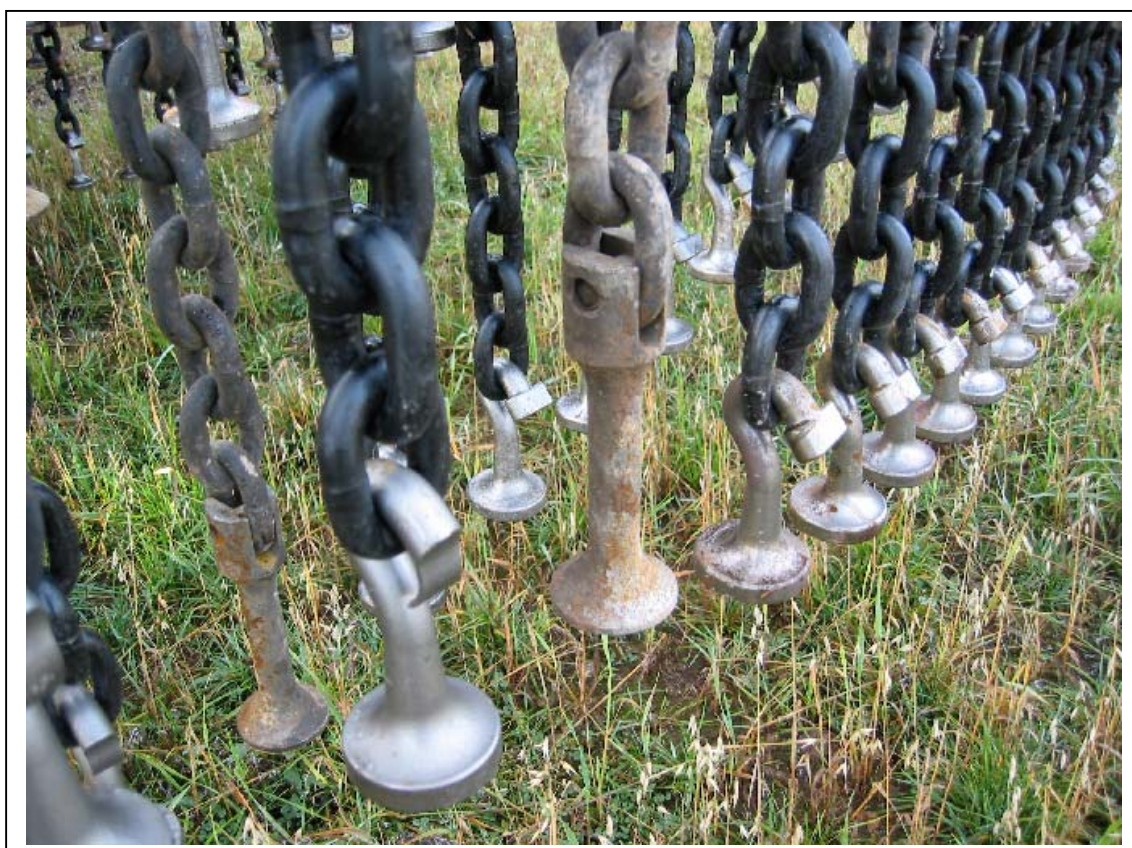




Göran Danielsson, SWEDEC



## Flail Hammer Head Test and Evaluation

2005



## Executive Summary

The Hammer Head Test project started in 2003 and finished in December 2005. The objective was to develop hammer heads to both the Armed Forces mine clearing machines, the Scanjack and the MV-4, with a maintained performance to a lower cost.

Involved partners has been the Swedish Defence Material Administration FMV, the Armed Forces (SWEDEC/Göta Engineers), with the Royal Institute of Technology (Kungliga Tekniska Högskolan KTH), High-Endengineering and Scanjack AB

Test results have been recalled since the acceptance tests for both machines. The conditions during the acceptance tests have been repeated as far as possible, so the results could be compared.

The studies and the tests showed that the weight distribution and centre of gravity of the hammers are essential for the performance of the machines. The design of the hammers in the tests in Dec 2005 also made it possible to use the flail chains more than once. This in combination with other production methods of the hammers will reduce the costs for mechanised mine clearing a lot. From a logistic point of view, it is also an advantage not to store and transport pre-assembled (chain and hammer) mine clearing tools.

The test team will recommend the following qualities for the future procurement of hammerheads:

### MV-4:

Development of a wrought iron Sprain Tool hammer. The chain attachment should be the same design as for the Scanjack, but adapted to the chain dimensions for the original chain.

- wear plate diameter of 60 mm
- wear plate thickness 10-15 mm
- weight about 550-600 grams

The length of the tool (hammer and chain) should be the same as original.

### Scanjack 3500:

Manufacturing of a wrought iron Sprain Tool hammer.

- wear plate diameter of 65 mm
- wear plate thickness 15 mm
- weight about 1000 grams
- chain quality should high so the chain can be used more than once. A cost analysis should be done in order to decide which quality should be used
- bolts/nuts should be off the shelf products. The quality should match the quality of the chains so they wear out simultaneously.

The length of the tool (hammer and chain) should be the same as the original.



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## 1 Introduction

The Swedish Armed forces purchased two types of mine clearing vehicles in 2003. During the acceptance tests of the machines, it became clear that the tools in the flail units wear out very fast. The fact that the Scanjack 3500 is equipped with 152 tools makes a change of clearing tools very costly.

The Swedish Defence Material Administration (FMV) and the Armed Forces (SWEDEC/Ing 2) started a project together with the Royal Institute of Technology (Kungliga Tekniska Högskolan KTH) in 2003. The Scanjack AB was also invited and has participated in the project. The main objective was to optimise the tool costs with life time and maintain the performance. Different alternatives were discussed, and a decision was made to order both cast iron hammers and wrought iron hammers because of production costs.

A study was made in order to learn what will happen when the hammers hits the ground. A high-speed video camera was used from the side during flailing with both the Scanjack and the MV-4. One essential conclusion after the tests was that the centre of gravity of the hammer is very important when it comes to performance in the ground. It is of importance that the weight of the hammer stays at the far end of the hammer.

The test called for wear out tests in ruff ground conditions and a performance test to confirm that the performance data of the machines should be better or at least maintained.

The wear out test was made at similar conditions in meadowland with a high density of rocks just outside the tests facilities of N Kulla. All the wear tests were made in the same area and the ground was only beaten once.

The performance tests were made in the test lanes at the tests facilities of N Kulla. The old reports from the acceptance tests in 2001 and 2002 were recalled. Ground-conditions, number of targets, depth of bury etc were repeated as far as possible.

High-Endgineering has produced two reports available in Swedish. The Scanjack AB has also produced their own report available in Swedish.



## 2 Hammer head description

Several designs and materials of hammer heads were tested during 2005. Figure 1 shows the tested tools. During the first test period in April the Mark I hammers were tested. The material in the cast iron was too brittle, so most of the tested hammers were lost during the first hour of flailing. The cast iron hammers (Mark II-III) in the second period were produced in a different cast iron alloy.

Scanjack AB was also invited to the first test period. They came up with a wrought iron tool riveted together with a chain (Figure 2). The test result of the Scanjack tool are presented in a Scanjack AB report.



*Figure 1: Selection of tested hammer heads during 2005 developed by the project group*



*Figure 2: Wrought iron tool manufactured by Scanjack AB*



## 2.1 MV-4

The MV-4 super tool mark I was tested in April 2005. Most of the hammers were lost during the first 20 min of flailing. A mark II tool was developed with a slightly modified design.



*Figure 3: Mark I of MV-4 Super Tool  
Wear plate Ø 60 mm, thickness 10 mm  
Weight: 496 grams  
Material: Cast Iron*



Modified design of the neck

*Figure 4: Mark II of MV-4 Super Tool  
Wear plate Ø 60 mm, thickness 15 mm  
Weight: 577 grams  
Material: Cast Iron*

## 2.2 Scanjack 3500

### 2.2.1 Sprain tool Mark I-III



*Figure 5: Mark I of Sprain Tool  
Wear plate Ø 65 mm, thickness 15 mm  
Weight: 884 grams  
Material: Cast Iron*



*Figure 6: Mark II of Sprain Tool  
Wear plate Ø 65 mm, thickness 15 mm  
Weight: 935 grams  
Material: Cast Iron*



*Figure 7: Mark III of Sprain Tool  
Wear plate Ø 73 mm, thickness 15 mm  
Weight: 1040 grams  
Material: Wrought Iron*



The hammer is attached to the chain by deforming the lip (figure 8)



Figure 8: A sledge hammer is used in order to deform the lip

## 2.2.2 Super Tool Mark I-II



Figure 9:  
Mark I of Super Tool  
Wear plate  $\varnothing$  65 mm,  
thickness 15 mm  
Weight: 910 grams  
Material: Cast Iron



Figure 10:  
Mark II of Super Tool  
Wear plate  $\varnothing$  : Asymmetric  
thickness 15 mm  
Weight: 1000 grams  
Material: Cast Iron

Asymmetric wear plate.  
6 mm added in  
direction of attack



*Figure 11: Chain attachment for the Super Tool*

### **2.2.3 Short Tool**



*Figure 12: Short Tool  
Wear plate Ø 65 mm, thickness 15 mm  
Weight: 890 grams  
Material: Steel, machined, not heat treated*



### **3 Trail Description**

#### **3.1 Test Team**

The test team for the Hammer Head Test and development included the following personnel:

|                        |                     |
|------------------------|---------------------|
| Mj Göran Danielsson    | SWEDEC              |
| Lt Tommy T Karlsson    | Göta Engineers      |
| Anders Johnsson        | High-Endengineering |
| Fredrik von Segerbaden | High-Endengineering |

#### **3.2 Trail Conditions**

The test was following the test plans (SWEDEC 2005-03-31 13345:60175 and SWEDEC 2005-09-29 13345:60566). The test was split in two periods. In the first period, different designs of hammer heads were tested in a wear test. The intention was to pick the best tool and continue the test with a performance test with a complete set of tools on both the Scanjack 3500 and the MV-4 machines in the fall. Because of different circumstances the hammer heads in the first period, were produced out of wrong material. Most of the hammers were lost during the first hours of flailing in rocky meadowland. The material in the hammerheads was supposed to be wrought iron, but when the tools were delivered, they were produced in cast iron.

The first test period in Apr 2005 became a lessons learned. Design, materials, alloy etc were modified until the second period. The test procedure from period one was repeated during period two.

A new test plan was produced and new hammer heads were ordered. The plan was the same as in the first step. The performance test of the best hammer had to be followed immediately after the wear out test. A modification of the plan was done during the test. The performance test of the wrought iron sprain tool was made before the endurance test because of lack of hammers.

The wear test was run in rocky meadowland just outside the test facilities of N Kulla. The ground was only treated once, so the conditions for the tested tools were similar in all cases. The machines were driven as they would have been in a minefield. The depth penetration was between 20-30 cm for the Scanjack and about 10 cm for the MV-4.

The performance test was made in the test lanes at N Kulla used for performance testing during the last years.

The conditions that were used during the acceptance tests in 2001 and 2002 for each machine were repeated as far as possible. The results of the performance tests will be compared with the performance data recorded in 2001 and 2002.



The MV-4 was supposed to be tested against 450 AP test targets at 5 cm, 10 cm and 15 cm depth of bury.

The Scanjack 3500 was supposed to be tested against 450 AP test targets and 45 AT test targets at a depth of bury at 0 cm, 10 cm and 20 cm.

Because of weather conditions, the performance in topsoil had to be cancelled. The right level of compaction in the gravel lane could not be obtained because of the same reason. No AT test targets were used in the performance test of the Scanjack.

The first test period was done in April 2005 and the second period in November/December 2005.

### **3.3 Test Results**

The details and data about the different tests are given in the enclosures.

All the tests were done with the original hammers as reference objects.

#### **3.3.1 Material**

##### **3.3.1.1 Cast Iron:**

A lot of the cast iron hammers were lost. The material broke either in the attachment to the chain or at the neck. The cast iron seemed too brittle to be used in an environment like this even if another alloy was used in period 2. From a wearing point of view, the cast iron hammers showed a similar resistant against wear as the other tested materials of the tested hammers.

##### **3.3.1.2 Wrought Iron:**

None of the hammers were lost during the wear test. After the test in meadowland, the hammers were tested in a mound of rocks. Only one hammer was lost after a 2 minutes flailing.

The wrought iron hammers have similar quality against wear as the other materials. No wrought iron hammers were available for the MV-4.

##### **3.3.1.3 Steel hammers. Short Tool and original:**

None of the hammers were lost during the test. From a wearing point of view, the original hammers have about the same quality as the others. The production cost for machined hammers is far to high.

#### **3.3.2 Attachment**



### **3.3.2.1 Sprain Tool:**

The Sprain Tool have a loop and a lip that will be battered to stay with the chain. Two different materials were tested on the sprain tool. The lip on the cast iron tool was very brittle and broke quite frequently when it was attached to the chain. In comparison between cast iron, Sprain and Super Tool, more Super Tools were lost. The Sprain Tools have also good qualities when it comes to weight distribution. The major part of the material used sits at the far end (wear plate) of the tool. The design of the loop increases the contact point between the chain and the tool which will decrease the wear on the attachment point compared with the original hammer (pin). The chain can be used over and over again until it is worn out if the lip is cut on the hammer and a new one is assembled.

### **3.3.2.2 Super Tool:**

The Super Tool has a hook in mechanism that is very fast and simple to use when it comes to assembling. After some hours when the attachment and the chain starts to wear out some of the Super Tools were lost. They seemed to hook out because the increased clearance. The design of the hammer increases the contact point between the chain and the tool which will decrease the wear on the attachment point compared with the original hammer (pin). The chain can be used over and over again until it is worn out. New hammers can easily be assembled. No wrought iron Super Tools have been tested during the test.

### **3.3.2.3 Original:**

None of the original tools were lost either on the Scanjack or the MV-4. The pin attachment used on the original hammers is the most effective. From a weight distribution point of view, the riveted pin has a lot of weight at the attachment point which is bad for the clearing result. The chain is more or less a consumable and has to be changed at the same time as the hammer, even if it is not worn out at all. The pin can not be removed without cutting the chain.

### **3.3.2.4 Diameter of wear plate:**

The original diameter for the Scanjack 3500 is 65 mm and the diameter of the tested wrought iron Sprain Tool mark III was 73 mm. The reason to increase the diameter was to add weight to the wear plate, get a better weight distribution and maybe get rid of the ridges in the ground when the hammers starts to wear out. During the performance tests some evidence of increased ridges was seen on the rear flail axle. The rotation speed was adjusted and the ridges went away.

The cast iron Super-Tool tested in Nov/Dec also had an asymmetric wear plate with an increased diameter in the direction of attack. The reason for that was to increase the life time of the hammer.

Both hammers with increased diameter tend to get stuck at the attachment point to the flail axle (Figure 13)



*Figure 13: Wrought iron Sprain Tool Ø73 mm stuck in the attachment to the flail axle*

### **3.3.2.5 Weight:**

The weight of the hammers was designed to be as close to the original hammers as possible. One link of the chain should be added (about 265 grams) to the total weight of the super tool and the Sprain Tool (two links for the short tool). The weight distribution of the hammer is of great importance. Most of the material should be concentrated to the wear plate.

### **3.3.2.6 Chains:**

If the machine works in ruff conditions, the hammers will wear out in 8-16 hours. The chain will be far from worn out after that. It should be cost effective to use the same chains more than once. The hammers should be easy to replace when they are worn out. The quality of the chain is a matter of price. Scanjack AB offers a special hardened chain that is about twice as wear resistant as a standard quality chain. Logistic aspects when it comes to storing and transporting the chains should also be considered.



The total length of the clearing tool (chain and hammer) should be the same as original for both machines. The manufacturer of the Scanjack has been asked if the length of the clearing tool for the rear flail can be reduced. It would be an advantage, in a logistic point of view, to use the same length of the clearing tools for both the front and the rear flail axle. No answer has yet been presented.

**3.3.2.7 Screw/nut:**

The screws and nuts should be off the shelf products. Two different qualities have been tested. The quality of the screws should match the quality of the chains so they wear out simultaneously.

**4 Performance test**

A performance test was made on both the machines with the most promising hammers. The details and the data sheets are found in Annex B and D.

**4.1 MV-4**

|                         | DOB<br>0 cm |             | DOB<br>10 cm |             | DOB<br>15 cm |             |
|-------------------------|-------------|-------------|--------------|-------------|--------------|-------------|
| <b>AP blast targets</b> | <b>2005</b> | <b>2002</b> | <b>2005</b>  | <b>2002</b> | <b>2005</b>  | <b>2002</b> |
| Sand                    | 100%        | 100%        | 100%         | 98%         | 98%          | 100%        |
| Gravel                  | 98%         | 96%         | 100%         | 100%        | 100%         | 92%         |
| Topsoil                 | N/A         | 100%        | N/A          | 96%         | N/A          | 62%         |

*Figure 14: Performance results for MV-4*

The result of the performance of the tested hammers for the MV-4 is by comparison with the acceptance test equal or even better.



## 4.2 Scanjack 3500

|                  | DOB<br>0 cm |      | DOB<br>10 cm |      | DOB<br>20 cm |      |
|------------------|-------------|------|--------------|------|--------------|------|
|                  | 2005        | 2001 | 2005         | 2001 | 2005         | 2001 |
| AP blast targets | 2005        | 2001 | 2005         | 2001 | 2005         | 2001 |
| Sand             | 100%        | 100% | 100%         | 100% | 100%         | 99%  |
| Gravel           | 100%        | 98%  | 100%         | 100% | 100%         | 94%  |
| Topsoil          | N/A         | 98%  | N/A          | 96%  | N/A          | N/A  |

*Figure 15: Performance results for Scanjack 3500*

The result of the performance of the tested hammers for the Scanjack 3500 is by comparison with the acceptance test equal or even better.

The settings for the machines in terms of flail speed, clearing speed, ground pressure, hydraulic pressure etc were as close as possible to the settings used during the acceptance tests.

The performance results of either machine are equal or better than the results during the performance tests. Some evidence of ridges were seen at the rear flail. The rear flail axle speed was increased and the ridges went away. The witness panels showed that the machine performed a uniform cut down to a depth of 25-30 cm.



*Figure 16: Evidence of ridges at the rear flail after a test in the sand lane*





## **Annex A: MV-4 Wear Out Test**

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**WEAR OUT TEST Start**

| <b>Test protocol Clearing Tools<br/>TMR</b>   |   |              |
|---|---|--------------|
| Date:   | Whether conditions:   | Temperature: |
| Ground conditions:  | Status:   | Location:    |
| Test number/overview:   |   | Photo/video: |
| Equipment:<br>Scale 5000 gr +/- 2 gr  |   |              |
| Photos of interest:   |   |              |
|   |  |              |
| <p><i>Figure 17: Weight of toll and chain before</i></p> <p><i>Figure 18: Weight of tool and chain (reference tool)</i></p> |   |              |
| Comments and results:   |   |              |
| <p>Weight of tool and chain before test: 1046 gr</p> <p>Weight of reference tool: 1364 gr</p>                               |   |              |
| Personnel/test leader:  |   | Signature:   |





**WEAR OUT TEST 5 min**

| <b>Test protocol Clearing Tools<br/>TMR</b>  |   |              |
|--|---|--------------|
| Date:<br>2005-11-07  | Whether conditions:   | Temperature: |
| Ground conditions:<br>Meadowland   | Status:   | Location:    |
| Test number/overview:  |   | Photo/video: |
| Equipment:<br>Mv-4 #020  |   |              |
| Photos of interest:  |   |              |
|                      |  |              |
| <p><i>Figure 91: 5 min flailing</i></p> <p><i>Figure 20: Reference tool</i></p>                        |   |              |
| Comments and results:  |   |              |
| <p>Time of processing the ground: 5 min</p> <p>One tool was hooked up</p> <p>18/18 tools remaining</p> |   |              |
| Personnel/test leader:   |   | Signature:   |






**WEAR OUT TEST 10 min**

| <b>Test protocol Clearing Tools<br/>TMR</b>  |                                      |   |
|--|--------------------------------------|---|
| Date:<br>2005-11-07  | Whether conditions:<br>Partly cloudy | Temperature:<br>9° C  |
| Ground conditions:<br>Meadowland   | Status:                              | Location:<br>N Kulla, Eksjo   |
| Test number/overview:  |                                      | Photo/video:  |
| Equipment:<br>Mv-4 #020  |                                      |   |
| Photos of interest:  |                                      |   |
|      |                                      |  |
| <p><i>Figure 21: After 10 min flailing</i></p> <p><i>Figure 22: Reference tool</i></p> |                                      |   |
| Comments and results:  |                                      |   |
| <p>Accumulated time since start: 10 min</p> <p>Tools remaining: 18/18</p>              |                                      |   |
| Personnel/test leader:   |                                      | Signature:  |



**WEAR OUT TEST 15 min**

| <b>Test protocol Clearing Tools<br/>TMR</b>   |  |                             |
|---|--|-----------------------------|
| Date:<br>2005-11-07   | Whether conditions:<br>Partly cloudy   | Temperature:<br>9° C        |
| Ground conditions:<br>Meadowland  | Status:  | Location:<br>N Kulla, Eksjo |
| Test number/overview:   |  | Photo/video:                |
| Equipment:<br>Mv-4 #020   |  |                             |
| Photos of interest:   |  |                             |
|   |   |                             |
| <i>Figure 23: 15 min flailing</i>   | <i>Figure 24: Reference tool</i>   |                             |
| Comments and results:   |  |                             |
| <p>20 min</p> <p>Tools remaining 17/18. 1 tool was lost</p> <p>The tool was searched for and found.<br/>The attachment<br/>broke in the curve</p> |  |                             |
| <i>Figure 25: Tool missing</i>  |  |                             |
| Personnel/test leader:  |  | Signature:                  |





**WEAR OUT TEST 25 min**

| <b>Test protocol Clearing Tools<br/>TMR</b>  |   |  |
|--|---|--|
| Date:<br>2005-11-07  | Whether conditions:<br>Partly cloudy  | Temperature:<br>9° C   |
| Ground conditions:<br>Meadowland   | Status:   | Location:<br>N Kulla, Eksjo  |
| Test number/overview:  |   | Photo/video:   |
| Equipment:<br>Mv-4 #020  |   |  |
| Photos of interest:  |   |  |
|              |  |  |
| <p><i>Figure 26: 25 min flailing</i>                      <i>Figure 27: Reference tool</i></p> |   |  |
| Comments and results:  |   |  |
| <p>25 min</p> <p>The hook has been slightly bent compared with reference tool to the right</p> |   |  |
| <p>Personnel/test leader:</p>  |   | <p>Signature:</p>  |





**WEAR OUT TEST 130 min**

| <b>Test protocol Clearing Tools<br/>TMR</b>  |   |                             |
|--|---|-----------------------------|
| Date:<br>2005-11-07  | Whether conditions:<br>Partly cloudy  | Temperature:<br>9° C        |
| Ground conditions:<br>Meadowland   | Status:   | Location:<br>N Kulla, Eksjo |
| Test number/overview:<br>130 minutes of flailing   |   | Photo/video:                |
| Equipment:<br>Mv-4 #020  |   |                             |
| Photos of interest:  |   |                             |
|    |  |                             |
| <p><i>Figure 29: 130 min flailing</i></p> <p><i>Figure 30: Reference tool</i></p>  |   |                             |
| Comments and results:  |   |                             |
| <p>The reference tool is worn out. Most of the tested tools have been lost. After a 40 min run in meadowland, the machine was moved to a soft gravel lane. The machine was working there for about one hour. It was then moved to a gravel road and was working there for another 30 minutes.</p> <p>The attachment and or the material (cast iron) will break before the tool is worn out. A wrought iron material in combination with an another attachment should be considered.</p> <p>Weight test tool: 934 gram<br/>Weight reference tool: 1212 gram</p> |   |                             |
| Personnel/test leader:   |   | Signature:                  |



## **Annex B: MV-4 Performance Test**

### **MV-4 Performance in Gravel Lane**

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**TEST PROTOCOL Gravel 0 cm**

Machine type  
MV-4

Manufacturer  
DOC-ING, Croatia

|                    |                   |                     |
|--------------------|-------------------|---------------------|
| Date<br>2005-11-10 | Whether<br>Cloudy | Temperature<br>6° C |
|--------------------|-------------------|---------------------|

|              |                          |
|--------------|--------------------------|
| Test number/ | Deployment depth<br>0 cm |
|--------------|--------------------------|

|                     |                                  |  |
|---------------------|----------------------------------|--|
| Test lane<br>Gravel | Rate of compaction<br>N/A to wet | Water content<br>N/A to high water content |
|---------------------|----------------------------------|--|

|                                 |                    |   |                           |
|---------------------------------|--------------------|---|---------------------------|
| Clearing depth<br>See fig 34-36 | Time/25 m<br>3 min | ⇒ | Clearing speed<br>500 m/h |
|---------------------------------|--------------------|---|---------------------------|

|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 50               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 48               |                    |                  |                  |
| Mech. Neutralised<br>>50%: |                  |                    |                  |                  |
| Live Damaged:              |                  |                    |                  |                  |
| Live:                      | 1                |                    |                  |                  |
| Total:                     |                  |                    |                  |                  |
| Detonations                | 39               |                    |                  |                  |

Comments:

Single fuses AP blast: 9 of which 4 were damaged  
Single fuses AP : of which were damaged

Accounted for AP blast: 49/50 (detonations+single fuses+uneffected+damaged)  
Accounted for AP bounce: %  
Accounted for AP frag: %  
Accounted for AT blast: %

Throw outs:



*Figure 31: Debris of Interest, Gravel 0 cm*



**TEST PROTOCOL Gravel 10 cm**

Machine type  
MV-4

Manufacturer  
DOC-ING, Croatia

|                    |                   |                     |
|--------------------|-------------------|---------------------|
| Date<br>2005-11-10 | Whether<br>Cloudy | Temperature<br>6° C |
|--------------------|-------------------|---------------------|

|              |                           |
|--------------|---------------------------|
| Test number/ | Deployment depth<br>10 cm |
|--------------|---------------------------|

|                     |                                  |  |
|---------------------|----------------------------------|--|
| Test lane<br>Gravel | Rate of compaction<br>N/A to wet | Water content<br>N/A to high water content |
|---------------------|----------------------------------|--|

|                                 |                    |   |                           |
|---------------------------------|--------------------|---|---------------------------|
| Clearing depth<br>See fig 37-39 | Time/25 m<br>3 min | → | Clearing speed<br>500 m/h |
|---------------------------------|--------------------|---|---------------------------|

|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 50               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 41+(3)           |                    |                  |                  |
| Mech. Neutralised<br>>50%: | 5                |                    |                  |                  |
| Live Damaged:              | 0                |                    |                  |                  |
| Live:                      | 0                |                    |                  |                  |
| Total:                     |                  |                    |                  |                  |
| Detonations                | 43               |                    |                  |                  |

Comments:

Triggered targets were found buried deep in the ground The detonation were probably not heard. All reasonable action has been taken to find the fuses. No live targets (mine +fuse) is left in the ground.

Single fuses AP blast: 3 of which 3 were damaged  
Single fuses AP : of which were damaged

Accounted for AP blast: 46/50 (detonations+single fuses+uneffected+damaged)  
Accounted for AP bounce: %  
Accounted for AP frag: %  
Accounted for AT blast: %

Throw outs:



*Figure 32: Debris of Interest, Gravel 10 cm*



**TEST PROTOCOL Gravel 15 cm**

|                      |                                  |
|----------------------|----------------------------------|
| Machine type<br>MV-4 | Manufacturer<br>DOC-ING, Croatia |
|----------------------|----------------------------------|

|                    |                   |                     |
|--------------------|-------------------|---------------------|
| Date<br>2005-11-10 | Whether<br>Cloudy | Temperature<br>6° C |
|--------------------|-------------------|---------------------|

|              |                           |
|--------------|---------------------------|
| Test number/ | Deployment depth<br>15 cm |
|--------------|---------------------------|

|                     |                                  |  |
|---------------------|----------------------------------|--|
| Test lane<br>Gravel | Rate of compaction<br>N/A to wet | Water content<br>N/A to high water content |
|---------------------|----------------------------------|--|

|                                 |                    |   |                           |
|---------------------------------|--------------------|---|---------------------------|
| Clearing depth<br>See fig 40-42 | Time/25 m<br>3 min | → | Clearing speed<br>500 m/h |
|---------------------------------|--------------------|---|---------------------------|

|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 17               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 7+(1)            |                    |                  |                  |
| Mech. Neutralised<br>>50%: | 0                |                    |                  |                  |
| Live Damaged:              | 1                |                    |                  |                  |
| Live:                      | 0                |                    |                  |                  |
| Total:                     | 16+1             |                    |                  |                  |
| Detonations                | 8                |                    |                  |                  |

Comments:

Triggered targets were found buried deep in the ground The detonation were probably not heard. All reasonable action has been taken to find the fuses. No live targets (mine +fuse) is left in the ground.

Single fuses AP blast: 7 of which 6 were damaged  
Single fuses AP : of which were damaged

Accounted for AP blast: 16/17 (detonations+single fuses+unaffected+damaged)  
Accounted for AP bounce: %  
Accounted for AP frag: %  
Accounted for AT blast: %

Throw outs:



*Figure 33: Debris of Interest, Gravel 15 cm*



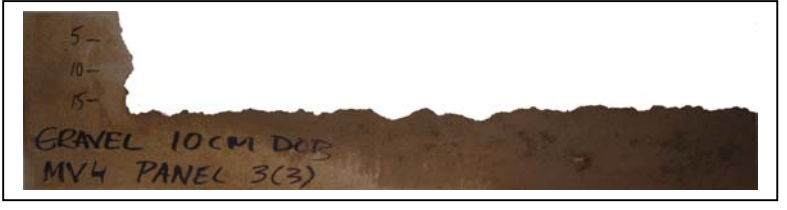


**WITNESS PANELS Gravel 0 cm**

| <b>Test protocol Clearing Tools<br/>TMR</b>  |   |                      |
|--|---|----------------------|
| Date:<br>2005-11-10  | Whether conditions:                                       | Temperature:         |
| Ground conditions:<br>Gravel lane  | Status:<br>Lane was to wet to compact to<br>decided level | Location:<br>N Kulla |
| Test number/overview:<br>Performance test gravel lane 0 cm DOB   |   | Photo/video:         |
| Equipment:<br>Doc-Ing MV-4, #020   |   |                      |
| Photos of interest:  |   |                      |
| <i>Figure 34:</i>  |   |                      |
| <i>Figure 35:</i>  |   |                      |
| <i>Figure 36:</i>  |   |                      |
| Comments and results:  |   |                      |
| <p>Rotation of flail: 80%<br/>Forward speed: Gear 0, 20 %, clearing speed 500 m/h<br/>Ground pressure: 6</p> |   |                      |
| Personnel/test leader:   |   | Signature:           |



**WITNESS PANELS Gravel 10 cm**

| <b>Test protocol Clearing Tools<br/>TMR</b>   |  |                      |
|---|--|----------------------|
| Date:<br>2005-11-10   | Whether conditions:  | Temperature:         |
| Ground conditions:<br>Gravel lane   | Status:<br>Lane was to wet to compact to decided level                               | Location:<br>N Kulla |
| Test number/overview:<br>Performance test gravel lane 10 cm DOB   |  | Photo/video:         |
| Equipment:<br>Doc-Ing MV-4  |  |                      |
| Photos of interest:   |  |                      |
| <i>Figure 37:</i>   |   |                      |
| <i>Figure 38:</i>   |  |                      |
| <i>Figure 39:</i>   |  |                      |
| Comments and results:   |  |                      |
| <p>Rotation of flail: 80%<br/>Forward speed: Gear 0, 20 %, clearing speed 500m/h<br/>Ground pressure: 6</p> |  |                      |
| Personnel/test leader:  |  | Signature:           |



**WITNESS PANELS Gravel 15 cm**

| <b>Test protocol Clearing Tools<br/>TMR</b>   |   |                      |
|---|---|----------------------|
| Date:<br>2005-11-10   | Whether conditions:                                       | Temperature:         |
| Ground conditions:<br>Gravel lane   | Status:<br>Lane was to wet to compact to<br>decided level | Location:<br>N Kulla |
| Test number/overview:<br>Performance test gravel lane 15 cm DOB   |   | Photo/video:         |
| Equipment:<br>Doc-Ing MV-4  |   |                      |
| Photos of interest:   |   |                      |
| <i>Figure 40:</i>   |   |                      |
| <i>Figure 41:</i>   |   |                      |
| <i>Figure 42:</i>   |   |                      |
| Comments and results:   |   |                      |
| <p>Rotation of flail: 80%<br/>Forward speed: Gear 0, 20 %, clearing speed 500m/h<br/>Ground pressure: 6</p> |   |                      |
| Personnel/test leader:  |   | Signature:           |



## **MV-4 Performance in Sand lane**

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**TEST PROTOCOL Sand 0 cm**

Machine type  
 MV-4

Manufacturer  
 DOC-ING, Croatia

|                    |                   |                     |
|--------------------|-------------------|---------------------|
| Date<br>2005-11-10 | Whether<br>Cloudy | Temperature<br>4° C |
|--------------------|-------------------|---------------------|

|              |                          |
|--------------|--------------------------|
| Test number/ | Deployment depth<br>0 cm |
|--------------|--------------------------|

|                   |                              |                        |
|-------------------|------------------------------|------------------------|
| Test lane<br>Sand | Rate of compaction<br>90,2 % | Water content<br>5,6 % |
|-------------------|------------------------------|------------------------|

|                                 |                           |   |                           |
|---------------------------------|---------------------------|---|---------------------------|
| Clearing depth<br>See fig 46-48 | Time/25 m<br>6 min 30 sek | ⇒ | Clearing speed<br>231 m/h |
|---------------------------------|---------------------------|---|---------------------------|

|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 50               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 50               |                    |                  |                  |
| Mech. Neutralised<br>>50%: | 0                |                    |                  |                  |
| Live Damaged:              | 0                |                    |                  |                  |
| Live:                      | 0                |                    |                  |                  |
| Total:                     | 50               |                    |                  |                  |
| Detonations                | 49               |                    |                  |                  |

Comments:

Single fuses AP blast: 1 of which 1 were damaged  
 Single fuses AP : of which were damaged

Accounted for AP blast: 50/50 (detonations+single fuses+uneffected+damaged)  
 Accounted for AP bounce: %  
 Accounted for AP frag: %  
 Accounted for AT blast: %

Throw outs:



*Figure 43: Debris of Interest, Sand 0 cm*



**TEST PROTOCOL Sand 10 cm**

|                      |                                  |
|----------------------|----------------------------------|
| Machine type<br>MV-4 | Manufacturer<br>DOC-ING, Croatia |
|----------------------|----------------------------------|

|                    |                   |                     |
|--------------------|-------------------|---------------------|
| Date<br>2005-11-10 | Whether<br>Cloudy | Temperature<br>4° C |
|--------------------|-------------------|---------------------|

|              |                           |
|--------------|---------------------------|
| Test number/ | Deployment depth<br>10 cm |
|--------------|---------------------------|

|                   |                              |                        |
|-------------------|------------------------------|------------------------|
| Test lane<br>Sand | Rate of compaction<br>90,2 % | Water content<br>5,6 % |
|-------------------|------------------------------|------------------------|

|                                 |                           |   |                           |
|---------------------------------|---------------------------|---|---------------------------|
| Clearing depth<br>See fig 49-51 | Time/25 m<br>6 min 30 sek | → | Clearing speed<br>231 m/h |
|---------------------------------|---------------------------|---|---------------------------|

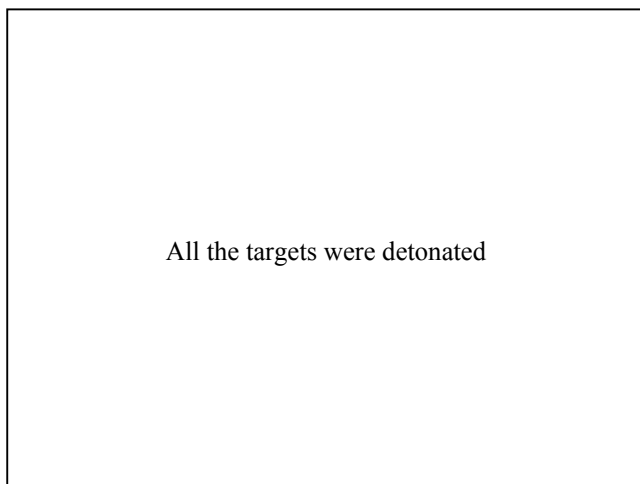
|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 50               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 50               |                    |                  |                  |
| Mech. Neutralised<br>>50%: | 0                |                    |                  |                  |
| Live Damaged:              | 0                |                    |                  |                  |
| Live:                      | 0                |                    |                  |                  |
| Total:                     | 50               |                    |                  |                  |
| Detonations                | 50               |                    |                  |                  |

Comments:

Single fuses AP blast: 0 of which 0 were damaged  
 Single fuses AP : of which were damaged

Accounted for AP blast: 50/50 (detonations+single fuses+uneffected+damaged)  
 Accounted for AP bounce: %  
 Accounted for AP frag: %  
 Accounted for AT blast: %

Throw outs:



*Figure 44: Debris of Interest, Sand 10 cm*



**TEST PROTOCOL Sand 20 cm**

Machine type  
MV-4

Manufacturer  
DOC-ING, Croatia

|                    |                   |                     |
|--------------------|-------------------|---------------------|
| Date<br>2005-11-10 | Whether<br>Cloudy | Temperature<br>4° C |
|--------------------|-------------------|---------------------|

|              |                           |
|--------------|---------------------------|
| Test number/ | Deployment depth<br>15 cm |
|--------------|---------------------------|

|                   |                              |                        |
|-------------------|------------------------------|------------------------|
| Test lane<br>Sand | Rate of compaction<br>90,2 % | Water content<br>5,6 % |
|-------------------|------------------------------|------------------------|

|                                 |                           |   |                           |
|---------------------------------|---------------------------|---|---------------------------|
| Clearing depth<br>See fig 52-54 | Time/25 m<br>6 min 30 sek | → | Clearing speed<br>231 m/h |
|---------------------------------|---------------------------|---|---------------------------|

|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 50               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 48               |                    |                  |                  |
| Mech. Neutralised<br>>50%: | 0                |                    |                  |                  |
| Live Damaged:              | 1                |                    |                  |                  |
| Live:                      | 1                |                    |                  |                  |
| Total:                     | 50               |                    |                  |                  |
| Detonations                | 50               |                    |                  |                  |

Comments:

Single fuses AP blast: 1 of which 1 were damaged  
Single fuses AP : of which were damaged

Accounted for AP blast: 50/50 (detonations+single fuses+uneffected+damaged)  
Accounted for AP bounce: %  
Accounted for AP frag: %  
Accounted for AT blast: %

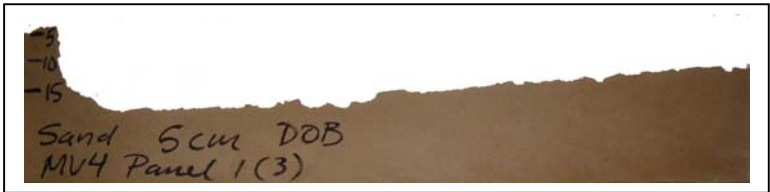
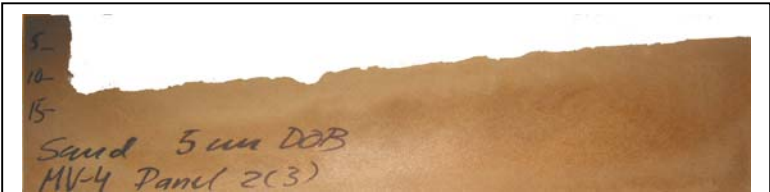
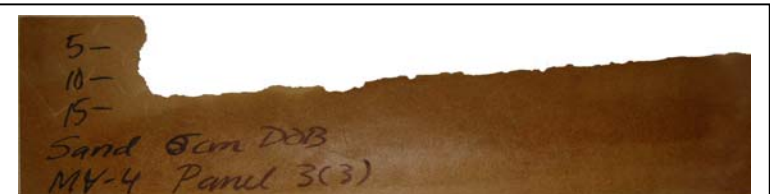
Throw outs:



*Figure 45: Debris of Interest, Sand 15 cm*

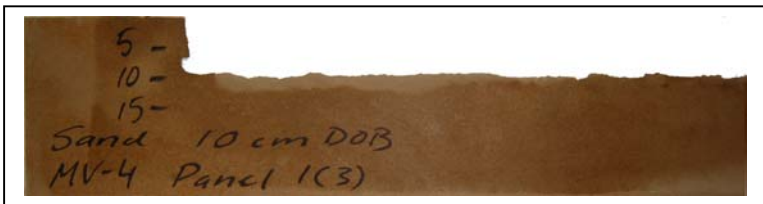
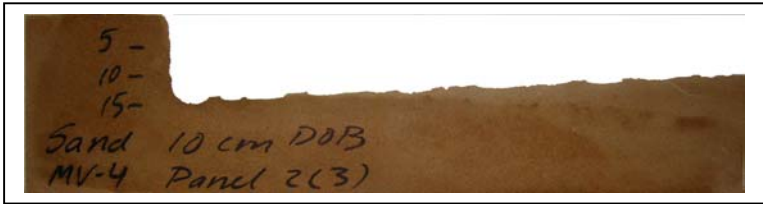
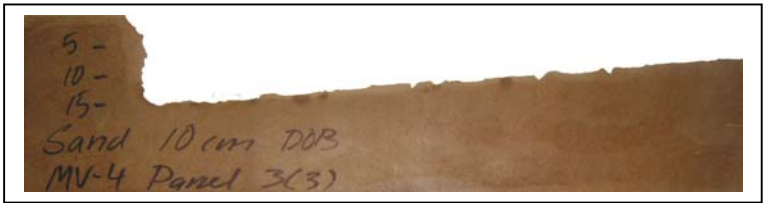


**WITNESS PANELS Sand 0 cm**

| <b>Test protocol Clearing Tools<br/>TMR</b>   |  |                      |
|---|--|----------------------|
| Date:<br>2005-11-11   | Whether conditions:  | Temperature:         |
| Ground conditions:<br>Sand lane   | Status:  | Location:<br>N Kulla |
| Test number/overview:<br>Performance test sand lane 0 cm DOB  |  | Photo/video:         |
| Equipment:<br>Doc-Ing MV-4, #020  |  |                      |
| Photos of interest:   |  |                      |
| <i>Figure 46:</i>   |   |                      |
| <i>Figure 47:</i>   |  |                      |
| <i>Figure 48:</i>   |  |                      |
| Comments and results:   |  |                      |
| <p>Rotation of flail: 80%<br/>Forward speed: Gear 0, 16 %, clearing speed 231m/h<br/>Ground pressure: 4</p> |  |                      |
| Personnel/test leader:  |  | Signature:           |



**WITNESS PANELS Sand 10 cm**

| <b>Test protocol Clearing Tools<br/>TMR</b>   |  |                      |
|---|--|----------------------|
| Date:<br>2005-11-11   | Whether conditions:  | Temperature:         |
| Ground conditions:<br>Sand lane   | Status:  | Location:<br>N Kulla |
| Test number/overview:<br>Performance test sand lane 10 cm DOB   |  | Photo/video:         |
| Equipment:<br>Doc-Ing MV-4, #020  |  |                      |
| Photos of interest:   |  |                      |
| <i>Figure 49:</i>   |   |                      |
| <i>Figure 50:</i>   |  |                      |
| <i>Figure 51:</i>   |  |                      |
| Comments and results:   |  |                      |
| <p>Rotation of flail: 80%<br/>Forward speed: Gear 0, 16 %, clearing speed 231m/h<br/>Ground pressure: 4</p> |  |                      |
| Personnel/test leader:  |  | Signature:           |



**WITNESS PANELS Sand 15 cm**

| <b>Test protocol Clearing Tools<br/>TMR</b>   |                     |                      |
|---|---------------------|----------------------|
| Date:<br>2005-11-11   | Whether conditions: | Temperature:         |
| Ground conditions:<br>Sand lane   | Status:             | Location:<br>N Kulla |
| Test number/overview:<br>Performance test sand lane 15 cm DOB   |                     | Photo/video:         |
| Equipment:<br>Doc-Ing MV-4, #020  |                     |                      |
| Photos of interest:   |                     |                      |
| <i>Figure 52:</i>   |                     |                      |
| <i>Figure 53:</i>   |                     |                      |
| <i>Figure 54:</i>   |                     |                      |
| Comments and results:   |                     |                      |
| <p>Rotation of flail: 80%<br/>Forward speed: Gear 0, 16 %, clearing speed 231m/h<br/>Ground pressure: 4</p> |                     |                      |
| Personnel/test leader:  |                     | Signature:           |






## **ANNEX C: Scanjack 3500 Wear Out Test**

### **Scanjack 3500 Cast Iron Hammers**

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**WEAR OUT TEST 5 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>   |  |   |
|---|--|---|
| Date:<br>2005-11-08   | Whether conditions:<br>Partly cloudy   | Temperature:<br>9° C  |
| Ground conditions:<br>Meadowland  | Status:  | Location:<br>N Kulla, Eksjo   |
| Test number/overview:   |  | Photo/video:  |
| Equipment:<br>Scanjack 3500 # 150493  |  |   |
| Photos of interest:   |  |   |
|   |  |  |
| <i>Figure 55: Sprain tool,<br/>cast iron</i>  | <i>Figure 56: Reference tool</i>   | <i>Figure 57: Super tool, cast<br/>iron</i>   |
| Comments and results:   |  |   |
| <p>Photos taken after 5 min of flailing in meadowland. One supertool was lost on the rear flail</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure: 6/180-200 bar<br/>Depth meter: ~ 20 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~300 m/h</p> |  |   |
| Personnel/test leader:  |  | Signature:  |



**WEAR OUT TEST 10 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>   |  |   |
|---|--|---|
| Date:<br>2005-11-08   | Whether conditions:<br>Partly cloudy   | Temperature:<br>9° C  |
| Ground conditions:<br>Meadowland  | Status:  | Location:<br>N Kulla, Eksjo   |
| Test number/overview:   |  | Photo/video:  |
| Equipment:<br>Scanjack 3500 # 150493  |  |   |
| Photos of interest:   |  |   |
|   |  |  |
| <i>Figure 58: Sprain tool,<br/>cast iron</i>  | <i>Figure 59: Reference tool</i>   | <i>Figure 60: Super tool, cast<br/>iron</i>   |
| Comments and results:   |  |   |
| <p>Photos taken after total time of 10 min flailing in meadowland. A total of one Super Tool was lost on the rear flail</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure: 6/180-200 bar<br/>Depth meter: ~ 20 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~300 m/h</p> |  |   |
| Personnel/test leader:  |  | Signature:  |






**WEAR OUT TEST 20 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>   |  |   |
|---|--|---|
| Date:<br>2005-11-08   | Whether conditions:<br>Partly cloudy   | Temperature:<br>9° C  |
| Ground conditions:<br>Meadowland  | Status:  | Location:<br>N Kulla, Eksjo   |
| Test number/overview:   |  | Photo/video:  |
| Equipment:<br>Scanjack 3500 # 150493  |  |   |
| Photos of interest:   |  |   |
|   |  |  |
| <i>Figure 61: Sprain tool,<br/>cast iron</i>  | <i>Figure 62: Reference tool</i>   | <i>Figure 63: Super tool, cast<br/>iron</i>   |
| Comments and results:   |  |   |
| <p>Photos taken after total time of 20 min flailing in meadowland. A total of one Super Tool was lost on the rear flail</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure: 6/180-200 bar<br/>Depth meter: ~ 20 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~300 m/h</p> |  |   |
| Personnel/test leader:  |  | Signature:  |






**WEAR OUT TEST 50 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>  |  |   |
|--|--|---|
| Date:<br>2005-11-08  | Whether conditions:<br>Partly cloudy   | Temperature:<br>9° C  |
| Ground conditions:<br>Meadowland   | Status:  | Location:<br>N Kulla, Eksjo   |
| Test number/overview:  |  | Photo/video:  |
| Equipment:<br>Scanjack 3500 # 150493   |  |   |
| Photos of interest:  |  |   |
|    |  |  |
| <i>Figure 64: Sprain tool,<br/>cast iron</i>   | <i>Figure 65: Reference tool</i>   | <i>Figure 66: Super tool, cast<br/>iron</i>   |
| Comments and results:  |  |   |
| <p>Photos taken after total time of 50 min flailing in meadowland.</p> <p>A total number of five Super Tool was missing on the rear flail<br/>One sprain tool was lost on the front flail</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure:6/180-200 bar<br/>Depth meter: ~ 20 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~300 m/h</p> |  |   |
| Personnel/test leader:   |  | Signature:  |







**WEAR OUT TEST 85 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>   |  |   |
|---|--|---|
| Date:<br>2005-11-08   | Whether conditions:<br>Partly cloudy   | Temperature:<br>9° C  |
| Ground conditions:<br>Meadowland  | Status:  | Location:<br>N Kulla, Eksjo   |
| Test number/overview:   |  | Photo/video:  |
| Equipment:<br>Scanjack 3500 # 150493  |  |   |
| Photos of interest:   |  |   |
|   |  |  |
| <i>Figure 67: Sprain tool,<br/>cast iron</i>  | <i>Figure 68: Reference tool</i>   | <i>Figure 69: Super tool, cast<br/>iron</i>   |
| Comments and results:   |  |   |
| <p>Photos taken after total time of 85 min flailing in meadowland.</p> <p>A total of five Super Tools were lost on the rear flail.<br/>A total of three Sprain Tools were lost in the front flail</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure: 6/180-200 bar<br/>Depth meter: ~ 20 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~300 m/h</p> |  |   |
| Personnel/test leader:  |  | Signature:  |






**WEAR OUT TEST 155 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>   |  |   |
|---|--|---|
| Date:<br>2005-11-08   | Whether conditions:<br>Partly cloudy   | Temperature:<br>9° C  |
| Ground conditions:<br>Meadowland  | Status:  | Location:<br>N Kulla, Eksjo   |
| Test number/overview:   |  | Photo/video:  |
| Equipment:<br>Scanjack 3500 # 150493  |  |   |
| Photos of interest:   |  |   |
|   |  |    |
| <i>Figure 70: Sprain tool,<br/>cast iron</i>  | <i>Figure 71: Reference tool</i>   | <i>Figure 72: Super tool, cast<br/>iron</i>   |
| Comments and results:   |  |   |
| <p>Photos taken after total time of 155 min flailing in meadowland.</p> <p>Rear flail: A total of 11 super tools and 1 sprain tool were missing<br/>Front flail: A total of 4 super tools and 4 sprain tools were missing</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure: 6/180-200 bar<br/>Depth meter: ~ 20 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~300 m/h</p> |  |  |
| Personnel/test leader:  |  | Signature:  |



**WEAR OUT TEST 230 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>   |  |   |
|---|--|---|
| Date:<br>2005-11-08   | Whether conditions:<br>Partly cloudy   | Temperature:<br>9° C  |
| Ground conditions:<br>Meadowland  | Status:  | Location:<br>N Kulla, Eksjo   |
| Test number/overview:   |  | Photo/video:  |
| Equipment:<br>Scanjack 3500 # 150493  |  |   |
| Photos of interest:   |  |   |
|   |  |  |
| <i>Figure 74: Sprain tool,<br/>cast iron</i>  | <i>Figure 75: Reference tool</i>   | <i>Figure 76: Super tool, cast<br/>iron</i>   |
| Comments and results:   |  |   |
| <p>Photos taken after total time of 230 min flailing in meadowland.</p> <p>Super tool: A total number of 119 were lost<br/>           Sprain tool: A total number of 99 were lost<br/>           Front flail speed/pressure: 7/180-200 bar<br/>           Rear flail speed/pressure:6/180-200 bar<br/>           Depth meter: ~ 20 cm<br/>           M2 engine rev: 1800 rpm<br/>           M1 engine rev: 1300 rpm<br/>           Clearing speed: ~300 m/h</p> |  |   |
| Personnel/test leader:  |  | Signature:  |





## **Scanjack 3500 Wrought Iron Hammers**

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**WEAR OUT TEST 20 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>   |   |                             |
|---|---|-----------------------------|
| Date:<br>2005-11-29   | Whether conditions:<br>Cloudy   | Temperature:<br>0° C        |
| Ground conditions:<br>Gravel mix  | Status:   | Location:<br>N Kulla, Eksjo |
| Test number/overview:   |   | Photo/video:                |
| Equipment:<br>Scanjack 3500 # 150493  |   |                             |
| Photos of interest:   |   |                             |
|   |  |                             |
| <p><i>Figure 77: Sprain tool, cast iron</i>                      <i>Figure 78: Reference tool</i></p>   |   |                             |
| Comments and results:   |   |                             |
| <p>Photos taken after total time of 20 min flailing in gravel mix.</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure: 6/180-200 bar<br/>Depth meter: 10-15 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~230 m/h</p> |   |                             |
| Personnel/test leader:  |   | Signature:                  |





**WEAR OUT TEST 35 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>  |                               |   |
|--|-------------------------------|---|
| Date:<br>2005-11-30  | Whether conditions:<br>Cloudy | Temperature:<br>0° C  |
| Ground conditions:<br>Sand lane  | Status:                       | Location:<br>N Kulla, Eksjo   |
| Test number/overview:  |                               | Photo/video:  |
| Equipment:<br>Scanjack 3500 # 150493   |                               |   |
| Photos of interest:  |                               |   |
|    |                               |  |
| <p><i>Figure 79: Sprain tool 73 mm,<br/>wrought-iron</i></p>   |                               | <p><i>Figure 80: Reference tool</i></p>   |
| Comments and results:  |                               |   |
| <p>Photos taken after total time of 20 min flailing in gravel mix and 15 min in the sand lane. Total accumulated time 35 min.</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure: 6/180-200 bar<br/>Depth meter: 10-15 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~230 m/h</p> |                               |   |
| Personnel/test leader:   |                               | Signature:  |





**WEAR OUT TEST 95 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>   |   |                             |
|---|---|-----------------------------|
| Date:<br>2005-12-01   | Whether conditions:<br>Cloudy   | Temperature:<br>-3° C       |
| Ground conditions:<br>Meadowland  | Status:   | Location:<br>N Kulla, Eksjo |
| Test number/overview:   |   | Photo/video:                |
| Equipment:<br>Scanjack 3500 # 150493  |   |                             |
| Photos of interest:   |   |                             |
|   |  |                             |
| <p><i>Figure 81: Sprain tool 73 mm, wrought-iron</i></p> <p><i>Figure 82: Reference tool</i></p>  |   |                             |
| Comments and results:   |   |                             |
| <p>Photos taken after one hour of flailing in meadowland. Total accumulated time 95 min.</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure: 6/180-200 bar<br/>Depth meter: 10-15 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~230 m/h</p> |   |                             |
| Personnel/test leader:  |   | Signature:                  |





**WEAR OUT TEST 155 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>  |                               |   |
|--|-------------------------------|---|
| Date:<br>2005-12-01  | Whether conditions:<br>Cloudy | Temperature:<br>-3° C   |
| Ground conditions:<br>Meadowland   | Status:                       | Location:<br>N Kulla, Eksjo   |
| Test number/overview:  |                               | Photo/video:  |
| Equipment:<br>Scanjack 3500 # 150493   |                               |   |
| Photos of interest:  |                               |   |
|    |                               |  |
| <i>Figure 83: Sprain tool 73 mm,<br/>wrought-iron</i>  |                               | <i>Figure 84: Reference tool</i>  |
| Comments and results:  |                               |   |
| <p>Photos taken after one hour of flailing in meadowland. Total accumulated time 155 min.</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure: 6/180-200 bar<br/>Depth meter: 10-15 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~230 m/h</p> |                               |   |
| Personnel/test leader:   |                               | Signature:  |



**WEAR OUT TEST 215 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>   |   |                             |
|---|---|-----------------------------|
| Date:<br>2005-12-02   | Whether conditions:<br>Cloudy   | Temperature:<br>-3° C       |
| Ground conditions:<br>Meadowland  | Status:   | Location:<br>N Kulla, Eksjo |
| Test number/overview:   |   | Photo/video:                |
| Equipment:<br>Scanjack 3500 # 150493  |   |                             |
| Photos of interest:   |   |                             |
|   |  |                             |
| <p><i>Figure 85: Sprain tool 73 mm, wrought-iron</i></p> <p><i>Figure 86: Reference tool</i></p>  |   |                             |
| Comments and results:   |   |                             |
| <p>Photos taken after one hour of flailing in meadowland. Total accumulated time 215 min.</p> <p>No lost tools</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure: 6/180-200 bar<br/>Depth meter: 10-15 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~230 m/h</p> |   |                             |
| Personnel/test leader:  |   | Signature:                  |




**WEAR OUT TEST 220 min**

| <b>Test protocol Clearing Tools<br/>DMR</b>   |                               |                             |
|---|-------------------------------|-----------------------------|
| Date:<br>2005-12-02   | Whether conditions:<br>Cloudy | Temperature:<br>-3° C       |
| Ground conditions:<br>Meadowland  | Status:                       | Location:<br>N Kulla, Eksjo |
| Test number/overview:   |                               | Photo/video:                |
| Equipment:<br>Scanjack 3500 # 150493  |                               |                             |
| Photos of interest:   |                               |                             |
|   |                               |                             |
| <p><i>Figure 87: Sprain tool 73 mm, wrought-iron in heavy vegetation</i></p>  |                               |                             |
| Comments and results:   |                               |                             |
| <p>A test how the tools performed in heavy vegetation was inserted.<br/>Total accumulated time 220 min.</p> <p>No lost tools</p> <p>Front flail speed/pressure: 7/180-200 bar<br/>Rear flail speed/pressure: 6/180-200 bar<br/>Depth meter: 10-15 cm<br/>M2 engine rev: 1800 rpm<br/>M1 engine rev: 1300 rpm<br/>Clearing speed: ~230 m/h</p> |                               |                             |
| Personnel/test leader:  |                               | Signature:                  |



**WEAR OUT TEST Stop**

| <b>Test protocol Clearing Tools<br/>DMR</b>  |                               |                             |
|--|-------------------------------|-----------------------------|
| Date:<br>2005-12-02  | Whether conditions:<br>Cloudy | Temperature:<br>-3° C       |
| Ground conditions:<br>Meadowland   | Status:                       | Location:<br>N Kulla, Eksjo |
| Test number/overview:  |                               | Photo/video:                |
| Equipment:<br>Scanjack 3500 # 150493   |                               |                             |
| Photos of interest:  |                               |                             |
|   |                               |                             |
| <p><i>Figure 88: Comparison<br/>between new and worn tools<br/>used in the test</i></p>  |                               |                             |
| Comments and results:  |                               |                             |
| <p>Tested tools were dismantled and washed. The tongue on the 73 mm sprain tool was cut with help of an angle grinder. The first link on the chain was also cut on the reference tool.</p> <p>The 73 mm sprain tool had lost 200,0 grams (19,3%) of weight during the test. The reference tool lost 151,3 grams (12,3 %).</p> <p>Most of the weight is still concentrated to the bottom of the tool.</p> |                               |                             |
| Personnel/test leader:   |                               | Signature:                  |



## **Annex D: Scanjack 3500 Performance Test**

### **Scanjack 3500 Performance in Gravel Lane**

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**TEST PROTOCOL Gravel 0 cm**

|                               |                             |
|-------------------------------|-----------------------------|
| Machine type<br>Scanjack 3500 | Manufacturer<br>Scanjack AB |
|-------------------------------|-----------------------------|

|                    |                   |                     |
|--------------------|-------------------|---------------------|
| Date<br>2005-11-29 | Whether<br>Cloudy | Temperature<br>0° C |
|--------------------|-------------------|---------------------|

|              |                          |
|--------------|--------------------------|
| Test number/ | Deployment depth<br>0 cm |
|--------------|--------------------------|

|                     |                            |                      |
|---------------------|----------------------------|----------------------|
| Test lane<br>Gravel | Rate of compaction<br>93,6 | Water content<br>5,4 |
|---------------------|----------------------------|----------------------|

|                |                    |   |                           |
|----------------|--------------------|---|---------------------------|
| Clearing depth | Time/75 m<br>5 min | → | Clearing speed<br>300 m/h |
|----------------|--------------------|---|---------------------------|

|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 50               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 50               |                    |                  |                  |
| Mech. Neutralised<br>>50%: | 0                |                    |                  |                  |
| Live Damaged:              | 0                |                    |                  |                  |
| Live:                      | 0                |                    |                  |                  |
| Total:                     | 50               |                    |                  |                  |
| Detonations                | 47               |                    |                  |                  |

Comments:

Single fuses AP blast 3 of which 2 were damaged  
 Single fuses AP : of which were damaged

Accounted for AP blast: 50/50 (detonations+single fuses+uneffected+damaged)  
 Accounted for AP bounce: %  
 Accounted for AP frag: %  
 Accounted for AT blast: %

Throw outs:



Figure 89: Debris of interest Gravel 0 cm



**TEST PROTOCOL Gravel 10 cm**

Machine type  
Scanjack 3500

Manufacturer  
Scanjack AB

|                    |                   |                     |
|--------------------|-------------------|---------------------|
| Date<br>2005-11-29 | Whether<br>Cloudy | Temperature<br>0° C |
|--------------------|-------------------|---------------------|

|              |                           |
|--------------|---------------------------|
| Test number/ | Deployment depth<br>10 cm |
|--------------|---------------------------|

|                     |                            |                      |
|---------------------|----------------------------|----------------------|
| Test lane<br>Gravel | Rate of compaction<br>93,6 | Water content<br>5,4 |
|---------------------|----------------------------|----------------------|

|                |                    |   |                           |
|----------------|--------------------|---|---------------------------|
| Clearing depth | Time/75 m<br>5 min | → | Clearing speed<br>300 m/h |
|----------------|--------------------|---|---------------------------|

|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 50               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 48               |                    |                  |                  |
| Mech. Neutralised<br>>50%: | 2                |                    |                  |                  |
| Live Damaged:              | 0                |                    |                  |                  |
| Live:                      | 0                |                    |                  |                  |
| Total:                     | 50               |                    |                  |                  |
| Detonations                | 45               |                    |                  |                  |

Comments:

Single fuses AP blast 5 of which 3 were damaged  
Single fuses AP : of which were damaged

Accounted for AP blast: 50/50 (detonations+single fuses+uneffected+damaged)  
Accounted for AP bounce: %  
Accounted for AP frag: %  
Accounted for AT blast: %

Throw outs:



*Figure 90: Debris of interest Gravel 10 cm*



**TEST PROTOCOL Gravel 20 cm**

Machine type  
Scanjack 3500

Manufacturer  
Scanjack AB

|                    |                   |                     |
|--------------------|-------------------|---------------------|
| Date<br>2005-11-29 | Whether<br>Cloudy | Temperature<br>0° C |
|--------------------|-------------------|---------------------|

|              |                           |
|--------------|---------------------------|
| Test number/ | Deployment depth<br>20 cm |
|--------------|---------------------------|

|                     |                            |                      |
|---------------------|----------------------------|----------------------|
| Test lane<br>Gravel | Rate of compaction<br>93,6 | Water content<br>5,4 |
|---------------------|----------------------------|----------------------|

|                |                    |   |                           |
|----------------|--------------------|---|---------------------------|
| Clearing depth | Time/75 m<br>5 min | → | Clearing speed<br>300 m/h |
|----------------|--------------------|---|---------------------------|

|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 50               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 45+1             |                    |                  |                  |
| Mech. Neutralised<br>>50%: | 4                |                    |                  |                  |
| Live Damaged:              | 0                |                    |                  |                  |
| Live:                      | 0                |                    |                  |                  |
| Total:                     | 49+1             |                    |                  |                  |
| Detonations                | 33               |                    |                  |                  |



Comments:

Triggered targets were found buried deep in the ground. The detonations were probably not heard. All reasonable action has been taken to find the fuses. No live targets (mine +fuse) is left in the ground.

Single fuses AP blast 16 of which 16 were damaged  
Single fuses AP : of which were damaged

Accounted for AP blast: 49/50 (detonations+single fuses+uneffected+damaged)  
Accounted for AP bounce: %  
Accounted for AP frag: %  
Accounted for AT blast: %

Throw outs:



Figure 91: Debris of Interest, Gravel 20 cm



## **Scanjack 3500 Performance in Sand Lane**

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**TEST PROTOCOL Sand 0 cm**

Machine type  
Scanjack 3500

Manufacturer  
Scanjack AB

|                    |                  |                      |
|--------------------|------------------|----------------------|
| Date<br>2005-11-30 | Whether<br>Sunny | Temperature<br>-4° C |
|--------------------|------------------|----------------------|

|              |                          |
|--------------|--------------------------|
| Test number/ | Deployment depth<br>0 cm |
|--------------|--------------------------|

|                   |                            |                      |
|-------------------|----------------------------|----------------------|
| Test lane<br>Sand | Rate of compaction<br>87,3 | Water content<br>5,8 |
|-------------------|----------------------------|----------------------|

|                              |                    |   |                           |
|------------------------------|--------------------|---|---------------------------|
| Clearing depth<br>See fig 95 | Time/75 m<br>5 min | → | Clearing speed<br>300 m/h |
|------------------------------|--------------------|---|---------------------------|

|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 50               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 50               |                    |                  |                  |
| Mech. Neutralised<br>>50%: | 0                |                    |                  |                  |
| Live Damaged:              | 0                |                    |                  |                  |
| Live:                      | 0                |                    |                  |                  |
| Total:                     | 50               |                    |                  |                  |
| Detonations                | 43               |                    |                  |                  |

Comments:

Single fuses AP blast: 7 of which 6 were damaged  
Single fuses AP : of which were damaged

Accounted for AP blast: 50/50 (detonations+single fuses+uneffected+damaged)  
Accounted for AP bounce: %  
Accounted for AP frag: %  
Accounted for AT blast: %

Throw outs:



*Figure 92: Debris of Interest, Sand 0 cm*



**TEST PROTOCOL Sand 10 cm**

Machine type  
Scanjack 3500

Manufacturer  
Scanjack AB

|                    |                  |                      |
|--------------------|------------------|----------------------|
| Date<br>2005-11-30 | Whether<br>Sunny | Temperature<br>-4° C |
|--------------------|------------------|----------------------|

|              |                           |
|--------------|---------------------------|
| Test number/ | Deployment depth<br>10 cm |
|--------------|---------------------------|

|                   |                            |                      |
|-------------------|----------------------------|----------------------|
| Test lane<br>Sand | Rate of compaction<br>87,3 | Water content<br>5,8 |
|-------------------|----------------------------|----------------------|

|                              |                    |   |                           |
|------------------------------|--------------------|---|---------------------------|
| Clearing depth<br>See fig 96 | Time/75 m<br>5 min | → | Clearing speed<br>300 m/h |
|------------------------------|--------------------|---|---------------------------|

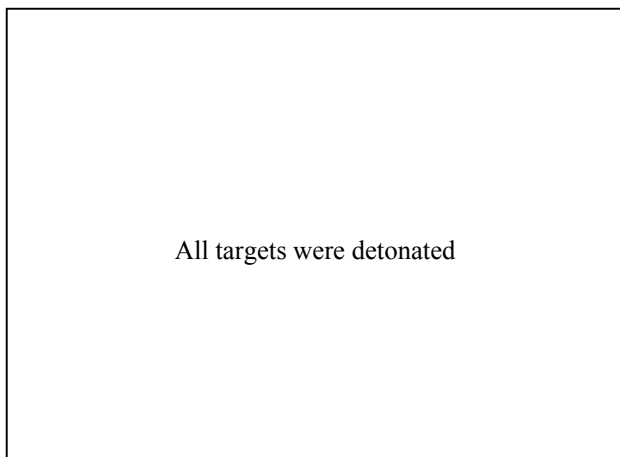
|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 50               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 50               |                    |                  |                  |
| Mech. Neutralised<br>>50%: | 0                |                    |                  |                  |
| Live Damaged:              | 0                |                    |                  |                  |
| Live:                      | 0                |                    |                  |                  |
| Total:                     | 50               |                    |                  |                  |
| Detonations                | 50               |                    |                  |                  |

Comments:

Single fuses AP blast 0 of which 0 were damaged  
Single fuses AP : of which were damaged

Accounted for AP blast: 50/50 (detonations+single fuses+uneffected+damaged)  
Accounted for AP bounce: %  
Accounted for AP frag: %  
Accounted for AT blast: %

Throw outs:



*Figure 93: Debris of Interest, Sand 10 cm*



**TEST PROTOCOL Sand 20 cm**

Machine type  
Scanjack 3500

Manufacturer  
Scanjack AB

|                    |                  |                      |
|--------------------|------------------|----------------------|
| Date<br>2005-11-30 | Whether<br>Sunny | Temperature<br>-4° C |
|--------------------|------------------|----------------------|

|              |                           |
|--------------|---------------------------|
| Test number/ | Deployment depth<br>20 cm |
|--------------|---------------------------|

|                   |                            |                      |
|-------------------|----------------------------|----------------------|
| Test lane<br>Sand | Rate of compaction<br>87,3 | Water content<br>5,8 |
|-------------------|----------------------------|----------------------|

|                              |                    |   |                           |
|------------------------------|--------------------|---|---------------------------|
| Clearing depth<br>See fig 97 | Time/75 m<br>5 min | → | Clearing speed<br>300 m/h |
|------------------------------|--------------------|---|---------------------------|

|                            | AP blast<br>PMA2 | AP bounce<br>PROM1 | AP frag<br>PMR2A | AT blast<br>TMM1 |
|----------------------------|------------------|--------------------|------------------|------------------|
| Deployed:                  | 50               |                    |                  |                  |
| Mech. Neutralised<br><50%: | 48+1             |                    |                  |                  |
| Mech. Neutralised<br>>50%: | 0                |                    |                  |                  |
| Live Damaged:              | 1                |                    |                  |                  |
| Live:                      | 0                |                    |                  |                  |
| Total:                     | 49+1             |                    |                  |                  |
| Detonations                | 43               |                    |                  |                  |



Comments:

Triggered targets were found buried deep in the ground. The detonation were probably not heard. All reasonable action has been taken to find the fuses. No live targets (mine +fuse) is left in the ground.

Single fuses AP blast 5 of which 4 were damaged  
Single fuses AP : of which were damaged

Accounted for AP blast: 49/50 (detonations+single fuses+uneffected+damaged)  
Accounted for AP bounce: %  
Accounted for AP frag: %  
Accounted for AT blast: %

Throw outs:

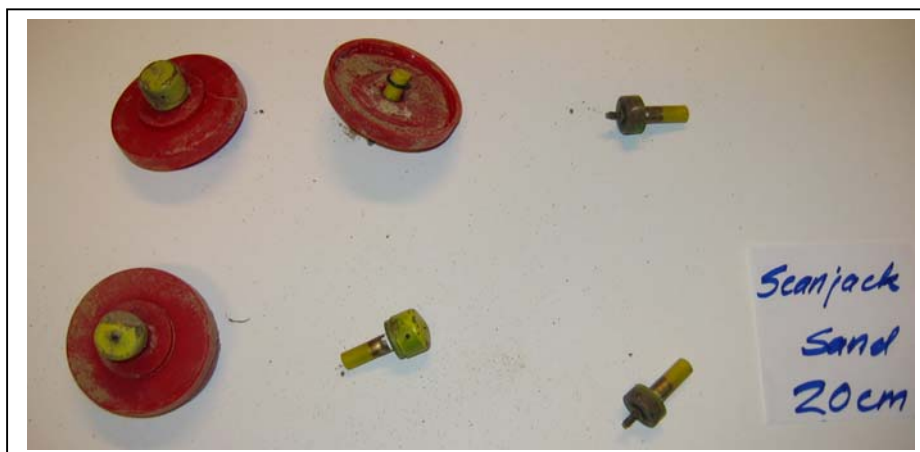


Figure 94: Debris of Interest, Sand 20 cm

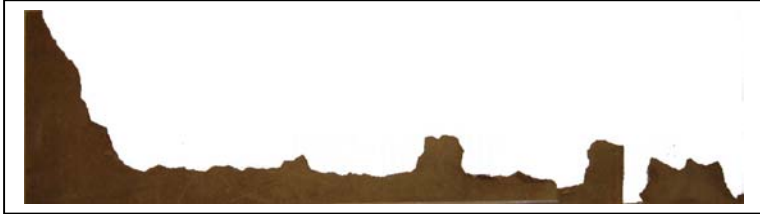




### WITNESS PANELS Gravel

| Test protocol Clearing Tools<br>DMR   |                     |                      |
|---|---------------------|----------------------|
| Date:<br>2005-11-29   | Whether conditions: | Temperature:         |
| Ground conditions:<br>Gravel lane   | Status:             | Location:<br>N Kulla |
| Test number/overview:<br>Performance test gravel lane   |                     | Photo/video:         |
| Equipment:<br>Scanjack 3500 Licence#150493  |                     |                      |
| Photos of interest:<br><br><p style="text-align: center;">No fibre boards were buried. The ground was to wet.</p>   |                     |                      |
| Comments and results:<br><br>Rotation/pressure of front flail: 7/180-200 bar<br>Rotation/pressure of rear flail: 6,5/180-200 bar<br>Forward speed: 300 m/h<br>Depth meter: 10-20 cm<br>M2 engine rev: 1800 rpm<br>M1 engine rev: 1300 rpm |                     |                      |
| Personnel/test leader:  |                     | Signature:           |



**WITNESS PANELS Sand**

| <b>Test protocol Clearing Tools<br/>DMR</b>  |  |                      |
|--|--|----------------------|
| Date:<br>2005-11-30  | Whether conditions:  | Temperature:         |
| Ground conditions:<br>Sand lane  | Status:  | Location:<br>N Kulla |
| Test number/overview:<br>Performance test sand lane  |  | Photo/video:         |
| Equipment:<br>Scanjack 3500 Licence#150493   |  |                      |
| Photos of interest:  |  |                      |
| <i>Figure 95:</i>  |   |                      |
| <i>Figure 96:</i>  |  |                      |
| <i>Figure 97:</i>  |  |                      |
| Comments and results:  |  |                      |
| <p>Rotation/pressure of front flail: 7,2/180-200 bar<br/>         Rotation/pressure of rear flail: 6,5/180-200 bar<br/>         Forward speed: 300 m/h<br/>         M2 engine rev: 1800 rpm<br/>         M1 engine rev: 1300 rpm</p> |  |                      |
| Personnel/test leader:   |  | Signature:           |