FINAL REPORT

# Test Report of Improved Backhoe

**July 2003**


Prepared by

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for


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# Test Report
# of
# Improved Backhoe

**July 2003**

# FOREWORD

The success of the Improved Backhoe test program was the result of the efforts of a large team of people from several organizations. The Project Engineer, Mr. Mike Collins, not only designed the improvements made to the commercial backhoe, but also directed the manufacturing and installation of all the armor upgrades to the JCB 215S backhoe and to the special equipment installations of the ROTAR© and the SETCO tires. A special debt of gratitude is paid to Mr. John Snellings, the Improved Backhoe operator throughout the test program, who managed to keep his cool even when temperatures inside the cab reached 120 $^{o}$F+. The Test Engineer was Ms. Sewaphorn (Noy) Rovira from Fibertek, Inc. (now Major Rovira, U.S. Army, as of December 2002) who provided background from previous test programs. Mr. Art Limerick, a member of the Humanitarian Demining staff at the NVESD/CM test site, rendered test support in the field. Mr. Harold Bertrand, Mr. Isaac Chappell, and Ms. Sherryl Zounes of the Institute for Defense Analyses (IDA) provided technical test support and were the authors of this report.

The equipment used on the Improved Backhoe and product information appearing in this report was obtained from the following organizations:

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P.O. Box 174, 8280 AD Genemuiden
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SETCO Tire Company,
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# 1 INTRODUCTION

## 1.1 Background

During many humanitarian demining operations, especially those in which extensive use is made of mechanical mine-clearing equipment, the mine-removal process frequently results in moving large amounts of surface soil and dirt from its original location to piles or berms located to the side of the clearing machine and running in a line parallel to the direction of the machine's movement. Clearing machines most apt to form berms are tillers, graders, and bulldozers. Experience has shown that the anti-personnel (AP) mines these machines are intended to destroy, uncover, or remove are frequently physically moved with the dirt and end up buried in the berms. Therefore, a machine that can be used to remove the AP mines [and other unexploded ordnance (UXO)] buried in the untreated berms is needed.

## 1.2 Objective

The objective of this test program was to evaluate the operational effectiveness of an improved commercial off-the-shelf (COTS) JCB 215S, Series 3, four-wheel steer (4WS) backhoe equipped with a Rotar International b.v. ROTAR©, model HPL 800 S soil sifter mounted on the front of the backhoe (see Figure 1). The Improved Backhoe was tested under conditions approximating those found by humanitarian demining organizations in easy to moderately difficult soil and terrain conditions. The ROTAR© subsystem was tested for its ability to remove mines from berms that were created by plowing or tilling operations and to continue to operate after sustaining an AP-mine-equivalent explosive charge. Vehicle on- and off-road handling was evaluated, and logistic considerations (e.g., spares and fuel/oil consumption) of importance to a user were measured and/or noted. Human factors issues (e.g., operator visibility and comfort under various moving situations) and maintenance issues were also addressed.

# 2 EQUIPMENT USED

## 2.1 Improved Backhoe

Starting with a JCB 215S, Series 3, 4WS (also capable of 2 wheel steer (2WS) and crab steer) commercial backhoe, the Modeling and Mechanical Fabrication Shop of the U.S. Army Communications & Electronics Command, Night Vision and Electronic Sensors Directorate (NVESD), Ft. Belvoir, Virginia, made structural modifications to the vehicle to improve its survivability in a hostile, land-mine environment. The modifications included a blast-resistant cab and armored chassis intended to protect the operator and the vehicle from a small-arms fire (up to 12.75 mm) attack and from shrapnel caused by a detonated AP mine under the vehicle or an anti-tank (AT) mine in near proximity to the vehicle. (An AT mine detonated under the improved backhoe would more than likely disable the vehicle and cause injury to the operator.)

**Figure 1. Improved Backhoe With HPL 800 S ROTAR**Ó

The changes made to the commercial backhoe were as follows:

- The fiberglass engine cowling[1] was replaced with 12.7 mm (0.5 inch) 6061 aluminum plate. This plating was also installed under the engine and cab area of the body. A 6.35-mm (0.25-in.) T-1 steel blast plate was mounted across the front lifting arms to protect the hydraulic lines from AP and AT mine shrapnel.

- The fiberglass shell of the cab was replaced with 6.35-mm (0.25-in.) T-1 steel. The fore and aft wind screen and side curtains were replaced with 31.75 mm (1.25 in.) of LEXAN©[2]. Exposed vehicle hydraulic lines were hardened to withstand fragmentation damage.

Figure 2 provides a silhouette of the Improved Backhoe. The reader should refer to this figure when as he examines the measurement and weight information in Tables 1 and 2. If the 6-in-1 bucket is also shipped with the Improved Backhoe, an additional 1,830 pounds must be added to the weights in Table 2.

To show the weight impact of providing ballistic survivability along with the soil sifting capability of the ROTAR© soil sifter, Table 3 provides a breakdown of the weight of the Improved Backhoe.

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1 The engine cowling is a covering that houses the engine.

2 LEXAN© is an engineering thermoplastic.

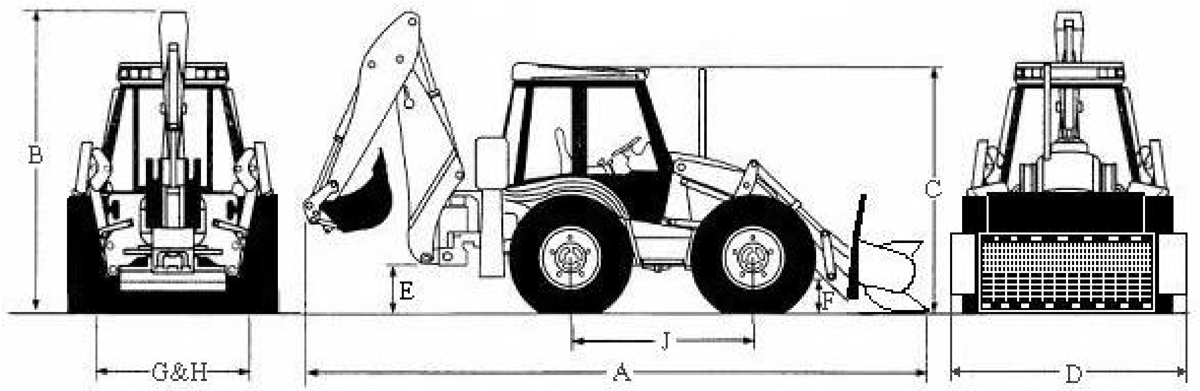


**Figure 2. Silhouette of Improved Backhoe**

**Table 1. Dimensions of Improved Backhoe**

| | **ft-in. (meter)** | | **ft-in. (meter)** |
|---|---|---|---|
| A. Transport length | 24-6 (7.47) | E. Ground clearance - mainframe | 1-1.5 (0.34) |
| B. Transport height | 12-10 (3.91) | F. Ground clearance – front axle | 1-5.7 (0.45) |
| C. Height to top of cab | 9-5 (2.87) | G&H. Front/rear wheel track | 6-3 (1.91) |
| D. Overall width with ROTAR© | 7-10 (2.30) | J. Wheelbase | 7-7 (2.31) |

**Note for Table 1:** *Letters refer to dimensions in Figure 2.*

**Table 2. JCB and Improved Backhoe Weights**

| **Backhoe** | **Weight lb (kg)** |
|---|---|
| JCB 215S-4WS Backhoe | 18,765 (with extradig) (8,514) |
| Improved Backhoe (with ROTAR©) | 27,300 (12,387) |

## 2.2 ROTARÓ Soil Sifter

The ROTAR© soil sifter, model HPL 800 S (manufactured by ROTAR© International, The Netherlands) used during this test was a COTS unit. The ROTAR© soil sifter comes in several sizes, ranging from light use to very heavy-duty use. Appendix A provides a list of over 600 commercial wheel loaders that will accept a ROTAR© soil sifter.

**Table 3. JCB 215S to Improved Backhoe Weight Statement**

| | Item Weight<br>lb<br>(kg) | Vehicle Cumulative Weight<br>lb<br>(kg) |
|---|---|---|
| COTS JCB 215S (4WS) | 18,114<br>(8,219) | 18,114<br>(8,219) |
| Less cab and engine cowling | 685<br>(310.8) | 17,429<br>(7,908) |
| Less standard loader bucket | 948<br>(430) | 16,481<br>(7,478) |
| Less four tires | 1,920<br>(871) | 14,561<br>(6,607) |
| Plus ROTAR© Soil Sifter | 2,855<br>(1,295) | 17,416<br>(7,902) |
| Plus four SETCO Tires | 6,600<br>(2,995) | 24,016<br>(10,897) |
| Plus armored cab, engine cowling, and vehicle blast plate = Improved Backhoe | 3,284<br>(1,490) | 27,300<br>(12,386) |

**Note for Table 3:** *Does not include 1,830 lb (832 kg) for 6-in-1 bucket.*

The ROTAR© model HPL 800 S selected for this test was mounted on the front loader arms of the JCB backhoe using the same attachment points used to mount the standard loader bucket. The NVESD Modeling and Mechanical Fabrication Shop manufactured the interface to mate the ROTAR© to the quick-disconnect mounting points. The ROTAR© barrel is constructed with 20-mm S2-3 steel bars to form a grid of 45-mm squares. Figure 3 is a picture of a COTS ROTAR© mounted to a wheel loader. Table 4 gives the specifications of the HPL 800 S ROTAR© sifter. Appendix B contains the specifications for the ROTAR© used in this test program.

**Figure 3. COTS ROTARÓ Soil Sifter**

**Table 4. HPL 800 S ROTAR© Soil Sifter Technical Specifications**

| ROTAR© Sifter | HPL 800 S |
|---|---|
| Capacity [1] | 800 liters |
| ROTAR© weight | 2,855 lbs (1298 kg) |
| Total width | 93.7 in. (2,380 mm) |
| Drum width | 70.9 in. (1,800 mm) |
| Bar diameter | 0.79 in. (20 mm) |
| Distance between bars | 1.77 in. (45 mm) |
| Material of frame/drum | S2-3 Steel |
| Cutting edge | Hardox 500 |
| Drive | Hydromotor Char-lynn Eaton 104-1390 |
| Maximum rotations (drum) | 28/min |

**Note 1 for Table 4:** *Working capacity is 2/3 of the drum capacity.*

## 2.3 SETCO Tires

The standard tires that came with the JCB backhoe were replaced with COTS SETCO solid rubber tires, manufactured by the SETCO Tire Company, Idabel, Oklahoma (see Figure 4). SETCO tires are a commercial product and are adaptable to any wheeled loader. Using SETCO tires (vs. standard tires) added 4,680 pounds (2,123 kg) to the gross vehicle weight of the Improved Backhoe.[3] The SETCO tires will withstand the blast from a 500-gm AP mine, with only slight blast abrasion to the rubber tire and *no* damage/deformation to the metal tire rim.

**Figure 4. SETCO Solid Rubber Tire**

[3] SETCO tires sized to fit the JCB 215S weigh 1,650 lbs (748 kg) each. Standard tires weigh 480 lbs (218 kg) each.

### 2.4 Test Targets

All operational berm-cleaning tests of the ROTAR© soil sifter were made using AP mechanical reproduction mines (MRM) manufactured by Amtech Aeronautical Limited, Medicine Hat, Alberta, Canada. MRMs were buried in random patterns on the top and sides of the berms at depths ranging from surface to approximately 400 mm. The MRMs used were PMA-1, PMA-2, PMN, and Type 72A AP mines. Figure 5 shows pictures of the MRMs used during ROTAR© soil sifter operational tests.

**PMA-1** **PMA-2** **PMN** **Type 72A**

**Figure 5. AP MRMs Used During ROTARÓ Soil Sifter Operational Tests**

Six explosive tests were conducted against the ROTAR© soil sifter, using ¼-lb (113.4 gm), ½-lb (226.8 gm), and 1-lb (453.7 gm) blocks of trinitrotoluene (TNT) command-detonated inside the closed ROTAR© barrel. Nine blast tests were conducted against the right front SETCO tire, using eight ½-lb blocks of TNT and a 1-lb block of TNT, all detonated by a small AP mine.[4] One test was conducted against the chassis/cab, using an AT mine containing 22 lbs (10 kg) of explosives was conducted. See paragraph 3.4 for a discussion of these survivability tests.

## 3 TEST DESCRIPTION, PROCEDURES, AND RESULTS

### 3.1 Test Sites and Testing Organization

The Improved Backhoe test was conducted on a NVESD/CM test facility (see Figure 6), from 23 September through 4 October 2002.

Two test sites were used. Test Site 1 was a training site comprised of raw, unimproved land, open meadow, scrub growth, and timber. The terrain varied from level to moderately level to severely rolling land. Meadow growth is uncut (2–3 ft high). Scrub growth is 8–10 ft high. Timber is an old-growth mix of pine and hardwoods. Soil composition is a sandy loam. Test Site 2 was the main U.S. Army countermine test area. The site has heated and air-conditioned office space, fiber-optic computer and phone lines, two buildings containing 10 vehicle work bays, a machine shop, 10+ storage sheds for equipment, 3 movable trailer offices, and 6 test areas for mine detection, neutralization, and weapons testing and humanitarian demining equipment testing. The soil composition is predominantly a heavy clay and sand mixture.

4 The AP mine used is a nonmetallic blast-type AP mine consisting of a main charge of tetryl (1 oz.).

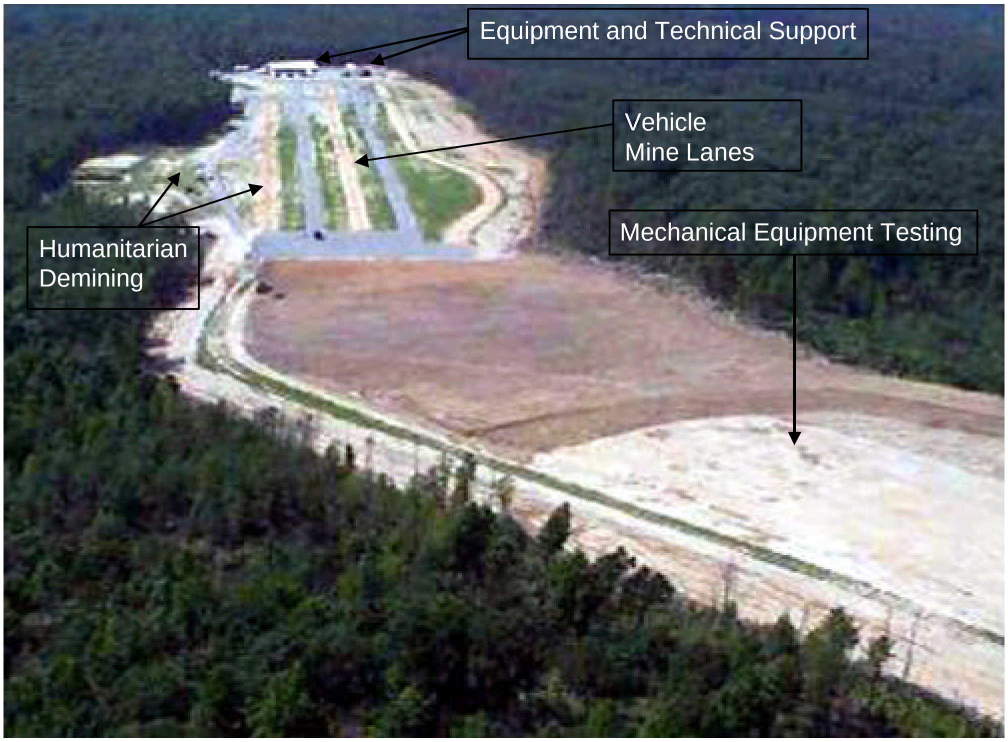


**Figure 6. Equipment Test Site**

NVESD staff permanently assigned to the test site provided test-site support. The test engineer and the backhoe operator were NVESD Humanitarian Demining Program staff members. The Institute for Defense Analyses (IDA), Alexandria, Virginia, provided technical support.

## 3.2 Logistic Issues and Tests

### 3.2.1 Transportability

The Improved Backhoe was transported from Ft. Belvoir to the test site on a flatbed, lowboy trailer pulled by a Ford F350 with a diesel engine. Once delivered to the test site, the Improved Backhoe was driven to the various locations on the test facility where testing was conducted. The distance between the Test Sites 1 and 2 was approximately 8.3 km (5 mi) over paved and gravel roads.

### 3.2.2 Turning Radius

The Improved Backhoe was parked on a level dirt field. The starting positions of the front and rear wheels and the front, outside corner of the ROTAR© were marked in the soil. Placement of the marks was checked and reestablished as necessary before each of the tests. Table 5 presents the turning radius test results.

**Table 5. Turning Radius Test Results**

| Test Configuration | Outside R. (m) | Inside R. (m) |
|---|---|---|
| Left-hand turn, 2-wheel drive, front-wheel steer | 24.7 | 21.0 |
| Right-hand turn, 2-wheel drive, front-wheel steer | 16.1 | 12.75 |
| Left-hand turn, 4-wheel drive, front-wheel steer | 24.7 | 19.25 |
| Right-hand turn, 4-wheel drive, front-wheel steer | 16.75 | 11.5 |
| Left-hand turn, 2-wheel drive, 4-wheel steer | 11.8 | 6.9 |
| Right-hand turn, 2-wheel drive, 4-wheel steer | 11.7 | 6.85 |
| Left-hand turn, 4-wheel drive, 4-wheel steer | 11.8 | 6.8 |
| Right-hand turn, 4-wheel drive, 4-wheel steer | 12.28 | 7.12 |

### 3.2.3 Mobility

#### 3.2.3.1 On-Road Mobility

A 5-km (3-mi) paved road section incorporating level and hilly terrain was measured off for use in an on-road mobility test. The road, a minimally crowned, two-lane, blacktop paved road, was dry and in excellent condition. The Improved Backhoe operator was told to drive the 5-km course at a speed that provided him with a comfortable ride and at which he felt he had the Improved Backhoe under control at all times. The time to transit the 5-km was 11 min and 50 sec. The average speed over the 5-km course was 25.35 kph (15.5 mph). The transit between the two test sites included a run of 1.83 km (1.1 mi) over a bladed gravel road. Once again, the Improved Backhoe operator transited this section of road at what he considered a safe speed for the road conditions (bladed road, loose gravel, minimal rutting, 3 steep inclines each 30–32 m in length, slight crown, 1 hard right turn at the bottom of one of the inclines requiring a near stop). The time to transit the 1.83 km was 8 min. The average speed was 13.7 kph (8.24 mph).

#### 3.2.3.2 Off-Road Mobility

An off-road mobility test was run over a 3.5-km dirt track through the woods surrounding Test Site 1. The track cover was a mix of dirt, exposed rock, and some grass. The topography ranged from near level (about 10 percent of the distance) to steep (up to 30-deg slope) for distances up to 1 ½ vehicle lengths, and side slopes of less than 10 deg. The track was rutted, muddy in places from rainwater drainage, and under a canopy of trees for most of the distance. The time required to transit this track was 25 min. The average speed was 8.4 kph (5 mph). At no time did the Improved Backhoe "get stuck" or lose traction because of slope, moisture, or grass or other vegetation.

### 3.2.4 Servicing and Maintenance

Servicing and maintenance to the backhoe and ROTAR© followed the recommended schedule provided by the manufacturers, with two exceptions. Both exceptions were caused by operation in an extremely dusty environment. First, the locking mechanism on the ROTAR© was greased daily. It tended to stick if this was not done. Second, the primary air filter on the backhoe was cleaned every morning.

### 3.3 Operational Testing

#### 3.3.1 Berm-Clearing/Sifting (ROTAR®)

The ability of the ROTAR© to remove landmines from different types of soil was tested by cleaning/sifting a berm at each of the two test sites. The soil composition in the berm at Test Site 1 was sandy loam. The soil composition at Test site 2 was a mixture of clay and sand.

In actual use, the ROTAR© would not normally be used as a stand-alone mine-clearing machine. It would be used to remove mines from dirt that had been disturbed or moved (into berms) by mine-clearing machines such as tillers, flails, plows, and so forth. For this test, the ROTAR© was used to clean two berms of different soils at the two test sites to determine how efficiently it would remove mines.

A physical description of the test sites used in this test and the total operating time to complete the tests follows:

***Test Site 1:*** *(see Figure 7)*

**Berm size:** 38 m (L) × 5 m (W) × 2 m (H) = 380 $m^3$ (volume)
**Soil type:** Sandy loam
**Foliage coverage:** Grass covered
**Total operating time:** 13 hrs over 4 days

**Figure 7. Berm at Test Site 1**

***Test Site 2:*** *(see Figure 8)*

**Berm size:** 20 m (L) × 5 m (W) × 1.5 m (H) = 150 $m^3$ (volume)

**Soil type:** Red clay with sand mixture (when dry, loose and powdery; when damp, soil stuck together) with loam soil underneath (dark, oily, smelly, clay-like)

**Foliage coverage:** Almost none

**Total operating time:** 7 hrs 38 min over 3 days

**Figure 8. Berm at Test Site 2**

In actual operation, the sifting area should be somewhat removed from the berm being cleaned for several reasons. First, the clean sifted dirt will occupy a greater volume than the dirt being cleaned until the cleaned dirt has had time to resettle. The more compact the dirt in the berm, the greater the volumetric difference between the sifted and unsifted dirt. Second, since there was a reasonable amount of spillage from the ROTAR© during dirt pickup at the berm, we found it better to have a clear demarcation area between the berm and the sifted dirt. The working distance used for the test was 21 m between the foot of the berm and the foot of the sifted-dirt berm. Figure 9 is a schematic showing the layout for the berm-clearing test.

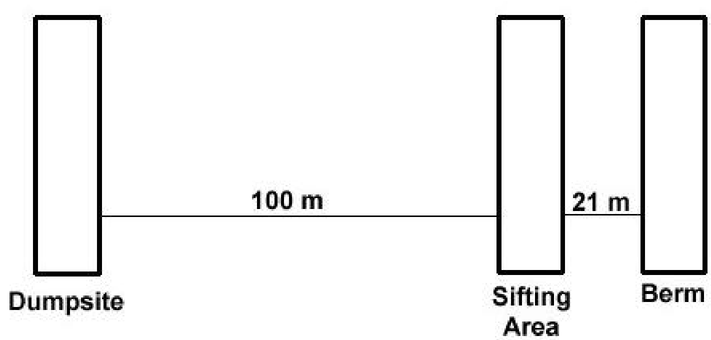


**Figure 9. Berm-Clearing Schematic**

Figures 10 and 11 are pictures of the ROTAR© sifting berm soil and the sifted soil from the Test Site 1 berm.

**Figure 10. ROTAR© Sifting Berm Soil**

**Figure 11. The Sifted Soil From the Test Site 1 Berm**

A description of Test Site 1 and Test Site 2 berms and the results of the berm-clearing phase of the test at each site are presented as follows:

***Test Site 1:***

**Berm size:** 38 m (L) × 5 m (W) × 2 m (H) = 380 $m^3$ (volume)
**Total clearing time:** 13 hrs over 4 days
**Removal rate:** approximately 29.2 $m^3$/hr
**Soil type:** Sandy loam (see Table 6)
**Weather conditions:** Varied (see Table 6)

**Table 6. Weather and Soil Conditions: Test Site 1 Berm**

| | Day 1 (09/23/02) | Day 2 (09/24/02) | Day 3 (10/01/02) | Day 4 (10/02/02) |
|---|---|---|---|---|
| Weather | Overcast, light wind | Cool morning, clear sky, warmed up to 70 °F | Light wind, sunny, clear blue sky | Morning fog, clear sky, warmed up to 80 °F |
| Temperature | 75 °F | 56 °F | 70 °F | 70 °F |
| Moisture | 4.4% | 6.8% | 7.0% | 7.8% |

The Test Site 1 berm was totally processed and leveled. In addition to the simulated mines, the ROTAR© also sifted out mortar training rounds and many pieces of debris including concertina wire, barbed wire, engine parts, pieces of railroad track, metal debris and the long grass growing on and buried in the berm. Figure 12 shows the mines recovered by the ROTAR©.

**Figure 12. Mines Recovered by ROTAR[Ó]**

***Test Site 2:***

**Berm size:** 20 m (L) × 5 m (W) × 1.5 m (H) = 150 $m^3$ (volume) (1/2 size of berm at Site Test Site 1)
**Total operating time:** 7 hrs 38 minutes over 3 days
**Removal rate:** approximately 20 $m^3$/hr
**Soil type :** Sand and red clay (See Table 7)
**Weather conditions:** Varied (see Table 7)

**Table 7. Weather and Soil Conditions: Test Site 2 Berm**

| | **Day 1 (09/25/02)** | **Day 2 (09/26/02)** | **Day 3 (09/30/02)** |
|---|---|---|---|
| Weather | Cloudy, light wind | Overcast, rainy<br>Stopped operations at 10:30 a.m. because of rain | Sunny, partly cloudy |
| Temperature | 62–75 °F | 60 °F range | 70 °F range |
| Soil Moisture | 11.8% | 9.7% | 18.3% |

The Improved Backhoe cleared the designated area of the berm shown in Figure 8. In dry soil conditions, the Improved Backhoe turns the soil to powder. When the soil is wet or damp, the dirt was compacted to almost rock hardness. Other than the simulated mines, some rock, and some long field grass, no other pieces of debris were found during the berm-clearing operation.

### 3.3.2 Berm-Clearing Test Observations

Following are some berm-clearing test observations:

- Attempting to load the ROTAR© by pushing it into the berm, as someone operating a loader bucket would do, did not work well (see Figure 13). The optimal method for loading the ROTAR© barrel was to start with the ROTAR© at the bottom of the berm and raise the ROTAR© while slowly moving forward toward the berm (see Figure 14). This resulted in loading the ROTAR© while scraping up the face of the berm.

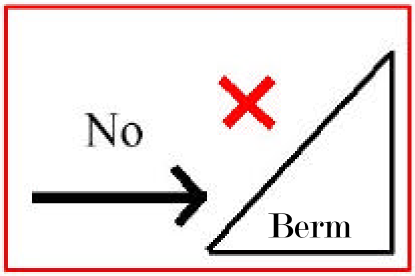


**Figure 13. Loading Method Not Recommended**

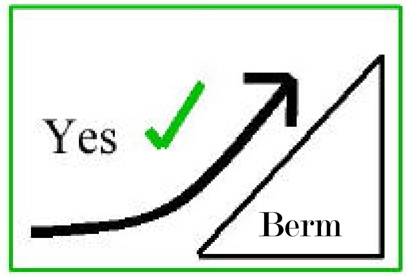


**Figure 14. Loading Method Used**

- Completion of the soil-sifting process was not obvious to the equipment operator or to observers standing at a safe distance. During some runs (particularly in the sand-clay soil type), after spinning the ROTAR© a reasonable number of times, the barrel still contained about one-half barrel of dirt and debris. This was attributed to grass blocking the sifting screen and, on occasions when the soil was wet, to the soil being compacted within the barrel by the centrifugal force of rotation. Under these conditions, the cleaning efficiency was improved by rotating the barrel at a slower speed and by reversing the direction of rotation a couple of times to dislodge compacted soil.

- The barrel-locking mechanism needed to be greased daily because of the dust raised by the sifting action of the ROTAR©.

- Depending on the moisture content of the soil and the wind conditions, the dirt from the ROTAR© reduced the driver's visibility from the cab to the point where the vehicle had to be stopped to have the windscreen cleaned.

- There was a slight interference between the armor engine cover and the front lifting arms. This was caused by loss of the clearance between the lifting arms and the engine cowling when the fiberglass cowl was replaced with the thicker aluminum plate cowl. Minimal scoring occurred.

- During the test, most of the surrogates detonated during the pickup and sifting process. Other surrogate mines that were sifted out of the berms and deposited in the debris pile were located by raking through the debris. In actual practice, the test procedure used to locate mines in the debris would not be safe. Perhaps, an armored dump truck, such as the one used by Menschen gegen Minen (MgM), a German non-governmental (humanitarian demining) organization (NGO) during ROTAR© testing in Angola, might be the way to go.

- As the ROTAR© scooped dirt from the berm, especially when the dirt was dry, the dirt avalanched down the face of the berm. When a surrogate mine was uncovered on the face of the berm, it was frequently carried to the base of the berm's face and occasionally buried by the avalanching dirt or dirt spillage from the ROTAR©. If the equipment operator did not see the mine, there was a strong possibility that it would not be picked up on the next pass by the ROTAR© but would be compacted into the dirt by the weight of the ROTAR© or the vehicle. A live mine would more than likely be detonated during subsequent loads taken from the berm. This situation can be avoided by having an observer notify the equipment operator that there is a mine in the dirt at the base of a berm. Once this was recognized, the backhoe operator always started the upward motion of filling the ROTAR© at the very bottom of the berm.

- The working capacity of the ROTAR© is two-thirds of the full volume of the ROTAR© barrel. Overfilling the barrel prevented the closing of the barrel and required emptying some of the barrel's contents or totally emptying and refilling the barrel. When the soil was damp or moist, overfilling the barrel actually impeded the sifting process. This situation also led to mines being redeposited on the berm, and occasionally at the base of the berm. As the operator gained experience with the ROTAR©, the occurrence of this situation decreased dramatically.

- The optimal sifting rotational speed of the ROTAR© is a function of the type of soil being processed and its moisture content. For dry, sandy soil, a slower rotational speed provided excellent sifting and minimized the dust cloud caused by higher speed rotation. For damp loam or sandy clay or soil containing sod or field grass, maintaining a rotational speed that caused the dirt to tumble in the barrel and reversing the barrel's direction of rotation yielded the best sifting results. Higher rotational speeds for damp or clay soils caused the soil to pack up on one side of the barrel (being held in place by centrifugal force). Again, experience with the ROTAR© enabled the equipment operator to maximize its operational effectiveness.

### 3.3.3 Test Area Restoration, 6-in-1 Bucket

The 6-in-1 bucket (see Figure 15) was used to spread the sifted berm dirt at the Test Site 1 test site. It took 13 hrs to sift the original berm and 2 hrs and 12 min to spread the sifted dirt and fill in several large holes that had been dug for a unit training exercise.

The six functions that can be performed by the bucket are dozing, loading, digging, grabbing, spreading, and grading.

### 3.3.4 Equipment Change-Out

The time required to remove the ROTAR© and install the 6-in-1 bucket was 10 min. After the sifted dirt was spread, the bucket was removed, and the ROTAR© was installed.

**Figure 15. The 6-in-1 Bucket**

Again, the time lapse was 10 min. The change-out process was facilitated by having someone on the ground to guide the backhoe operator (whose vision was blocked by the steel blast shield on the lifting arms) in lining up the attachment points on the bucket or ROTAR© and the ends of the lifting arms.

### 3.3.5 Backhoe Operation

The backhoe (i.e., the digging or trenching bucket located at the rear of the vehicle) was operated to determine whether the modifications made to the vehicle or the additional weight of the installed ROTAR© compromised the backhoe's digging operations. Neither the modifications to the vehicle nor the additional weight of the ROTAR© caused any degradation to the digging operation, to the movement of the backhoe, or to the backhoe's reach. The armored cab did not degrade the operator's visibility.

## 3.4 Survivability Tests

Survivability in a mine blast test was conducted in three separate steps. The first was against the ROTAR©, the second was against the SETCO tires, and the third was against the overall vehicle. All survivability testing was done at Test Site 2. All explosive charges were TNT, initiated by either a blasting cap or a small AP mine.

### 3.4.1 ROTARÓ Blast Test

Six blast tests were conducted against the ROTAR©. The sizes of the explosive charges used were ¼-, ½-, and 1-lb blocks of TNT. Two blast tests were conducted for each size explosive: one with the ROTAR© barrel half filled with dirt (in which the explosive was buried) and the other with no dirt in the barrel (the explosive was suspended on the axis of rotation). In all cases, the explosive was remotely detonated. For the 1-lb explosive test, the test in the half-filled barrel resulted in damage to the barrel's steel liner at the midpoint of its length. Therefore, when the explosive test was conducted without dirt in the barrel, the explosive was suspended on the axis of rotation, at a point one-fourth the length of the barrel from the right side of the barrel. Table 8 presents the results of the explosive test in the ROTAR©. Some of the blast damage to the steel liner caused pieces of the steel liner to be pushed through the mesh of the reinforcing bars of the barrel. The protruding steel liner had to be beaten almost flush with the barrel bars to eliminate interference with the ROTAR© frame. Figure 16 is a picture of the bowing distortion to the ROTAR© barrel from the 1-lb block of TNT in Test 6. Figure 17 shows the damage to the steel liner from this series of tests.

**Table 8. Blast Tests on ROTARÓ**

| Test No. | Weight of Explosive | Soil Contents | Damage to ROTAR© | ROTAR© Operable? |
|---|---|---|---|---|
| 1 | ¼ lb | ½ full | No damage. | Yes |
| 2 | ½ lb | ½ full | No damage. | Yes |
| 3 | 1 lb | ½ full | 1-11/16” × 5/8” hole in steel barrel liner. Some outward bowing of longitudinal bars. | Yes |
| 4 | ¼ lb | Empty | 5” × 3” hole in steel barrel liner. | Yes |
| 5 | ½ lb | Empty | 13” × 4.5” hole in steel barrel liner. | Yes |
| 6 | 1 lb | Empty | Pressure-rise tearing of steel barrel liner at juncture with end of barrel. Noticeable bowing of longitudinal barrel bars. | Yes. ROTAR© able to close, lock, and spin. |

**Figure 16. Blast Distortion (Bowing) to ROTARÓ**

**Figure 17. Blast Test Damage to Steel Liner**

### 3.4.2 SETCO Tire Blast Test

The blast test against the SETCO tires was designed to investigate two survivability issues. The first issue was to determine the ability of the SETCO tire to withstand repeated AP mine blasts (8 tests) at different points on the tire's diameter from ½-lb blocks of TNT. The second issue was to determine the ability of the SETCO tire to withstand the blast from a large AP mine containing 1 lb of TNT (9$^{th}$ test). Figure 18 shows a 1-lb explosive charge.

**Figure 18. A 1-lb Explosive Charge**

The procedure followed in each test was to bury the block of TNT, to which a small AP mine had been taped to act as a fuse for the TNT. The mine and TNT were buried flush with the surface in front of the front right wheel of the Improved Backhoe vehicle. The soil in the test area was a dry sand-clay mixture. The Improved Backhoe was then pulled forward by another vehicle until the right front wheel rolled onto the AP/TNT mine causing a detonation. In all 8 tests with the ½-lb blocks of TNT, the damage to the tire was similar. The blast charred the tire and generally took an oval pattern in the 4–5 in. (102 mm–127 mm) by 6–8 in. (152 mm–203 mm) size range. Gouging of the tire face ranged in depth from 0.75 in. (1 9 mm) to 1.375 in. (35 mm). The mines were buried so detonation would occur near the center of the tire. Therefore, on almost all 8 tests, there was some splitting of the tire along the center mold seam at the point of the blast (1–2 in. long and 1+in. deep) (25–50 mm long and ~ 25 mm deep). Since the tire does not flex while being driven, there was no progression of the splits during subsequent use. The resultant blast crater was 12–15 in. (305–381 mm) in diameter and 8–12 in. (203–305 mm) deep, depending on the looseness of the soil. Surface scarring caused by blast forces escaping out from under the tire generally scrubbed the earth in a circular pattern out to about 44 in. (1,118 mm). Figure 19 shows the damage from ½-lb and 1-lb mine charges.

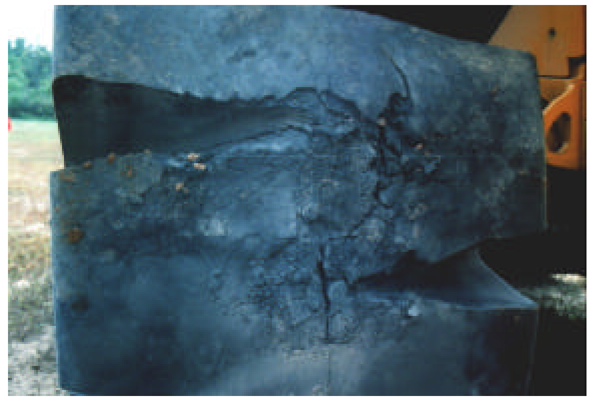

**Figure 19. Tire Damage From ½-lb (left) and 1-lb (right) Mine Charge**

The test using the 1-lb block of TNT caused a bit more damage but in no way incapacitated the operation of the Improved Backhoe. The damage to the face of the tire by the blast measured about 6 in. (152 mm) in diameter, with cracks penetrating to a depth of 1.5 in. (38 mm). The blast crater was about 20 in. (508 mm) in diameter and 15 in. (381 mm) deep. The surface scrubbing created a circle of 58 in. (1,473 mm).

### 3.4.3 Chassis/Cab Blast Test

The Improved Backhoe was subjected to the blast affects of a 10 kg AT mine buried at a depth of 5 cm, at a distance of 3 m in front of the ROTAR© when the ROTAR© was in a normal, retracted position. For the test, the ROTAR© was lifted 8 cm off the ground. The purpose was to determine what damage might be caused by mine shrapnel and blast debris from an AT mine detonated within the working radius of the ROTAR©. The result was no visible damage to any part of the vehicle. Figure 20 shows the Improved Backhoe before AT mine detonation, and Figure 21 shows the Improved Backhoe after AT mine detonation.

## 3.5 Human Factors

The primary human factors issue during the test program was related to the operator and the overheating of the cab during operations. Because of the danger inherent in mine-clearing operations, the Improved Backhoe had to be operated with the cab doors and windows closed. On days when the morning temperatures were in the low to mid 70°F (21–24°C), the temperature in the Improved Backhoe cab would reach temperatures of 120 to 127°F (48.8 to 52.7°C). The cause of the overheating was rerouting of the air conditioning duct adjacent to the transmission during the shielding of the engine compartment while

**Figure 20. Improved Backhoe Before AT Mine Detonation**

**Figure 21. Improved Backhoe After AT Mine Detonation**

armoring the backhoe chassis. The only thing that could be done to cool the cab was to shut the engine down and open the cab doors. Because of the rerouting of the air conditioning ductwork, simply idling the engine and running the air conditioner did not cool the cab. Each time this overheating condition occurred, 2 to 3 hrs of work time were lost waiting for the temperature to cool down. While the cab cooled off, a more serious engine-heating problem became evident. This is covered under "Maintainability/Modifications" in paragraph 3.6.

## 3.6 Maintainability/Modifications

The modifications made to the JCB backhoe did not degrade the ability of the operator and other support personnel to perform maintenance service on the Improved Backhoe. However, there is an operability issue that affects the operator's and the vehicle's ability to function optimally.

In modifying the commercial backhoe to protect the power train and the operator from mine fragments, mine-blast debris, and small-arms fire, 6061 aluminum plate was used to replace the fiberglass engine cowling. In the commercial version, the engine compartment was open to the atmosphere on the bottom side, just as it is in an automobile, allowing air to flow up and assist in cooling the engine. The installation of the bottom armor plate effectively sealed the engine and power train compartment against the threat of fragment and explosive damage but also sealed it off from cooling air. The temperature rise in the power train compartment not only contributed to the excessive heat in the operator's cab, but also caused the engine to overheat. When the engine was shut down to cool, it would not restart until the engine temperature dropped down into the normal operating range. This took 2 to 3 hours. As of the writing of this report, several modification alternatives are being considered to improve the cooling for the operator and the engine. Options include adding an additional air-circulating fan in the engine compartment, removing all or part of the under-engine armor, rerouting the air conditioning ducts, and combinations of these and other solutions.

After operating a couple of hours in a dust-heavy environment, the ROTAR© barrel locks tended to hang-up and not seat properly in the barrel locking slots. This problem was solved by frequent lubrication of the ROTAR© locking arms.

The dust generated by operating the ROTAR© collected on the windscreen and impaired the vision of the operator to the point where he would have to stop operations and “dust” down the windscreen. Use of a windshield washing system would not help since the excessive amount of dust would mix with the water and quickly become mud rather than being washed away. The operation of a windshield wiper without water would only lead to scoring of the windscreen by the sand in the dust. However, this is a situation where operator experience can lessen the impact of the dust. By positioning the cab in an upwind direction from the ROTAR©, the amount of dust blown back on the windscreen is reduced. Also, operator management of the ROTAR© during the sifting mode can reduce the amount of dust generated.

The SETCO tires not only will absorb a lot of mine-blast punishment, but they also eliminate the time lost in repairing flat tires or replacing the more easily damaged foam-filled tires. In addition, the flat road face of the tire directs the blast forces from a detonated AP mine along a path more parallel to the surface of the earth. This minimizes the amount of damage that might be caused to parts of the backhoe on the bottom side of the vehicle and to equipment and personnel flanking the Improved Backhoe.

### 3.7 Consumables

On the day of transportation to the test site, the backhoe engine clock read 42.0 hours. At the end of the test, on 4 October 2002, the engine clock read 81.1 hours. During the test, 67 gal of diesel fuel (avg. of 1.72 gal/hour) and 3 quarts of coolant were consumed, in addition to the grease applied to the ROTAR© locking mechanism.

## 4 OVERALL ASSESSMENT

### 4.1 ROTARÓ

The ROTAR© performed exceptionally well during the soil-cleaning test and allowed fast, continuous use during berm-clearing operations. Operator experience, which was gained quickly, contributed greatly to the operating efficiency of the ROTAR©. On a couple of occasions, opening and closing the barrel’s locking mechanism caused binding because of dirt/dust buildup; however, this problem was eliminated by daily greasing of the locking arms.

Blast tests were conducted using ¼-, ½-, and 1-lb (113, 227, 454 gm) charges of TNT against the ROTAR© both half full and empty of dirt. *After each blast test, regardless of the size of explosive charge used, the ROTARÓ was fully functional and operable.* However, some damage was sustained. With dirt in the ROTAR©, no damage was caused by the ¼- and ½-lb (113 and 227 grams) charges of TNT. The 1-lb charge of TNT, when detonated with dirt in the ROTAR©, caused a hole to be punched through the steel liner and caused slight bowing of the horizontal bars. Without dirt in the ROTAR©, damage was caused to the steel liner by each of the TNT charges (¼, ½, and 1 lb), and the bowing of the horizontal bars was noticeable after the 1-lb charge test.

Subsequent to the test, the horizontal bars were straightened and the steel liner was replaced.

### 4.2 SETCO Tires

A single SETCO tire was subjected to 9 blast tests: 8 blasts of a small AP mine and ½ lb (227 grams) of TNT and 1 blast of an M14 AP mine and a 1 lb (454 grams) of TNT. The ½-lb charge of TNT caused minimal abrasion to the face of the tire. The 1-lb charge of TNT caused only minor blast abrasion. When blasts took place directly under the mold seam of the tire, minor cracks at the seam line were evident. No damage was caused to the metal rim. Given the amount of damage to this tire, we estimate that this tire could withstand upwards of 100 blast occurrences before having to be replaced.

Traction with the SETCO tires on the Improved Backhoe was excellent during all test operations. Under no conditions, including climbing grades on damp, grassy slopes, was there any loss of traction or skidding. There is also no ride conditioning on a rough surface since the tires are solid rubber on a very strong, rigid rim. The normal bounce generally generated by air-filled tires is not present. Operating the backhoe on gravel or paved roads did not produce any noticeable wear to the tires, and running over metal debris and sharp rocks in the field did not produce any observable cuts in the rubber.

The tire used during the explosives tests was replaced after the test and is being retained as a spare.

### 4.3 Improved Backhoe

There was no noticeable degradation to the performance of the backhoe because of the additional weight from armoring the chassis and using the heavier SETCO tires. During blast tests on the ROTAR© and the SETCO tire, parts of the vehicle not subjected to the blast tests did not sustain any damage. The one blast test against the chassis (an AT mine set off in front of the vehicle) did not damage the backhoe.

The only problem encountered during backhoe operations was an overheating problem. This was attributed to a combination of restricted airflow to the engine compartment, which resulted from the installation of the armored engine cowl and the under-engine/chassis blast plate, and the increased weight of the Improved Backhoe (8,535 lb/3,880kg). The increase in the amount of heat in the engine compartment led to overheating of the engine and a dramatic decrease in the efficiency of the air conditioner's operation. This led to overheating of the operator's cab.

In the time since the tests were conducted, modifications have been made to the engine cowl to increase airflow to the engine. Additional insulation was installed on all air conditioning lines within the engine compartment, and additional air conditioning ducts were installed in the cab.

Additional implements can be installed on the same operating arms used for the ROTAR©. The 6-in-1 Bucket, Loading Forks, The Mini Vegetation Cutter, currently being fabricated, and the large electro magnet can all be used on various aspects of a demining mission.

## 5 RECOMMENDATIONS

- In selecting a ROTAR© for a wheeled loader, follow the guidance provided by ROTAR© *International b.v.* presented in Appendix B. If the ROTAR© is to be used for demining purposes, this should be mentioned to the ROTAR© representative since they offer an upgrade consisting of heavier horizontal and vertical bars.

- If structural modifications are to be made to the chassis of a wheeled loader to provide armor protection to the vehicle and driver, adequate engine compartment airflow should be provided for cooling purposes.

- When live mines are likely to be present, operation observers should be far enough away from the ROTAR© (berm or debris dumping site) so that they will not be injured by mine or ordnance fragments if one should be detonated.

- The ROTAR© is not recommended for clearing AT mines.

# GLOSSARY

| | |
|---|---|
| 2WS | two-wheel steer |
| 4WS | four-wheel steer |
| AP | anti-personnel |
| AT | anti-tank |
| CECOM | Communications-Electronics Command |
| COTS | commercial off-the-shelf |
| deg | degree |
| IDA | Institute for Defense Analyses |
| in. | inch |
| JCB | Joseph Cyril Bramford |
| kg | kilogram |
| km | kilometer |
| kph | kilometers per hour |
| l | litre |
| l/m | litres per minute |
| lb | pound |
| m | meter |
| MgM | Menschen gegen Minen |
| mm | millimeters |
| mph | miles per hour |
| MRM | mechanical reproduction mine |
| NGO | nongovernmental organization |
| NVESD | Night Vision and Electronic Sensors Directorate |
| oz | ounce |
| rpm | revolutions per minute |
| TNT | trinitrotoluene |
| UXO | unexploded ordnance |

# APPENDIX A
# CLASSIFICATION LIST OF WHEEL LOADERS: ROTARÓ SOIL SIFTERS

# APPENDIX A
# CLASSIFICATION LIST OF WHEEL LOADERS: ROTAR^Ó SOIL SIFTERS

| Machine | Model | Rotar^Ó Sifters | Range Loader |
|---|---|---|---|
| AHLMANN | AS 4/S | HPL 400 M | 1 |
| AHLMANN | AL 6B | HPL 600 S | 2 |
| AHLMANN | AL 7 | HPL 600 S | 2 |
| AHLMANN | AL 7C/CS | HPL 600 S+ | 2 |
| AHLMANN | AL 7D | HPL 600 S+ | 2 |
| AHLMANN | AL 8 | HPL 750 8 | 2 |
| AHLMANN | AL 8C/CS | HPL 750 9 | 2 |
| AHLMANN | AS 7B | HPL 750 9+ | 3 |
| AHLMANN | AS 7C/CS | HPL 750 9+ | 3 |
| AHLMANN | AS 10/S | HPL 1100 9 | 4 |
| AHLMANN | AS 12 | HPL 1100 S+ | 5 |
| AHLMANN | AS 17B | HPL 1500 S+ | 5 |
| AHLMANN | AS 18/S | HPL 1500 S+ | 5 |
| AHLMANN | AZ 9 | HPL 750 S+ | 3 |
| AHLMANN | AS 15/5 | HPL 1300 S- | 5 |
| ATLAS | 32 C | HPL 400 M- | 1 |
| ATLAS | 42 C | HPL 500 S- | 2 |
| ATLAS | 46 C | HPL 500 S | 2 |
| ATLAS | 51 C | HPL 600 S | 2 |
| ATLAS | 51 CE | HPL 600 S+ | 2 |
| ATLAS | 52 C | HPL 600 S+ | 2 |
| ATLAS | 52 D | HPL 600 S+ | 2 |
| ATLAS | 61 B | HPL 750 S- | 3 |
| ATLAS | 61 C | HPL 750 S | 3 |
| ATLAS | 62 C | HPL 750 S- | 3 |
| ATLAS | 72 C | HPL 750 S | 3 |
| ATLAS | AR 41 A | HPL 400 M | 1 |
| ATLAS | AR 41 B | HPL 400 M+ | 1 |
| ATLAS | AR 45 B | HPL 600 S- | 2 |
| ATLAS | AR 51 B | HPL 600 S | 2 |
| ATLAS | AR 51 C | HPL 600 S+ | 2 |
| ATLAS | AR 51 B | HPL 750 S- | 2 |
| AUSTOFT | DMC 102 | HPL 400 M | 2 |
| BALDWIN | 800 C | HPL 400 M | 2 |
| BARALDI | FB 6.03 | HPL 400 M- | 1 |

| Machine | Model | RotarÓSifters | Range Loader |
|---|---|---|---|
| BARALDI | FB 7.04 | HPL 400 M+ | 2 |
| BARALDI | FB 8.04 | HPL 400 M+ | 2 |
| BELL. | L 1206 B | HPL 1500 S | 3 |
| BELL. | L 1706 B | HPL 2000 S+ | 6 |
| BENATI | 2.20 T | HPL 750 S- | 3 |
| BENATI | 5.10 | HPL 600 S- | 2 |
| BENATI | 5.12 | HPL 1100 S | 4 |
| BENATI | 5.15 | HPL 1100 S | 4 |
| BENATI | 5.20 | HPL 1500 S+ | 5 |
| BENATI | 5.25 | HPL 2000 S | 6 |
| BENATI | 5.30 | HPL 2500 | 7 |
| BENATI | 9.SA | HPL 1100 S | 4 |
| BENATI | 12 SB | HPL 1100 S+ | 4 |
| BENATI | 12 SB SUPER | HPL 1500 S | 5 |
| AHLMANN | AS 4/S | HPL 400 M | 1 |
| AHLMANN | AL 6B | HPL 600 S | 2 |
| AHLMANN | AL 7 | HPL 600 S | 2 |
| AHLMANN | AL 7C/CS | HPL 600 S+ | 2 |
| AHLMANN | AL 7D | HPL 600 S+ | 2 |
| AHLMANN | AL 8 | HPL 750 S | 2 |
| AHLMANN | AL 8C/CS | HPL 750 S | 2 |
| AHLMANN | AS 7B | HPL 750 S+ | 3 |
| AHLMANN | AS 7C/CS | HPL 750 S+ | 3 |
| AHLMANN | AS 10/S | HPL 1100 S | 4 |
| AHLMANN | AS 12 | HPL 1100 S+ | 5 |
| AHLMANN | AS 17B | HPL 1500 S+ | 5 |
| AHLMANN | AS 18/S | HPL 1500 S+ | 5 |
| AHLMANN | AS 9 | HPL 750 S+ | 3 |
| AHLMANN | AS 15/S | HPL 1500 S- | 5 |
| ATLAS | 32 C | HPL 400 M- | 1 |
| ATLAS | 42 C | HPL 600 S- | 2 |
| ATLAS | 46 C | HPL 600 S | 2 |
| ATLAS | 51 C | HPL 600 S | 2 |
| ATLAS | 51 CE | HPL 600 S+ | 2 |
| ATLAS | 52 C | HPL 600 S+ | 2 |
| ATLAS | 52 D | HPL 600 S+ | 2 |
| ATLAS | 61 B | HPL 750 S- | 3 |
| ATLAS | 61 C | HPL 750 S | 3 |
| ATLAS | 62 C | HPL 750 S- | 3 |
| ATLAS | 72 C | HPL 750 S | 3 |
| ATLAS | AR 41 A | HPL 400 M | 1 |
| ATLAS | AR 41 B | HPL 400 M+ | 1 |
| ATLAS | AR 45 B | HPL 500 S- | 2 |
| ATLAS | AR 51 B | HPL 600 S | 2 |

| Machine | Model | RotarÓ Sifters | Range Loader |
|---|---|---|---|
| ATLAS | AR 51 C | HPL 600 S+ | 2 |
| ATLAS | AR 61 B | HPL 750 S- | 2 |
| AUSTOFT | DMC 102 | HPL 400 M | 2 |
| BALDWIN | 800 C | HPL 400 M | 2 |
| BARALDI | FB 5.03 | HPL 400 M- | 1 |
| BARALDI | FB 7.04 | HPL 400 M+ | 2 |
| BARALDI | FB 8.04 | HPL 400 M+ | 2 |
| BELL. | L 1206 B | HPL 1500 S | 3 |
| BELL. | L 1706 B | HPL 2000 S+ | 6 |
| BENATI | 2.20 T | HPL 750 S- | 3 |
| BENATI | 5.10 | HPL 600 S- | 2 |
| BENATI | 5.12 | HPL 1100 S | 4 |
| BENATI | 5.15 | HPL 1100 S | 4 |
| BENATI | 5.20 | HPL 1500 S+ | 5 |
| BENATI | 5.25 | HPL 2000 S | 6 |
| BENATI | 5.30 | HPL 2500 S | 7 |
| BENATI | 9 SB | HPL 1100 S | 4 |
| BENATI | 12 SB | HPL 1100 S+ | 4 |
| BENATI | 12 SB SUPER | HPL 1500 S | 5 |
| BENATI | 16 SB | HPL 1500 S+ | 5 |
| BENATI | 16 SB SUPER | HPL 2000 S | 6 |
| BENATI | 19 SB | HPL 2000 S | 6 |
| BENATI | 19 SB | HPL 2500 S | 7 |
| BENATI | 22 SB | HPL 2500 S | 7 |
| BENATI | 22 SB SUPER | HPL 2500 S+ | 8 |
| BENATI | 25 SB | HXI 3600 H | 8 |
| BENATI | 25 SB TURBO | HXI 3600 H | 9 |
| BENATI | 35 SB | HXI 3600 H | 10 |
| BENATI | 1900 | HPL 750 S- | 3 |
| BENATI | 2000 S 4 WS | HPL 750 S | 3 |
| BENATI | 5.08 | HPL 600 S | 2 |
| BENFRA | 1.05 | HPL 400 M- | 1 |
| BENFRA | 1.15 | HPL 600 S | 2 |
| BENFRA | 1.25 | HPL 600 S | 2 |
| BENFRA | 1.35 | HPL 750 S | 3 |
| BENFRA | 4.06 – 4.07 | HPL 600 S | 3 |
| BENFRA | 4.08 | HPL 750 S | 3 |
| BENFRA | 4.10 | HPL 750 S | 3 |
| BENFRA | 4.12 | HPL 1100 S | 3 |
| BENFRA | 4.47 H | HPL 750 S | 3 |
| BENFRA | 215 I | HPL 600 S | 2 |
| BENFRA | 315 I | HPL 750 S | 3 |
| BENFRA | 415 I | HPL 1100 S | 4 |
| BENFRA | 515 I | HPL 1100 S+ | 4 |

| Machine | Model | RotarÓ Sifters | Range Loader |
|---|---|---|---|
| BENFRA | 415 B | HPL 600 S | 4 |
| BENFRA | 515 B | HPL 750 S+ | 5 |
| BOBCAT | 440 | XXXXXXX | 1 |
| BOBCAT | 443 | XXXXXXX | 1 |
| BOBCAT | 543 | XXXXXXX | 1 |
| BOBCAT | 641 | XXXXXXX | 1 |
| BOBCAT | 643 | XXXXXXX | 1 |
| BOBCAT | 741 | HPL 400 M | 1 |
| BOBCAT | 743 | HPL 400 M | 1 |
| BOBCAT | 753 | HPL 400 M | 1 |
| BOBCAT | 843 | HPL 400 M | 2 |
| BOBCAT | 853 | HPL 400 M | 2 |
| BOBCAT | 943 | HPL 600 S | 2 |
| BOBCAT | 974 | HPL 600 S | 3 |
| BOBCAT | 980 | HPL 750 S | 3 |
| BOBCAT | 1600 | HPL 400 M | 2 |
| BOBCAT | 2000 | HPL 600 S | 3 |
| BOBCAT | 2400 MTC | HPL 750 S- | 3 |
| BRISTAR | UN 053.2 | HPL 400 M+ | 2 |
| CASE | 480 | HPL 400 M | 2 |
| CASE | 480 ELL | HPL 400 M | 2 |
| CASE | 480 F | HPL 600 S | 2 |
| CASE | 480 FLL | HPL 600 S | 2 |
| CASE | 580 SUPER K | HPL 750 S | 3 |
| CASE | 580 SUPER K PR | HPL 750 S | 3 |
| CASE | 580 SUPER K TU | HPL 750 S | 3 |
| CASE | 580 G | HPL 750 S | 2 |
| CASE | 580 K | HPL 750 S | 3 |
| CASE | 580 K TURBO | HPL 750 S | 3 |
| CASE | 621 | HPL 1500 S | 5 |
| CASE | 680 K | HPL 750 S | 3 |
| CASE | 680 L | HPL 750 S | 3 |
| CASE | 721 | HPL 2000 S | 6 |
| CASE | 730 | HPL 1100 S | 4 |
| CASE | 740 | HPL 1100 S+ | 4 |
| CASE | 750 B | HPL 1500 S | 5 |
| CASE | 750 B | HPL 2000 S | 7 |
| CASE | 821 | HPL 2500 S | 8 |
| CASE | 855 D | HPL 1500 S | 5 |
| CASE | 1155 E | HPL 1500 S+ | 5 |
| CASE | 1818 | XXXXXXXX | |
| CASE | 1825 | XXXXXXXX | |
| CASE | 1835 B | XXXXXXXX | |
| CASE | 1840 | HPL 400 M | 2 |

| Machine | Model | Rotar[Ó] Sifters | Range Loader |
|---|---|---|---|
| CASE | 1845 B | HPL 400 M | 2 |
| CASE | 1845 C | HPL 400 M | 2 |
| CASE | W 11 B | HPL 750 S | 3 |
| CASE | W 14 | HPL 1100 S- | 3 |
| CASE | W 15 | HPL 1100 S | 4 |
| CASE | W 20 | HPL 1500 S | 5 |
| CASE | W 20 C | HPL 1500 S | 5 |
| CASE | W 24 B | HPL 1500 S | 5 |
| CASE | W 26 B | HPL 2500 S | 7 |
| CASE | W 30 | HPL 2000 S+ | 6 |
| CASE | W 30 C | HPL 2500 S- | 6 |
| CASE | W 36 | HPL 2500 S | 7 |
| CASTORO | 38 | HPL 400 M | 2 |
| CASTORO | 68 | HPL 600 S | 2 |
| CATERPILLAR | 416 | HPL 600 S- | 2 |
| CATERPILLAR | 426 | HPL 600 S | 2 |
| CATERPILLAR | 428 | HPL 750 S | 3 |
| CATERPILLAR | 436 B | HPL 750 S | 2 |
| CATERPILLAR | 446 | HPL 750 S | 3 |
| CATERPILLAR | 910 | HPL 750 S+ | 3 |
| CATERPILLAR | 910 E | HPL 750 S | 3 |
| CATERPILLAR | 916 | HPL 1100 S | 4 |
| CATERPILLAR | 920 | HPL 1500 S- | 4 |
| CATERPILLAR | 926 | HPL 1500 S | 5 |
| CATERPILLAR | 926 E | HPL 1500 S | 5 |
| CATERPILLAR | 930 | HPL 1500 S | 5 |
| CATERPILLAR | 936 | HPL 1500 S+ | 6 |
| CATERPILLAR | 936 E | HPL 2000 S | 6 |
| CATERPILLAR | 936 F | HPL 2000 S | 6 |
| CATERPILLAR | 950 B | HPL 2000 S+ | 7 |
| CATERPILLAR | 950 E | HPL 2500 S | 7 |
| CATERPILLAR | 950 ES | HPL 2500 S | 7 |
| CATERPILLAR | 950 F | HPL 2500 S | 7 |
| CATERPILLAR | 966 C | HPL 2500 S | 7 |
| CATERPILLAR | 966 D | HPL 2500 S+ | 8 |
| CATERPILLAR | 966 E | HXI 3600 H- | 8 |
| CATERPILLAR | 966 F HL | HPL 2500 S | 8 |
| CATERPILLAR | 980 B HL | HXI 3600 H | 9 |
| CATERPILLAR | 980 C | HXI 3600 H | 9 |
| CATERPILLAR | 980 F | HXI 3600 H | 9 |
| CATERPILLAR | 980 F HL | HXI 3600 H | 9 |
| CATERPILLAR | 988 B | XXXXXXXX | 11 |
| CATERPILLAR | 992 C | XXXXXXXX | |
| CATERPILLAR | 992 C HL | XXXXXXXX | |

| Machine | Model | RotarÓ Sifters | Range Loader |
|---|---|---|---|
| CATERPILLAR | 994 | XXXXXXXX | |
| CATERPILLAR | IT 12 | HPL 750 S+ | 3 |
| CATERPILLAR | IT 12 B | HPL 750 S+ | 3 |
| CATERPILLAR | IT 14 B | HPL 750 S | 4 |
| CATERPILLAR | IT 18 | HPL 1100 S | 4 |
| CATERPILLAR | IT 18 B | HPL 1100 S+ | 4 |
| CATERPILLAR | IT 28 | HPL 1100 S+ | 5 |
| CATERPILLAR | IT 28 B | HPL 1500 S | 6 |
| DRESSER | 100 G | HPL 750 S | 3 |
| DRESSER | 125 G | HPL 1500 S | 5 |
| DRESSER | 175 C | HPL 2500 S | 8 |
| DRESSER | 200 | HPL 2500 | 8 |
| DRESSER | 510 | HPL 1100 | 4 |
| DRESSER | 515 C | HPL 1100 S+ | 4 |
| DRESSER | 520 C | HPL 1500 S+ | 5 |
| DRESSER | 530 C | HPL 2500 S- | 5 |
| DRESSER | 540 | HXI 3600 H- | 8 |
| DRESSER | 545 | HXI 3600 H- | 8 |
| DRESSER | 550 | HXI 3600 H | 9 |
| DRESSER | 560 B | XXXXXXXX | |
| DRESSER | 570 | XXXXXXXX | |
| DRESSER | 570 HL | XXXXXXXX | |
| DRESSER | 580 | XXXXXXXX | |
| DRESSER | 580 HL | XXXXXXXX | |
| EUROCAT | 920 | XXXXXXXX | |
| EUROCAT | 940 | HPL 400 M- | 1 |
| EUROCAT | 950 | HPL 400 M | 2 |
| FAI | 555 | HPL 600 S | 2 |
| FAI | 575 | HPL 600 S | 3 |
| FAI | 585 | HPL 750 S | 3 |
| FAI | 595 | HPL 750 S- | 3 |
| FAUN | F 1110 | HPL 1100 S | 4 |
| FAUN | F 1110 IL | HPL 750 S | 4 |
| FAUN | F 1310 | HPL 1500 S | 5 |
| FAUN | F 1410 | HPL 2000 S | 6 |
| FAUN | F 1810 | HPL 2500 S | 7 |
| FAUN | F 2000 C | HPL 2500 S | 8 |
| FAUN | F 2010 | HPL 2500 S | 8 |
| FAUN | F 3500 | HXI 3600 | 10 |
| FAUN | F 5000 | XXXXXXXX | 10 |
| FIATALLIS | 215 | HPL 600 S | 2 |
| FIATALLIS | 545-B | HPL 1100 S | 4 |
| FIATALLIS | 645-B | HPL 1500 S+ | 6 |
| FIATALLIS | FR 7 | HPL 750 S | 3 |

| Machine | Model | RotarÓ Sifters | Range Loader |
|---|---|---|---|
| FIATALLIS | FR 7B | HPL 1100 S- | 3 |
| FIATALLIS | FR 9 | HPL 750 S+ | 4 |
| FIATALLIS | FR 9B TURBO | HPL 1100 S | 4 |
| FIATALLIS | FR 10B | HPL 1500 S | 5 |
| FIATALLIS | FR 10C | HPL 1500 S | 5 |
| FIATALLIS | FR 10E TURBO | HPL 2000 S | 6 |
| FIATALLIS | FR 12B | HPL 2000 S | 6 |
| FIATALLIS | FR 12B TIRBP | HPL 2000 S | 6 |
| FIATALLIS | FR 15B | HPL 2500 S | 7 |
| FIATALLIS | FR 15B TURBO | HPL 2500 S | 8 |
| FIATALLIS | FR 20B | HXI 3600 H- | 8 |
| FIATALLIS | FR 30 | HXI 3600 H+ | 9 |
| FIATALLIS | FR 35 | XXXXXXXX | 10 |
| FIATALLIS | FR 7C | HPL 1100 S- | 3 |
| FIATALLIS | FR 9C | HPL 1100 S | 4 |
| FIATALLIS | FR 130 | HPL 2000 S | 6 |
| FIATALLIS | FR 160 | HPL 2500 S | 8 |
| FIATALLIS | FR 220 | HXI 3600 H- | 8 |
| FIORI | FA 30 | XXXXXXXXX | |
| FIORI | FA 40 | HPL 600 S | 2 |
| FIORI | FA 80 | HPL 750 S | 3 |
| FIORI | LBX | HPL 400 M | 2 |
| FORD | A-62 | HPL 1100 S | 4 |
| FORD | A-64 | HPL 1500 S- | 5 |
| FORD | A-66 | HPL 1500 S | 5 |
| FORD | L-455 | HPL 400 M | 2 |
| FORD | L-533 | HPL 400 M | 2 |
| FORD | L-555 | HPL 400 M | 2 |
| FORD | L-785 | HPL 600 S | 2 |
| FURUKAWA | 305 | HPL 750 S- | 3 |
| FURUKAWA | 310 | HPL 1100 S | 4 |
| FURUKAWA | 335 | HPL 2000 S | 8 |
| FURUKAWA | 345 | HPL 2500 S | 8 |
| FURUKAWA | 355 | HPL 2500 S+ | 7 |
| FURUKAWA | 365 | HXI 3600 H- | 8 |
| FURUKAWA | FL 35-II | XXXXXXXX | |
| FURUKAWA | FL 50-I | HPL 400 M | 2 |
| FURUKAWA | FL 90-I | HPL 600 S | 2 |
| FURUKAWA | FL 100-I | HPL 750 S | 3 |
| FURUKAWA | FL 120-I | HPL 1100 S- | 3 |
| FURUKAWA | FL 150-I | HPL 1100 S | 4 |
| FURUKAWA | FL 200-I | HPL 1500 S+ | 6 |
| FURUKAWA | FL 230-I | HPL 2000 S+ | 6 |
| FURUKAWA | FL 270-I | HPL 2000 S+ | 7 |

| Machine | Model | RotarÓ Sifters | Range Loader |
|---|---|---|---|
| FURUKAWA | FL 330-I | HPL 2500 S | 8 |
| FURUKAWA | FL 450 | HXI 3600 H | 9 |
| FURUKAWA | WL 315 | HPL 1100 S | 4 |
| GEHL | 1620 | XXXXXXXX | 1 |
| GEHL | 2610 | XXXXXXXX | 1 |
| GEHL | 3610 | XXXXXXXX | 1 |
| GEHL | 4610 | HPL 400 M | 1 |
| GEHL | 5625 | HPL 400 M+ | 1 |
| GEHL | 6620 | HPL 600 S | 2 |
| GEHL | KL 305 | HPL 400 M+ | 2 |
| GEHL | KL 405 | HPL 400 M+ | 2 |
| HALLTRAX | 400 = | XXXXXXXX | |
| HALLTRAX | 800 = | HPL 400 M | 2 |
| HANOMAG | 6 D | HPL 400 M+ | 2 |
| HANOMAG | 10 E | HPL 400 M | 2 |
| HANOMAG | 15 F | HPL 600 S | 2 |
| HANOMAG | 20 E | HPL 750 | 2 |
| HANOMAG | 20 E-LD | HPL 750 S | 2 |
| HANOMAG | 22 C | HPL 750 S+ | 3 |
| HANOMAG | 22 D | HPL 1100 S- | 3 |
| HANOMAG | 22 DI | HPL 750 S | 3 |
| HANOMAG | 33 C | HPL 1100 S- | 4 |
| HANOMAG | 33 D | HPL 1100 S | 4 |
| HANOMAG | 33 DI | HPL 1100 S | 4 |
| HANOMAG | 35 D | HPL 1100 S | 4 |
| HANOMAG | 35 DI | HPL 1100 S | 4 |
| HANOMAG | 44 | HPL 1500 S | 5 |
| HANOMAG | 44 C | HPL 1500 S- | 5 |
| HANOMAG | 44 D TURBO | HPL 1500 S | 5 |
| HANOMAG | 44 D/DI | HPL 1500 S | 5 |
| HANOMAG | 44 DI TURBO | HPL 1500 S | 5 |
| HANOMAG | 50 E | HPL 2000 S | 6 |
| HANOMAG | 55 D | HPL 2000 S+ | 6 |
| HANOMAG | 60 E | HPL 2500 S | 7 |
| HANOMAG | 66 C | HPL 2500 S | 8 |
| HANOMAG | 66 D | HPL 2500 S | 8 |
| HANOMAG | 66 D TURBO | HPL 2500 S | 8 |
| HANOMAG | 70 E | HXI 3600 H+ | 8 |
| HANOMAG | 77 D | HXI 3600 H | 8 |
| HANOMAG | 77 D TURBO | HXI 3600 H | 9 |
| HANOMAG | 80 E | XXXXXXXX | 10 |
| HANOMAG | 10 E LD | HPL 400 M | 2 |
| HITACHI | LX 70 | HPL 750 S | 3 |
| HITACHI | LX 80 | HPL 1100 S | 4 |

| Machine | Model | RotarÓ Sifters | Range Loader |
|---|---|---|---|
| HITACHI | LX 100 | HPL 1500 S | 5 |
| HITACHI | LX 150 | HPL 2000 S | 6 |
| HITACHI | LX 200 | HPL 2500 S | 8 |
| HYDRA-MAC | 1450 | XXXXXXXX | 1 |
| HYDRA-MAC | 1850 | XXXXXXXX | 1 |
| HYDRA-MAC | 2550 | HPL 400 M | 2 |
| HYDREMA | 805 | HPL 600 S | 2 |
| HYDREMA | 808 | HPL 750 S | 3 |
| HYMAC | 180 C | HPL 750 S | 3 |
| HYTRACK | 1760 | HPL 400 M | 2 |
| HYUNDAI | HL 25 | HPL 2500 S | 8 |
| HYUNDAI | HL 35 | HXI 3600 H | 9 |
| HYUNDAI | HL 17 | HPL 2000 S | 6 |
| ICH | 515 B | HPL 1100 S+ | 4 |
| INTERNATIONAL | 1000 HD | XXXXXXXX | |
| INTERNATIONAL | 1300 HD | HPL 400 M- | 1 |
| INTERNATIONAL | 1700 HD | HPL 400 M | 2 |
| INTERNATIONAL | 502 | XXXXXXXX | 1 |
| INTERNATIONAL | 503 | HPL 400 M | 2 |
| INTERNATIONAL | 510 B | HPL 1100 S | 4 |
| INTERNATIONAL | 510 B/H | HPL 750 S | 3 |
| INTERNATIONAL | 510 C | HPL 1100 S | 4 |
| INTERNATIONAL | 515 B | HPL 1100 S+ | 4 |
| INTERNATIONAL | 515 B/H | HPL 1100 S- | 4 |
| INTERNATIONAL | 515 C | HPL 1100 S | 4 |
| INTERNATIONAL | 520 B | HPL 1500 S+ | 5 |
| INTERNATIONAL | 520 B/H | HPL 1100 S | 5 |
| INTERNATIONAL | 530 A | HPL 2000 S | 6 |
| INTERNATIONAL | 530 AII | HPL 2500 S | 7 |
| INTERNATIONAL | 540 AII | HPL 2500 S+ | 8 |
| INTERNATIONAL | 545 | HXI 3600 H- | 8 |
| INTERNATIONAL | 550 | HXI 3600 H+ | 9 |
| INTERNATIONAL | 560 B | XXXXXXXX | 11 |
| INTERNATIONAL | 570 | XXXXXXXX | |
| INTERNATIONAL | 570 HL | XXXXXXXX | |
| INTERNATIONAL | 580 | XXXXXXXX | |
| INTERNATIONAL | 580 HL | XXXXXXXX | |
| JCB | 3 D | HPL 750 S- | 2 |
| JCB | 2 CX | HPL 400 M | 2 |
| JCB | 2 CXL | HPL 600 S | 2 |
| JCB | 3 CX | HPL 600 S | 2 |
| JCB | 3 CX SILVER | HPL 600 S | 3 |
| JCB | 3 CX-5 | HPL 750 S | 2 |
| JCB | 3 CX-TE | HPL 750 S | 2 |

| Machine | Model | RotarÓ Sifters | Range Loader |
|---|---|---|---|
| JCB | 4 CX | HPL 750 S | 3 |
| JCB | 406 | HPL 400 M+ | 2 |
| JCB | 408 | HPL 750 S | 3 |
| JCB | 410 | HPL 750 S | 3 |
| JCB | 412 | HPL 1100 S- | 3 |
| JCB | 413 | HPL 1500 S- | 5 |
| JCB | 415 | HPL 1100 S | 4 |
| JCB | 418 | HPL 1500 S+ | 5 |
| JCB | 420 | HPL 1100 S+ | 4 |
| JCB | 423 | HPL 2000 S+ | 7 |
| JCB | 425 | HPL 1500 S | 5 |
| JCB | 428 | HPL 2500 S | 8 |
| JCB | 430 | HPL 1500 S | 5 |
| JCB | 435 | HPL 2000 S- | 6 |
| JOGGER | 600 | HPL 600 S | 2 |
| JOGGER | 700 | HPL 600 S | 2 |
| JOGGER | 800 | HPL 600 S | 2 |
| JOGGER | 600 S | HPL 600 S | 2 |
| JOGGER | 600 SB | HPL 600 S | 2 |
| JOGGER | 700 B | HPL 600 S | 2 |
| JOGGER | 800 B | HPL 600 S | 2 |
| JOHN DEERE | 444 C | HPL 1100 S+ | 4 |
| JOHN DEERE | 444 D | HPL 1100 S+ | 4 |
| JOHN DEERE | 544 C | HPL 1500 S | 5 |
| JOHN DEERE | 544 D | HPL 1500 S | 5 |
| JOHN DEERE | 644 C | HPL 2500 S- | 6 |
| JOHN DEERE | 644 D | HPL 2000 S- | 6 |
| JOHN DEERE | 844 | XXXXXXXX | 8 |
| KAEBLE | SL 30 | HXI 3600 H- | 9 |
| KAEBLE | SL 14-B | HPL 1500 S | 5 |
| KAELBLE | SL 12-C | HPL 1500 S | 6 |
| KAELBLE | SL 14 | HPL 2000 S | 6 |
| KAELBLE | SL 18-E | HPL 2500 S | 8 |
| KAELBLE | SL 18-F | HXI 3600 H- | 8 |
| KAELBLE | SL 20 | HXI 3600 H | 8 |
| KAELBLE | SL 20-B | HXI 3600 H | 9 |
| KAELBLE | SL 25-B | HXI 3600 H | 9 |
| KAELBLE | SL 25-C | HXI 3600 H | 9 |
| KAELBLE | SL 26 | HXI 3600 H | 9 |
| KAWASAKI | KSS 50 Z | XXXXXXXX | 2 |
| KAWASAKI | KSS 50 Z2 | HPL 750 S | 3 |
| KAWASAKI | KSS 60 Z2 | HPL 1100 S+ | 4 |
| KAWASAKI | KSS 65 Z3 | HPL 1500 S+ | 4 |
| KAWASAKI | KSS 70 Z2 | HPL 2000 S | 6 |

| Machine | Model | Rotar® Sifters | Range Loader |
|---|---|---|---|
| KAWASAKI | KSS 70 Z3 | HPL 2000 S | 6 |
| KAWASAKI | KSS 80 | HPL 2000 S | 7 |
| KAWASAKI | KSS 80 Z2 | HPL 2500 S+ | 8 |
| KAWASAKI | KSS 80 Z3 | HPL 2500 S | 7 |
| KAWASAKI | KSS 85 Z2 | HPL 2500 S | 8 |
| KAWASAKI | KSS 85 Z3 | HPL 2500 S | 8 |
| KAWASAKI | KSS 90 Z | HXI 3600 H- | 9 |
| KAWASAKI | KSS 90 Z3 | HXI 3600 H | 9 |
| KAWASAKI | KSS 95 ZZ | HXI 3600 H | 9 |
| KAWASAKI | KSS 95 Z3 | HXI 3600 H- | 9 |
| KAWASAKI | KSS 110 Z2 | XXXXXXXX | 11 |
| KAWASAKI | KSS 115 Z2 | XXXXXXXX | |
| KAWASAKI | KSS 115 Z3 | XXXXXXXX | |
| KLEIS | 500 | HPL 500 S | 2 |
| KOBELCO | LK 200 | HPL 500 S | 2 |
| KOBELCO | LK 230 Z | HPL 1500 S+ | 3 |
| KOBELCO | LK 270 Z | HPL 2000 S+ | 7 |
| KOBELCO | LK 300 A | HPL 750 S+ | 3 |
| KOBELCO | LK 310 Z | HPL 2500 S | 8 |
| KOBELCO | LK 350 Z | HPL 2500 S | 8 |
| KOBELCO | LK 400 | HPL 1100 S | 4 |
| KOBELCO | LK 470 Z | HXI 3600 H | 9 |
| KOBELCO | LK 500 | HPL 1500 S- | 5 |
| KOBELCO | LK 570-Z | HXI 3600 H | 9 |
| KOBELCO | LK 600 | HPL 2000 S- | 5 |
| KOBELCO | LK 700 A | HPL 2500 S | 7 |
| KOBELCO | LK 900 | HPL 2500 S+ | 8 |
| KOBELCO | LK 300 | HPL 1100 S | 4 |
| KOMATSU | WA 20-1 | XXXXXXXX | |
| KOMATSU | WA 30-1 | HPL 400 M- | 1 |
| KOMATSU | WA 30-2 | HPL 400 M | 1 |
| KOMATSU | WA 40-1 | HPL 600 S | 2 |
| KOMATSU | WA 70-1 | HPL 600 S | 2 |
| KOMATSU | WA 100-1 | HPL 1100 S | 3 |
| KOMATSU | WA 120-1 | HPL 1100 S | 4 |
| KOMATSU | WA 150-1 | HPL 1100 S | 4 |
| KOMATSU | WA 180-1 | HPL 1500 S | 5 |
| KOMATSU | WA 200-1 | HPL 1500 S | 5 |
| KOMATSU | WA 250-1 | HPL 1500 S+ | 6 |
| KOMATSU | WA 300-1 | HPL 2000 S | 6 |
| KOMATSU | WA 320-1 | HPL 2000 S+ | 6 |
| KOMATSU | WA 350-1 | HPL 2500 S- | 7 |
| KOMATSU | WA 380-1 | HPL 2500 S | 7 |
| KOMATSU | WA 400-1 | HPL 2500 S | 7 |

| Machine | Model | RotarÓ Sifters | Range Loader |
|---|---|---|---|
| KOMATSU | WA 420-1 | HPL 2500 S | 8 |
| KOMATSU | WA 450-1 | HPL 2500 S- | 8 |
| KOMATSU | WA 470-1 | HXI 3600 H | 9 |
| KOMATSU | WA 500-1 | HXI 3600 H- | 9 |
| KOMATSU | WA 600-1 | XXXXXXXX | 11 |
| KOMATSU | WA 700-1 | XXXXXXXX | |
| KOMATSU | WA 800-1 | XXXXXXXX | |
| KOMATSU | WA 800-2 | XXXXXXXX | |
| KRAMER | 112 SL | XXXXXXXX | 1 |
| KRAMER | 212 E | HPL 400 M- | 1 |
| KRAMER | 212 LT TURBO | HPL 400 M- | 1 |
| KRAMER | 312 E | HPL 400 M | 1 |
| KRAMER | 312 ET TURBO | HPL 400 M | 1 |
| KRAMER | 312 L | HPL 400 M | 2 |
| KRAMER | 312 LT TURBO | HPL 400 M | 2 |
| KRAMER | 312 SE | HPL 400 M | 2 |
| KRAMER | 312 SL | HPL 400 M+ | 2 |
| KRAMER | 412 E | HPL 600 S- | 2 |
| KRAMER | 416 S | HPL 600 S | 2 |
| KRAMER | 512 | HPL 600 S | 2 |
| KRAMER | 516 | HPL 600 S | 2 |
| KRAMER | 512 | HPL 750 S- | 3 |
| KUBOTA | R 310 | XXXXXXXX | |
| KUBOTA | R 310B | XXXXXXXX | |
| KUBOTA | R 400B | XXXXXXXX | 1 |
| KUBOTA | R 410 | HPL 400 M- | 1 |
| KUBOTA | R 410B | HPL 400 M- | 1 |
| KUBOTA | R 510 | HPL 400 M+ | 2 |
| KUBOTA | R 510B | HPL 400 M+ | 2 |
| LANNEN | C 7 | HPL 750 S | 3 |
| LANNEN | C 20 | HPL 1500 S | 3 |
| LANNEN | C 100 | HPL 1100 S | 3 |
| LANNEN | C 110 | HPL 1100 S | 3 |
| LEADER | U 800 | HPL 400 M | 2 |
| LIBRA | SE 30 | XXXXXXXX | |
| LIBRA | SE 40 | HPL 400 M- | 1 |
| LIEBHERR | L 506 | HPL 600 S | 2 |
| LIEBHERR | L 508 | HPL 750 S- | 2 |
| LIEBHERR | L 510 | HPL 1100 S | 4 |
| LIEBHERR | L 511 | HPL 1100 S+ | 4 |
| LIEBHERR | L 521 | HPL 1100 S+ | 5 |
| LIEBHERR | L 522 | HPL 1500 S- | 5 |
| LIEBHERR | L 531 | HPL 1500 S+ | 6 |
| LIEBHERR | L 541 | HPL 2500 S- | 7 |

| Machine | Model | Rotar® Sifters | Range Loader |
|---|---|---|---|
| LIEBHERR | L 551 | HPL 2500 S+ | 8 |
| LIEBHERR | L 561 | XXXXXXXXX | |
| LIEBHERR | L 512 | HPL 1000 S+ | 4 |
| LJUNGSYMASKIN | 1015 | HPL 1100 S+ | 5 |
| LJUNGSYMASKIN | 1221 | HPL 1500 S+ | 6 |
| LJUNGSYMASKIN | 1530 R2.8 | HPL 2000 S | 7 |
| LJUNGSYMASKIN | 2240 R3.8 | HPL 2500 S | 8 |
| LJUNGSYMASKIN | 1530 D3.0 | HPL 2500 S- | 7 |
| LJUNGSYMASKIN | 1312 | HPL 2000 S- | 6 |
| LJUNGSYMASKIN | 1631 | HPL 2500 S | 8 |
| LJUNGSYMASKIN | 2240 D4.0 | HXI 3600 H- | 8 |
| LJUNGSYMASKIN | 1118 | HPL 1500 S | 5 |
| LJUNGSYMASKIN | 1016 | HPL 1500 S- | 5 |
| MACMOTOR | LE-5 | HPL 500 S | 2 |
| MASSEY-FERG | 750 | HPL 750 S | 3 |
| MASSEY-FERG | 860 | HPL 750 S | 3 |
| MASSEY-FERG | 865 | HPL 750 S | 3 |
| MASSEY-FERG | 30 H | HPL 400 M | 1 |
| MASSEY-FERG | 40 H | HPL 600 S | 1 |
| MASSEY-FERG | 50 H | HPL 750 S | 2 |
| MASSEY-FERG | 50 HX | HPL 750 S | 2 |
| MASSEY-FERG | 60 HX | HPL 750 S | 3 |
| MASSEY-FERG | 65 A | HPL 750 S | 3 |
| MASSEY-FERG | 613 | HPL 600 S- | 2 |
| MASSEY-FERG | 615 | HPL 750 S | 3 |
| MECALAC | 8 CX | HPL 750 S | 3 |
| MECALAC | 11 CX | HPL 1100 S | 4 |
| MECALAC | 16 DX | XXXXXXXX | |
| MICHIGAN | 35 B | HPL 750 S | 3 |
| MICHIGAN | 45 B | HPL 1100 S | 4 |
| MICHIGAN | 45 C | HPL 1100 S | 4 |
| MICHIGAN | 55 B | HPL 1500 S | 5 |
| MICHIGAN | 55 C | HPL 1500 S | 5 |
| MICHIGAN | 75 B | HPL 2000 S | 6 |
| MICHIGAN | 75 C | HPL 2500 S | 6 |
| MICHIGAN | 125 B | HPL 2500 S | 8 |
| MICHIGAN | 175 B | HXI 3600 H | 9 |
| MICHIGAN | 175 C | HXI 3600 H+ | 9 |
| MICHIGAN | 275 B | XXXXXXXX | 10 |
| MICHIGAN | 275 C | XXXXXXXX | 10 |
| MICHIGAN | 475 CT | XXXXXXXX | |
| MICHIGAN | 475 B | XXXXXXXX | |
| MICHIGAN | 475 C | XXXXXXXX | |
| MITSUBISCHI | WS 300A | HPL 400 M | 1 |

| Machine | Model | Rotar© Sifters | Range Loader |
|---|---|---|---|
| MITSUBISCHI | WS 500A | HPL 500 S | 2 |
| MUSTANG | 920 | XXXXXXXX | |
| MUSTANG | 930 A | XXXXXXXX | |
| MUSTANG | 940 | HPL 400 M- | 1 |
| MUSTANG | 960 | HPL 400 M- | 1 |
| O&K | L 5 | HPL 600 S | 2 |
| O&K | L 6 | HPL 600 S | 2 |
| O&K | L 7 | HPL 600 S | 2 |
| O&K | L 10 | HPL 750 S+ | 3 |
| O&K | L 12 | HPL 1100 S- | 4 |
| O&K | L 15 | HPL 1100 S+ | 4 |
| O&K | L 15 | HPL 1100 S | 4 |
| O&K | L 18 | HPL 1500 S | 5 |
| O&K | L 20 | HPL 1500 S | 6 |
| O&K | L 20 I | HPL 1500 S | 5 |
| O&K | L 25 | HPL 2000 S | 6 |
| O&K | L 30 | HPL 2500 S | 7 |
| O&K | L 35 | HPL 2500 S+ | 8 |
| O&K | L 40 | HXI 3600 H | 10 |
| O&K | L 45 | HXI 3600 H | 8 |
| O&K | L 55 | HXI 3600 H+ | 10 |
| O&K | L 8 | HPL 750 S- | 3 |
| O&K | L 4 | HPL 400 M+ | 2 |
| PRIME-MOVER | L-930 | XXXXXXXX | |
| PRIME-MOVER | L-1100 | HPL 400 M | 2 |
| PRIME-MOVER | LD 50 | HPL 400 M | 2 |
| PRIME-MOVER | LS 70 | XXXXXXXX | |
| PRIME-MOVER | LS 75 | XXXXXXXX | |
| RAMMAX | LR 2-110 | XXXXXXXX | |
| RAMROD | 230 A | XXXXXXXX | |
| RAMROD | 300 A | XXXXXXXX | |
| RAMROD | 524 AS | HPL 400 M- | 1 |
| RAMROD | 580 A | HPL 400 M- | 1 |
| RAMROD | 584 AS | HPL 400 M | 2 |
| RAMROD | 784 AS | HPL 400 M- | 1 |
| SCHAEFF | SKB 900 | HPL 600 S | 2 |
| SCHAEFF | SKB 902 | HPL 600 S- | 2 |
| SCHAEFF | SKB 1000 | HPL 750 S | 3 |
| SCHAEFF | SKL 809 S | XXXXXXXX | 1 |
| SCHAEFF | SKL 811 A | XXXXXXXX | 1 |
| SCHAEFF | SKL 820 A | HPL 400 M+ | 1 |
| SCHAEFF | SKL 821 | HPL 400 M+ | 2 |
| SCHAEFF | SKL 821 A | HPL 400 M+ | 2 |
| SCHAEFF | SKL 830 A | HPL 600 S- | 2 |

| Machine | Model | Rotar® Sifters | Range Loader |
| --- | --- | --- | --- |
| SCHAEFF | SKL 831 A | HPL 600 S | 2 |
| SCHAEFF | SKL 832 | HPL 600 S | 2 |
| SCHAEFF | SKL 840 A | HPL 750 S- | 2 |
| SCHAEFF | SKL 841 | HPL 600 S | 2 |
| SCHAEFF | SKL 841 A | HPL 750 S | 3 |
| SCHAEFF | SKL 850 A | HPL 750 S | 3 |
| SCHAEFF | SKL 851 | HPL 750 S | 3 |
| SCHAEFF | SKL 851 A | HPL 750 S | 3 |
| SCHAEFF | SKL 861 A | HPL 1100 | 4 |
| SCHAEFF | SKL 831 | HPL 600 S- | 2 |
| SCHAEFF | SKL 831 L | HPL 600 S- | 2 |
| SCHAEFF | SKL 631 | HPL 600 S | 2 |
| TCM | 808 A-2 | HPL 400 M | 1 |
| TCM | 810 A-2 | HPL 400 M | 1 |
| TCM | 815 | HPL 400 M+ | 2 |
| TCM | 820 | HPL 730 S | 2 |
| TCM | 820-2 | HPL 750 S | 3 |
| TCM | 830 | HPL 1100 S | 3 |
| TCM | 830-2 | HPL 1100 S | 4 |
| TCM | 835 | HPL 1100 S | 4 |
| TCM | 835-2 | HPL 1500 S | 5 |
| TCM | 840 | HPL 1500 S | 5 |
| TCM | 840-2 | HPL 1500 S | 5 |
| TCM | 850 | HPL 2000 S | 6 |
| TCM | 850-2 | HPL 2000 S | 6 |
| TCM | 860 | HPL 2500 S | 7 |
| TCM | 870 | HXI 3600 S- | 8 |
| TCM | 870-2 | HXI 3600 S | 9 |
| TCM | 890 | XXXXXXX | |
| TEREX | 72-31-B | HPL 2000 S+ | 5 |
| TEREX | 72-51-B | HXI 3600 H- | 8 |
| TEREX | 72-61 | HXI 3600 H | 9 |
| TEREX | 72-61/80 C | HXI 3600 H | 9 |
| TEREX | 72-71 B | XXXXXXXX | |
| TEREX | 72-81 | XXXXXXXX | 11 |
| TEREX | 72-51 B | HXI 3600 H- | 8 |
| TEREX | 72-31 B | HPL 2000 S+ | 7 |
| THOMAS | T-83 | XXXXXXXX | |
| THOMAS | T-103 | XXXXXXXX | |
| THOMAS | T-133 | HPL 400 M- | 1 |
| THOMAS | T-173 | HPL 400 M | 2 |
| THOMAS | T-183 HD | HPL 400 M | 2 |
| THOMAS | T-233 | HPL 400 M | 2 |
| THOMAS | T-233 HD | HPL 600 S | 2 |

| Machine | Model | RotarÓ Sifters | Range Loader |
|---|---|---|---|
| TOYOTA | 2 SDK 4 | XXXXXXXX | 1 |
| TOYOTA | 2 SDK 5 | XXXXXXXX | |
| TOYOTA | 2 SDK 6 | XXXXXXXX | 1 |
| TOYOTA | 2 SDK 7 | HPL 400 M- | 1 |
| TOYOTA | 2 SDK 8 | HPL 400 M- | 1 |
| TOYOTA | 500 D | HPL 600 S | 2 |
| TOYOTA | 500 I | HPL 600 S | 2 |
| TOYOTA | SDE 10 | HPL 400 M | 2 |
| UNC | 053 | HPL 400 M | 2 |
| UNC | 061 | HPL 400 M | 2 |
| UNC | 201 | HPL 2000 S | 6 |
| UNC | 500 | HPL 2500 S | 8 |
| VENIER | 1.63 | HPL 400 M | 1 |
| VENIER | 1.63 B | HPL 600 S | 2 |
| VENIER | 2.33 | HPL 600 S | 2 |
| VENIER | 3.63 B | HPL 400 M | 2 |
| VENIER | 3.63 C | HPL 600 S- | 2 |
| VENIER | 3.63 D | HPL 600 S | 2 |
| VENIER | 4.23 | HPL 600 S | 2 |
| VENIER | 4.53 B | HPL 600 S- | 2 |
| VENIER | 4.63 C | HPL 600 S | 3 |
| VENIER | 5.23 | HPL 600 S | 2 |
| VENIER | 5.23 | HPL 750 S | 3 |
| VENIER | 5.33 | HPL 600 S | 2 |
| VENIER | 5.63 | HPL 750 S | 3 |
| VENIER | 7.33 | HPL 750 S+ | 3 |
| VENIER | 8.23 | HPL 750 S | 3 |
| VENIER | 8.33 B | HPL 1100 S | 3 |
| VENIER | 8.33 C | HPL 1100 S | 3 |
| VENIER | 8.63 | HPL 1100 S | 3 |
| VENIER | 10.23 | HPL 1100 S | 3 |
| VENIER | 12.23 | HPL 1100S | 4 |
| VOLVO | 4200 B | HPL 750 S | 3 |
| VOLVO | 4300 B | HPL 1500 S- | 4 |
| VOLVO | 4400 | HPL 2000 S- | 5 |
| VOLVO | 4500 | HPL 2000 S+ | 7 |
| VOLVO | 4600 B | HXI 3600 H- | 8 |
| VOLVO | 6300 | HPL 1100 S | 4 |
| VOLVO | L-30 | HPL 600 S+ | 3 |
| VOLVO | L-50 | HPL 1100 S- | 3 |
| VOLVO | L-70 | HPL 1500 S- | 4 |
| VOLVO | L-90 | HPL 2000 S- | 6 |
| VOLVO | L-120 | HPL 2500 S | 7 |
| VOLVO | L-120 B | HPL 2500 S | 8 |

| Machine | Model | RotarÓ Sifters | Range Loader |
|---|---|---|---|
| VOLVO | L-150 | HXI 3600 H- | 8 |
| VOLVO | L-160 | HXI 3600 H- | 9 |
| VOLVO | L-190 | HXI 3600 H | 9 |
| VOLVO | L-190 S | HXI 3600 H | 9 |
| VOLVO | L-180 | HXI 3600 H | 9 |
| VOLVO BM | 846 | HPL 1500 S- | 5 |
| WERKLUST | WG 16 | HPL 750 S- | 3 |
| WERKLUST | WG 18 | HPL 1500 S | 5 |
| WERKLUST | WG 25 | HPL 1500 S+ | 5 |
| WERKLUST | WG 35 | HPL 2000 S+ | 5 |
| WERKLUST | WG 45 | HPL 2500 S | 7 |
| WERKLUST | WG 55 | HPL 2500 S+ | 8 |
| YANMAR | V 1 | XXXXXXXX | |
| YANMAR | V 2 | HPL 400 M- | 1 |
| YANMAR | V 3 | HPL 400 M- | 1 |
| YANMAR | V 4 | HPL 400 M | 2 |
| ZEPPELIN | LL 20.2 | XXXXXXXX | |
| ZEPPELIN | LL 24 | HPL 400 M- | 1 |
| ZEPPELIN | LL 30.1 | HPL 400 M | 2 |
| ZEPPELIN | LL 41 | HPL 400 M | 2 |
| ZEPPELIN | LL 50 | HPL 400 M | 2 |
| ZEPPELIN | LL 60.1 | HPL 400 + | 2 |
| ZEPPELIN | ZK 32 | HPL 400 M- | 1 |
| ZEPPELIN | ZL 4 B | HPL 600 S- | 2 |
| ZEPPELIN | ZL 6 B | HPL 600 S+ | 3 |
| ZEPPELIN | ZL 8 B | HPL 750 S | 3 |
| ZEPPELIN | ZL 10 B | HPL 750 S | 3 |
| ZEPPELIN | ZL 12 B | HPL 1100 S | 4 |
| ZETTLEMEYER | ZL 401/WE | HPL 400 M | 1 |
| ZETTLEMEYER | ZL 402 | HPL 400 M+ | 2 |
| ZETTLEMEYER | ZL 501 B | HPL 500 S | 2 |
| ZETTLEMEYER | ZL 502 | HPL 500 S | 2 |
| ZETTLEMEYER | ZL 601 B | HPL 600 S | 2 |
| ZETTLEMEYER | ZL 602 | HPL 750 S | 3 |
| ZETTLEMEYER | ZL 801 | HPL 750 | 3 |
| ZETTLEMEYER | ZL 1001 | HPL 1100 S | 3 |
| ZETTLEMEYER | ZL 1001 1 | 750 S | 3 |
| ZETTLEMEYER | ZL 1801 | HPL 1500 S | 5 |
| ZETTLEMEYER | ZL 2001 | HPL 1300 S | 6 |
| ZETTLEMEYER | ZL 2002 | HPL 2000 S+ | 6 |
| ZETTLEMEYER | ZL 3002 | HPL 2500 S | 8 |
| ZETTLEMEYER | ZL 4001 | HXI 3600 H | 8 |
| ZETTLEMEYER | ZL 4001 B | HXI 3600 H | 8 |
| ZETTLEMEYER | ZL 4002 | HPL 2500 S+ | 8 |

| Machine | Model | Rotar[Ó] Sifters | Range Loader |
| --- | --- | --- | --- |
| ZETTLEMEYER | ZL 5001 | HPL 2500 S | 8 |
| ZETTLEMEYER | ZL 5001 | HXI 3600 H | 9 |
| ZETTLEMEYER | ZL 802 | HPL 750 | 3 |

# APPENDIX B
# INFORMATION PROVIDED BY *Rotar International b.v.*

## APPENDIX B
## INFORMATION PROVIDED BY *Rotar International b.v.*

The following information was provided by *Rotar International b.v.* as a guide in selecting the proper size ROTAR© for a wheeled loader. If there are any questions, their engineering representative will gladly assist you in making your selection. Contact Mr. Louis Broekhuizen at l.broekhuizen@rotar.nl.

## LIFTING CAPACITY

If the maximum lifting capacity of the carrier machine is smaller than the total weight of the ROTAR© sifter, decrease the maximum weight of capacity with this difference. The result of this difference is the maximum lifting capacity (see delivery checklist).

To calculate the total weight of the ROTAR© sifter, add the following (see Table B-1):

- ROTAR© Sifter
- Plate (hinge plate carrier machine)
- Insert screen
- Capacity (maximum weight of capacity).

The maximum weight of capacity will be calculated as follows:

2/3 × litre capacity × specific weight of capacity. (Specific weight of capacity is lay down for 1800 m/3).

**Table B-1. Calculation of the Total Weight of the ROTAR© Sifter**

| | ROTAR© Sifter | Plate [1] | Insert Screen | Maximum Weight of Capacity | Total |
|---|---|---|---|---|---|
| **HPL 400 M** | **400** | + 50 | + 55 | **+ 480** | **= 985 kg** |
| **HPL 600 S** | **675** | + 75 | + 65 | **+ 750** | **= 1,540 kg** |
| **HPL 800 S** | **950** | + 125 | + 80 | **+ 960** | **= 2,115 kg** |
| **HPL 1500 L** | **1525** | + 150 | + 125 | **+ 1600** | **= 3,400 kg** |
| **HPL 1500 S** | **1705** | + 150 | + 125 | **+ 1875** | **= 3,855 kg** |
| **HPL 2000 S** | **2195** | + 200 | + 150 | **+ 2520** | **= 5,065 kg** |
| **HPL 2500 S** | **2600** | + 250 | + 170 | **+ 3060** | **= 6,080 kg** |
| **HXI 3600 H** | **4125** | + 350 | + 200 | **+ 4320** | **= 8,995 kg** |
| **HEX 350 M** | **450** | + 50 | + 65 | **+ 420** | **= 985 kg** |
| **HEX 700 S** | **900** | + 75 | + 80 | **+ 780** | **= 1,835 kg** |
| **HEX 850 S** | **1200** | + 75 | + 90 | **+ 1044** | **= 2,409 kg** |
| **HEX 1000 S** | **1700** | + 150 | + 100 | **+ 1350** | **= 3,300 kg** |
| **HEX 1400 S** | **2150** | + 175 | + 125 | **+ 1890** | **= 4,340 kg** |

**Note 1 for Table B-1:** *Average weight of the plate.*

## TECHNICAL SPECIFICATIONS OF THE HPL SERIES

**Standard model:**

- Massive bars steel St. 52.3
- Bar distance 45 mm (only HPL 2500 S and HPL 3000 S have 60-mm bar distance)
- Hose connection on the ROTAR© frame.

**Hoses:**

- HPL 400 M / 600 S / 800 S 16 mm
- HPL 1500 L / 1500 S / 2000 S 20 mm
- HPL 2500 S / 3000 S 25 mm.

**Options:**

- Exchangeable insert screens from spring steel with meshes from 6 mm up to 40 mm
- Exchangeable heavy-duty 45-mm insert screens from steel St. 52-3
- Sealkit for screening materials finer than 10 mm.

**Hydraulics:**

The HPL series ROTAR© is available in A- and B-hydraulics:

- **A-hydraulics.** Carrier machine has to be provided with a proportional regulative, reversible hydraulic third valve spool

- **B-hydraulics.** Carrier machine is not provided with a proportional regulative, reversible third valve spool. Carrier machine only has a black/white hydraulic spool with one flow direction (e.g., a hammer valve).

  Table B-2 presents the technical specifications of the HPL series.

**Table B-2. Technical Specifications of the HPL Series**
**(Note:** *Specifications can change without notice.)*

| Model | Drum Capacity (l) | Drum Weight (kg) [1] | Total Width (mm) | Bar-Thickness (mm) | Drum Diameter (mm) | Rotation Speed (rpm) | Operation Pressure (bar) [2] | Oil flow (l/min) [3] |
|---|---|---|---|---|---|---|---|---|
| **Compact Models** | | | | | | | | |
| HPL 400 M | 400 | 385 | 2,020 | 16 | 607 | 30 | 250 | A 80 / B 45 |
| HPL 600 S | 600 | 675 | 2,100 | 20 | 710 | 28 | 250 | A 80 / B 80 |
| HPL 800 S | 800 | 875 | 2,380 | 20 | 760 | 28 | 250 | A 75 / B 75 |
| **Standard Models** | | | | | | | | |
| HPL 1500 L | 1,560 | 1,525 | 2,904 | 25 | 1,010 | 28 | 250 | A 125 / B 125 |
| HPL 1500 S | 1,560 | 1,700 | 2,904 | 25 | 1,010 | 28 | 250 | A 125 / B 125 |
| HPL 2000 S | 2,000 | 2,200 | 3,020 | 30 | 1,110 | 28 | 250 | A 125 / B 125 |
| **Industrial Models** | | | | | | | | |
| HPL 2500 S | 2,500 | 2,425 | 3,130 | 30 | 1,190 | 28 | 250 | A 160 / B 160 |
| HPL 3000 S | 3,000 | 4,125 | 3,430 | 30 | 1,150 | 28 | 250 | A 160 / B 160 |

**Note 1 for Table B-2:** *Weight exclusive flat hinge-plate, without screens.*

**Note 2 for Table B-2:** *Operation pressure 20–60 bar higher with B-hydraulics.*

**Note 3 for Table B-2:** *A = A-hydraulic, B = B-hydraulic.*

## Technical Specifications of the HEX Series

**Standard model:**

- B-hydraulics (A-hydraulics on request)
- Massive bars steel St 52-3
- Bar distance 60 mm (only HEX 350 M and HEX 700 S have 45-mm bar distance)
- Hose connection on the ROTAR© frame.

**Hoses:**

- HEX 350 M / 700 S / 850 S   20 mm
- HEX 1000 S / 1400 S   25 mm.

**Options:**

- Exchangeable insert screens from spring steel with meshes from 6 mm up to 40 mm
- Exchangeable heavy-duty 45-mm insert screens from steel St 52-3
- Sealkit for screening materials finer than 10 mm.

**Hydraulics:**

The HEX series ROTAR© is available in A- and B-hydraulics:

- **A-hydraulics.** Carrier machine has to be provided with a proportional regulative, reversible hydraulic third valve spool

- **B-hydraulics.** Carrier machine is not provided with a proportional regulative, reversible third valve spool. Carrier machine only has a black/white hydraulic spool with one flow direction (e.g., a hammer valve).

  Table B-3 presents the technical specifications of the HEX series.

**Table B-3. Technical Specifications of the HEX Series**
**(Note:** *Specifications can change without notice.)*

| Model | Drum Capacity (l) | Drum Weight (kg) [1] | Total Width (mm) | Bar-Thickness (mm) | Drum Diameter (mm) | Rotation Speed (rpm) | Operation Pressure (bar) [2] | Oil flow (l/min) [3] |
|---|---|---|---|---|---|---|---|---|
| **Standard Models** | | | | | | | | |
| HEX 350 M | 350 | 425 | 1,300 | 20 | 710 | 28 | 250 | A 80 / B 80 |
| HEX 700 S | 650 | 900 | 1,640 | 25 | 835 | 28 | 250 | A 75 / B 75 |
| HEX 850 S | 870 | 1,200 | 2,050 | 25 | 835 | 28 | 250 | A 75 / B 75 |
| HEX 1000 S | 1,050 | 1,700 | 1,750 | 30 | 1,025 | 28 | 250 | A 125 / B 125 |
| HEX 1400 S | 1,450 | 2,150 | 2,185 | 30 | 1,025 | 28 | 250 | A 125 / B 125 |

**Note 1 for Table B-3:** *Weight exclusive flat hinge-plate, without screens.*

**Note 2 for Table B-3:** *Operation pressure 20–60 bar higher with B-hydraulics.*

**Note 3 for Table B-3:** *A = A-hydraulic, B = B-hydraulic.*