DDAS Accident Report

Accident details

Report date:	19/05/2006	**Accident number:**	385
Accident time:	10:00	**Accident Date:**	30/10/2003
Where it occurred:	Chana Pale, Xangongo, Cunene Province	**Country:**	Angola
Primary cause:	Inadequate equipment (?)	**Secondary cause:**	Inadequate equipment (?)
Class:	Excavation accident	**Date of main report:**	31/10/2003
ID original source:	AVS	**Name of source:**	AVS
Organisation:	Name removed		
Mine/device:	TM57 AT blast	**Ground condition:**	agricultural (abandoned) dry/dusty grass/grazing area sparse trees
Date record created:	22/02/2004	**Date last modified:**	22/02/2004
No of victims:	0	**No of documents:**	2

Map details

Longitude:	15° 02' 54" E	**Latitude:**	16° 44' 28" S
Alt. coord. system:		**Coordinates fixed by:**	GPS
Map east:		**Map north:**	
Map scale:		**Map series:**	
Map edition:		**Map sheet:**	
Map name:			

Accident Notes

mechanical detonation (?)

non injurious accident (?)

inadequate equipment (?)

Accident report

The report of an independent investigator was made available in November 2003. It is reproduced below, edited for anonymity.

The accident involved the “Mine Clearance Cultivator”, a machine owned by the US government and under trial with [a demining NGO] in Southern Angola.

[The photograph above shows the MCC alongside the T55 tank after the accident.]

The report was compiled by [name excised] as an independent inquiry into the circumstances surrounding an accident in which a machine was damaged but no one was injured. The report is written on behalf of (and at the request of) [demining group]. The author was within 30 kilometres of the incident site when it occurred, engaged in an unrelated task, so was able to attend the accident site within an hour of the accident occurring. The staff involved were interviewed and the damage to the machine inspected with a view to carrying out an appropriate investigation according to the norms within Humanitarian Demining.

1 General data

Date of incident: 30th October 2003

Time of incident: approximately 10:00 hrs

Place of incident: Chana Pale, Xangongo, Cunene Province, Angola.

Access: Road No,6(8)A from Xangongo to Ondjiva. Turn onto a dirt road 6.3 km from Xangongo and drive 3.4 km through bush.

GPS: S16° 44’ 28”; E15° 02’ 54”

2 Accident site

The accident occurred at Chana Pale, in the 3rd (outer) ring of mine belts around the city of Xangongo, Cunene Province, Angola.

The ground is level in the area with scattered bush in the surroundings. The area to be worked is clear of trees. Because of the level ground, large areas become shallowly submerged in the rains, and some of these only completely dry out for a short time in the dry season. The incident occurred in one of the areas that are shallow ponds for much of the year and over which there is now long, dry, marsh grass. The soil was dry but friable.

Local people have been moving back to the area in the last year and establishing Kimbos (brush-fenced enclosures of thatched huts). There is a Kimbo within 200 metres of the accident site.

3 History

The incident occurred in an area that had been the outer ring of three defensive minefields around the city of Xangongo.

The AT mines present are reported to have been laid mechanically by Cuban forces in support of the government. The mines used are reported to have been TM62B, TM57 and TM46 Anti-Tank mines. The mine-laying machine dug holes at 3m spacing and the mines were placed either by men or machine. There were two (sometimes three) rows of tank mines. In some areas each mine on the outer (enemy) side was protected with three PMD-6 AP blast mines. Some mines in the area had been collected and removed by local people. This was in response to a “bounty” offered for mines across the border in Namibia. The bounty was paid by the South African armed forces based in Namibia at that time. As a result, erratic gaps in the mine belts occur.

Accident No. 368 in the Database of Demining Accidents (UNMAS/GICHD) occurred at the same place (within four metres) on 18th March 1993. The Humanitarian Demining group involved in that incident were named [name excised]. They had deployed disarmed Soviet T55 tanks with KMT5 roller systems mounted on the front in the hope of carrying out rapid mechanised clearance of the area. At that time, the area was wet and the tank was low to the ground when a TM-57 AT mine detonated under a track (having been missed by the rollers). The hull was breached and one occupant of the tank was killed. The severely damaged tank was deliberately burnt out and remains in place. The mine involved was identified by inference because other mines found in that part of the mine belt (located manually) were said to have been TM-57s.

Mine clearance records were not accurately kept at that time, so no-one is entirely certain whether the wet area around the tank was later cleared manually (in the next dry season, or later). Some of the area traversed by the T-55 was later cleared and it was claimed that functional TM-57 mines were found. This meant that the entire area over which the T55 roller system was used “suspect”. Prior to the MCC deployment, local people reported that the area around the wrecked T55 tank was still mined but the information was considered uncertain because these people were not there at the time of the first mine clearance attempts, having only returned to the area recently.

4 Threat assessment

The threat mines were believed to be TM-57 Soviet AT mines. The pre-deployment assessment did not include an expectation of finding PMD-6 mines in this part of the mine-belt.

During the work of the MCC it uncovered and drove over a PMD-6 AP mine, crushing it but not detonating it. Manual deminers found it and another MUV fuze (as used in the PMD-6) in the area traversed by the MCC. They could not find the second wooden box and believed that it may have been broken up and driven deep into the ground. The box has two small hinge pins of ferrous metal but these often disintegrate with the passage of time (especially in wet areas) so the rest of the mine can be impossible to detect with a metal-detector. Without the fuze the mine presents, of course, a very low threat.

The photograph above shows the crushed PMD-6 recovered by the deminers.

Both MUV fuzes were heavily corroded but still included the “delay” arming section at the top and the remains of a rusted arming pin. These mines were not armed.

When the PMD-6 was found (24th October), the threat assessment was expanded to include AP mines. As there are people living in the area and crossing the suspect land, the risk of civilian injury was considered higher and the task’s priority enhanced.

5 The MCC

The MCC in use in Angola was remotely controlled while in the suspect area. Control was from a large armoured vehicle named the “Cougar”. The Cougar and the MCC’s carrier were fitted with a total of four cameras, with screens showing their pictures inside the Cougar.

The Mine Clearance Cultivator is a large “agricultural” attachment designed to fit a heavy carrier vehicle (bulldozer). The attachment uses shaped tines to “til” the ground and a wormscrew auger to carry large items that are incovered to one or other side of the machine.

The MCC is described on its designers website [http://www.humanitarian-demining.org/demining/clearance/mcc.asp]. See Related papers.

This particular deployment had included another attachment for the bulldozer. This was a “sifting” device intended to process “berms” left by the MCC. Field staff pointed out that the MCC did not leave appreciable berms and so the sifter had not been deployed. Because it was not used (and was not intended to be used) at the accident site, I did not examine the sifter and had no opportunity to see it work.

6 MCC deployment

On 16th October the MCC deployed to the accident area and it began work on 20th October. The task-plan involved processing the perimeters of the area beyond the flood line, starting from the outside with a safe lane that marked out a “box”. All areas traversed by the MCC were to be cleared manually after the machine had passed. It was intended that the safe lane should mark the perimeter of the area, but this was varied when local people wanted the area around the tank cleared as a priority. The perimeter was unmarked. Marking tape was not used because the MCC needed to be able to manoeuvre as the base line was moved forward following manual clearance of strips processed by the MCC.

MCC cultivated two adjacent straight-line sides of the “box” it would work, then worked in from these “sides” towards the ruined T55 tank. For safety, the “box” was considerably larger than the suspect area (approximately 90 x 90 meters). The MCC made 15 passes on the East/West side, and 7 on the South/North side leading up to the tank. On the 8th pass South to North, which was the first on the East side of the tank, the incident occurred as the MCC was passing the tank. [Diagram removed.]

7 Investigation

I arrived at the site at around 10:50 and found the [demining group] deminers checking around the MCC with metal detectors. They were removing a large amount of debris from the explosion, most of which was on the surface. A grass-fire around the explosion had either burned out or been extinguished.

I reported to the Site Manager and explained that I had been asked by [the Demining group] to make an investigation. The Site Manager did everything possible to assist me, providing an interpreter and helping me to ask questions and understand answers. All [demining group] personnel were open and frank at all times.

The personnel interviewed were [four names excised].

The team had deployed at around 08:00 and the MCC machine was brought into the suspect area from its place of safe-keeping nearby at around 08:30. It was manually driven to the

edge of the safe lane and thereafter operated remotely from the Cougar armoured command vehicle about 120 metres away (as far away as possible while still allowing a camera view through trees). The threat of MCC damage from concealed roots (left after burning trees down to make charcoal) meant that progress was cautious. The MCC's tines had already been damaged by contact with concealed roots of dead trees at the site. The MCC made one pass South to North on the West side of the T55, passing as close as possible to it. It was driven (RC) back to the South side and lined up for a pass on the East side of the tank. Manual deminers checked the area it had just traversed. Then the MCC made its first that pass on the East side of the T55 (and as its cultivator attachment began to pass alongside the T55 turret) there was a detonation.

Normal [demining group] hand-held radio communication was not possible because the use of these radios interfered with the video signal from the cameras mounted on the MCC. The images from these cameras allowed the machine to be controlled with precision by operators who did not have direct line of sight themselves (an external camera on the command vehicle did have direct line of sight).

After the detonation, the signal from the MCC's video cameras was lost. The machine stopped moving but its engine was running. [The Site Manager] left the command vehicle using the door on the safe side and warned the rest of the team to stay behind the vehicle while he went to investigate. He went to the T55 crossing the cleared area and stood on the T55 tank to assess the damage. A grass fire was spreading away from the accident site but was not providing an immediate threat to the MCC. The MCC motor was still running. He was able to pass from the tank to the MCC in order to switch the motor off.

When I arrived at the site, the MCC was standing alongside and slightly behind the T55 tank. The distance between them was about 40 centimetres at its closest point.

I found that the device had detonated on the left-hand side (facing forwards) of the MCC's cultivating attachment. It had apparently detonated above ground level and on top of the auger to the rear of the attachment, exploding as it passed to the side of the machine. Damage to that side of the auger and entire cultivating attachment was severe, with large parts separated. This means that the mine detonated on the T55 side of the MCC, and there was some evidence of sooting and light fragmentation damage to the side of the T55 tank. The tank was in poor condition and some damage may have been old. There was no evidence that either the tank or the MCC were physically lifted or moved sideways by the detonation.

The rear window of the MCC cab had sprung inward (unbroken) and the control panels come loose. There was also some damage to the cab structure, with one door jammed and another twisted. The glass inside the camera on that side was broken, although the cover (presumably polycarbonate) was not.

The left side of the cultivator attachment was wrecked as shown below (this picture was taken after the machine had been withdrawn from the suspect area).

I examined the machine thoroughly before it was moved (driven manually) backwards along its own tracks out of the suspect area. For this manoeuvre, all personnel except the driver, [the Site Manager], withdrew 100 metres behind the armoured command vehicle (Cougar). A

deminer then checked where the MCC had been standing and found further debris from the detonation. None of that debris was from the device involved in the accident. There was no crater, but there was evidence of a point of initiation with “teeth” broken from the auger driven into the ground - indicating that the device was above those teeth when it detonated. Damage to the auger’s drive-train on that side was catastrophic (all parts separated, including parts of the triple-width chain) which confirms where the detonation occurred.

The picture below show the auger damage.

Blast sooting on the cultivator backplate supported the inference about the place of detonation.

I checked the ground at the point of initiation but could find no evidence of the device involved. The ground at that place had been passed by the MCC’s tines, and was disrupted to a depth of 8-10cm. There was scrap metal contamination alongside the T55 tank and the tank itself made a fast metal-detector search difficult. I did not spend hours looking for evidence of the mine involved because I had no reason to expect to find any evidence.

8 MCC performance

I asked about the MCC’s past performance and was told that it had largely been deployed in safe areas as a data-gathering and testing exercise. During this time, dummy mines provided by its owners had sometimes been placed in the ground at a shallow depth to help assess its ability to unearth mines. It had unearthed some of these concrete dummies, but it had also missed at least one and run over it with its tracks causing damage. (See photograph below.) The relatively hard soil in the dry season caused regular tine-damage, breaking shear bolts and sometimes welds in the cultivator attachment. This meant that the tines could not be deployed to dig deeply, even in the softer ground of the accident site.

Earlier this year, prior to [the Site Manager’s] employment, the MCC had been moved to its first genuinely suspect area. As it drove into the area cultivating a strip that would become a safe-lane after manual clearance, it detonated an AT mine on top of the auger and on the left side of the attachment. The mine was probably in the open inside the attachment and damage was far less extensive than in this accident, but the machine had to be withdrawn for extensive repair and the replacement of parts. On that occasion, the rear window of the cab shattered. Remote control of the machine was also lost on initiation, and the machine stopped advancing (presumably as it is designed to do).

Since deployment at the accident site, the MCC has missed and crushed with its tracks at least one PMD-6 mine and probably two. One was found during manual demining as follow-up. A second intact fuze was found.

9 Conclusions

The MCC struck an explosive device as it passed close to a ruined T55 with roller-attachment that had also struck an explosive device and been severely damaged in 1993. The MCC was being operated safely and while paying due cognisance to all the available information about threats and local concerns.

The fact that local people believed the area was dangerous may be of greater significance than is obvious. Frequently, local people will move unknown or suspect devices out of their way, putting them in a place that everyone knows should be avoided (such as the obvious wreck of the T55 tank). People may have placed ERW items close to the tank. The fact that they knew that a deminer died inside the tank may have meant that it would be disrespectful for them to enter the tank itself, so placing the items close by might be expected. The items moved to the vicinity of the tank could have been far more extensive than mines. However, I found no evidence of penetrative or fragmentation damage that implied that the device involved was anything other than a large blast mine.

The explosive device involved in this incident is most likely (by inference) to have been a TM-57 with 6.34 kg of TNT. The extent of the damage implies that it may have been a TM-62B with a main charge of 7.5 kg TNT.

The mine appeared to have initiated as it left the auger and so below or beyond the left-side upper support arm of the cultivator and alongside the auger-drive mechanism. This means that the detonation was confined on one side by the cultivator and on the other by the wrecked T55 tank. The T55 is embedded in the ground and has not moved (crusted earth around the wheels and rollers was unbroken). Reflection from the tank may have had the effect of intensifying the blast damage to the cultivator and auger mechanism.

The cultivating attachment is so severely damaged that it may not be economic to repair it.

While I have not carried out an extensive engineering assessment in a workshop, repair requirements to the “bulldozer” carrier seem to be limited to cab-repair and the replacement of one major bolt-on ball-joint, where the left arm of the “C” frame is attached. The electronics involved in the RC and Video systems will also require repair/replacement.

10 Recommendations

In line with normal HD accident investigations, “recommendations” are included in the hope of providing guidance to avoid any repetition of the accident and to increase safety.

The MCC

This machine had only worked on a total of a few hundred square metres of suspect ground when this accident occurred. Over that few hundred square metres, its performance had been demonstrably poor (with two known missed and two detonated devices). The missed AP mines mean that it must always be followed by full manual clearance, and the devices it leaves behind may well be damaged (as with the PMD-6 found at this site), so the follow-up requires increased caution in response to an elevated risk assessment. For this reason, full manual follow-up is likely to take as long (or longer) than it would take to clear the area manually in the first place. The detonated AT mines have done extensive and costly damage to the machine and imply that its design (intended to move mines to one side) is flawed.

The threat mines in the area are the TM57 and TM62B AT mines and the PMD-6 AP mine. The ground is not electromagnetic, although there is fragmentation in the immediate vicinity of the T55 tank. The ground is relatively soft and the area is clear of significant undergrowth. It also has easy access. These facts mean that the area could have been cleared manually with relative ease and with no unusual costs.

The cost of the MCC operation is not known, but can be presumed to be high given the cost of the machine and its control vehicle, their deployment, their running costs and their staffing by dedicated support personnel. It has worked slowly (very slowly when compared to designer's claims – see Related papers) and has required frequent running repairs. My estimate of the repair costs involved in both accidents (including the cost of sending staff from the USA to oversee repairs) far exceeds the cost of a ten-man manual clearance team for several months. This leads me to the opinion that the MCC is an uneconomic tool for use in support of wide-area Humanitarian Demining at a site like this.

I recommend that there would be little or no value in repairing/replacing the damaged cultivating attachment. However, it is possible that another attachment might make the machine more useful despite its gross weight (the bulldozer is so heavy that it cannot be driven over road bridges in the region).

If the MCC is to be repaired, I recommend that the repair should include the installation of a means of removing the vehicle from a suspect area after a blast without having to drive it manually. This may be achieved by fitting a properly armoured cab (so protecting the RC systems) and duplicating controls so that a secondary system can be switched on after a blast – one that is unaffected by the magnetic surge associated with the first large blast. Fitting an armoured cab would also reduce the risk involved in withdrawing the machine from a suspect area manually if this is required.

The suspect area

I recommend that the ruined T55 tank should be moved from the area, if possible, so allowing easier access to the ground around and beneath it and its roller attachment.

The entire area around the T55 tank to a distance of 40 metres each side North and South, 25 metres West and 70 metres East should be cleared/recleared using proven methods involving the removal of all metal fragments. Preliminary checks close to the T55 imply that there is not extensive fragmentation over a wide area, so the use of good metal-detectors should be viable in all except a few square metres. These should be excavated with a minimum 15 cm of topsoil removed. This clearance should be done as a priority in order to rebuild local confidence in [the demining group] and its operations.

Analysis

The primary and secondary causes of this accident are listed as "Inadequate equipment" because it is apparent that the machine cannot achieve its design aims. It is not designed to withstand AT mine blasts and in this accident it spread parts of itself over a wide area. This is both costly and dangerous, because the operating SOP is use did not involve imposing a wide-area exclusion zone on the people living in the area.

Related papers

The following description of the MCC was found on a US government website (December 2003).

"DESCRIPTION: The Mine Clearing Cultivator (MCC) is a large tine array designed to uncover buried AT mines from the soil without destroying its ability to support agriculture. The tine array lifts the mines to the surface without creating a berm or spoil. A hydraulically powered auger casts the mines to both sides of the vehicle for neutralization. The MCC is a kit designed for installation onto 150KW (200HP)-class dozers. The kit contains a tine array, auger assembly, hydraulic power unit, linkage assembly and an ultrasonic depth control system for the tine. The current system is mounted onto a Liebherr 742B dozer. The kit can be integrated onto a Caterpillar D7R dozer and other tractors as well.

"SPECIFICATIONS:

Weight

MCC Assembly:	7,420 kg (16,324 lbs.)
Hydraulic power unit:	1,889 kg (4,156 lbs.)
Liebherr 742B (Dozer):	22,636 kg (49,800 lbs.)

General:

Clearance Width:	3.66 m (144 in.)
Clearance Depth:	20-38 cm (8-15 in.) depending on vegetation
Tine Array:	23 tines spaced @ 14.3 cm (5-5/8 in.)
Auger Operation:	25 rpm
Hydraulic Power Unit Output:	132 kw (177 hp)

Capabilities:

· Clearance rate of 4000 square meters/hour in light-to-moderate vegetated and denuded areas to a depth of 25 cm (10 in.).

· Reached mines as deep as 38 cm (15 in.) in light soils.

· Tine arrangement survived live mine blasts equivalent to 6 kg (13.4 lbs.). Damage was field repairable with parts in the support package.

· To date, no fused AT mines have been initiated during operations.

Limitations:

- Small mines pass through the auger assembly.
- Remote control operation tends to slow clearance rate.
- Terrain limited.
- Total system weight exceeds 32 metric tons.
- In desert sand, the mines tend to stall in auger.

[The statement that "no fused mines have been initiated during operations" was not true even before the latest accident. No mention of using another "ground sifting" machine after the MCC was made at the website where the above information was downloaded.

In a telephone discussion with the head of the group that designed and built the MCC, its performance was called a "success" because there were fewer mines around as a result.]