

## Instruction Manual HMM

### MOBILE LEEB HARDNESS TESTER



**Model: HMM**

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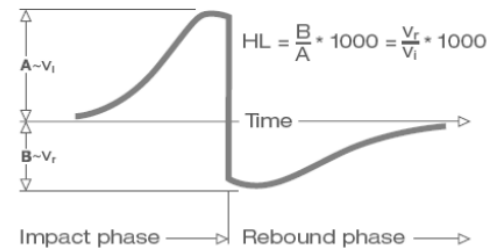
#### Caution

##### Please read this carefully first:

1. Only the special battery offered by our Company may be used in the main body of the hardness tester. Improper batteries might cause damages to the instrument, battery leakage, even fire or explosion.
2. Any components of the instrument may not get submerged in water or get exposed to rain, which could cause a battery explosion and damage the main body.
3. Electrical shocks have to be avoided; the cabinet may not be opened.
4. If the instrument hasn't been used for a longer period, it has to be stored in a cool and dry place.

#### 1. Summarize

##### 1.1 Measuring Principle Scope



The measuring principle of HMO Hardness Tester is physically a rather simple dynamic hardness test:

An impact body with a hard metal test tip is propelled by spring force against the surface of the test piece. Surface deformation takes place when the impact body hits the test surface, which results in a loss of kinetic energy. This energy loss is calculated by velocity measurements when the impact body is at a precise distance from the surface for both, the impact phase and the rebound phase, of the test. The permanent magnet in the impact body generates an induction voltage in the single coil of the impact device. The voltage of the signal is proportional to the velocity of the impact body. A signal processing by the electronics provides the hardness reading for display and storage. Simply said, harder materials produce higher rebound velocities than less harder ones (higher L- value). HMM Hardness Tester provides a direct hardness measurement within any particular material group (i.e. steel, aluminium etc.). It can be used as a final test result without conversion. However, there are established conversions to other hardness scales in this Hardness Tester as a comfort for our customers. These conversions to other scales (HRC, HRB, HB, HV, HSD etc.) are programmed into the electronics and they can be shown directly on the display as a test result. All data is stored in the native L scale to prevent any possible errors with multiple conversions.

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#### 1.2. The Hardness value "L"

This term was introduced 1978 into measuring technology by Dr. Dietmar Leeb. It contains the quotient for the impact body's rebound and impact velocity, multiplied by 1000. Harder materials produce higher rebound velocity than less harder ones. With reference to a particular material group (i.e. steel, aluminium etc.), the L value represents a direct hardness measurement and is used as such. Comparison curves with other standard statistic hardness values have been established (Brinell, Vickers, Rockwell C, B) for the most prevalent materials, enabling the L values to be converted into the relevant values by these procedures. With this hardness tester, such hardness values can directly be displayed in the hardness scales HRC, HRB, HB, HV, HSD and tensile strength (MPa).

#### 1.3 Main features

- Highly accurate,  $\pm 6$  HL
- Automatic correction for impact direction
- Large, easy to read display with backlight
- User profiles for fast change of all settings
- Conversion to all common hardness scales HRC, HRB, HB, HV, HSD and tensile strength (MPa).
- Supplied by dry-cell, Ultra-low-power
- Easy calibration
- Conforms to the Standard ASTM A956-02

#### 1.4 Application range

- Appropriate for all metals
- Ideal for production level testing
- Best suited for on- site testing of heavy, big or already installed parts
- Handy for difficult to access or confined test locations
- Automatic compensation for impact direction
- Excellent for material selection and acceptance tests
- Easy to handle and accurate on curved test surfaces (R> 10mm)
- Metal production & processing
- Automotive & transportation
- Aerospace & shipyard
- Testing services & laboratories

#### 1.5 Technical information

##### 1.5.1 Display unit

- \* HL Display range: 0 to 999 HLD
- \* Accuracy:  $\pm 6$  HL
- \* LCD: large LCD with backlight
- \* Resolution: 1 HL; 1 HV; 1 HB; 0,1 HRC; 0,1HRB; 1 HSD; 1 MPa
- \* Power: dry cell (3 x 1.5V AAA)
- \* Operating temperature: 0°C up to + 50°C (32°F up to 122°F)

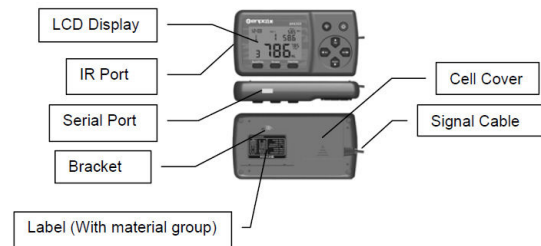
- \* Storage Temperature: -10°C up to + 60°C (14°F up to 140°F)
- \* Humidity: 90 % max.
- \* Dimensions: 150mm x 80mm x 24mm (5.9 x 3.1 x 0.9 inches)
- \* Weight: Approx. 200g (main body)

#### 1.5.2 Impact unit D

- Impact energy: 11 Nmm
- Mass of the impact body: 5.5 g
- Test tip diameter: 3 mm
- Test tip material: tungsten carbide
- Test tip hardness:  $\geq 1600$  HV
- Impact length: 147 mm
- Impact maximum diameter: 20 mm
- Impact weight: 75 g

#### 1.6 Overview Display Unit

Picture 1-1



#### 1.7 Impact Device Assembling

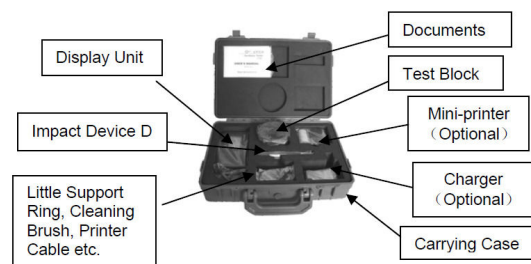
1. Impact body
2. Support ring
3. Coil
4. Cable
5. Catch chuck
6. Loading tube
7. Release button



#### 2. Checking supplied accessories

It should be checked that the following accessories are supplied with your instrument

Picture 2-1



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The items are supplied with the hardness tester. The accessories available may vary from retailer to retailer, depending on the country or service provider. The purchased accessories only have to be used with Polygon-authorized devices. The use with other devices could cause problems and any repair costs wouldn't be covered by warranty.

### 3. Quick start guide

#### 3.1 Connection

The signal cable has to be connected to the impact device and the display unit.

Picture 3-1



#### 3.2 Calibration

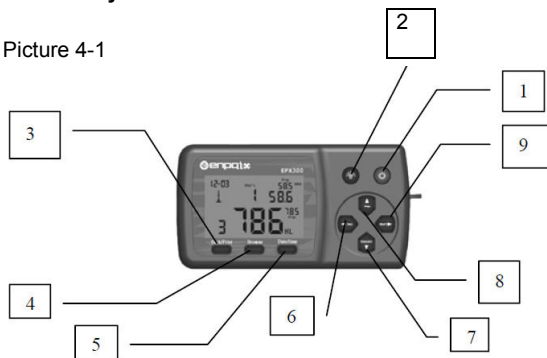
The test block has been calibrated in accordance with the dynamic hardness value L. The HMM Impact Hardness Tester has to be calibrated by the test block before the first use (APPENDIX 1)



### 4. Operating instructions

#### 4.1 Display unit







##### 4.1.1 Keys

Picture 4-1



1. **“On/Off“** button: The instrument is turned on and off by pressing and holding the  button.
2. **Backlight** button: The button  has to be pressed to turn on and off the LCD backlight.
3. **“Back/Print“** button:
  - a) In measurement mode, the **“Back/Print“** button has to be pressed to erase the measured data. At the same time, if the mini-printer is linked with the display unit, those data will be printed out.

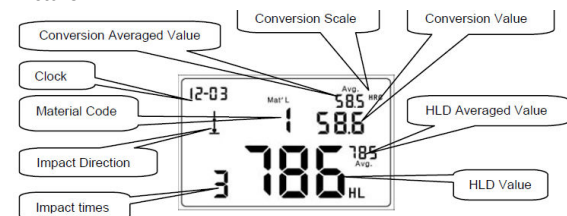
b) In other mode, the **“Back/Print“** button has to be pressed to complete setup and to save the parameters set. Then it is returned to measurement mode.

4. **“Browse“** button: browse the memory data.
5. **“Date/Time“** button: adjustment of clock and calendar
6.  button: This button has to be pressed to delete current data in measurement mode or browse mode.
7.  button: It has to be pressed to setup the conversion scale in measurement mode. In Date/Time setup mode and in calibration mode, this button has to be pressed to decrease the flickering bit. In browse mode,  button has to be pressed to display the next data.
8.  button: It has to be pressed to setup the impact direction in measurement mode. In Date/Time setup mode and in calibration mode, this button has to be pressed to increase the flickering bit. In browse mode,  button has to be pressed to display the previous data.
9.  button: In measurement mode, it has to be pressed to select the material that will be impacted. In Date/Time setup mode and in calibration mode, this button has to be pressed to select the next bit.

#### 4.1.2 Measurement Mode


HMM Hardness Tester has got a large LCD and an abundance of information.

Picture 4-2



#### 4.1.3 Setup


##### 4.1.3.1 Material Group

In measurement mode,  button has to be pressed to select the material that will be impacted. Following material list is shown on the back of the instrument:

Hardness	Tensile strength (MPa)
01. Steel and Cast Steel	11. Low Carbon Steel
02. Alloy Tool Steel	12. Hi Carbon Steel
03. Stainless Steel	13. Chrome Steel
04. Grey Cast Iron	14. Cr-V Steel
05. Ductile Iron	15. Cr-Ni Steel
06. Cast Al Alloys	16. Cr-Mo Steel
07. Cu-Zn Alloys	17. Cr-Ni-Mo Steel
08. Cu-Sn Alloys	18. Cr-Mn-Si Steel
09. Copper	19. Hi Strength Steel
10. Forging Steel	20. Stainless Steel

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If  button is pressed continuously, material changes according to following sequence:

01→02→03→...→10→11→...→20→01→...

**Note:**


1. **It is necessary to select the material classification. If the type of material isn't known, the related material handbook will help.**
2. **If the material group is changed, the impact times counter will be set to "0".**
3. **Default setting: steel and cast steel.**

#### 4.1.3.2 Impact Direction

Ideal Leeb Hardness Testing is a downward straight testing method. As a result of gravity, the test should be amended when measuring other directions in order to measure correct hardness values of materials. As long as the impact direction is chosen correctly, impact direction is automatically amended by the hardness tester.

There are five impact directions to chose:



In measurement mode, the  button has to be pressed to select the impact direction. It changes to following sequence:




**Note: Default setting is .**

#### 4.1.3.3 Scale

HLD values can be automatically converted by HMM Hardness Tester to other scales HRC,HRB, HB, HV, HSD or tensile strength (MPa) according to a particular material group (e.g. steel, aluminium etc.)

In measurement mode, the  button has to be pressed to convert all common hardness scales or tensile strength

(MPa).  button has to be pressed continuously and the scale changes according to following sequence:

HRC→HRB→HB→HV→HSD→MPa→HRC...



**Notes:**

1. **If the conversion is out of range, the conversion value is indicated by "---".**
2. **If the conversion is set from hardness scale to tensile strength or the other way round, the material group has to be reset.**
2. **Conversion value only supplies a general reference, which results in some offset. Generally, comparative tests are necessary to achieve precise conversion.**
3. **If the hardness scales are changed, the current impact times counter will be cleared to "0".**
4. **Standard setting for the conversion is "HRC".**

#### 4.1.3.4 Browse

"Browse" button has to be pressed to browse stored data and to display the first data group of the last nine test data,



including hardness value HLD, material, conversion values, impact direction, date and time etc.



The  button has to be pressed to browse the next data group.  button has to be pressed to browse the previous data group. "Back/Print" button has to be pressed to get back to measurement mode.


#### 4.1.3.5 Adjusting Clock and Calendar



HMM Hardness Tester has got an inbuilt real-time clock-system. Clock and calendar have to be adjusted if, i.e. the dry cell has been reinstalled. The procedure is as follows:


The "Date/Time" button has to be pressed to enter clock and calendar adjustment mode. If the "month" bit starts



flickering, the  button has to be pressed to increase and  button to decrease. Valid numbers are 1 to 12.


The  button has to be pressed and the "day" bit starts flickering, the  button has to be pressed to increase



and  button to decrease. Valid numbers are 1 to 31.


The  button has to be pressed and the "year" bit starts flickering, the  button has to be pressed to increase

and  button to decrease. Valid numbers are 00 to 99.

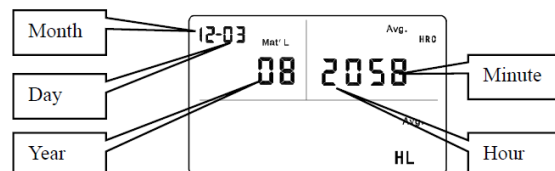
The  button has to be pressed and the "hour" bit starts flickering, the  button has to be pressed to increase

and  button to decrease. Valid numbers are 00 to 23.

The  button has to be pressed and the "minute" bit starts flickering, the  button has to be pressed to

increase and  button to decrease. Valid numbers are 00 to 59.

"Back/Print" button can be pressed every time if the adjustment is completed and to return to measurement mode.






#### 4.1.3.6 Calibration

Calibration is used to calibrate the measured value (HLD) of the hardness tester to decrease the measuring error as far as possible. The procedure is as follows:

- 1) "Back/Print" button has to be pressed to clear the testing times to "0". It has to be impacted 5 times on the test block to get an average value (some previous error data can be deleted).

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2) **“Date/Time”** button has to be pressed about two seconds to display the calibration mode. The HLD value which is remarked on the test block has to be input by the buttons  or  or . By pressing the **“Back/Print”** button again, the calibration is finished.

**Note:**

**The hardness tester must be calibrated on the test block before use.**


**The default impact direction is  (see Appendix 1)**

### 4.2 The Format of Memory Data


The data group (such as test result, material and impact direction) are automatically saved in memory after each individual measurement. HMM Hardness Tester can store 9 sets of data. When measuring more than 9 times, the last group of data will be stored in 9<sup>th</sup> position and the first one will be erased. The second group will be moved into the 2<sup>nd</sup> position. Simultaneously, the position of other groups of data will be moved into one lower position.

**“Back/Print”** button has to be pressed and held to end the measurement and print out the memory data (if connected to a printer). If printing is completed, the original data will be erased automatically.

### 4.3 Backlight

LED backlight is used for poor light conditions. It can be turned on and off by pressing the  button. The present situation will be saved while the instrument is powered off. If there is no measurement and no key operation within 10 seconds, the backlight will be turned off automatically and the display unit will be shut off in 3 minutes.

### 4.4 System Reset

If the display unit isn't working properly or halts, the **“Reset”** button has to be pressed by inserting a slender rod into the reset hole on the backside of the display unit. Then the display will be shutdown. To reboot the system, the  button has to be pressed and held.

### 4.5 Automatic Shutdown

If there is no measurement and no key operation within 3 minutes, the display unit will automatically be switched off in order to save battery power. All the parameters will be stored before.

## 5. Printing Data

HMM Hardness Tester can be linked with a micro-computer on infrared base to print out the hardness test result report.

### 5.1 Printer Link

Picture 5-1








The infrared connection is used for display unit and printer: The printer has to be moved to the left side of the display unit. The printer infrared window has to be opposite to the infrared window of the display unit. The micro-printer and the display unit has to be turned on. Then the **“Back/Print”** button has to be pressed to print out the test report.

### 5.2 Test Report Format

A complete test report format is shown in picture 5-2.

Picture 5-2


```

-----
                    Test Report
-----
Impact Unit Type: D
Material : Steel&Caststeel
1  808 HLD  61.2 HRC
Date: 06/07/31 Time: 18:21:27
2  808 HLD  61.2 HRC
Date: 06/07/31 Time: 18:21:27
3  805 HLD  60.8 HRC
Date: 06/07/31 Time: 18:21:27
4  808 HLD  61.2 HRC
Date: 06/07/31 Time: 18:21:27
5  805 HLD  60.8 HRC
Date: 06/07/31 Time: 18:21:27
-----
s = 3  HLD  00.4 HRC
x̄ = 806 HLD  61.0 HRC
Printed: 06/07/31  18:21:27
-----
  
```

**Note: The date and time printed are the actual time, which means the report end date and time.**

## 6. Hardness Test

### 6.1 Test preparation

- 1) It has to be assured that the system connection is safe and reliable.
- 2) The  button has to be pressed to switch on the power. It has to be inspected if every setting of the display unit is correct, particularly material type and impact direction. It may cause a great error if the setting is not in accordance with the actual conditions.

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### 6.2 Sample Preparation

Inappropriate samples will cause great measurement errors. Therefore, preparation and the necessary handling should be done under original conditions of the sample.

Preparation of the sample and surface of test should be coincident with the following basic requirements:

1) Cold processing and thermal processing of the impact device during the process of sample surface preparation should be avoided.

2) The surface of the sample should be plane, with a metallic sheen, and not involve oxide layer or other stains.

3) Roughness of the test surface:  $Ra \leq 1.6$

4) The sample has to be of sufficient quality and rigidity. Otherwise displacements or shaking during the test might happen. These could also lead to measurement errors.

A sample quality of  $\geq 5$  kg can be directly tested. If the sample quality is 2~5 kg, it should be fixed before the test by appropriate clamps. If the sample quality is 0.05~2 kg, it should be coupled before the test; if it is  $< 0.05$  kg, this hardness tester is inappropriate to use.

Coupling method: The testing sample's back should be plane as well as the surface of the supporting object.

A little coupling substance (i.e. Industry Vaseline) has to be filled between the two components. Then the two parts have to be pressed together. If the weight of the supporting object is more than 5 kg, it can be replaced by the test block.

5) Samples should be thick enough with sufficient layered surface. If the D-type of impact sensor is used, the thickness of the sample should be less than 5 mm and the surface absorption layer (surface- hardening layer) should not be less than 0.8 mm. To perform accurate hardness measurements, the best way is to remove this layer before testing.

6) If the testing sample surface isn't horizontal and flat, the curvature radius of the testing and nearby surface should be larger than 30 mm. An appropriate supporting ring has to be selected and installed.

7) A sample should not be magnetic. The signal of the impact sensor would be seriously affected, which might cause inaccurate test results.

### 7. Test Steps

#### 1) Loading:

The loading tube has to be slid forward to load the impact device.



#### 2) Placing:

The impact device has to be placed and held on the surface of the test piece at the desired test point. Impact direction should be vertical with the surface being tested.



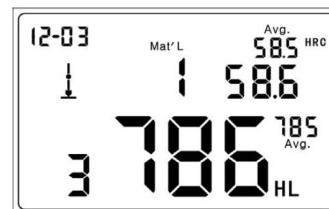
#### 3) Measuring:

The trigger button has to be pressed to trigger the impact device. The hardness value will be immediately displayed.



#### 4) Reading the test result

The test result has to be read as shown in picture 6-4:



Sample Material: steel and cast iron

Impact direction: downwards

Date: 3<sup>rd</sup>, December

Current hardness value: 786 HLD

The current measurement is the third point

Current mean value: 785 HLD

Conversions to HRC: 58.6 HRC

Mean value of HRC: 58.5 HRC

Repeating the above steps, tests in more points can be carried out.

**Note: Generally, each measurement location of sample is conducted for five tests. The X (difference of max. value and the min. value) values must be less than 15 HL. The distance between any two impact positions should be  $\geq 3$ mm; the distance between impact position and the edge of the sample should also be  $\geq 3$ mm.**

### 7. Troubles and solutions

No.	Trouble	Reasons	Solutions
1	No response switched	Lack power	Recharge battery
2	Keys no response	System halt	Reset
3	Abnormally high results	Steel ball wearing	Replace the Steel ball
4	No test results	Sensor cables loose	Re-linking
5	Printer no response	Printer cable loose	Re-linking

\* Other Trouble ,please contact with Polygon agencies or distributor.

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### 8. Maintenance and Service

#### 8.1 Impact Device maintenance

After 1000- 2000 times use, the impact device and the impact body should be cleaned with a nylon brush. The screw of the supporting ring has to be turned off before the catheter can be cleaned. Then the impact body has to be taken out and it has to be rotated into the tube with the nylon brush in anti-clockwise direction. The brush has to be pulled out when touching the bottom. This procedure has to be repeated several times. Then the impact body has to be loaded and the supporting ring reinstalled. The impact body should be released after use. The use of any lubricant is banned.

#### 9.2 Storage of the report

Printing paper is thermal paper and it should be preserved to avoid heat and direct light. If the print records are necessary to be kept in long-term conservation, they should be copied and preserved in time.

#### 8.3 Normal Maintenance procedures


If the error is larger than 12HLD by calibrating the hardness tester, the steel ball or the impact body has to be renewed. Those parts may be worn out and this may lead to failure in operation.

In case if any other abnormal phenomena occur to the Hardness Tester, it should not be either demolished or any fixed assembly parts may not be adjusted. Instead, the warranty card has to be completed and the Hardness Tester has to be sent to our Maintenance department.

We will care for a prompt checking and if necessary, repair of the device.

### Appendix 1 Daily Checking

The test block is mainly used to calibrate the Hardness Tester. The error and repeatability of it should be in the scope defined in following table:

Impact Device	Impact direction	Hardness of Test block (HL)	Error Allowed	Repeatability Allowed
D		750~830	±12HLD	12HLD
		490~570	±12HLD	12HLD

**Note:**

#### 1. Error=HLD-HLD

HLD is the mean value of 5 Leeb Hardness values measured on the test block.

HLD is the value marked on the test block.

#### 2. Repeatability= HLD<sub>max</sub>-HLD<sub>min</sub>

HLD<sub>max</sub> is the maximum value of 5 Leeb Hardness values measured on the test block.

HLD<sub>min</sub> is the minimum value of 5 Leeb Hardness values measured on the test block.

### Appendix 2 Factors affecting the Accuracy

Incorrect operation or improper testing conditions can seriously affect the accuracy. The following factors are the main accounts in lack of accuracy:

#### 1) Roughness of sample surface

When the impact body impacts on the sample, a small pit will arise on the surface of it. The less roughness, the less consumption of impact energy is needed. According to this, the roughness of the surface should be Ra≤ 1.6.

#### 2) The shape of the sample surface

Leeb testing principle demands that the velocity of rebound and impact are on the same line, because the impact body is moving in a metal tube. Of course, hardness can also be shown if the velocity of rebound and impact are not on the same line. In this case, the impact body would collide with the tube wall when it rebounds, which will affect the velocity of rebound. This will cause an error on test accuracy. If the radius of curvature of the sample surface is smaller, a suitable variant supporting circle has to be used. We can contribute to design and release those supporting circles, if needed.

#### 3) The weight of the sample

If the weight of the sample is more than or equal to 5 kg, testing can be directly started. If it is less than 5 kg, the sample needs a special charge. The supporting piece has to be coupled by a coupling medium and pressed onto the surface of the test piece. By doing this, better test results will be achieved.

The area of the testing points should be free of vibrations or shaking. If the weight of the sample is not enough, supporting, coupling and compressing must be increased to avoid jitter and sloshing. Shocks should be avoided.

#### 4) The sample stability

Any effective tests need to minimize possible interference from outside. This is very important for dynamic measurements, such as Leeb Hardness testing. Therefore, measurements are only allowed in a stable hardness testing system.

### Appendix 3 Measuring and Conversion Range

Materials	HV	HB	HRC	HRB	HSD	Tensile strength (MPa)
Steel & cast steel	83-976	140-651	19.8-68.5	59.6-99.6	26.4-99.5	375-2639
Cold work tool steel	80-900		21-67			
Stainless steel	85-802	85-655	20-62	47-102		
Cast iron		140-387				
Cast aluminum alloys		30-159				
Copper/zinc alloys (brass)		40-173		13.5-95.3		
CuAl/CuSn alloys (bronze)		60-290				
Wrought copper alloys, low alloyed		45-315				

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### Appendix 4 Material Code

Code	Material	Code	Material
01	Steel & Cast Steel	11	Low Carbon Steel
02	Alloy Tool Steel	12	Hi Carbon Steel
03	Stainless Steel	13	Chrome Steel
04	Grey Cast Iron	14	Cr-V Steel
05	Ductile Iron	15	Cr-Ni Steel
06	Cast Al Alloys	16	Cr-Mo Steel
07	Cu-Zn Alloys	17	Cr-Ni-Mo Steel
08	Cu-Sn Alloys	18	Cr-Mn-Mo Steel
09	Copper	19	Cr-Mn-Si Steel
10	Forging Steel	20	Hi Strength Steel

### DESIGNED IN REGARD TO THESE STANDARDS:

- ASTM A956
- DIN 50156

### 9. Declaration of Conformity



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#### Konformitätserklärung

Declaration of conformity for apparatus with CE mark  
 Konformitätserklärung für Geräte mit CE-Zeichen  
 Déclaration de conformité pour appareils portant la marque CE  
 Declaración de conformidad para aparatos con marca CE  
 Dichiarazione di conformità per apparecchi contrassegnati con la marcatura CE

**English:** We hereby declare that the product to which this declaration refers conforms with the following standards.

**Deutsch:** Wir erklären hiermit, dass das Produkt, auf das sich diese Erklärung bezieht, mit den nachstehenden Normen übereinstimmt.

**Français:** Nous déclarons avec cela responsabilité que le produit, auquel se rapporte la présente déclaration, est conforme aux normes citées ci-après.

**Español:** Manifestamos en la presente que el producto al que se refiere esta declaración está de acuerdo con las normas siguientes.

**Italiano:** Dichiariamo con ciò che il prodotto al quale la presente dichiarazione di conformità è conforme alle norme di seguito citate.

#### LEEB Hardness Tester: SAUTER HMM

Mark applied	EU Directive s	Standards
<b>CE</b>	2004/108/EC	EN61000-6-2 :2005 EN61000-6-4 :2007

Date: 07.01.2009

Signature: 

SAUTER GmbH  
 Management

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