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HYDREMA 910 MCV

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## 1. Introduction

During the days of September 28-30 2004, the HYDREMA 910 MCV-flail was tested at the SWEDEC facilities outside of Eksjö, Sweden. This test was a repetition of the performance test made in 2001.

The test team was made up of the following people:

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The trial plan called for performance, or effectiveness testing against antipersonnel mine targets buried to a depth of 20 cm.

The Test Data Sheets contained in Annex A describe the number of:

- mechanically neutralized targets
- damaged intact targets that would not function under normal loading conditions
- intact still live targets
- separate fuzes

that were found after the test.

Throw outs (targets that are still live and thrown out of the lanes) are also recorded in the data sheets.

Pictures of the Debris Of Interest after each test are shown in Annex B.



## 2. Trial Description

### 2.1. Test Facilities and Tools

The test facilities at Norra Kulla, just outside of Eksjö, have been used to test several pieces of equipment in recent years. This site includes three soil environments specifically for performance tests. Parallel lanes 8 m wide and 100m long provide compacted sand, compacted gravel and compacted topsoil. The sand and gravel lanes are easily replicated almost anywhere. As the characteristics of topsoil may vary from one location to the next, data from the topsoil lane may not be quite as repeatable, but the variation is not expected to be significant.

The soil in each test lane is prepared as follows. Prior to a test the soil is loosened with ordinary agricultural or construction equipment ([Figure 1](#)). It is then compacted using the vibratory compactor shown in [Figure 2](#). The soil compaction and moisture content are monitored until the compaction reaches the defined level (shown below) for that soil type. Compaction and moisture content are measured using the CPN International model MC-3 Portaprobe shown in [Figure 3](#). Ideally the soil would be compacted to virtually 100%, or its theoretical maximum level of compaction. This is very difficult to achieve, and depends on the moisture content of the soil. The compaction level selected allows testing over a range of soil moisture contents, and is a reasonable and practical approximation of well compacted soil.

Along with the test lanes, the facilities at Norra Kulla provide office and administration space, warehouse and storage space, and basic workshop facilities.



*Figure 1. Soil Preparation – Loosening the Soil*



**Figure 2.** Soil Preparation – Compacting the Soil



*Figure 3. MC-3 Portaprobe for Measuring Soil Compaction and Moisture Content*

## 2.2. Soil Specifications

### 2.2.1. Soil Compaction

Ideally the soil would be compacted to virtually 100%, or its teoretical maximum level of compaction. This is hard to achive because it depends on the moisture content in the soil. Based on the results of soil analyses conducted for SWEDEC, the compaction levels shown below were selected to allow testing over a range of soil moisture contents and wheather conditions, and are reasonable and practical approximations of well compacted soil.

- Sand compaction level:
  - intended 90 % of maximum dry density (1,8 kg/dm<sup>3</sup>)
- Gravel mix compaction level:
  - intended 94 % of maximum dry density (2,0 kg/dm<sup>3</sup>)
- Topsoil compaction level:
  - intended 85% of maximum dry density (1,7 kg/dm<sup>3</sup>)



An example of soil analysis for the topsoil is shown in Figure 4. The horizontal axis refers to the moisture content while the vertical axis shows the density, with a maximum occurring at 2,024 kg/dm<sup>3</sup>. By compacting the lane to 85% of its theoretical maximum, tests can be performed in most weather conditions.

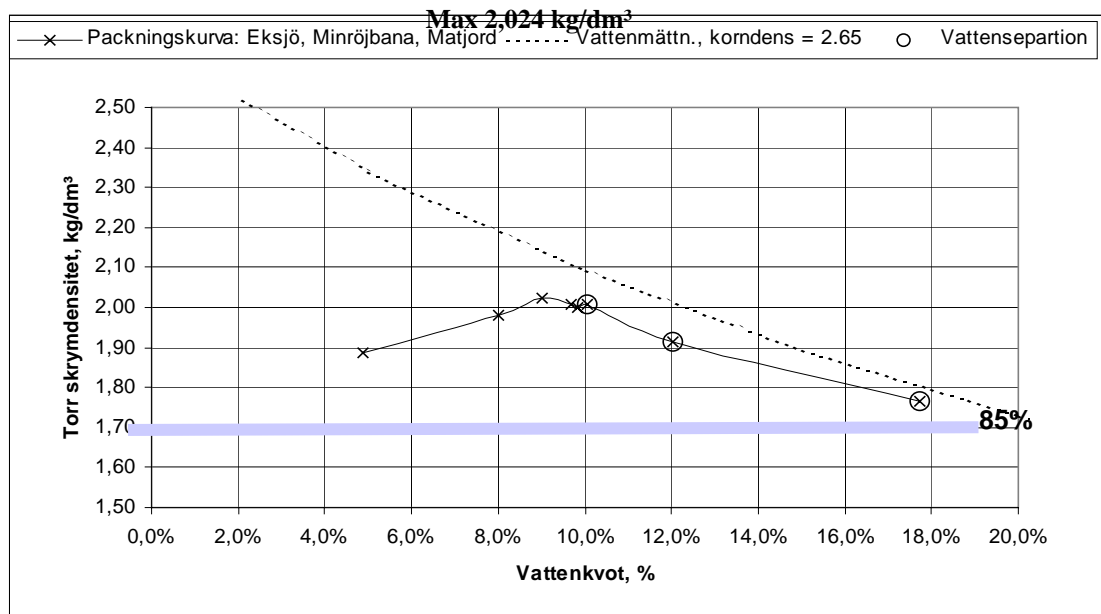


Figure 4. Soil Analysis - Topsoil

### 2.2.2. Soil Particle Size Distribution

Samples from the sand, gravel and topsoil lanes were analysed to determine particle size distribution, with Figure 5 showing the results.



Lane A-C

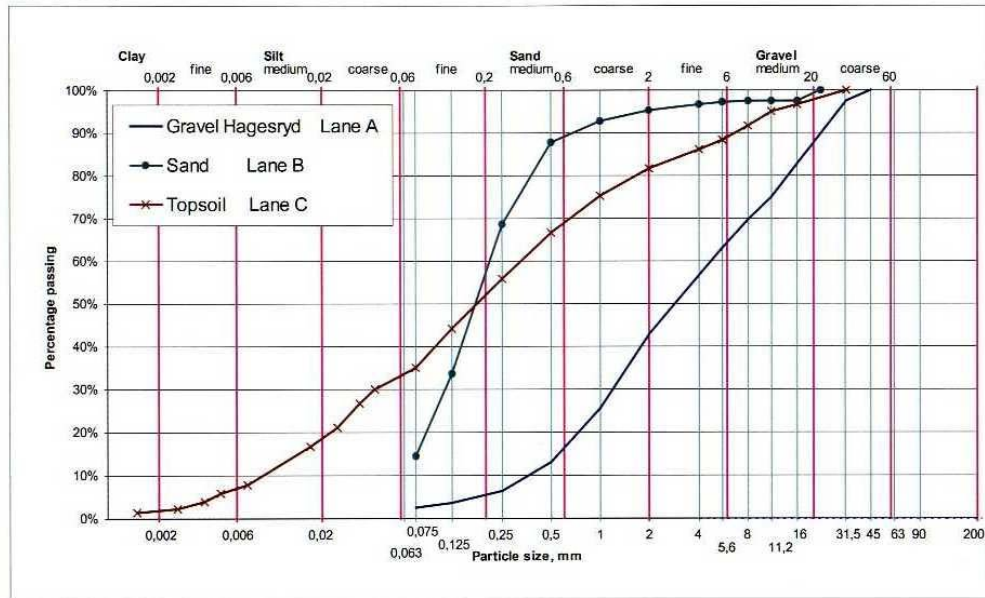


Figure 5. Soil Particle Distributions

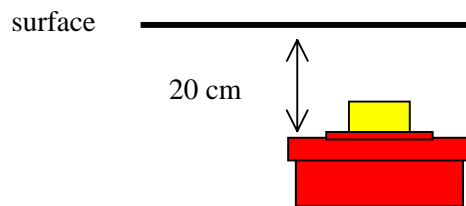
### 2.3. Test Targets

The test targets used in this trial were the standard SWEDEC mine surrogates shown in [Figure 6](#). The AP blast targets make use of live fuzes from the m/49 B anti personnel mine, installed in inert, plaster-filled plastic bodies. These targets closely replicate many typical, small, antipersonnel landmines which a flail might be expected to encounter.

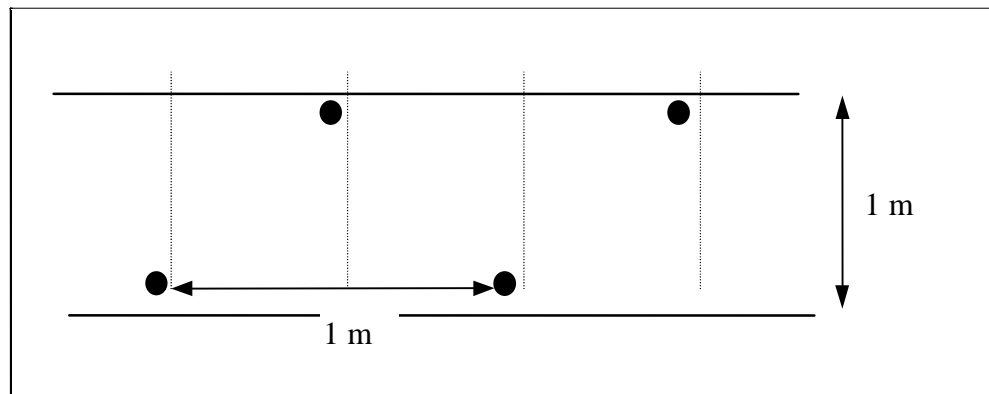


**Figure 6.** SWEDEC Antipersonnel Mine Surrogates

In all cases, the AP blast targets were buried as shown in [Figure 7](#). The depth of burial (DOB) was measured from the top surface of the mine (not the top surface of the fuze), to the ground surface. The targets were buried in a pattern as in [Figure 8](#). To minimize soil disturbance, the tool shown in [Figure 9](#) was used to pull out a soil core just slightly larger than the mine body. The live fuzes were installed only just before the test began.



**Figure 7.** Depth of Burial For AP blast Targets



**Figure 8.** Mine Target Burial Pattern.



**Figure 9.** Mine Target Burial Tool To Minimize Soil Disturbance.



## 2.4. Test Methods

Following preparation of the soil in the test lanes, and installation of the mine targets as described above, the machine was prepared for a test run. The machine was positioned about 5 metres before the start of the test lane to allow the operator to get the machine operating in a consistent, stable manner prior to the start of the lane. Cameras were started and personnel were put in place to count detonations from the triggered fuzes.

A manufacturer's representative was used as a machine operator to ensure that the machine was operated in the most effective manner possible. When all was ready, the machine operator was signalled to begin, and the machine was operated through the test area containing 100 mine targets. With two or three people counting fuze detonations, the number of 'triggered mines' could easily be determined.

Following the test, metal detectors were used to locate any untriggered fuzes and also the metal washers in the plaster-filled bodies (Figure 10). In this way, the untriggered fuzes could be examined and ultimately discarded in a safe manner, and any untriggered or undamaged surrogate mine bodies could be inspected to determine the probable level of damage inflicted by the machine.

Missing mines/fuzes after the test are recorded in the data sheets. After the lanes have been searched with the detectors, additional steps were taken. A plow (Figure 3) was used to turn the soil upside down. Another run with the detectors were done. To be sure that no live targets or fuzes were in the lanes, the soil was turned back again, and run over a third time with the detectors. In this situation, while extremely unlikely, it is *possible* that the mine/fuze might have been left live and intact. It is also possible and most likely that the separate fuze might have been thrown away and not found or have been detonated and not heard by any of the three observers.

In Figure 11, the first figure shows intact, functional targets missed by a machine (Live). The next two pictures shows targets which do not work as supposed but fuze is still in the body (Live Damaged). Third picture shows an example of a target where the fuze has been separated from the mine body without triggering (Mechanically Neutralized), more than 50 % of the plaster is left (the main charge in a real mine). The fourth picture shows an example of a target where only the metal washer with less than 50% of the explosive is left..



**Figure 10.** Locating Untriggered Fuzes After The Machine



**Figure 11.** Samples of Targets After Test



### 3. Test Results

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The results<sup>1</sup> after the HYDREMA 910 MCV performance in the 20 cm conditions were:

- 2/300 (0,7%) of the targets were still live and unaffected
- 6/300 (2,0%) of the targets were live but damaged
- 292/300 (97,3%) of the targets were neutralized if the missing mines are counted as neutralized (three targets/fuzes were not found).

The clearing speed during the tests were between 106-221 m/h.

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<sup>1</sup> This material is taken from the data sheets contained in Annex A



## **Annex A – Test Data Sheets**

The tables that follow show the data collected from the SWEDEC test targets. This data is the source for the tables and analyses in the main body of this report.



## TEST PROTOCOL, sand 20 cm

Machinetype  
910 MCV

Manufacturer  
HYDREMA

Date 2004-09-29	Wheather Sun	Temperatur 14°C
--------------------	-----------------	--------------------

Test number/ Clear in sand	Deployment depth 20 cm
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Testlane Sand	Rate of compaction 91,5 %	Water content 4,6 %
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Clearing depth 30 cm	Time/50 m 13.34.85	⇒	Clearing speed 221	m/h
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	AP blast PMA2	AP bounce PROM1	AP frag PMR2A	AT blast TMM1
Deployed:	100	N/A	N/A	N/A
Mech. Neutralised <50%:	84			
Mech. Neutralised >50%:	11			
Live Damaged:	4			
Live:	1			
Total:	100			
Detonations	62			

### Comments:

**Single fuses AP blast:** 32 of which 22 were damaged

**Accounted for AP blast:** 99/100 tagets/fuzes were found after the test.  
Procedure in "2.4 Test Methods" was used to search them

### Throw outs:

No throw outs



## TEST PROTOCOL, gravel mix 20 cm

Machinetype 910 MCV	Manufacturer HYDREMA
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Date 2004-09-28	Wheather Sun	Temperatur 12°C
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Test number/ Clear in gravel mix	Deployment depth 20 cm
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Testlane Gravel	Rate of compaction 93,8 %	Water content 4,9 %
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Clearing depth 30 cm	Time/50 m 20.08.49	→	Clearing speed 149	m/h
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	AP blast PMA2	AP bounce PROM1	AP frag PMR2A	AT blast TMM1
Deployed:	100	N/A	N/A	N/A
Mech. Neutralised <50%:	98			
Mech. Neutralised >50%:	1			
Live Damaged:	1			
Live:	0			
Total:	100			
Detonations	82			

### Comments:

**Single fuses AP blast:** 17 of which 12 were damaged

**Accounted for AP blast:** 100/100 targets/fuzes were found after the test.  
Procedure in "2.4 Test Methods" was used to search them

**Throw outs:**  
No throw outs



## TEST PROTOCOL, top soil 20 cm

Machinetype 910 MCV	Manufacturer HYDREMA
------------------------	-------------------------

Date 2004-09-30	Wheather Sun	Temperatur 14°C
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Test number/ Clear in top soil	Deployment depth 20 cm
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Testlane Top soil	Rate of compaction 85.1 %	Water content 11,9 %
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Clearing depth 30 cm	Time/50 m 28.22.47	⇒	Clearing speed 106 m/h
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	AP blast PMA2	AP bounce PROM1	AP frag PMR2A	AT blast TMM1
Deployed:	100	N/A	N/A	N/A
Mech. Neutralised <50%:	94			
Mech. Neutralised >50%:	4			
Live Damaged:	1			
Live:	1			
Total:	100			
Detonations	81			

### Comments:

**Single fuses AP blast:** 15 of which 9 were damaged

**Accounted for AP blast:** 98/100 targets/fuzes were found after the test.  
Procedure in "2.4 Test Methods" was used to search them

### Throw outs:

One live mine was found 5 m beside cleared path to the right



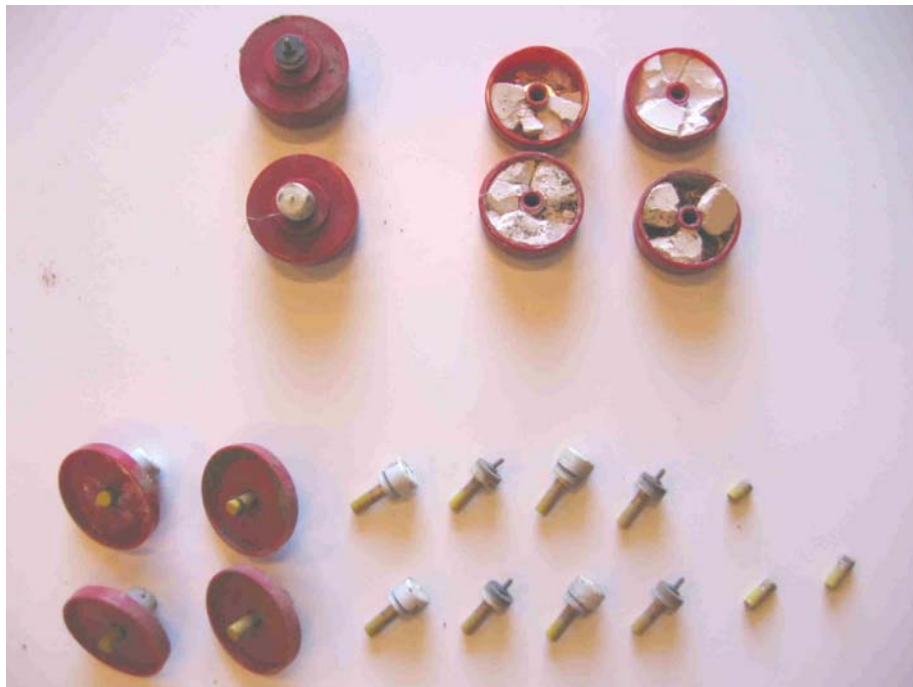
## Annex B – Debris of Interest



*Figure 12. Debris of Interest – Sand, 20 cm DOB*



**Figure 13.** Debris of Interest – Gravel mix, 20cm DOB



**Figure 14.** Debris of Interest – Top Soil, 20cm DOB