

9-29-2001

# DDASaccident353

Humanitarian Demining Accident and Incident Database  
*AID*

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# DDAS Accident Report

## Accident details

<b>Report date:</b> 06/04/2004	<b>Accident number:</b> 353
<b>Accident time:</b> 07:35	<b>Accident Date:</b> 29/09/2001
<b>Where it occurred:</b> Shilalo, Ladesley, Gash Barka	<b>Country:</b> Eritrea
<b>Primary cause:</b> Inadequate equipment (?)	<b>Secondary cause:</b> Management/control inadequacy (?)
<b>Class:</b> Missed-mine accident	<b>Date of main report:</b> 01/11/2001
<b>ID original source:</b> BOI 03/01 DB/DW/PM/PH date inferred	<b>Name of source:</b> UNMEE
<b>Organisation:</b> Name removed	
<b>Mine/device:</b> TM57 AT blast	<b>Ground condition:</b> bushes/scrub clay dry/dusty hard sparse trees
<b>Date record created:</b> 21/02/2004	<b>Date last modified:</b> 06/04/2004
<b>No of victims:</b> 1	<b>No of documents:</b> 2

## Map details

<b>Longitude:</b> 37° 35' 40" E	<b>Latitude:</b> 14° 38' 15" N
<b>Alt. coord. system:</b> Shilalo minefield ER246	<b>Coordinates fixed by:</b> GPS
<b>Map east:</b>	<b>Map north:</b>
<b>Map scale:</b>	<b>Map series:</b>
<b>Map edition:</b>	<b>Map sheet:</b>
<b>Map name:</b>	

## Accident Notes

mechanical detonation (?)  
mine/device found in "cleared" area (?)  
inconsistent statements (?)  
inadequate communications (?)

inadequate medical provision (?)

inadequate equipment (?)

## Accident report

A Board of Inquiry report and some appendices were made available in 2001 and is reproduced below (edited for anonymity. Photographs were sourced from elsewhere. A cursory IMSMA report was made available in 2004. See *Related papers* at the *Other documents* tab.

## Executive Summary

A Board of Inquiry (1301) 03/01 2001 was convened as a result of a mine strike on a Hydrema flail being operated by [two NGO's together] on 29 Sep 01 in Shilalo minefield ER246.



The picture above shows the machine after the blast.

The operator of the flail machine received a number of injuries none of which were life threatening. He was successfully extracted from the mined area, given appropriate medical treatment and evacuated by road and air to the JORBAT Level 2 hospital in Asmara. Following diagnosis and further treatment he was later evacuated by air to Denmark for reconstructive surgery to his right ankle.

The BOI was appointed by the UNMEE MACC to investigate the accident and to draw any relevant conclusions to further the safety of humanitarian mine clearance operations in Eritrea with particular reference to the operation of the Hydrema flail.

A number of factors that may have contributed to the accident were considered by the BOI during the investigation, including the following:

1. Geography, Terrain and Climate.
2. Site History.
3. Agency History.
4. Sequence of Activities immediately pre and post-accident.
5. Equipment History and Applicability.
6. Quality Assurance History of the Site.
7. Communications.
8. Medical Procedures and Evacuation Drills.
9. Evidence of re-mining.
10. The mine/UXO involved.
11. Application of Safety Standards, SOPs and other relevant documentation.

The investigation was conducted smoothly with excellent cooperation from all of the organizations involved. This greatly enhanced the ability of the BOI to conclude its investigation and draw relevant conclusions and make valuable recommendations.

The geography, geology and climatic conditions at the site of the accident did not contribute significantly to the accident. However, the depth of penetration achieved by the flail unit was much reduced from that claimed.

It was clear from the site history that the presence of AT mines should have been well known. It should, therefore, have been unsurprising that a mechanical flail sustained an AT-mine strike. What was disturbing was the fact that there appeared to be disparity between the original minefield records, how those records were interpreted and how the clearance was approached. The risk assessment of low medium still stands. The Hydrema is a mine clearance vehicle and should be capable of withstanding such a strike. The question of whether it was operator or mechanical failure that caused the accident still is unresolved. What is clear is that the operator, supervisors and both internal and external QA at no time tested the actual depth of ground penetration and this may have contributed to the accident.

All organizations involved in the accident acted appropriately to the situation and were operating the flail according to tried and tested procedures with the exception of flailing depth. However, the SOPs in use for the flail were still being developed for specific application in Eritrea. Clearly, this issue needs to be addressed soonest.

The sequence of activities immediately prior to and after the accident is as per drill. That is with the exception of the response time of the helicopter to effect evacuation of the casualty. 130 minutes, although acceptable considering the state of the casualty appears excessive when the rescue party was expecting that the helicopter would be on site in 30 minutes or so. The lack of effective communication between AirOps and the people-awaiting rescue at the Helicopter Landing Site (HLS) should be addressed. The response to a mine accident should be one of the highest priorities as mine accidents are normally of the traumatic amputation type. Agencies must also be aware that the helicopter is not a primary option for CASEVAC and planning must focus on alternatives mechanisms.

Quality Assurance (QA) had been effective at the site prior to the accident and, in fact, it was the QA visit and CASEVAC rehearsal conducted a couple of days prior to the accident that may have played a significant part in the successful extraction of the casualty from the danger area. QA teams had already picked up many of the problems encountered on the site during the accident period but unfortunately a method of sanctions against organizations failing QA inspections is not in place. As has been mentioned the QA teams did fail to pick up the lack of penetration. The flail system is recommended to have a follow up system such as dogs or manual deminers rechecking the land flailed. Should the mine not have been detonated the follow up system would have found the mine and the overall demining process would have worked.

Another point of concern is the system by which Task Orders are processed and monitored. The Task Order was not signed and accepted prior to the commencement of operations. There may be a need to review the system of issuing, signing and receiving Task Orders within the EMAP, agencies and UNMEE MACC.

The rapid attendance of medics at the scene and to the casualty no doubt ensured that treatment was administered as quickly as is possible. The issue of whether or not the medics should have entered the mined/danger area is open to debate. Whether the CASEVAC was done effectively is beyond question. It was. The issue is whether or not it was done safely this appears to have been done although there is no written SOP on the subject on site. What is clear is that there is a requirement for further discussion about this issue especially when applied to the emergency extraction of a casualty from a minefield.

The contradictory evidence when it comes to how many morphine injections were given is also a cause for concern and needs immediate attention. There is definitely some question as to whether the patient received one or 2 doses of morphine

As a result of the crater analysis and the inspection of the accident scene the mine responsible for the explosion was, beyond reasonable doubt, a TM-57. This is consistent with the minefield record and the threat assessment. The large crater is not in itself unusual and may be due to a number of contributing factors. How the mine came to be detonated by the rear-most wheel and not the front wheel is open to a multitude of interpretations and can never be specified. However, what was very surprising was the degree of damage to the flail.

The Hydrema flail is purported to be able to withstand a direct strike from AT mines without significant injury to the driver. This was not the case. Weaknesses in the cab of the driver compartment led to blast overpressure and shock waves to flow directly into the cab. In fact, if it were not for the fact that the doors blew open, then the casualty would have sustained more

grievous injuries. This design fault has been acknowledged by the Danish Military inspection team and will be addressed.

In light of the findings of the BOI, in particular with reference to the unacceptable damage sustained by the flail, the BOI had no choice but to recommend the suspension of the operations of the second flail unit in any minefields suspected of containing AT mines until modifications have been made and the system tested further.

### **Attachments [The few made available are appended]**

Attachment A: Appointment of BOI  
Attachment 13: Minutes BOI meeting 9 October 2001  
Attachment C: Minutes BOI meeting 10 October 2001  
Attachment D: Minutes of BOI meeting 11 October 2001  
Attachment E: Preliminary Investigation Report  
Attachment F: Investigator's notes  
Attachment G: Investigator's notes  
Attachment H: Investigator's notes  
Attachment I: Investigator's notes  
Attachment J: Consolidated Notes  
Attachment K: Hydrema advertising Brochure  
Attachment L: UNMEE air mission request  
Attachment M: English translation of minefield record.  
Attachment N: TM57 specifications  
Attachment O: SOP being used on site  
Attachment P/Q: QA Reports for site  
Attachment R: Draft [Demining group] Report  
Attachment T: Letter suspending Hydrema Flail operations.  
Attachment U: Supplementary maps of MF and surrounding MF.

## **Full BOI report**

### **Introduction**

A board of enquiry was convened on the 05 October 2001 to investigate the mine accident on the 29 Sept 2001. (See attachment A.)

The following persons were appointed to the board:

Chairman:	Chief QA Officer UNMEE MACC
Technical:	EOD Officer UNMEE MACC
Agency member:	[Demining group] Technical Advisor
EMAP Representative:	EMAP CO EMAP.
Agency member:	DCA Operations Officer

A Provisional Investigation Report has been submitted and this has been accepted into the Board of Enquiry.

### **Geography, Terrain and weather Conditions**

The area where the mine accident happened is flat, sandy ground with clay under the surface dotted with various size bushes and trees; the flail removed most of the smaller ones but had worked around the larger ones. The ground was hard about 30mm under the topsoil. The weather was good at the time of the accident and it is the board's belief that the accident had nothing to do with geography, terrain and weather conditions. (See Attachment M for reference)

## Site History

The site was an area heavily contested by the warring parties during the conflict. The area was known to have both AT and AP mines, although the Ethiopians lifted most of theirs. There is a minefield record (see attachments M) for English version with accident site marked in). The minefield fitted the profile considered suitable for the Hydrema prior to this accident.

## Agency History [Demining group]

[The demining group] was founded in 1997 by three Non-Governmental organisations as a joint venture, in order to establish a [Base nation National] capacity within humanitarian mine clearance. All these organisations have considerable experience in other aspects of international humanitarian aid. Since June 1998, the [Demining group] has been running a mine-clearance operation in Afghanistan. [The Demining group] has since January 1999 been operating in Somaliland. During April 2001 also saw the start of a mine-clearance/EOD programme in Eritrea.

[The Demining group] co-operates closely with the Danish Armed Forces and Norwegian People Aid ("NPA") in order to develop and maintain its capacity. This co-operation comprises secondments, instruction and on the job training.

## Detailed Account of activities

Date/Time	EVENT/ACTIVITY
SEP 29	
06:40	Casualty departed compound for the minefield area in Shilalo, driving the flail.
07:00	Casualty arrived in cleaning area at the minefield tasks site and began to prepare the machine for operations. [Ex-pat No.1] took over responsibility for the demining operations from [Ex-pat No.2] in the neighbouring minefield.
07:15	Flailing operations began.
07:35	Detonation occurred.  Machine operator extracted himself from the cabin and onto the roof of the machine. The site supervisor informed all other sites, the UNMO Team Shilalo of the accident and suspended further operations.
07:40	[Ex-pat No.1] radioed [name excised] to inform him that he was on route to the accident site. He also radioed the [Demining group] HQ in Asmara to inform the Project Manager.
07:45	[Ex-pat No.1] arrived at the accident site with additional medics.  Casualty had arrived in the admin area of the site.  [Ex-pat No.1] instructed the casualty to be taken to the HELIPAD and made a HELIVAC request to the UNMO Team Shilalo.  [Name excised] organized a HELIVAC. Morphine may have been administered.
07:55	Casualty moved to the HELIPAD.
08:05	Casualty and rescue party arrived at the HELIPAD.  [Name excised] informed UNMEE MACC of the accident.
08:20	Casualty may have been administered 20g of morphine.
08:30	Casualty was administered oxygen.
09:45	Helicopter arrived at the HLS in Shilalo.

Casualty was put on the vehicle.

09:48 Helicopter departed for Asmara.

10:32 Casualty arrived at the JORBAT Level 1 Hospital in Asmara:

11:00 [Demining group] manual demining Section commenced clearance of a safe lane up to the machine for the investigation team.

12:30 UNMEE MACC Investigation Team departed Asmara.

19:00 UNMEE MACC Investigation Team arrived at Shilalo.

OCT2

01:25 Casualty evacuated by air from Eritrea to Denmark for further treatment.



The picture above shows the front of the machine after the accident (it reverses into the mined area with the flail on the back).

### **Quality Assurance**

QA teams had regularly visited the site and in fact the QA officer for sector west had only a few days prior to the accident observed a casualty evacuation being conducted. (See Attachments P and Q)

### **Process of the Investigation**

#### **First Board meeting 9<sup>th</sup> October 2001**

The board convened its first meeting on the 9th October 2001 at which stage a plan of action was developed as well as some preliminary questions raised. (See annex B)

The questions were:

1. Why was the vehicle so damaged?
2. How did the driver sustain blast injuries in the cab?
3. What were the drills that were carried out post accident?
4. What type of mine was it?
5. What did the mine records say?
6. What recommendations should be made with regards to the second flail?

A plan was mooted to conduct trials to determine whether the flail was working correctly to destroy the mines; this was because the flail, according to the PIR, was flailing to a depth of 0.5 m and it seemed strange that if the flail was digging to this depth why did it fail to destroy the mine?

Tasks were spread amongst the board and the board was encouraged to read the PIR (Attachment E) prior to the next meeting.

### **Second Board Meeting 10 October 2001**

The next meeting was held the following day (see Annex C) with the same attendees.

The Chairman gave a detailed time line of the lead up to the accident and post accident activities.

Other points that were discussed were:

- 1) Concern was raised about the time taken to obtain helicopter evacuation and there seems to be some unanswered questions regarding communications between the accident site and airops.
- 2) It was suggested that a recommendation should be that the site medics should accompany the injured party through to the hospital to ensure a proper hand over, as this was not done.
- 3) The issue of waivers was raised, as the pre-signed waivers were not on site.
- 4) Operator and machinery recovery from the site and whether the deminers could have cleared the distance safely and effectively in the short time recorded.
- 5) Accident control and site access.
- 6) Movement and control of medics into the accident site.
- 7) Accuracy of MF records was raised.
- 8) The applicability of the use of the Hydrema was raised and the question asked if this was a freak accident or was there a general fault in the machine?
- 9) [One Investigator] raised the point about the Task Order, which appeared in the PIR documentation that was not signed. There are clear ramifications if the process of issuing, receiving and accepting tasks is faulty. [The demining group] were requested to follow up this by trying to obtain a copy of the original order. There may be a requirement to conduct an audit within the UNMEE MACC to determine the frequency, if any, of task orders remaining unsigned even after tasks have been started.
- 10) The flail was not working on Eritrean designed SOPs and it was agreed amongst the board that these had to be finalized.
- 11) [The Demining group] confirmed a second flail would be ready for a demonstration when the site visit was conducted.

The chairman requested all questions arising from the first 2 meetings be presented to him for the following meeting (see Attachment F to I)

### **Third Board meeting 12<sup>th</sup> October 2001**

During the following meeting on the 11th October 2001 the questions arising out of the previous meeting were discussed and developed. An intended out puts and finalized list of concerns and questions was decided on subject to the site visit. (See attachment J)

Further discussions of the trial were held and the travel arrangements to the accident site were finalized.

### **The Site Visit 13<sup>th</sup> October 2001**

All members of the board as well as a 4-man team from the Danish military conducted the site visit on the 12 October 2001.

The members of the Danish military were a Lieutenant Colonel, an Engineer and two Majors.

The team arrived at the accident site at about 9am in the morning and was given a site briefing and orientation and then the site was handed over to the Board. The Sequence of events and findings on site are as follows

1. The Danish team was allowed to take soil samples out of the crater
2. [Three Investigators] excavated the crater



3. [Another investigator] set about determining the exact location of the vehicle in relation to the Eritrean mine records.
4. [Another investigator] did numerous tests of the ground to determine flail penetration.
5. All members of the team did an inspection of the cab and vehicle.
6. The team conducted a debriefing and joint meeting (see below).

### **Crater**

1. The crater was 700mm deep when excavated.
2. The crater was 1200mm in diameter.
3. The crater excavation clearly showed the mine was positioned with the base no deeper than 300mm, i.e. the top would have been a maximum of 200mm from surface.
4. The ground immediately surrounding the flail was flailed no deeper than 100mm.
5. There was a small tree stump near the crater that may have caused the rear wheels not to track with the front.
6. The mine was determined to be a TM 57 as sufficient mine parts were collected to discredit any other known mine in theatre.
7. Explosive residue samples are being analysed by the Danish team.

The following conclusions can be drawn regarding the crater.

1. The mine was laid at normal depth.
2. The mine functioned normally and there is no evidence of boosting or other tampering with the mine.

### **The vehicle**

The vehicle was damaged as described in the PIR; however, the following needs to be emphasized:

1. The vehicle was severely damaged by the mine and may require factory repair before working again. This is disturbing as the mine was a common mine used throughout the world. This is in contradiction to the manufacturers claims (see Attachment K).
2. The vehicle flail was missing 2 hammers and one chain, however, not in the area where the mine had passed under the flail, this is normal during operations.
3. The cabin had blast penetration as a result of the manufacturer building most of the cab out of 10mm armour steel plate with the exception of all maintenance access hatches for pedals and pipes etc. These were covered only with a 3 mm steel plate mounted from inside the cab and lightly bolted. Therefore, blast access to the interior to the cab was easily achieved
4. One door lock had broken and, according to the Danish military team, this was experienced during blast trials in Denmark as well.
5. The vehicle had a supposed blast deflector underneath. However, this had been torn off and thrown clear of the vehicle. There seems to be some confusion as to whether this is just protection for the pipes under the vehicle or actually a blast protector.
6. The vehicle was not flailing to the prescribed depth this may have been due to the operator not wanting to stress the machine or secondly the machine was incapable of doing so in that terrain and this is addressed in the conclusions and recommendations

The following conclusions can be reached about the vehicle

1. Damage was greater than should have been expected under the circumstances of the accident. The manufacturer claims a 2 to 6 hour repair cycle.

2. Protection to the operator was inadequate as shown by the blast penetration of the cab.
3. The vehicle needs strengthening in key places, primarily on the floor and door locks
4. The machine was determined to have passed only once over the ground where flailed and on the site the deepest penetration achieved by the flail was found to be only 100mm (4").
5. Should the vehicle have performed to the manufacturer's claimed standards or at least the national standards, the mine would have been destroyed by the flailing action and if it had missed the mine there should have been no injuries to the operator as a result of blast directly under the vehicle cab.



The picture above shows the floor of the cab where the steel plate covering the pedal-stem hole has lifted.

#### **Fourth Board meeting 13th October 2001**

The fourth board meeting was held at the [Demining group] camp in Shilalo after the site visit and all members of the board agreed to a number of conclusions. These can be found in the conclusions part of this document.

The trial was cancelled because the findings during the site investigation proved that the flail was flailing above the mine and had no effect on the mine at all, therefore the trial could have added nothing to the investigation.

#### **Conclusions**

- a. The mine was a TM57 (7Kg of RDX/TNT/A1). See attached technical data in Attachment N.
- b. The machine was serviceable and the operators had the highest confidence in the machine, the operators at SOP discussion groups stated this to the BOI Chairman prior to the accident.
- c. The minefield was considered suitable for the flail should it have performed as expected as the manufacturer and operators claimed that the flail could withstand multiple anti tank mine blasts in front of the flail and also blasts under the wheels, see Attachment K.
- d. The mine was buried to a depth considered to be normal at no more than 200mm.
- e. The accident happened because the flail was not flailing to either the claimed depth of 500mm or the required depth of 200mm.
- f. The 100mm maximum actually achieved is not acceptable as the national standards require 200mm and also the claims of the manufacturer were well in excess of that.
- g. External QA visits were conducted on the site but did not pick up the failure to penetrate to 200mm.

- h. It is thought both machine and operator failure may have contributed to the accident as the wheels may not have tracked each other and the flail did not penetrate the ground sufficiently either due to mechanical or operator failings.
- i. Casevac procedures as defined by the organization's SOPs were adequate however there are contradictory statements regarding how many morphine injections were given in various statements, this needs urgent attention by the agencies involved.
- j. The vehicle cab is not sufficiently protected against AT mines as shown by all the internal damage, the broken door and the injuries to the operator.
- k. There is no evidence to suggest that the vehicle cab is not safe against AP and omni-directional, fragmentation mines.
- l. The front wheels did not detonate the mine as designed because of one or other of the following factors:
  - 1. They did not track the same as the rear wheels and did not drive over the mine.
  - 2. The stump, soil conditions or surface variations prevented sufficient pressure being exerted on the pressure plate by the front wheel, and only the second wheel for whatever reason exerted sufficient pressure to initiate the mine.
- m. The mechanical SOP was incomplete, but under development. This lack of a comprehensive SOP contributed to the accident, as it would have included verification of the flailing depth as well as an internal QC process
- n. The drill used by the deminers was safe but no SOP was used to access the accident site.
- o. Management and staffing of task orders, mine records and other relevant information is insufficient by both humanitarian-demining agencies, EMAP and the UNMEE MACC.
- p. Analysis of mine records was incomplete. The records clearly show 37 AT mines in the field but the operators felt for some reason that they were some distance from the mines. This would not however have affected the works procedure as born out in point E of the conclusions.
- q. Pre-signed Helicopter Waivers were not available on site despite 2 QA reports indicating this failing being forwarded to the agencies HQ.
- r. Considering a mine accident had taken place and there was a helicopter 20 minutes away the response time of the helicopter 130 minutes was not acceptable.
- 5. The continued use of Hydrema flails in its present form cannot be endorsed in any minefield known or suspected to contain AT mines in Eritrea unless modifications are done to enhance safety.
- t. There is no evidence to suggest the Hydrema flail cannot be safely used in other minefields.
- u. Minefields cleared by the Hydrema thus far must be considered to be suspect until proven by another method.
- v. The PIR was extremely helpful to the board and the conclusions and recommendations are accepted and developed in this board's conclusions and recommendations, with the exception of items 5 and 9 in the conclusions and recommendations with are dealt with in the recommendations of this report.



### Recommendations

- a. The Hydraflail should be suspended from operations in AT minefields in UNMEE AOR until safety modifications are done and the machine is retested and certified to be suitable for use.
- b. The Hydraflail when returned for service should be repeatedly tested for ground penetration; failure to achieve 200mm consistently should result in the machine being classified as a ground preparation and not clearance tool.
- c. Comprehensive crater analysis should be done on all mine accidents and accidents in UNMEE AOR.
- d. All organizations should be given a set period of time to finalise their SOPs and drills, have them approved and complete licensing or otherwise be suspended by EMAP and UNMEE MACC from operations in the AOR. (To date out of 12 different demining operations only 2 have been licensed despite all efforts and one of these, [name excised], is not operating)
- e. EMAP and UNMEE MACC need to agree to and institute a system of sanctions to be used against organizations who consistently fail QA and other safety inspections
- f. All task orders should be controlled and signed copies with work plans must be returned prior to the commencement of operations on a site. It is the responsibility of EMAP to ensure this is achieved.
- g. MACC needs a better system to translate and relay MF information to the demining agencies in an accurate manner
- h. Demining organizations need to undertake better analysis of the MF records given to them.
- i. Morphine overdose can result in death therefore control is critical. A method such as writing on the patient's forehead and better record keeping should be instituted to ensure the process of administering drugs is clear.
- j. Helicopter Casevac needs to be better coordinated and planned. A mine accident normally results in serious traumatic amputation and thus airrops on receiving such a report should deploy the nearest helicopter and not make medical judgment calls they are patently unqualified to make.
- k. Drills need to be in place for the handing over of the patient from the field medics to the helicopter medics. Or, the attendant medics should be permitted to accompany the casualty to the hospital to ensure continuity of treatment and patient confidence.
- l. Helicopter waiver forms need to be checked as an inspection item during QA site visits.
- m. All minefields that have had mechanical demining used on them need to have sampling or to be 100% verified using a second system.
- n. PIR recommendation 5. The BOI recommends that a TWG is convened to discuss the issue of medics entering a minefield and that the PIR recommendation 5 is disregarded.

- o. PIR recommendation 9. The board's opinion is that it is not within the remit of the PIR or BOI to make such statements and item 9 of the PIR should be disregarded.
- p. The BOI recommends that QA forms be amended to include depth penetration sampling on mechanical forms

## **ENCLOSURE A: Report from survey of damaged Hydrema Flail in Eritrea**

### **Crater Analysis and evaluation of flailing depth**

#### **1. Method**

The analysis comprised of the following parts:

- Excavating the crater for loose soil.
- Shifting the excavated soil from the crater for mine fragments in order to determine which mine had been detonated.
- Evaluating the dimensions of the crater in order to determine how the mine was placed.
- Evaluating the sides of the crater in order to determine firstly whether the mine had been connected to secondary or improvised firing mechanisms, secondly to determine the depth the mine was placed in.
- Prodding the topsoil layer and evaluating remnants of vegetation next to the crater in order to estimate the actual flailing depth at the scene of the accident.

The analysis was carried out in co-operation with the UNMEE Board of Inquiry (BOI). All the findings were compared and evaluated at the site. The findings of this analysis are identical to the findings of the BOI.

Swap samples were taken from exposed sides of the flail, earth samples from the loose soil in the crater and a very large numbers of fragments were seized at the scene of the accident. They were handed over for further analysis in order to determine the explosive independently of the field evaluations. The results confirmed the type of mine and explosives mentioned below.

#### **2. Findings**

The object was identified to be a TM-57 Antitank Mine, containing app 6.5 kilo of TNT. It was identified through the colour of some of the fragments and parts of its handle and characteristic foldings from the shoulder of the mine.

The mine detonated under front right wheel under the cabin. The rear wheel under the flail seemed to have passed the mine without initiating it.

The (centre of the) mine was placed approximately 40 centimetres from a stump of a small tree or a very large bush. The mine had lifted the mineflail approximately 70 centimetres to the left and approximately 50 centimetres forward; opposite the flailing direction, when triggering the mine.

No indication of secondary initiation was found.

The mine was buried at normal depth. The depth (approximately 20 centimetres to the bottom plate of the mine) was determined by measuring the depth of a horizontal crack in the very heavy soil. The crack was produced by the horizontal blast wave of the mine. The crack was consistent with the dimensions of the excavated crater. The overall depth of the excavated crater was approximately 70 centimetres to undisturbed soil and the diameter was approximately 150 centimetres.

The flailing depth was determined two ways: by prodding a number of places around the flail and evaluating the vegetation, i.e. stumps and remnants of bushes, in the already flailed area, especially a stump next to the crater. Both findings from the prodding and evaluation of

vegetation were consistent: the flailing depth around the scene of the accident was estimated to be approximately 10 centimetres - and perhaps even less.

The Danish Survey team - in agreement with the BOI Investigation Team - believe that the reason why the first wheel could pass the mine could be explained in one or more of the following ways:

- The stump next to the crater shielded a part of the mine.
- The fuse was partly initiated by the first wheel
- The loosened topsoil of the hard surface absorbed a part of the pressure from the first wheel.

### **3. Conclusion**

The accident occurred due to insufficient flailing depth.

## **ENCLOSURE B: survey of damaged Hydrema Flail in Eritrea**

### **Computer Data**

Hydrema Flail (910 MCV) Board Computer evaluation

#### **1. Method:**

The analysis comprised the following parts:

- A dismantling of the computer from the wrecked Hydrema flail by [Demining group] mechanics. Shipment of the computer by [Demining group] to the "Danish Army Engineer and NBC school" in Denmark via [Demining group] main office.
- An installation of the computer in a 3 echelon test set-up for 91 OMCV computers and a following read-out of the actual settings in the computer.
- An interview with the flail operator in order to determine his actual settings of the computer.
- The readings were compared with the ground findings/estimates on the scene of the accident

Danish Army personnel, one Hydrema Flail technician and one Hydrema Flail instructor carried out the read-out and the analysis of the computer.

#### **2. Findings:**

The computer showed the following data input:

- All basic factory computer settings were complete and the computer worked as intended.
- Actual settings of the flail from the time of the accident were lost. It has to be remarked that the computer is not intended to work as "black box", but it is designed to keep the data from the last flailing operation as long as it is installed in the flail. The read out was a try in expectation of that the computer would keep the data even after a longer period without its main power supply.
- The operator of the flail informed that he used the following settings on the flail at the time of the accident:
  - Normal ground conditions,
  - Flail pressure 50%,
  - Shield pressure 30%,
  - Speed: about 600 m/h,
  - Flail rotation: about. 300 rotations/min.

The ground on the scene of the accident is estimated to be very hard, with moderate grass vegetation and random spread small bushes.

With the on board computer working correctly and provided that the information of operator is correct, is it notable that the operator is only programming the computer to flail in normal ground condition and the high speed. The other settings of the computer seem all to be reasonable and correct. The ground conditions on the scene of the accident were estimated to be very hard, and a setting of the flail to work in normal ground combined with the high speed, would cause the flail not to go deep enough into the ground.

### **3. Conclusion**

The settings of the flail to operate in normal ground conditions compared with the hard ground conditions on the scene, has properly caused that the flail did not work at the expected ground depth.

## **ENCLOSURE F: survey of damaged Hydrema Flail in Eritrea**

### **English Summary**

1. The Danish national Survey Team received good support and co-operation from SNR, from UNMEE MACC, and from [Demining group] personnel in Eritrea. All information and relevant copies were made readily available.
2. The team comprised [names excised].
3. Purpose was information gathering and evaluations for a national report in order to establish the need for further national Danish injunctions, procedural changes or equipment modifications related to personnel safety.
4. The flail was stationed in Eritrea on loan to [Demining group and partner agency] personnel in Humanitarian Demining Operations.
5. At the time of the accident, it was employed in flailing an assigned area for verification of an already lifted anti personnel minefield within that area.
6. During this task, an AT mine detonated under the front right wheel, letting smoke and dust into the cabin, opening the right hand side door, and injuring and bruising the operator. He was able to leave the cabin and await evacuation on the cabin roof.
7. A Crater Analysis was performed in good co-operation with UNMEE BOI, and the final results after laboratory tests in Denmark has been forwarded to UNMEE by separate mail. It indicated the use of a TM 57, with 6,5 kg TNT, buried in the normal depth of app. 20 cm. The actual flailing depth was estimated to be max.10 cm.
8. Ground surface was found to be very hard, and a significant number of loose tools and accessories were found in the cabin.
9. The cabin computer was analysed in Denmark, and the results forwarded to UNMEE MAC by separate mail. Conclusions were that factory settings were complete, but that the actual data could not be recovered. The settings and parameters obtained from the operator included 'normal ground conditions' as well as a relatively high speed. Compared to the harder ground, this properly caused the reduced flailing depth.
10. A number of suspected causes were eliminated by the survey. There were no worn down chains and hammers, nor any too sharp turns, there was sufficient overlap of flail trails, the computer was fully operational, no unauthorised spare parts or modifications were found, and state of maintenance, maintenance facilities and knowledge and skill of maintenance personnel were found to be good.
11. The likely cause of the accident was identified as follows: The data entered into the computer, related to ground, speed, and engine rpm, did not in the actual terrain facilitate a flail depth sufficient to detonate or destroy the mine.
12. Unexpected damage to the vehicle included the relocation of the protective plate under the cabin, and loosening of the covering plate under the pedals inside the cabin. (It should be noted that no such damages were incurred during a previous worst case acceptance test, detonating 10 kg TNT under a corresponding wheel).

13. Injuries sustained by the driver included bruises, caused i.a. by loose objects in the cabin, and a broken heel, caused by the upward movement of the covering plate under the pedals.

14. Recovery will be possible, utilising an in area UNMEE recovery tank, and modifications can be done and repair be initiated at [Demining group] Echelon facilities with spare parts and other support from Hydrema as required. Repair time t.b.d. after recovery.

15. UNMEE BOI deliberations based on the investigations were ongoing at the time of departure of the Danish survey team. Flail Policy and Quality Control procedures during Humanitarian Mine Clearance were discussed in general terms. The unexpected damage inside the cabin resulted in an UNMEE MACC ban on further use of Hydrema Mineflails, until a modification was made. This should comprise the mounting of an armour plate covering the pedal holes from underneath the cabin, and having the same depth as the cabin floor itself.

16. Done actions include authorisation for Hydrema to carry out such a modification. Throughout, briefings and information for flail crews with SFOR and KFOR have been carried out, and injunctions of certain existing rules and procedures have been made. They comprise: use of seat belt, ear protection, and helmet, storing of necessary accessories in authorised holders and mounts - and removal of all other items from the cabin. In addition there should be no contact between operators' feet and cabin floor or pedals during flailing operations; instead adjusting speed with handle. Finally it has been emphasised, that data should be set to accommodate a flail depth of no less than 20 cm, and that the actual flail depth is to be checked by pre-flailing similar ground over 30 meters immediately prior to entering the susceptibly mined area.

17. Contacts with Hydrema so far have resulted in DAMC approving a prototype bolt on plate that meets all requirements. In addition, Hydrema will implement this modification on the two [Demining group] flails at Shelalo, which is in progress, and foresee similar modifications on other Danish flails.

18. The overall conclusion of the Danish team is that the accident could not have happened if normal Danish Army procedures had been used.

19. Thus, no procedural changes or higher level decisions are found necessary.

20. Follow on actions include: Inclusion of above injunctions in future training, modification of remaining flails for moral grounds and uniformity of inventory, and thorough inspection of [Demining group] flails on their return to the Army.

## Victim Report

<b>Victim number:</b> 450	<b>Name:</b> Name removed
<b>Age:</b>	<b>Gender:</b> Male
<b>Status:</b> driver	<b>Fit for work:</b> presumed
<b>Compensation:</b> not made available (insured)	<b>Time to hospital:</b> 3 hours
<b>Protection issued:</b> None	<b>Protection used:</b> none

### Summary of injuries:

minor Arm

severe Foot

### COMMENT

No medical report was made available. The victim also suffered unspecified "bruising"



## Analysis

The primary cause of this accident is listed as "*Inadequate equipment*" because the machine involved was clearly not able to perform as advertised. The secondary cause is listed as a "*Management/control inadequacy*" because the MAC and the demining group did not have approved SOPs before allowing deployment of the machine in live areas.

The general conclusion (and that of the Danish army investigators) put the cause of the accident down to the operator having set the flail to operate on "normal" ground when the ground was actually "hard". The BOI found that the ground was sandy and soft until a depth of 3cm, then became hard. They found that the flail had been working to 10cm depth (at the most). The mine was found to have been 20cm deep to its base-plate. When fused (MVN-62 or similar fuze), the mine stands over 10cm high, so it was less than 10cm below ground surface or 7cm below the hard-ground surface. That is 3", and less than 4" below the actual ground surface. Therefore the Danish army conclusion and those of the BOI over flail-depth are internally inconsistent.

At the time of the accident, the flail was "employed in flailing an assigned area for verification of an already lifted anti personnel minefield within that area". This raises the obvious question - with a TM-57 10cm under the surface - how could any demining group using a decent detector have missed such a large metal signature during manual clearance? In the light of that observation, there is no evidence to support the BOI's contention (stated as fact) that "should the mine not have been detonated the follow up system would have found the mine".

The manufacturers sold a machine that could not live up to their own sales claim that it could withstand stacked AT mines under a cab-wheel without operator injury. The manufacturers were aware that the cab of the Hydrema was not sealed against blast. This lack of sealing had caused problems with heavy dust ingress in the NPA Angola operations and the dust had affected the computer. Two years ago, it was possible to see the ground from inside the cab of a Hydrema in Angola. And the fixing of thin hole covers to the inside of the cab shows either a complete ignorance of the forces involved in an AT blast or a design carelessness that borders on incompetence.

## Related papers

An IMSMA report on the accident was made available in 2004 in response to a UNMAS request for accident reports. The format is brief, but many of the fields were left empty so the information available was cursory. The accident was described in a single sentence that made light of the Victim's injuries:

"The operator of the MMCT was flailing a new fourth lane when a detonation occurred under the rear left wheel causing minor injuries to the operator."

The Victim was described as a "Danish civilian".

The only additional information in the report was the GPS reading of the accident site.