) showed obvious damage, particularly to the base (***Figure B3***) where the detonator plug was cracked and a section of the mine casing had been broken away. The broken section of the base was found close to the mine body.

4. The primary purpose of exploitation was to gather evidence to support an explanation for this mine's presence outside the minefield rows, in addition to making it safe for disposal.

Figure B2
The SB-33 mine found in SA064

Figure B3
Base view of the casing

Findings

Figure B4

On initial inspection, the fuze and main charge appeared to be relatively intact. The ingress of water would not prevent the mine from functioning

Figure B5

Removal of the fuze plunger revealed that the several of the fuze components had been shattered and the striker displaced

Figure B6

Removal of the fuze components exposed the full extent of the damage

Figure B7

The detonator plug had also been shattered and could not be used to remove the detonator

Figure B8

The detonator was seized into place and surrounded by impacted explosive from the main charge

Figure B9

The main charge, normally a rigid horseshoe of pressed explosive, had been pulverised

Conclusions

5. The isolated SB-33 mine discovered in SA064 had clearly been subjected to a substantial amount of shock. This was evident in the shattering of fuze components made from polycarbonate (the plastic used in protective visors) and the pulverisation of the main charge.

6. Although the exterior of the mine casing showed no evidence of scarring from fragmentation, the internal damage is entirely consistent with the effects of a nearby detonation.

7. The damage to the mine, together with its displacement and the presence of a crater in the mine row, strongly suggest that this mine was thrown out by the detonation of an artillery shell during the conflict.

8. The mine was incapable of functioning as designed; however, the condition of the detonator means that it might have been in an unstable state.

9. The demining team and DPO were absolutely correct not to attempt to defuze or disassemble this mine.

ANNEX C

COMMENTS ON BOOBY TRAP REMNANTS

Background

1. Several booby traps (BT) were discovered during Phase 3, all being typical of the type laid by Argentinian forces during the conflict. Each consists of a simple firing device in which a spring-loaded striker is released by tension on a tripwire. The firing device is designed to initiate a percussion cap, which ignites a length of pyrotechnic fuze running to a detonator placed within the main charge. The main charge consists of TNT blocks.

2. The following booby traps have been located:

SA number	Number of BT found	Number of TNT blocks In each
064	2	31
095	2	6
095A	2	5

3. None of the firing devices associated with these booby traps have yet been located, but they are believed to be the type shown in ***Figure C1***.

4. Detailed exploitation of the booby trap remnants was not deemed to be worthwhile; however, some of the comments in the captions below are based on findings from the Landmine Ageing Study[1].

Figure C1

The firing device typically used with Argentinian booby traps. The tube contains a spring-loaded striker retained by both a pin and a shear wire; this allows for optional pull or pressure actuation. The striker initiates a percussion cap, which ignites a safety fuse link to the detonator in the main charge. The safety fuze is retained in the fuze holder by the screw on the side

Figure C2

The fuze holder with percussion cap removed. The cap unit is a standard 12 bore shotgun primer. Although robust, these are unlikely to remain functional after 30 years exposure to wet conditions

[1] Three year Landmine Ageing Study conducted by C King Associates Ltd in association with James Madison University under funding from US State Department, Office of Weapons Removal and Abatement (WRA)

Findings

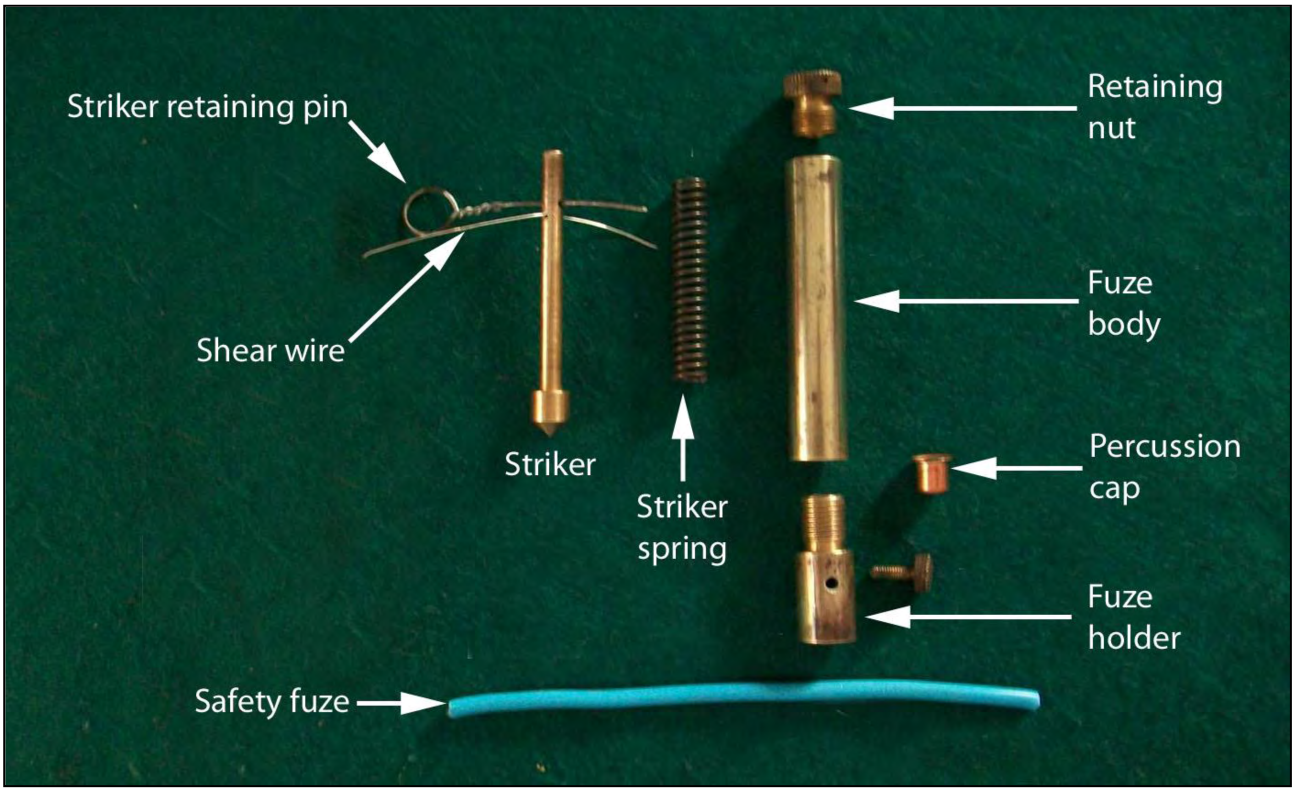

Figure C3

Components of the Argentinian firing device

Figure C4

TNT charges from a booby trap in SA064. These appear to have been 400 g blocks of pressed TNT, wrapped in waxed paper. Pressed TNT is deemed 'cap sensitive', meaning that it can be initiated directly by a No 8 strength detonator. The edges of the blocks have been eroded but the bulk of the explosive remains intact. Historical data on TNT suggests that it can remain capable of detonation for several decades

Figure C5

TNT blocks containing detonators and the remnants of safety fuzes. It is clear that any pyrotechnic composition in the fuse or detonator will be non-functional. However, findings from the Ageing Study (involving explosives of a similar type and age) suggested that the primary explosive in the detonator may be viable; this means that the explosive could be initiated by either fire or substantial impact

Conclusions

5. The booby traps found during Phase 3 were incapable of functioning as designed for the following reasons:

a. Firing devices were absent;

b. Even if firing devices had been present, data from the Ageing Study suggests that internal components (such as the steel striker spring) would be seized and incapable of functioning;

c. The shotgun primer used as the percussion cap is unlikely to remain functional after prolonged exposure to wet conditions;

d. The pyrotechnic compositions of the safety fuse and detonator flash receptor are vulnerable to water and were virtually unprotected for more than 30 years.

6. The Ageing Study suggests that the primary explosive within the detonator may still be capable of detonation. Initiation might arise from heat (such as a peat fire) or from shock (such as the impact from a flail hammer).

7. If the detonator functions, it is quite likely that TNT in contact will be initiated; this may, in turn, detonate other adjacent TNT blocks.