

LAARMANN[®]

Innovators in Solids



PBM-1 PLANETARY BALL MILL USER MANUAL

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1 General Information / Introduction

1.1 Notes about Operating Instructions

- The copyright to these technical documents is the property of LAARMANN.
- These operating instructions are not to be reprinted or copied without the express approval of LAARMANN
- Please study these instructions carefully before operation
- All operators must be familiar with the contents of the operating instructions.
- Please observe all notes concerning your safety.
- The mill was designed with the user's safety in mind, however inherent risks cannot be excluded. Follow the advices in these instructions to avoid risks to users.
- The symbols in the right hand are also to be found on the instrument warning users of possible risks. Warning symbols are surrounded by a triangle.
- These operating instructions do not constitute a complete technical description.

They describe only the details required for safe operation and maintenance for usage under normal conditions.

1.1 Explanations of the signs at the instrument and in the operating instructions



This symbol indicates a potential risk and alerts you to proceed with caution.



This symbol indicates the presence of high voltage and warns the user to proceed with caution.



This symbol indicates the presence of risk of explosion and warns the user to proceed with caution.



This symbol indicates risks associated with hot surfaces.



Attention! inflammable substances



wear protective gloves!



wear ear protectors!



wear safety goggles!



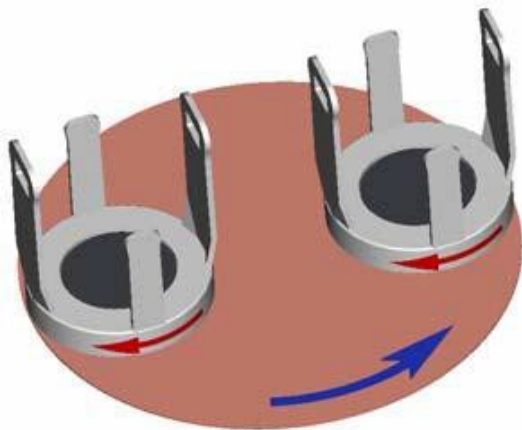
Do not step below lifted load!

1.3 Short Description of the Machine

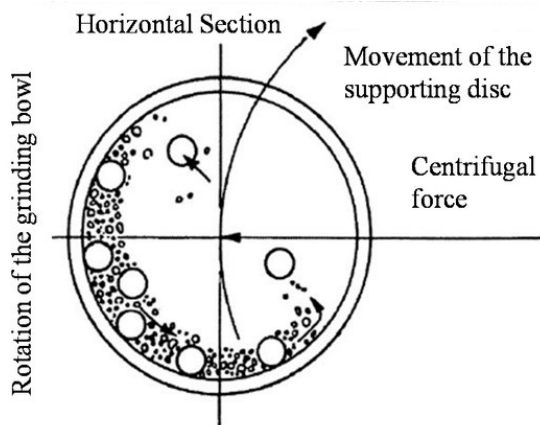
1.3.1 Applications

The LM PBM1 laboratory planetary mill is universally applicable for quick dry or wet grinding of inorganic and organic samples for analysis, quality control, materials testing and mechanical alloying. In synthesis, the LM PBM1 can be used for mixing and homogenization of dry samples of emulsions and of pastes.

1.3.2 Method of Operation



The material is crushed and torn apart in up to four grinding bowls by grinding balls. The grinding balls and the material in the grinding bowl are acted upon by the centrifugal forces due to the rotation of the grinding bowl about its own axis and due to the rotating supporting disc.



The grinding bowl and the supporting disc rotate in opposite directions, so that the centrifugal forces alternately act in the same and opposite directions. This results in, as a frictional effect, the grinding balls running along the inner wall of the bowl, and as an impact effect, the balls impacting against the opposite wall of the grinding bowl. The impact effect is enhanced by the grinding balls impacting against one another.

Loss-free grinding, even in the case of grinding of suspensions, is guaranteed by a hermetic seal between the grinding bowl and the cover.

1.3.3 Drive Motor and Speed Control

The machine is driven by a single-phase a.c. motor, which receives single-phase a.c. 230 V of variable frequency from a frequency converter.

1.4 Technical data

1.4.1 Dimensions

850 x 550 x 550

1.4.2 Weight

90 kg

1.4.3 Voltage

The machine can be operated in two voltage ranges:

- Single-phase voltage 230VAC \pm 10%.

1.4.4 Power consumption

The maximum power consumption is approx. :

- 175KW

1.4.5 Electrical fuses

Automatic circuit breaker at the rear of the machine: 10 A

1.4.6 Material

- Maximum feed size in the case of hard material approx. 10 mm
- Maximum feed quantity \pm 900 ml divided in 4 x 500 ml grinding bowls + grinding balls. Depending on the sample material.
- Achievable mean final fineness (depending on material) down to $d_{50} < 1 \mu\text{m}$

1.4.7 Final fineness

- Dry grinding down to $d_{50} < 20 \mu\text{m}$ (depending on material)
- Wet grinding down to $d_{50} < 1 \mu\text{m}$ (depending on material)

2 Operating safety

2.1 General Safety Instructions

- Read the operating instructions carefully before use.
- The instrument can only be used for the purpose described in section 1.3 Short Description of the Machine.
- Use only original accessories and original spare parts. Failure to do so may call into question the performance of the instrument.
- Do not use damaged accessories.
- The operators must be familiar with the contents of the operating instructions.

To this end, for example, the operating instructions must with the instrument.

- Do not remove labels.
- Protective devices must not be made unserviceable or removed.
- Wear protective gloves!

Grinding bowls may be very hot after grinding.

- Wear safety glasses
- Wet grinding may cause high pressure in the grinding bowl- Danger of squirting!
- Wear ear protectors - noise level up to 85dB(A).
- Don't run the instrument several hours without cooling phases - Danger of overheating.
- Behavior at all times must be such as to strictly preclude any accidents.
- When oxidizable materials such as metals, organic materials, wood, coal, plastic, etc. are ground or sieved, the risk of spontaneous ignition (dust explosion) exists whenever the fine particles exceed a specific percentage. While such materials are being ground, it is therefore necessary to take special safety precautions (e.g. wet grinding) and a specialist must supervise the work.
- Do not allow the instrument to run unsupervised. Due to the vibrations, under certain operating conditions, the machine may creep along the surface on which it is located or mounted.
- Suggestion: the machine had better to be used on the floor.



2.2 Operators

- No one other than authorized persons should operate the instrument and it must be serviced and repaired by trained specialists.
- No one suffering from medical problems or under the influence of medications, drugs, alcohol or overtiredness should be permitted to operate the instrument.

2.3 Protective devices

Protective devices should be used for the intended purpose and must not be made unserviceable or removed. All protective devices should be regularly checked for completeness and to ensure that they are functioning correctly.

See section 6 Maintenance.

The hood must be closed when the machine is started up.

The hood is locked:

- when the machine is disconnected from the mains supply
- during operation

Notice: The lid can be opened only when the drive of the mill has come to stop

2.3.1 Protective devices

The emergency release must not be operated while the machine is running! Disconnect the machine from the mains before using the emergency release. If this instruction is not observed, no guarantee or claims will be accepted for damages to the device or injuries to persons

1. Insert the attached triangular wrench (A) through the bore, and turn clockwise.
2. The closure hatch can now be opened after the spring-loaded lock at the front of the hood is opened.
3. The instrument can now not be switched on. If it is to be switched on, the safety lock must be activated by turning the triangular wrench anticlockwise, and the hood must be closed.

2.4 Danger points



- Danger of crushing when the hood is being closed.
- Danger of crushing at the grinding bowl holder.

2.5 Electrical safety

- No one other than authorized persons should operate the instrument and it must be serviced and repaired by trained specialists.
- No one suffering from medical problems or under the influence of medications, drugs, alcohol or overtiredness should be permitted to operate the instrument.

2.5.1 General

- when the machine is disconnected from the mains supply
- Switch off the main switch finish grinding (e.g. over night).

2.5.2 Protection against restarting

In the event of a mains failure during operation or after switching-off with the main switch, the hood will remain locked. When the mains voltage is restored, the lock of the hood will open. For safety reasons, however, the instrument will not start again.

2.5.3 Overload protection (see 7 troubleshooting checklist)

In the event of a mains failure during operation or after switching-off with the main switch, the hood will remain locked. When the mains voltage is restored, the lock of the hood will open. For safety reasons, however, the instrument will not start again.

3 Installation

3.1 Unpacking

- Unscrew and take away all the tapping screws, remove the all wood plates.
- Remove the five screws then Lift the machine off the transport pallet.
- Check that the items supplied correspond to your order.

3.2 Transport

Transport the mill on the transport pallet with a forklift truck or a hand fork lift truck

To carry the machine, grip it below the edge of the housing.



3.3 Erection

- Lift the instrument with the transport pallet.
- The instrument is attached to the transport pallet with 5 screws. Undo the screws.
- Lift the instrument off the transport pallet.
- Place the instrument on a level, stable surface, indoors. It is not necessary to fasten the instrument on the erection site. The instrument can also be mounted on a sturdy table.

It is inadvisable to operate the instrument while it is standing on the transport pallet.

- Ensure that there is good access to the instrument. There must be enough space to reach the main switch.
- Do not block the exit of air from the ventilator louver at the side. There is a danger of overheating if the louver is blocked.

3.4 Transport

Use the instrument only inside.

- The air must not contain any electrical conductive dust.
- The ambient temperature must be between 5 and 40°C.
- Height up to 2000m M.S.L.
- Maximum relative humidity of air 80% temperature up to 31C, linear decreasing down to 50% relative humidity of air at 40C

3.5 Erection

Before making the connection, compare the voltage and current values shown on the nameplate with the values of the mains supply to which the instrument is to be connected. Only a trained expert may change the connecting cable.

3.6 Erection

Switch on the machine only when all the work described in section 3 Installation has been done.

Switching On

1. Connect the machine to the mains supply.
2. Switch on the machine with the main switch at the rear.
3. Open the Lid.
4. If the grinding bowl holder or any wood are present, take them out. There should be nothing in the grinding bowl holder.
6. Close the Lid.

Switching Off

- Press STOP on the control panel.
- After a short period (after the mill has come to a stop), the hood is unlocked and can be opened.

4 General description

Notice:

Before starting the machine, ensure that the grinding bowl is correctly braced and there are no loose parts inside the device. There is a risk that loose grinding bowls or parts will be thrown out. If this instruction is not observed, no guarantee or claims will be accepted for damages to the device or injuries to persons.

Notice:

The grinding tools are subject to normal wear. Prior to each comminution the thickness of the grinding bowl wall is to be inspected. With severe wear the grinding bowl is to be changed. If not, the possibility exists that the grinding ball due to high centrifugal forces, which occur during the grinding, may strike through the grinding bowl wall, damaging the mill. We don't honor the warranty or accept complaints for instrument damage or personal injuries occurring when disregarding the above information.

4.1 Choice of grinding bowls and grinding balls

Notice: No warranty or claims shall be accepted in case of damages caused on account of using grinding bowls and grinding balls that are not original accessories of the appliance.

Material (bowl and balls)		desity
Agate	(99.9% SiO ₂)	2.65
Sintered corundum	(99.7% Al ₂ O ₃)	3.8
Zirconium dioxide	(95% ZrO ₂)	5.7
Stainless steel	Bowls: (17-19% Cr + 8-10% Ni) Balls: (12,5-14,5% Cr + 1% Ni)	7.8
Tempered steel	Bowls: (11-12% Cr)	7.9
Tungsten carbide	(93%WC+6% Co)	14.7

4.1.1 Choice of grinding bowls and grinding balls

The grinding bowls and grinding balls of zirconium dioxide are resistant to acids with the exception of hydrofluoric acid. Normally, grinding bowls and grinding balls of the same material should be chosen. Exception: Tungsten carbide balls may be combined with steel bowls. The size of the grinding bowls and grinding balls should be determined experimentally.

Material (bowl and balls)	desity
Hard samples feed particle size <10 mm	30 mm or 40 mm
Medium piece size (<5 mm)	20 mm
Fine material (0.5 mm)	10 mm or 5 mm
Homogenisation of dry or liquid samples	10 mm
Homogenisation of viscous samples	20 mm

These are just clues: the size of the grinding bowls and grinding balls should be determined experimentally if necessary.

Notice: We do not recommend mixing grinding balls with different diameters.

4.1.2 Choice of grinding bowls and grinding balls

A larger number of balls reduce the grinding time, and the grinding result will lie within a narrower grain bandwidth.

Ball Ø (mm)	Grinding bowl volume (ml)	80	250	500
5	Number of balls (piece)	250 - 300	1200 - 1300	2000 - 2500
10	Number of balls (piece)	30 - 35	50 - 150	100 - 250
15	Number of balls (piece)	10	45 - 50	70 - 100
20	Number of balls (piece)	5	15 - 20	25 - 35
30	Number of balls (piece)		5 - 6	10
40	Number of balls (piece)			4

These values are just clues: the number of balls should be determined experimentally if necessary. For Ø 30 and Ø 40 mm balls, please keep the machine under observation during operation. Because of the vibrations, there is a danger of the machine creeping.

4.1.3 Calculated ball weight

A larger number of balls reduce the grinding time, and the grinding result will lie within a narrower grain bandwidth.

Ball diameter in mm		5	10	15	20	30	40
Material	Desity in g/cm ³	Calculated ball weight in g					
Agate	2,65	0,17	1,39	4,68	11,10	37,46	88,80
Sintered corundum	3,8	0,25	1,99	6,72	15,92	53,72	127,34
Zirconium oxide	5,7	0,37	2,98	10,07	23,88	80,58	191,01
Tempered steel	7,9	0,52	4,14	13,96	33,09	111,68	264,73
Hardmetal	14,7	0,96	7,70	25,98	61,58	207,82	492,60

To calculate the weight of the required balls, the “calculated ball weight” is multiplied by the “number” of balls needed.

Example: A 250 ml agate bowl must be filled with 1221 agate balls of 5 mm diameter.

Calculation: $0.17 \text{ g} * 1221 \text{ balls} = 207.57\text{g}$

207.57g of grinding balls can be weighed out and placed in the grinding bowl; this saves the time required for counting out the balls.

4.2 Filling the grinding bowl

Grinding mill	Min. filling	Max. filling
500ml	80ml	250 -300
250ml	30ml	125ml
80ml	1ml	30ml

Filling = material to be ground

It is imperative that the following sequence be observed:

1. Place the grinding balls in the empty bowl.
2. Fill the material to be ground on the balls.

Notice: Never use the mill without sample material , Danger of badly damage of the grinding balls and bowl.

4.3 Influencing quantities during grinding

Running time (grinding time)

A longer grinding time will increase the fine fraction.

Speed: a higher speed will reduce the grinding time and increase the fine fraction.

Reversing operation (regular reversal of the direction of rotation)

- useful for mechanical alloying
- improves homogenizing of the material

Number and size of the balls

Pre-grinding coarse, hard material with large balls: small fine fraction.

Use of many small balls will increase the fine fraction if the running time is increased.

Mass of the balls (type of material)

A higher mass (density) of the grinding balls will accelerate the grinding. (see the table in section 4.1)

4.3.1 Dry grinding

Below a particle size of approx. 20 μm , surface forces predominate and the material will start to "stick". Further dry grinding can be achieved if surface-active substances are added to the material. Examples (maximum quantity to be added in % by mass)

- Stearic acid 2-3%
- Aerosol (micro dispersed silicic acid) 0.5-2%
- Silica sand ~ 2%
- Glass powder ~ 2%



4.3.2 Wet grinding (grinding in suspension)

When grinding in suspension, you can add auxiliary substances in liquid form with a high boiling point and low vapor pressure. Flammable liquids such as ketones and petroleum spirits with a boiling point $<120^{\circ}\text{C}$ should not be used.

4.4 Clamping the grinding bowls

4.4.1 Clamping with the "safe lock" holder

The following tests should be performed before the grinding bowls are clamped in the machine before each grinding operation:

- Is the black rubber disk inserted in the bowl holder (Check before first run)
- Check the rubber disc in the bowl holder for damage.

Replace rubber discs that are flattened.

- The Viton seal (for sealing between the lid and the bowl) must not be damaged or dirty.

Replace severely deformed flat Viton seals.

- The surfaces of the lid and of the bowl on which the flat Viton seal rests must be clean.

Clamping

- Place the grinding bowl on the grinding platform;(Note: there are four location hole on the grinding bowl corresponding to four cylinders on the platform)
- Place safe lock device to the suitable location on the lock strip
- Screwed the lock-handle on the top of the safe lock device clockwise ;
- Screwed the anti-looseness-handle on the below of the safe lock device clockwise
- Use the weights to ease the grinding process

After a few minutes of grinding, and in the cooling phases, check that the clamping is secure.



4.5 Mass balance

Notice: Symmetrical charging

For weight balancing, always clamp a grinding bowl of the same weight with a cover and sealing ring in the opposite pot mounting.

As a temporary solution, use an empty bowl as a counterweight.

4.6 Grinding time

In accordance with the application, the grinding time should be adapted to the heating of the bowl.

There is a max. temperature of 150°C allowed for the grinding bowls. This temperature determines the grinding time. The grinding time that does not exceed this temperature depends on the sample material, the balls and the speeds. For this reason the grinding



In the case of grinding at high speeds and with large bowls, the grinding time should not exceed 1 hour. Then allow cooling for 0.5 to 1 hour.

Pay attention to the heating of the material; in the case of extended running times, if necessary set a break time for cooling.

To reduce the grinding time, choose grinding balls of a higher density.

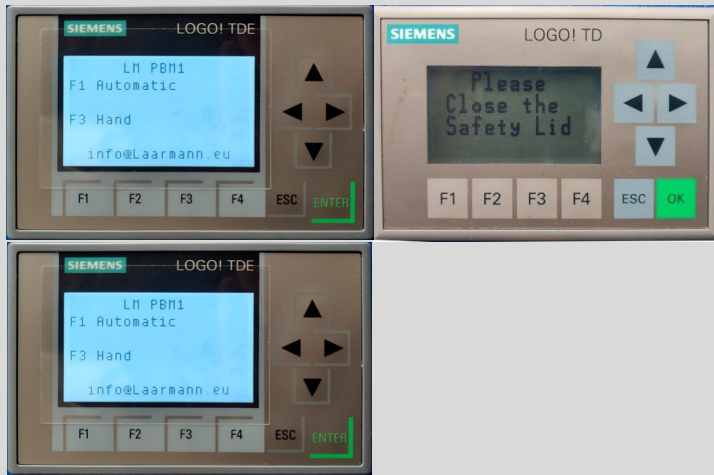
Before switching on again after a cooling phase, check that the clamping is secure.

In the case of operation for mixing and homogenization at low speeds, the mill may run for several hours without harm being done.

4.7 Control panel

- Switch on the main switch at the rear of the machine
- Press F4 to proceed to the next step
- If the lid is open you will have to close it first else you won't be able to run the machine for safety
- You will have to option between Automatic and Hand. Explanation will follow below

4.7 Operating the machine



- Switch on the main switch at the rear of the machine.
- Press F4 to proceed to the next step
- If the lid is open you will have to close it first else you won't be able to run the machine for safety
- You will have to choose between Automatic and Hand. Explanation will follow below

4.7.1 Manual run



Press F3 open the Manual control screen

With this function you can easily start running the machine while holding F1 you can adjust the rotating speed with the turning wheel below the display. To switch to automatic press F4.

4.7.2 Set up automatic



Press F1 to start Automatic from the starting menu.

From here you can set up the time for the automatic run. It will start off with days if you want a lower time set up simply press F1 for the next option. Next will be hours and it will go down to seconds. Press F3 and F4 to increase and decrease the time. You can start the program by pressing F3 and the last step.

Increase the rotating speed with the wheel

After a few seconds while the program is running the remaining time will show in the display

4.7.2 Closing the lid

The lid has to be closed when running the program and cannot be opened while the program is running for safety regulations.

4.7.3 Emergency to stop

Pressing the emergency stop button will immediately stop the program

4.8 Cooling the grinding bowls

- with the Lid open
- at the programmed break times with the hood closed (locked) and the ventilator running.



4.6 Grinding time

Important. Load the mill symmetrically! See section 4.5 Mass Balance

For grinding under protective gas, the same conditions apply for the selection of the grinding set and grinding balls.

Two valves are screwed onto the gas lid. Before switching on the laboratory planetary mill, you can introduce protective gas, e.g. nitrogen, through these. A Viton flat seal is used instead of the Teflon flat seal.

4.7 Control panel

- Fill the grinding bowl with grinding balls and the material to be ground.
- Put on the lid with seal (use Viton seal).
- Insert the grinding bowl in the grinding bowl holder.
- Clamp the grinding bowl
- Connect the gas hose to an insert gas supply with the aid of the attached hose clip.
- Screw the de-airing fitting onto one of the two valves.
- Fit the coupling of the gas hose onto the free valve.

4.7 Control panel

- Slowly open the inert gas feed.
- Press on the top of the de-airing fitting so that the air can escape from the grinding bowl.
- The inert gas will now flush the air out of the grinding bowl.
- The flushing period must be determined experimentally; the flushing period is dependent on, inter alia, the grinding bowl size, the filling and the gas feed.
- To end the flushing, close the inert gas feed and release the de-airing fitting.
- Unscrew the de-airing fitting.

Notice: Switch the machine on only when both the coupling and the de-airing fitting have been removed.

Excess pressure can occur during grinding.

4.8 Mass balance

- After grinding, screw on the de-airing fitting.
- For pressure equalization, carefully press on the de-airing fitting.
- Release the grinding bowl clamping only after de-airing.

Notice: Either valve can be used for airing and de-airing. The black, soft sealing made of Viton are temperature stable up to 200C. The valves are temperature stable up to 180C for one hour max.

5 Cleaning

5.1 Grinding accessories

- Clean the grinding jar and grinding balls after each use:
e.g. brush them clean under running water with usual cleaning agents.
- Fill the grinding bowl with grinding balls and some sand and water half-full and run the LMPBM-1 for 2 to 3 minutes (with the grinding bowl correctly clamped in position).
- Cleaning in the ultrasonic bath is permissible.
- When sterilizing the grinding bowl and grinding balls in the drying chamber, heat only to 250°C.

Do not heat agate grinding parts above 110°C. Cool them slowly and carefully. Agate parts must never be heated in the microwave (they heat up too rapidly).

They must never be subjected to temperature shocks, such shocks may destroy the parts They burst apart explosively.

5.2 Mill

- When switched off, the mill can be wiped down with a damp cloth.

Notice: Do not allow any liquids to seep into the machine.

5.2 Adding grease

Unscrew the small plate at the back of the machine. From here you can reach the machine and adding grease to it



Before commencing maintenance work, disconnect the mains plug and secure the machine against being switched on again unintentionally.

When maintenance work is being performed, this should be indicated with a warning sign.

Functional part	Task / description	Test	Maintenance interval
Safety lock	Locking the lid	Is the closed hood held shut when the main switch is off? If this test fails, you must not continue to work before the error is corrected	Before each use
Rotating bearings	Permanent lubrication	Bearing play	Every 2000 hours or annually
Drive motor	Permanent lubrication	Bearing play	Every 4000 hours or annually
V-belt	Motor planet disc	Check the tension disconnect the mains plug, unscrew the upper plate at the back; the belt should not yield by more than approx. 10 mm under thumb pressure.	1 x annually
Fan, vent duct	Cooling the grinding chamber and electronics	Operation; clean when dirty	2 x annually
Grinding bowl holder and clamping „safelock“	Rubber disk of the pressure piece and rubber disk in the grinding bowl holder	Signs of use; when it has been pressed flat and is thus non-elastic, replace it	Every 1000
Steel grinding bowl	Grinding bowl lid seal	If dirt presses in the sealing, replace it	Every 100 hours

- Regular cleaning is the most important part of maintenance.

7 Troubleshooting Checklist

Malfunction	Possible cause	Elimination of error
POWER SUPPLY display not illuminated	Locking the lid	Plug in mains plug
	Main switch	Switch on the main switch
	Fuses break at the rear of the machine	Replace fuses
START button pressed but mill does not start	If POWER SUPPLY display not illuminated check see above	See above
	Break time active	Wait for break to or press stop
	Rubber disk of the pressure piece and rubber disk in the grinding bowl holder	See section 2.3 Protective Devices
Mill stops	Overheating of the drive motor	Let the mill cool down and select lower speed Turn off the switch and then turn on
	Drive is obstructed	Eliminate trouble in grinding chamber
	V-belt loosen or broken	Check or change v-belt
hood cannot be opened	Not connected to Main switch	Fuses break at the rear of the machine
	Fuses break at the rear of the machine	Replace fuses
Material escapes	Holder loose	Check
	Sealing ring defective or dirty	Replace or clean the sealing ring

7 Warranty

The warranty card enclosed with the machine upon delivery must be completely filled out and returned to the delivering factory so that the warranty can enter into effect.

Online registration is also possible. More information can be found on your warranty card or on our website www.laarmann.eu
The company LAARMANN or the corresponding national representatives would be happy to provide you with advice and assistance.

Please include the serial number given on the type plate along with any question

The warranty term for one year. No warranty is given for parts subject to wear and tear



Planetary ball mill

Type PBM-1

Product	Planetary ball mill
Model	PBM-1
Power supply	230V/50Hz

This declaration of conformity confirms compliance of the above mentioned equipment to the relevant sections of the following European Directives:

91/368EWG	European machine guideline
73/23/EWG	EC Low Voltage Guidelines
EN 292, 294, 418	Safety guidelines
VBG 1,4,5 en 22	General electrical facilities
89/336/EEC	Electromagnetic Compatibility Directive (EMC)
EN 5008-1-1992	Emissions
EN 50082-1-1992	Immunity
EN 60204-1 Part 1	Safety of Machinery – Electrical Equipment of Machines

WARNING:

This equipment is required to be operated strictly in accordance with the instructions given in the operating manual supplied with the product. All supply voltages and frequencies as stated on the rating plate must be used. External power cables and connectors must be supplied by LAARMANN. Any additional equipment used must be of a type approved by LAARMANN.

This conformity certificate will lose its validity in case of:

- Usage of unlicensed spares
- Usage of unlicensed accessories
- Any self made modifications of the machine