

**REPUBLIC OF CROATIA
CROATIAN MINE ACTION CENTER
CENTER FOR TESTING, DEVELOPMENT AND
TRAINING**

**TESTING OF
«Z E U S - 1» DEMINING MACHINE**

(SUMMARY)



Sisak, June 2004

1. TECHNICAL DATA

1.1. Description

MKA-DEMING d.o.o. demining company, in cooperation with LENERZ company, has divided the existing mechanical system „KMMCS-KERBER“ and has mounted the tiller working tool intended for destruction of antipersonnel mines on the two machines, which means that two ZEUS-1 machines are completely the same, they have the same working tool and they work separately (they no longer belong to a mechanical system).

ZEUS-1 machine is based on a construction machine – loader, weighing 35 tons (heavy demining machine), with specially constructed working tool – tiller, intended for vegetation cutting (low, medium and high, and individual trees up to 10 cm in diameter), breaking and grinding the soil and destroying all types of antipersonnel and antitank mines (by activating or breaking).

The cabin of the loader was replaced by a new one made of a protective material HARDOX-400 in two layers between which there are several layers of rubber with an interlaced inserted part. Protective glass is 35 mm thick. There are doors to the left and to the right and a roof door as an emergency exit. A specially constructed tiller is used as a working tool, which has been tested several times in different soil, mine, vegetation and climatic conditions. There are fire extinguishers in the machine. The machine moves on tracks. The machine is operated from the cabin which protects the operator from all types of antipersonnel and antitank mines.

The testing was performed on the ZEUS-1 machine, chassis number 0120412. The same data are valid for another machine, chassis number 0320311.

1.1. Technical data

- Operation – from the cabin
- Operated by one person
- Dimensions:
 - Length 7,00 m
 - Width 3,00 m
 - Height 2,65 m
 - Weight 35 tons
- Engine: CATERPILAR, 756 kW
- Cooling: water
- Fuel: diesel, D-2
- Fuel tank capacity . . . 1.200 liters
- average fuel consumption60-80 liters/hour
- Hydraulic oil fuel capacity . . . 800 liters
- Capacity of the fuel tank is sufficient for 15 hours of work
- The machine moves on tracks 800 mm wide
- Track pressure on the ground is 60 kg/cm²
- The cabin is made of several layers in the total thickness of 40 mm. On the inner and outer side the is HARDOX-400 armored metal plate, 5 mm thick,

and between the two layers there is a two-layer rubber with interlaced inserted part 30 mm thick.

- Armored glass has got three layers, 35 mm thick
- There are left and right doors and a roof door for emergency exit
- The cabin is air-conditioned
- The inside of the cabin is isolated with a layer of glass wool, for the purpose of noise protection
- Working speed of the machine is 1.5 km/h
- Foreseen depth of soil treatment is 30 cm
- The machine works in longitudinal slopes of up to 40% and vertical slope of 25%
- The working tool is a tiller
- The tiller is 3 m wide
- The tiller with diggers has 96 cm in diameter, 60 cm without diggers
- The tiller weighs 1,200 kg
- There are 160 diggers
- There are knives between the diggers which cut and grind the ground
- The tiller revolves 135 times per minute
- The tiller revolves forward, clockwise
- The tiller is powered by two side hydro engines
- The width of the treated lane is 250 cm

2. RESULTS ACHIEVED DURING TESTING

2.1. Field test results

The following results were achieved in field testing:

2.1.1. Size of the land treated

No.	date	Effective time (h)	LAND TREATED (m ²)
1.	28.05.2004.	5 ⁰⁰	17.000
2.	29.05.2004.	3 ³⁵	13.686
3.	31.05.2004.	5 ¹⁰	11.895
4.	01.06.2004.	6 ⁰⁰	21.385
5.	03.06.2004.	6 ³⁰	21.875
TOTAL		26¹⁵	85.841

Table No. 1 – Size of the land treated

The above table shows the following:

- The machine has worked for **5 business days**

- The machine has effectively worked for **26¹⁵ working hours**
- Total area treated was **85,841 m²**
- Average area treated per 1 hour - **3,270.13 m²/h**
- In one shift of 5 working hours, **average area treated was 14,715.58 m²** (including a 30 minute brake)
- **Average treating capacity in the II-III class land is 12,000 – 18,000 m²/5h**
- There were several shorter standstills during the testing, for clearing the tiller from vegetation and mud. Minor breakdowns of the machine were repaired at the work site in 10 to 30 minutes.
- The land was class II to III, flat with gentle slopes, very suitable for tiller treatment
- Vegetation was low (around 60%) and medium (around 40%) with individual bushes

2.1.2. Treatment depth

Treatment depth was measured at a flat treated area in 140 samples with the following results:

No.	date	No. of samples	AVERAGE DEPTH (cm)
1.	28.05.2004.	30	25,33
2.	29.05.2004.	20	27,90
3.	31.05.2004.	30	28,30
4.	01.06.2004.	30	27,03
5.	03.06.2004.	30	25,63
UKUPNO		140	26,83

Table No. 2 – Average treatment depth

The average treatment depth of 140 samples was **26.83 cm**. The highest depth measured was 36 cm, and the lowest 14 cm.

2.1.3. Results of the testing on AP mines

The following results were achieved with antipersonnel mines:

a) Antipersonnel pressure activated mines

MINE TYPE	MINE BURIAL DEPTH (cm)				
	5	10	10	15	20
PMA-1A	A	A	A	A	A
PMA-2	R	R	A	R	A
PMA-3	A	A	A	A	A

Table No. 3 – Results with antipersonnel pressure activated mines

A = activated

R = broken

- 15 mines were buried
- **12 mines were activated**
- **3 mines were broken**
- The tiller and the machine were not damaged

b) Antipersonnel fragmentation mines

MINE TYPE	1. Mine	2. Mine
PMR-2A	A	Fuse knocked off
PROM-1	Destroyed later	Destroyed later
PROM-1	R	A

Table No. 4 – Results with antipersonnel fragmentation mines

- 6 mines were placed
- 2 mines were activated
- 1 mine was broken
- One mine (PMR-2A) was not activated because the fuse was pulled out when the tripwire was pulled
- Due to these undefined results, the procedure was repeated with two additional PROM-1 mines
- Neither the tiller nor the machine were damaged significantly from activation of fragmentation mines (apart from the fragments hitting the machine armor).

2.1.4. Testing results with an antitank mine

In the Report No. 2900-835/04 dated 20 May 2004, «The Croatian Institute of Construction» Ltd.- Zagreb, on the basis of measuring the noise and acceleration of the machine in the moment of activation of TMA-3 antitank mine, made the following conclusions:

- The level of the sound pressure in the cabin of the heavy demining machine ZEUS-1, made as the result of the detonation of TMA-3 mine, is lower than 140 dB and is situated in the area bellow W curve, in accordance with MILD-STD-147D. In line with the above said, a person operating the machine does not have to wear additional protective aids (ear plugs) and will not risk permanent hearing damage.**
- The total level of the shock acceleration measured on a rigid base of the seat inside the cabin, made as a result of the detonation of TMA-3 mine, was lower**

than 15 g, in accordance with HIRSCH, A.H: Man's Reponse to Shock Motions, January 1964, Report 1997“, and will not cause damage to the foot/ankle or vertebra of a machine operator and he will be able to continue with demining work.

2.1.5. Results of manual verification of mechanically treated land

The verification was conducted manually (with metal detectors and prodders), and the following results were achieved:

- **83,070 m²** of land were verified.
- 870 working hours were spent.
- Remains of the following broken antipersonnel mines were found: PMR-2A (1 piece), PMA-1A (7 pieces) and PMA-2 (11 pieces)
- A false alarm rate of metal detectors was relatively low, the land was not contaminated with metal objects
- Average area verified by one shift of deminers was **477.41 m²/5h/1 person**.
- Efficiency of a deminer in II-III class soil was **450-500 m²/5h**.

3. DRAFT EVALUATION OF THE APPLICATION OF ZEUS-1 MACHINE

On the basis of the stated Testing Report and Article 5.6. of the „Program of Testing and Evaluation of the Application of Machines Used in Humanitarian Demining“, we made the following

EVALUATION OF THE APPLICATION OF ZEUS-1 DEMINING MACHINE

- **It is suitable for mechanical treatment of mine suspected land**
- **It can be used in soil class II to V**
- **it removes low, medium and high vegetation, as well as individual trees up to 10 cm in diameter**
- **It destroys all types of antipersonnel and antitank mines**
- **The machine operator operates from the cabin**
- **It treats land up to 25-30 cm depth**
- **In a working hour in soil class II-III it treats 3,270.13 m²/h, and in 5 working hours it may treat 12,000 – 18,000 m²**
- **The machine operator is protected inside the cabin and is safe from all types of antipersonnel and antitank mines**
- **Machine operator is not permitted to walk on a mechanically treated land before verification of the area by another method**
- **After mechanical treatment of mine affected area with ZEUS-1 machine it is necessary to use a verification method. One deminer may verify 450-500 m² in 5 working hours**

On the basis of testing results and the criteria of the “Program of Testing and Evaluation of the Application of Machines Used in Humanitarian Demining”, the ZEUS-1 demining machine and its tiller, with their current characteristics, may be used in humanitarian demining in Croatia.

Sisak, 21 June 2004

Report made by:
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