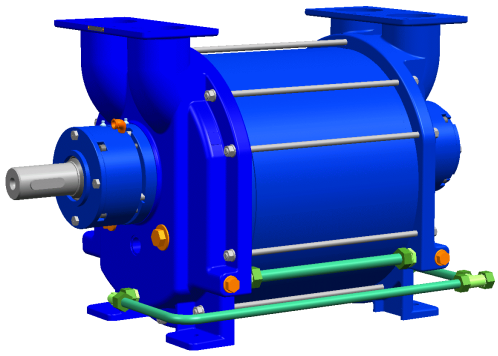
# SL B 2100 / 2700 / 3100

**Vacuum pumps for waste disposal vehicles**



# Translation of the original instructions



**Note:** This pump and/or this pump package must be installed and operated only by qualified technical personnel. In addition, these operating instructions and the associated site and legal requirements must be strictly observed. If you these operating instructions are not followed,

- **danger** may result for you and/or your colleagues,
- **the pump** or **the pump package** may be **damaged**,
- **the manufacturer is not liable** for damage resulting from failure to observe these instructions.

These operating instructions are valid for pumps in standard executions including their application in explosive areas corresponding to Category 2. For use in Category 1 applications the operating instructions Ex 1G/2G must, in addition, be observed.

**Please be aware of your responsibility for your fellow men when working at the pump or the pump unit!**


Document No. ..... : **BA 27729_EN_02**
File ..... : VFSL3de-b.doc
Date ..... : 15.06.2010



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## 1.0 Safety

This operating manual gives basic instructions which are to be observed during installation, operation and maintenance of the pump. It is therefore imperative that this manual is read by the responsible personnel/operator prior to assembly and commissioning. It must always be kept available at the installation site.
Not only the general safety instructions contained in this chapter “Safety” must be observed, but also the specific information provided under the other chapters.

## 1.1 Identification of safety notices in the operating instructions

Safety notices given in these operating instructions, non compliance with which would affect safety, are identified by the following symbol

Danger symbol as per DIN 4844-W9
(ISO 3864 - B.3.1)

or in case of danger of electric shock with the symbol:

Danger symbol as per DIN 4844 W-8
(ISO 3864 - B.3.6)

The word

**ATTENTION**

identifies those safety notices where non compliance may cause danger for the unit and also its function. It is imperative that signs affixed to the machine, e.g.

- arrow indicating the direction of rotation
- symbols indicating fluid connections
- type plate

are observed and kept legible.

## 1.2 Qualification and training of personnel

The personnel responsible for operation, maintenance, inspection and assembly must be adequately qualified. The scope of responsibility of, and supervision of, the personnel must be defined precisely by the plant operator. If staff do not have the necessary knowledge, they must be trained and instructed. This may be performed by the machine manufacturer or supplier on behalf of the plant operator. Moreover, the plant operator must ensure that the contents of the operating instructions are fully understood.

## 1.3 Hazards in case of non compliance with the safety instructions

Non compliance with the safety instructions may cause risk to the personnel as well as to the environment and the unit and result in a loss of any right to claim damages.
For example non compliance may involve the following hazards:

- failure of important functions of the unit
- failure of specified procedures of maintenance and repair
- exposure of people to electrical, mechanical and chemical hazards
- endangering the environment owing to hazardous substances being released.

## 1.4 Compliance with regulations relating to safety at work

When operating the pump the safety instructions contained in this manual, the relevant national accident prevention regulations and any other service and safety instructions issued by the plant operator, must be observed.

## 1.5 Safety instructions relevant for operation

- If hot or cold components of the unit involve hazards, they must be guarded by the user against accidental contact.
- Guards for moving parts (e.g. couplings) must not be removed from the machine while in operation.
- Any leakage of hazardous (e.g. explosive, toxic, hot) fluids (e.g. from the shaft seal) must be drained away so as to prevent any risk occurring to persons or the environment. Statutory regulations are to be complied with.
- Hazards resulting from electricity are to be eliminated by the user (see for example the VDE-specifications and the bye-laws of the local power supply utilities).

## 1.6 Safety instructions relevant for maintenance, inspection and assembly work

It is the plant operator's responsibility to ensure that all maintenance, inspection and assembly work is performed by authorised personnel who have adequately familiarised themselves with the subject matter by studying this manual in detail.

Any work on the machine must only be performed when it is at a standstill. It is imperative that the procedure for shutting down the machine described in this manual is followed.

Pumps and pump units which convey hazardous media must be decontaminated.

On completion of work all safety and protective measures must be re-installed and made operative again. Prior to restarting the machine, the instructions listed under „first commissioning" must be observed.

## 1.7 Safety instructions for use in areas with explosion hazard

In this paragraph information is given for operation in areas with explosion hazards.

### 1.7.1 Packaged unit/System

If the pump is combined with other mechanical or electrical components to form a package/system, the complete unit may be considered as meeting the requirements of directive 94/9/EC only if each component individually meets these requirements.

**Note:**

This guideline has particular significance when using pumps which correspond to a machine category in the directive 94/9/EC, but are driven by a motor which does not meet this directive. Thus it may be that the pump has been provided with the EX-label but the unit must not be used in areas with explosion hazard because the motor has not been certified for use in these areas. Thus the operator must always pay attention to compliance of all the components used in the package with the directive 94/9/EC.

### 1.7.2 Types of coupling guards for shaft couplings

Coupling guards which are to be used in areas with explosion hazard must fulfill the following criteria:

- non- sparking material e.g. brass must be used or
- sheet steel fabrications must be used, designed in such as way that potential damage (e.g. deformation by stepping on the coupling guard) will not cause contact between the rotating parts and the coupling guard.

### 1.7.3 Pump Monitoring

When using pumps in areas with explosion hazards the operator must check regularly for the following:

- leakage at the shaft seals
- if necessary, bearing temperatures
- liquid level in the pump during commissioning
- for pumps with magnetic coupling, the temperature of the electrically conductive shroud should be monitored.

The operator must ensure that the pump, under abnormal conditions is taken out of operation and not restarted until normal operating conditions are re-established. The instructions regarding operation and maintenance given in this operation manual must be observed.

Specific information regarding the surface temperatures of the pump are given in chapter 9 of this operation manual.

### 1.7.4 Avoiding sparks caused by the effect of external impact

The operator must ensure that when operating the pump in areas where there is an explosion hazard, no external impact on the pump casing can cause sparks.

### 1.7.5 Electric Equi - Potential

The operator must ensure that where the unit is used in an explosion hazard area, that potential for static discharges is eliminated by ensuring an equi – potential.

Hence, all metal parts of the pump package must, where appropriate be linked through electrically conducting cables and with the process plant/unit using e.g. earthing cables. The insulating effects of paint coatings must also be considered.

## 1.8 Unauthorised alterations and production of spare parts

Any unauthorized modification of the unit will result in absolving Sterling SIHI of any liability. In such cases the operator of the machine assumes responsibility for safe operation of the unit.

Using spare parts and accessories authorised by the manufacturer is in the interests of safety. Use of other parts may absolve the manufacturer of any liability.

## 1.9 Unauthorised methods of operation

The reliability of the machine supplied will only be guaranteed if it is used in the manner intended and in accordance with the instructions of this manual. The specified operational limits must not be exceeded in any circumstances.

## 1.10 Warranty / guarantee

Sterling SIHI guarantee longterm, satisfactory operation if:

- the pump is installed and operated in compliance with these instructions and under conditions approved by Sterling SIHI.
- no modifications are undertaken without Sterling SIHI's written agreement.

## 2.0 Application

Liquid ring vacuum pumps and compressors are used to transfer and compress gases and vapours. These pumps can also handle small quantities of liquid e.g. as liquid “carry-over”.

The pump must only be used under the operating conditions set out by the customer and confirmed by the supplier. The guarantee terms and conditions are as set out in our general terms and conditions of sale.

## 2.1 Misuse warning

The pump must only be used for the approved operating conditions. Otherwise it may be dangerous for people and/or the environment.

## 2.2 Construction and mode of operation

The pump operates according to the liquid ring principle. The vane wheel impeller is arranged eccentrically in the circular pump casing. It transfers kinetic energy to a liquid ring that forms concentric to the casing when starting the pump. This arrangement causes the liquid to leave and to enter individual vane wheel impeller cells with similar effects to a piston. Where the liquid leaves the cell of the impeller it draws in the gas to be evacuated through the suction opening in the guide disc. Conversely, where the liquid ring enters the vane wheel impeller cells the gas is compressed and pushed out via a discharge port.

During operation the pump must continuously be supplied with service liquid, normally water. This liquid serves to eliminate the heat resulting from the gas compression, which is largely taken up by the liquid ring, and also to replenish the liquid ring, because a portion of the liquid ring escapes with the gas. This liquid can be recycled to be used as service liquid.

## 2.3 Operating limits

**ATTENTION**

The pump operating limits must be observed.

These are set out in chapter 9:

- Max. temperature of the medium handled
- Max. temperature, max. viscosity and max. density of service liquid
- Max. permissible discharge pressure and max. permissible pressure difference
- Max. speed

For use in Ex areas, the additional limits set out in chapter 9.5 or 9.6 (explosion protection) must also be observed.

**ATTENTION**

Avoid the following conditions when using the liquid ring vacuum pump:

- Combining several operating limits
- Switching the pump on and off frequently (max. 5 - 10 per hour)
- Significant pressure increases of the gas
- Significant temperature increases of either the gas or of the service liquid
- Entrainment of larger surge liquid flows

## 2.4 Accessories

The accessories included in the scope of supply are indicated in the annex. The corresponding operating and installation instructions can also be found in the annex.

Before installing other accessories on the pump or to the pump unit, please contact the manufacturer.

# 3.0 Planning the installation

## 3.1 Pump construction, method of operation

The construction of the pump and the selection of the method of operation depend primarily on the duty requirements. Typical methods of operation are described in the following sections.

The figures in this section are schematic drawings. The dimensions of the pump and the exact position of the connections are indicated in the dimensions table (see annex).

### 3.1.1 Circulating liquid operation

This method of operation is recommended for:

- Service liquids that due to their properties must neither leave the process circuit nor come into contact with the cooling liquid (e.g. when using oil, alkali or acid as service liquid).
- Waste water systems that must not be contaminated by the service liquid or by the gas dissolved in it etc.

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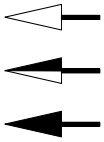
### 3.1.2 Construction for elimination vehicles

**Designations in the illustrations:**

| | |
|---|---|
| 1 | Water ring vacuum pump |
| 2 | Separator tank |
| 3 | Water / air cooler |
| 4 | Circulating pump |
| 5 | Non-return valve |
| 6 | Dirt drain |
| 7 | Liquid level |
| 8 | Water deficiency switch |
| 9 | Drain |
| 10 | Suction tank |
| 11 | Strainer |
| 12 | Ball type non-return valve (buoyant ball) |
| 13 | Four-way valve |
| 14 | Safety valve |
| 15 | Vacuum limiting valve |
| 16 | Vent cock |
| 17 | Non-return valve |
| 18 | Sound absorber |



Gas flow

Gas / liquid flow

Liquid flow

| | |
|---|---|
| $u_{sp}$ | Purge liquid connection |
| $u_B$ | Service liquid connection |
| $u_e$ | Drain |
| $u_{se}$ | Dirt drain |
| $u_v$ | Evaporation cooling |

The figures in this section are schematic drawings. The dimensions of the pump and the exact position of the connections are indicated in the dimensions table in the annex.

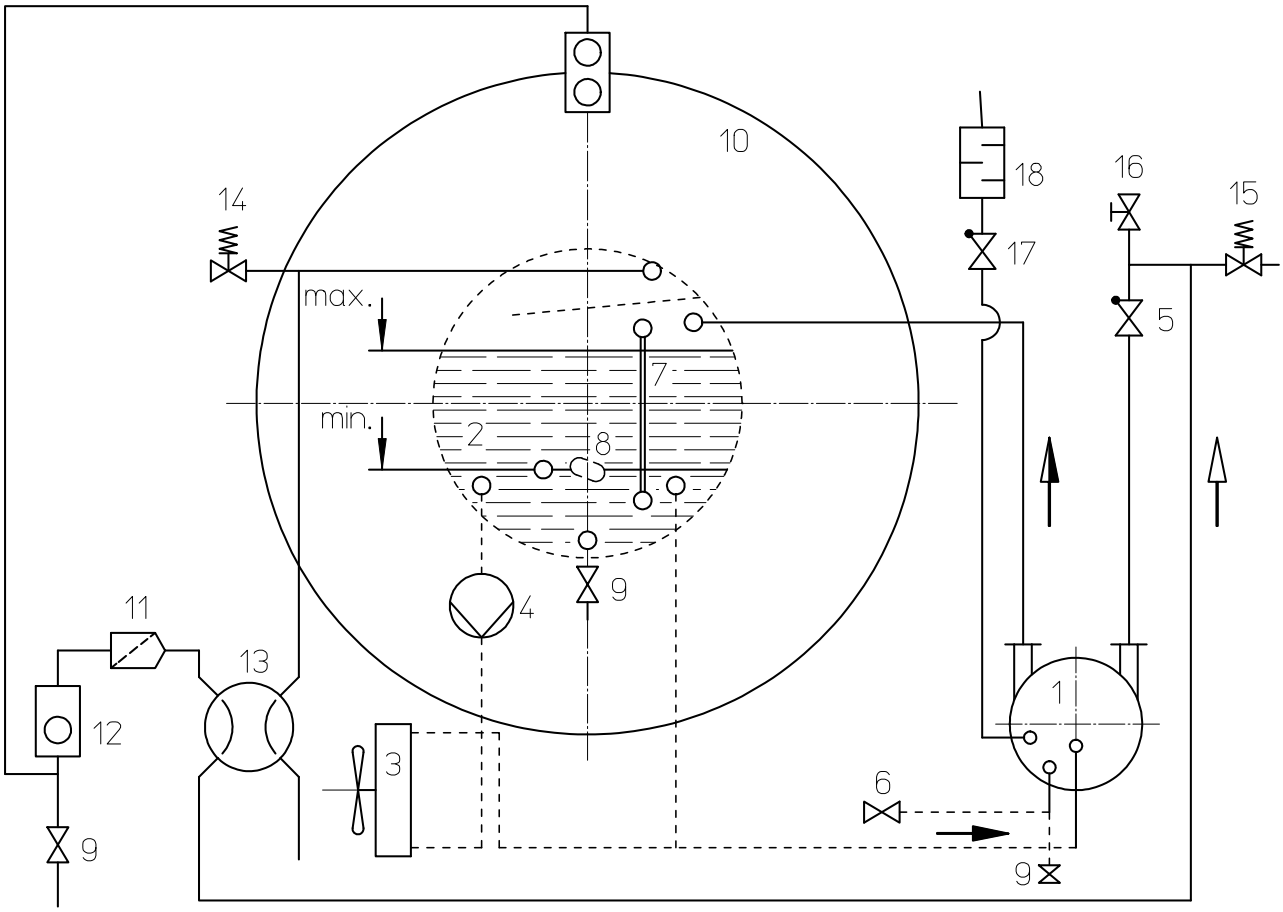



Illustration 3.1: Wiring scheme with fixed suction tank

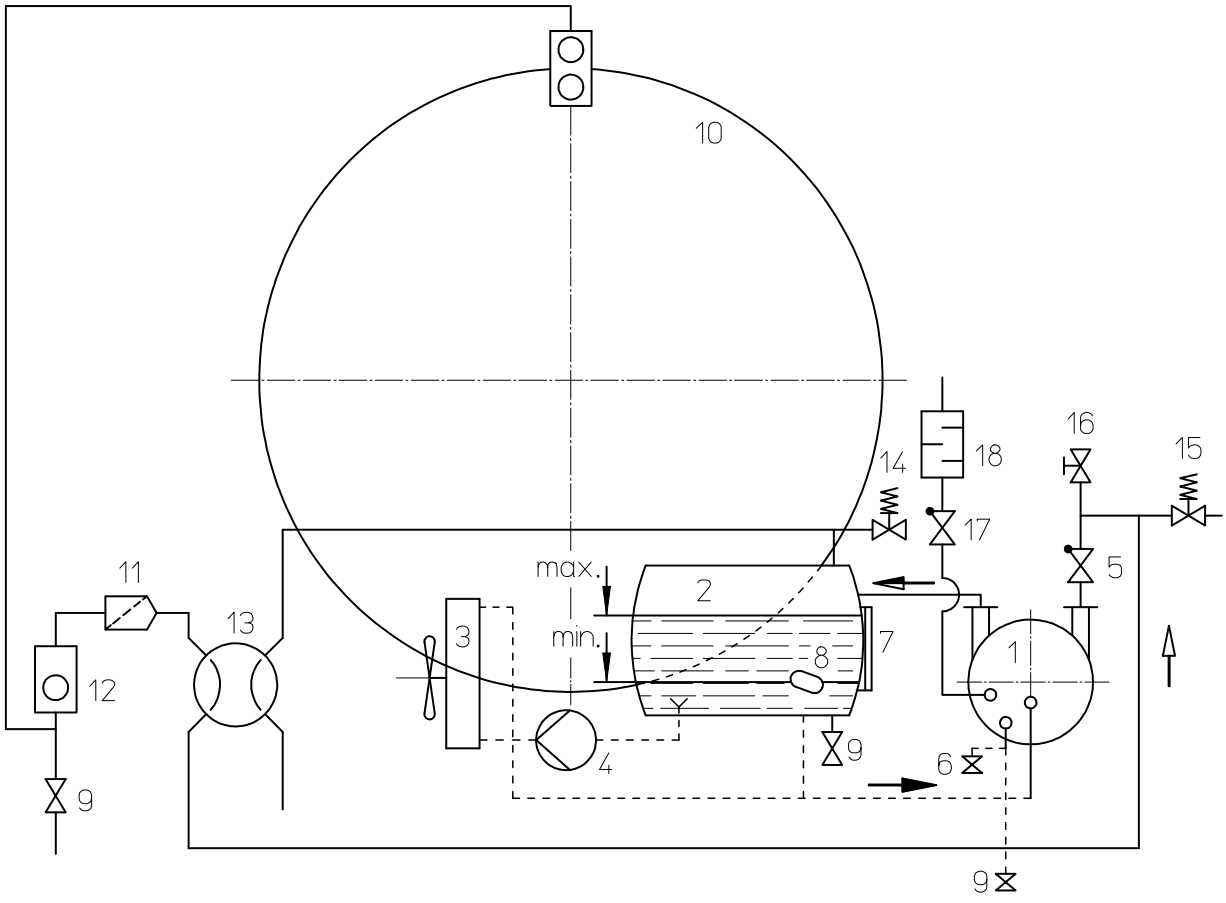



Illustration 3.2: Wiring scheme with suction tank

The service liquid consists of the circulating liquid that is cooled to the required operating temperature in the heat exchanger (water / air cooler 3). The heat exchanger must be selected so that it is able to extract completely the power produced by the drive and the heat of condensation to be occurred.
The liquid pump (4) shown in the bypass line is necessary if the vacuum pump runs without a significant pressure difference between suction- and discharge branch or, if the flow resistance of the heat exchanger exceeds approx. 0.2 bar.
The heat exchanger can be omitted if the pump runs for only few minutes and the liquid can cool down to around ambient temperature before the next start-up.

### 3.1.3 Evaporation Cooling

The connection of the evaporation cooling enables an installation of the liquid ring vacuum pump on the vehicle without an additional cooler in the operating water cycle.
Beyond the connections $u_v$ atmospheric air is supplied to the pump.

**ATTENTION**

The line for the evaporation cooling has to be realized without cross section reductions.
If these two lines $u_v$ (drive side and non-driving side) are united, then the common line has to be dimensioned more largely correspondingly.

To avoid liquid run out during compressor operation, the installation of a non return valve is recommended. Depending on the truck configuration a sound absorber can be required on the evaporation cooling pipe inlet.

The liquid ring vacuum pump can also be operated,
- if the evaporation cooling is not connected or
- if the valves are closed in the line of the evaporation cooling.

Then a stronger heating of the operating water arises.

The liquid level in the separator has to be checked regularly. If necessary, water has to be refilled.

## 3.2 Pump, pipework connections

**ATTENTION**

- Take note of the arrows indicating flow direction.
- The nominal diameters of the pipework must not be smaller than the nominal diameters of the corresponding pump branches (see annex).
- All pipework must be cleaned prior to installation of the pump.
- The pipework must be supported in order to avoid damage to pump components (danger of breaking the pump components, loosening of the tube connections due to the gas forces).
- The suction, discharge and service liquid lines must be as short as possible and their cross section must be at least as large as the corresponding pump connections. For long lengths of pipework larger cross sections are required.

### 3.2.1 Position of the pump

The pump must be installed horizontally, suction and discharge branch must point vertically upwards. A slight incline (max. 10°) of the pump is admissible .

### 3.2.2 Suction line

A non-return valve (5) should be installed in the suction line. For that purpose the non-return valves, type XCk from Sterling SIHI have proved effective because of their low pressure loss.
The venting of the pump, for example during starting-up and stopping, is possible by means of a vent cock (16). This must be installed in the suction line.
In order to avoid cavitation and to ensure the boiler pressure is not fallen below in the vacuum range a vacuum limiting valve (15) can be used.

### 3.2.3 Discharge line

The discharge line must not be led more than 2 m vertically or diagonally upwards. If a shut-off element is installed in the discharge line behind the liquid separator, it must be ensured that the pump cannot be put into operation while this shut-off element is closed.

### 3.2.4 Operation with minimal pressure difference

If a pump is run for a long period without a significant pressure difference (less than 0.2 bar), e.g. to evacuate a large tank, an orifice plate must be installed in the suction line. Alternatively a liquid pump (4) can be installed in the service liquid line as well.

### 3.2.5 Shaft seal

The sealing of the shaft is made by grease chambers closed by shaft seal rings with one gland ring each pre-arranged towards the pump.

**ATTENTION**

The shaft seal must be provided with a gas purge. For this the suction connection ($u_{sp}$ below) must be connected to the suction line (if this connection is carried out with a transparent hose, the leakage is getting visible). The gas feed connection ($u_{sp}$ above) must be opened towards the atmosphere or must be connected to the discharge side (liquid separator) respectively that no liquid can be primed. If necessary, non-return valves must be used in order that no service liquid can enter into the shaft seal.
Should the purge of the shaft seal not be used, it must be ensured that leakage maybe can occur ($u_{sp}$ below) and the sealing chamber is sufficiently ventilated ($u_{sp}$ above).

## 3.3 Drive of the pump

For the drive a lateral drive of the suction vehicle is provided.

## 3.4 Liquid separator

A part of the service liquid leaves the pump together with the compressed gas. In the liquid separator gas and liquid are separated.

## 3.5 V – Belt Operation

The preferred method of drive for the load on both the pump shaft and on its bearings is direct drive. In case of large vacuum pumps it is recommendable to use a gearing between motor and pump. If a V-belt drive is to be used, the motor should be arranged as follows:

– Pump with clockwise rotating shaft (fig. 3.3):
  Motor adjacent to and on the right side of the pump
– Pump with anticlockwise rotating shaft:
  Motor adjacent to and on the left side of the pump

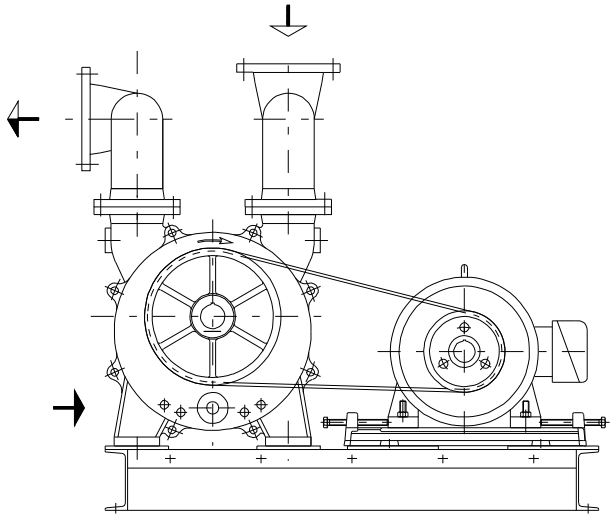


fig. 3.3 Pump with clockwise rotating shaft

**ATTENTION**

The minimum permitted diameter of the pulley is set out in chapter 9.2.

In Ex- areas, electrically conducting pulleys must be used (< $10^6$ Ω). The halves of the sheave must be electrically connected to ensure that they are at the same potential.

## 3.7 Explosion protection

In accordance with the Directive 94/9/EG, all components of a package for use in explosive areas must comply with the required equipment category.

In this connection it is important to distinguish between the location of the pump and the internal environment of the pump.

### 3.7.1 Location

Pump location corresponds to Category 2.

### 3.7.2 Internal environment of the pump

**Requirements:**

If it is required that the internal parts of the pump conform to Category 2, then the following additional requirements must be considered at the planning stage of the installation.

Category 1 for the pump internals :

For applications requiring Category 1, the operating instructions Ex 1G/2G must, in addition, be adhered to.

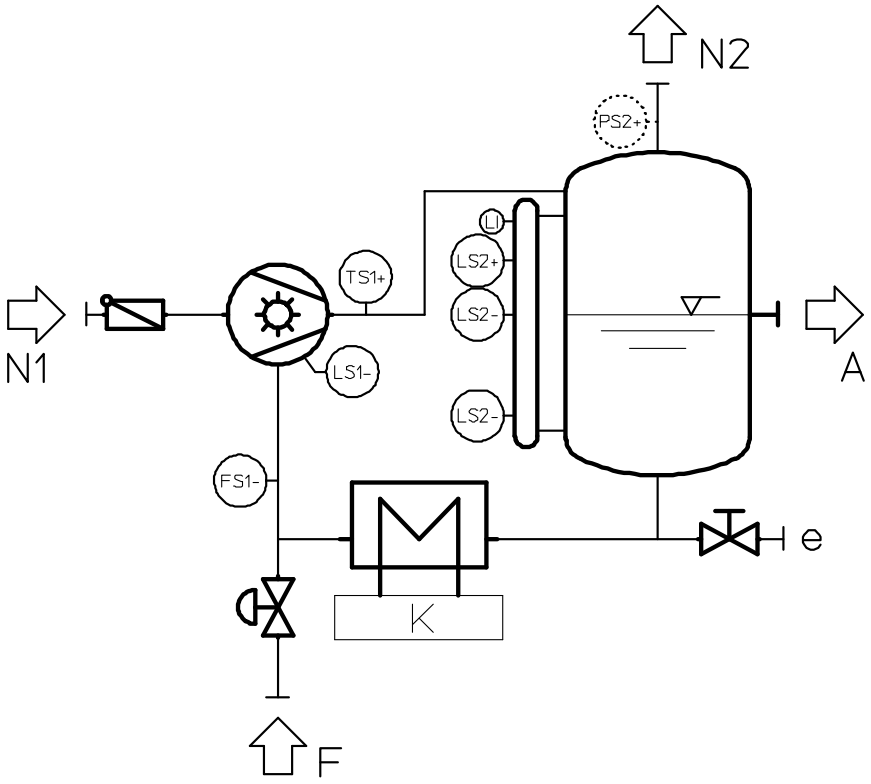
Category 2 for the pump internals:

Explosion protection in the working chamber of the liquid ring vacuum pump is assured by prevention of any effective ignition source. This is made possible by ensuring that in all operating conditions (at start up, shut down as well as when operating) a sufficient quantity of liquid is in the pump.

- For conformity with Category 2 for the pump internals, the level of the liquid in the pump on start up and the liquid inlet during operation, must be monitored.
- When a safety control is activated, the vacuum pump must automatically switch off.

**Technical Execution:**

To guarantee Category 2 for the internals of the liquid ring vacuum pump, Sterling SIHI suggests the following lay-out:




N1 = Process gas
N2 = Gas out
A = Overflow
F = Make-up liquid
K = Cooling liquid
e = Draining

**Flow chart:** Vacuum pump system with alternative safety devices
Package with liquid separator unit with a backflow prevention ball valve in the suction line.

Measuring equipment:

- LS1 Liquid level in the vacuum pump
  or
  LS2 Liquid level in the adjacent liquid separator.
- FS1 Liquid flow in the service liquid line
  or
  TS1 Temperature in the pressure chamber of the pump casing or in the pressure line directly behind the discharge orifice of the pump.

The measurement positions LS1 and LS2 should be adjusted so as to be on the same level as the shaft of the liquid ring vacuum pump. For LS1 the connection $u_{m1}$ resp. $u_m$ (see dimensions table) can be used.
If a check valve is installed in the service liquid line from the liquid separator to the pump, it must be ensured that during start up as well as during operation, that the valve remains open.
Monitoring of the pressure in the pressure line PS2 is recommended if, because of the system design, the permitted compression pressure (see Chapter 9) is likely to be exceeded.

## 4.0 Unpacking, transport, storage

## 4.1 Safety measures

- Never stand underneath the suspended load.
- Keep a sufficient safety margin between you and the load during transport.
- Use only licensed lifting appliances which are in perfect condition.
- Adjust the length of the lifting straps in such a way that the pump or the pump unit is suspended horizontally.
- Do not remove documents which are attached to the pump.
- Remove the protection caps from the pump inlet/outlet branches only immediately before installation of the piping system. This is to avoid contamination.

## 4.2 Unpacking

Before unpacking a visual check of the packaging is recommended. If transport damage is visible, its extent is to be noted on the receipt or on the delivery note. Possible claims are to be lodged immediately with the carriers or the insurance company.

## 4.3 Intermediate storage

If the pump or the pump unit is not installed immediately after delivery, it must be stored free from vibration in a dry room.

## 4.4 Protection during storage

The pump is protected with a preservative as stated on the pump label.

### 4.4.1 Removing the preservative

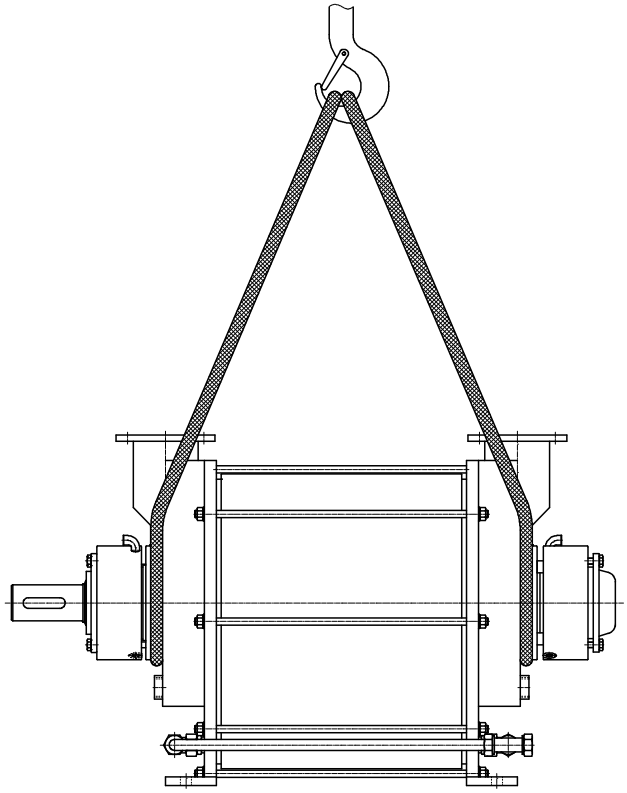
The preservative can be removed as described in the instructions on the pump label.
The preservative must be disposed of in accordance with the applicable regulations.

### 4.4.2 Re-protection

The pump must be protected with a preservative as indicated on the pump label.

## 4.5 Transport

The pump must be transported as shown in the following diagram.



## 5.0 Installing the pump

The work described in this chapter must be carried out only by skilled and appropriately trained staff.

## 5.1 Requirements

The pump must have been handled as set out in chapter 4.

## 5.2 Safety precautions

- Make sure that the motor cannot be started. Otherwise there exists danger to life.
- Make sure that the preservative has been removed as set out on the pump label. Failure to follow these instructions may lead to contamination of the equipment.
- Make sure that the pipework has been cleaned before installing the pump.
- Support the pipework to avoid subjecting pump components to stress (danger of damage).
- Ensure that the suction line and the discharge line are closed.
- Connect the pipework to avoid leakage of the pumped media during operation which may endanger the operator and the environment.
- After installing the motor / drive the coupling guard for the belt drive / coupling must be attached.
- When installing and operating the unit the rules for the prevention of accidents and any other relevant regulations and laws must be observed.
- Pay attention to site instructions regarding operating equipment of this type.

- Ensure that all electrical connections are free from current. Otherwise there is a risk to life.

## 5.3 Notes

### 5.3.1 Connections to the pump

The labelling of the connections as well as their exact positions are indicated in the dimensional table (see annex).

***SL 2100 / 2700 / 3100:***

**ATTENTION**

When connecting the gas flushing device of the shaft sealing $u_{sp}$ it must be secured that the gas supply connection is open against atmosphere. Alternatively the gas supply connection can be connected with the discharge side (liquid separator) in such a way that liquid cannot be sucked in.

### 5.3.2 Assembly tools

Special tools are not required for assembly and installation of the pump.

### 5.3.3 Permissible ambient conditions

The ambient temperature may be between -10°C and +40°C.

### 5.3.4 Base, foundation

The pump or the unit must be installed on a plane, torsionally resistant base frame. Vibration dampers should be arranged towards the chassis of the vehicle, the pipework has to be decoupled by hoses or compensators.

### 5.3.5 Space required

The dimensions for the space required for the pump or package are set out in the dimension tables in the annex.

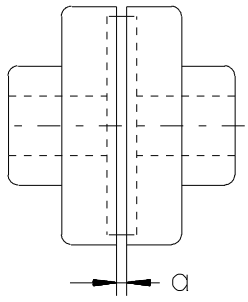
Ensure unhindered access to the shut-off and control devices as well as to the measuring instruments.

## 5.4 Mounting

When mounting the pump on the chassis pay attention that the pump shaft runs in parallel with the shaft of the auxiliary drive and that the pulleys are in alignment with each other.

**ATTENTION**

Hammer blows must not be used to force the pulley / coupling onto the shaft end. The distance between both coupling halves must correspond to the measurement specified (see list of accessories).




measurement to be set “a“

After tightening the foot screws the parallelism of the shafts must be checked again. If the pulley / coupling runs in the danger zone, i.e. less than 2.5 m above floor level, the rotating parts must be screened, according to the rules for the prevention of accidents.

## 5.5 Checks before installation

Before installing the pump into the plant, check the following points:

1. Is the electrical connection of the drive motor free of tension?
2. Are suction and/or discharge line empty and closed?
3. Is it possible to rotate the pump by hand (rotate the pulley / coupling)?
4. Have site instructions with regard to operating this type of equipment been followed?

## 5.6 Mounting the pump and installation into the piping system

On delivery, suction and discharge branches as well as the service liquid connection are closed to prevent foreign bodies entering. The caps must be removed only immediately before connecting the pipework.

The pipework must be supported in order to prevent excessive tensile forces on the pump branches.

**Permitted branch load:** see chapter 9

The pump must be aligned with the pipework.

The screws must be tightened in the following order:

1. Tighten the flange connections of suction and discharge lines.
2. Fasten the service liquid line.
3. Tighten the pump feet.

## 5.7 Protection and control devices

The existing protection and control devices must be installed and connected according to the relevant instructions (see annex).

## 5.8 Finishing steps

The following final steps must be carried out:

1. Check the tightness of the connecting flanges.
2. Check the easy running of the pump (rotate the pulley / coupling).

## 6.0 Pump start-up and shut down

The work described in this chapter must only be carried out by skilled and appropriately trained staff.

## 6.1 Preconditions

The pump must have been installed according to the instructions set out in chapter 5.

## 6.2 Safety measures

- Electrical connections, if available, are to be carried out according to the regulations of the local public utilities and to the ELexV standards. Furthermore the ex-rules of the BG chemistry are to be observed.
- Only authorized personnel may carry out duties involving electrical installation.

- Ensure the pump is filled correctly.
- Check the direction of rotation only when the pump is filled.
- When handling explosive, toxic, hot or aggressive media ensure that there is no danger to persons or the environment.
- The pump may be operated only if a continuous supply of service liquid is available.

## 6.3 Filling and emptying

Before the initial start-up the pump must be filled with service liquid.

Filling with service liquid is via the connection for service liquid $u_B$. When starting-up the pump the liquid level in the pump must not be above the shaft.

***SL 09/01 up to SL 14/02:***

When operating using the circulating liquid method of operation (chapter 3.1.1) the pump can be filled via the connection $u_{m1}$. The installation of an automatic Sterling SIHI drain valve XCg to this connection prevents the liquid lvel rising above shaft height. The drain valve is not necessary, if the set-up and operation of the unit make it impossible for the liquid level to rise above shaft height (for example by using a liquid separator placed alongside).

**SL 2100 / 2700 / 3100:**

Installation and operation of the unit must not allow the increase of the liquid level above shaft height (for example by using a liquid separator placed alongside).

The pump can be emptied through the central drain $u_e$ (9) and the liquid separator through the connection (9). Note that there may be “dead” spaces within the pump, in which sediment from the service liquid can remain. Because of this, flush the pump before disassembly, particularly when using toxic media.

## 6.4 Mechanical connection

Please observe the specified measures and limiting values for the couplings / the belt drive (see annex).

## 6.5 Connection and checking of accessories and monitoring equipment

The connection and checking of monitoring equipment and of accessories must be in accordance with the attached operating instructions for the different equipment (see annex).

## 6.6 Checks before switching-on

**ATTENTION**

- The pump must never run dry.
- Fill the pump with service liquid before the initial start-up.
  The liquid level must not be higher than the shaft height.
- If in exceptional cases the pump can be started only in flooded condition, a slow acceleration up to operating speed has to be secured.
- Never start the pump when the discharge side is closed.

- Only start-up the pump if all safety facilities are in operation.

## 6.7 Checking direction of rotation

The direction of rotation is adjusted by the drive and cannot be changed (the arrow on the pump casing indicates the direction of rotation).

Checking the direction of rotation must only be done when the pump is full.

## 6.8 Start-up

For start-up proceed as follows:

1. Switch on the circulating pump (4).
2. Switch on the drive.
3. Ensure that the prescribed pressures are measured at the pressure measuring points.

## 6.9 Adjusting service liquid flow

An adjustment is not possible due to the construction.

In case of very high temperatures at the discharge branch or in case of loss of output the service liquid line incl. cooler has to be checked for contamination i.e. for free passage.

## 6.10 Shut down operation

For shutting down, proceed as follows:

1. Switch off the circulating pump 4.
2. Ventilate the suction chamber.
3. Switch off the drive.

**ATTENTION**

If there is a risk of freezing, drain the pump, the liquid separator and the pipework. The pump must be protected against corrosion if it is to be stopped for an extended period of time.

## 6.11 Explosion protection

If it is likely that at some time flammable media are likely to enter the liquid ring vacuum pump, the pump and/or pump package must be designed and operated to conform to Category 2 according to Directive 94/9EC (see chapter 3).

To ensure conformity to Category 2 for the interior of the pump, the liquid supply line or the liquid level must be monitored. If the safety controls are activated, the compressor must automatically shut down.

### 6.11.1 Start-up

Before starting up the liquid ring vacuum pump, check the following:

- LS1 Liquid level in the vacuum pump
  and/or
- LS2 Liquid level in the liquid separator

When controlling the unit, check that the pump can only be operated when liquid is indicated at the measurement points LS1 and/or LS2.

## 6.11.2 Operation

Check the following when operating the liquid ring vacuum pump:

- FS1 Service liquid flow
  and/or
- TS1 Temperature of the media conveyed in the working chamber or in the pressure line.

The „dead time“ from the start of the liquid ring vacuum pump to commencement of monitoring of the service liquid flow FS1 should not exceed the following values:

- Direct start: **$\Delta t = 10$ sec**
- Soft start: **$\Delta t = 30$ sec**

The control of the pump unit must be set such that the vacuum pump is automatically switched off if:

- at the measurement point FS1 the service liquid flow is below the minimum permitted service liquid flow $B_{min}$ (see chapter 9)

or

- at the measurement point TS1 the maximum permitted temperature $t_{2,max}$ (see chapter 9) is exceeded.

The operator must ensure that technical operating limits (see chapter 9) at all points are maintained.

## 7.0 Maintenance, disassembly, assembly

Trained and appropriately skilled staff must carry out the work described in this chapter.

Only authorised, skilled staff must carry out work on electrical connections.

## 7.1 Requirements

The pump or pump package must have been shut down as set out in chapter 6.

## 7.2 Safety measures

- Make sure that an unintentional start-up of the motor cannot take place if work on the belt drive / coupling / pump are carried out. Otherwise there exists danger to life.
- When assembling and disassembling the pump particularly make sure that no toxic or aggressive media can escape from open pipework. Secure the shut-off devices against unauthorised operation.
- Drain the pump before removing from the plant. After draining, liquid may remain in the pump which must be removed by flushing the pump with a suitable liquid.

- The electrical connections must be connected and disconnected only after removal of corresponding fuses.

## 7.3 Maintenance

The pump requires only limited maintenance.

However the following points must be observed:

- Actuate for short periods the dirt drain $u_{se}$ in regular intervals 1 - 2 times a week while the pump is running.
- The bearings shall be re-lubricated after approximately 1.000 service hours or every 18 weeks, respectively.
  Required quantity of lubricant: 20g per bearing.
  On delivery lithium-saponified grease, dropping point approx. 180℃, worked and other tests for greases 265/295mm/10 has been used.
- In case of danger of freezing, anti-freezing agent has to be admixed to the service liquid. Otherwise pump, liquid separator and pipework must be drained. If necessary the pump must be protected against corrosion/rust.
- If hard (high calcium content) water is used as service liquid, the pump must be opened at least every six months and the calcium deposits removed.
  The calcium deposits can be prevented if the service liquid is dosed with a suitable agent. The measures adopted depend on length of operation and water quality.
  If the pump will not be used for extended periods, it must be drained and, if necessary, protected against corrosion.
- As contamination will accumulate in the pump and in the liquid separator, both must be cleaned at appropriate intervals.
- **Shaft sealing 053:**
  The grease chambers must be refilled through the grease nipples, item 63.61 after 35 operating hours or every 7 days, if the pump has been run. The necessary quantity of grease is 2 g for each shaft seal.
  The shaft seals must not be over-greased.
- **Belt drive:**
  In case of slip / backlash the discs and belts have to be checked for cleanness. Carry out the re-tightening or replacement respectively according to the specification in the annex.

## 7.4 Notes

### 7.4.1 Assembly tool

For the disassembly and assembly of the pump no special tools are required.

### 7.4.2 Sealing surfaces and alignment

**ATTENTION**

All parts of the pump, especially the sealing surfaces must be handled with care to avoid damage and ensure trouble free operation.

### 7.4.3 Spare parts

When ordering spare parts indicate the Part No., the pump type and the Pump No. (see annex or type plate). Typical wear parts are marked by frames in the sectional drawings.

### 7.4.4 Sectional drawings

The disassembly and assembly of the pumps are described by means of the sectional drawings (see annex).

## 7.5 Disassembly

Take care with dangerous media because even after flushing the pump carefully, residues of the medium and/or the service liquid can remain in dead spaces in the pump.

### 7.5.1 Preparation for disassembly

Proceed according to the following check list:

1. Drain the installation at least within the pump area, i.e. between the valves on the suction- and discharge side.
2. If necessary, disconnect any measuring probes or control instruments and remove them.
3. Drain the pump.
4. Remove the pump from the plant.
5. If necessary, flush the pump.
6. Remove the drive parts.

### 7.5.2 Disassembly of the pump

Proceed as follows:

1. Place the pump vertically with the drive side upwards.
2. Remove the key 94.01, the V-ring 41.01 and the bearing cover 36.00 (with radial shaft seal ring 42.10). Withdraw the bearing housing 35.01 together with the bearing 32.01 and the radial shaft seal ring 42.11. Loosen the casing for mechanical seal 44.10 or the stuffing box housing 45.10 by means of the threat bores M10 and draw off together with the static part of the mechanical seal 43.30 or with the complete shaft seal from the shaft 21.00.
3. Rotate the pump through 180º, so that the non-drive side points upwards.
4. Dismount the bearing cover 36.10. Loosen the shaft nut 92.21 and take off the lock washer 93.11. Loosen the withdrawal sleeve 52.80 by tightening the delivered shaft nut 92.31. Draw off the disc spacer 50.90 and the bearing housing 35.00 with the bearing 32.02 and the radial shaft seal ring 42.10. Loosen the casing for mechanical seal 44.10 or the stuffing box housing 45.10 by means of the threat bores M10 and draw off together with the static part of the mechanical seal 43.30 or with the complete shaft seal from the shaft 21.00.
5. Detach the drain pipe 70.30. Loosen the pipe unions from the by-pass line 70.10. Loosen and take off the tie bolts 90.50. Remove the vacuum casing 10.70 (anticlockwise rotating pump) or 10.60 (clockwise rotating pump) with guide disc 13.70 and the central body 10.90.
   Pull out upward the shaft 21.00 with the vane wheel impeller 23.50.
6. Remove the o-rings 41.40 from the central body 10.90. If necessary, loosen the bolts 91.80 and separate the guide discs 13.70 from the vacuum casings 10.60 and 10.70.

7. *Shaft sealing BHE:*
   Take off the rotating parts of the mechanical seal 43.30 from the shaft protection sleeve 52.40.
8. The vane wheel impeller should be dismounted only, if absolutely necessary. Loosen the shaft nut 92.20. Take off the lock washers 93.10 and the shaft protection sleeves 52.40 with the O-rings 41.20.
9. *Disassembly of the shaft sealing 053:*
   Take the gland 45.20 out off the stuffing box housing 45.10. Press the radial shaft seal rings 42.12, the spacer ring 45.00, the lantern ring 45.80, the gland packing ring 46.10 and the bottom header 45.70 out of the stuffing box housing 45.10. Take off the O-rings 41.21.

## 7.6 Assembly

### 7.6.1 Preparation for assembly

1. Clean carefully all pump parts.
   Make sure that the sealing surfaces have no grooves and that the guide disk is perfectly flat. If necessary, the guide disk must be ground on a levelling plate by means of abrasive cloth.
2. Coat the running surface of the guide disk as well as all threads and fittings (except the sealing fittings) with Molykote lubrication paste.
3. During assembly no foreign matter must enter the pump.
4. Use appropriate clamps/vices for clamping the parts for assembly.

### 7.6.2 Tightening torque

When tightening the bolts and nuts the following tightening torques must be observed:

Item 92.20 : M78 x 2 : 600 Nm  Item 92.21 : M60 x 2 : 260 Nm

| | M 6 (Nm) | M 8 (Nm) | M 10 (Nm) | M 12 (Nm) | M 16 (Nm) | M 20 (Nm) | M 24 (Nm) |
|---|---|---|---|---|---|---|---|
| Bolts under pressure | 8,5 | 12 | 25 | 40 | 90 | 175 | 300 |
| Tie bolts (Item 90.50) | 8,5 | 12 | 25 | 40 | 90 | 140 | 150 |

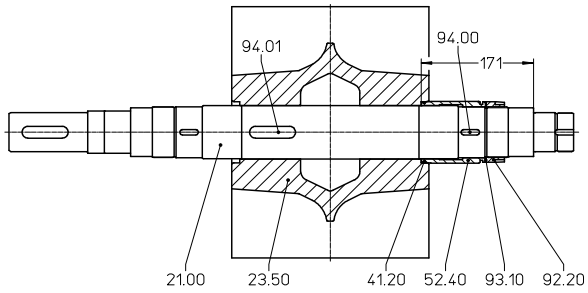
**Note:** Bolts made from stainless steel must be retightened after 24 hours.

### 7.6.3 Pump assembly

Proceed as follows:

1. All marks must be in perfect alignment.
   If one or several parts are replaced, which may affect the position of the rotor by their axial length, the rotor must be adjusted in such a way that between vane wheel impeller and the guide disks a gap is formed of half the total play. The total play is 0,5 mm.
2. Attach the guide discs 13.70 with screws 91.80 to the vacuum casings 10.60 and 10.70. Make sure that at the vacuum casing 10.60 the large suction port is attached to the suction side and at the vacuum casing 10.70 the small pressure port is attached to the discharge side.

3. *Standard gauge of the vane wheel impeller:*




Insert the keys 94.01 and 94.00 into the grooves of the shaft 21.00. Insert the O-rings 41.20 into the shaft protection sleeves 52.40. Put on the shaft 21.00, at the non-drive side, one shaft protection sleeve 52.40 and also the lock washer 93.10 and the shaft nut 92.20. Adjust a dimension of 171 mm from the shaft chamfer ∅60/75 mm until the stop of the vane wheel impeller. Pull the vane wheel impeller 23.50 on the shaft 21.00. The vanes of the impeller must point in the direction of rotation. Push the second shaft protection sleeve 52.40 on the shaft 21.00, put on the lock washer 93.10, tighten both shaft nuts 92.20 and secure them.

**4. Assembly of the shaft sealing 053:**

4.1 Place the stuffing box casing 45.10, the open side must point upwards, on the work bench and coat thinly the inner side with lithium saponified grease for anti-friction bearings.

4.2 Put into the stuffing box housing in the following order:

Bottom header 45.70, gland packing ring 46.10 and lantern ring 45.80. The open side of the lantern ring must point upwards. Put the O-rings 41.21 into the grooves.

4.3 Push in the first radial shaft seal ring 42.12 with the open side downward into the stuffing box casing.

4.4 Coat amply the spacer ring 45.00 with lithium saponified grease and insert it into the stuffing box housing with the supporting edge ahead.

4.5 Fill the open side of the second radial shaft seal ring 42.12 with lithium-saponified grease as well and push in with filled side in front and gland 45.20 into the stuffing box casing.

4.6 Screw on the grease nipples 63.61.

4.7 Connect the previously assembled parts (according to point 4.1 to 4.6) with the vacuum casing 10.60 or 10.70.

5. **Assembly of the shaft sealing BHE:**

Provide the shaft protection sleeves 52.40 with grease. Push the rotating parts of the mechanical seal 43.30 on both sides on the shaft protection sleeves 52.40. Place the casing for mechanical seal 44.10, the open side must point upwards, on the work bench. Insert the O-ring 41.21 into the groove and coat the O-ring seat of the mechanical seal thinly with lithium-saponified anti-friction grease.

Insert the static part of the mechanical seal 43.30.

6. Place the previously assembled vacuum casing 10.60 (clockwise rotating pump) or 10.70 (anti-clockwise rotating pump) horizontally in an elevated position. Screw the pipe union of the by-pass line 70.10 into the vacuum casing and insert loosely the pipe of the by-pass line 70.10. Insert the previously assembled shaft 21.00, drive side upwards, into the vacuum casing. Insert the o-rings 41.40 into the grooves of the central body 10.90. Centre the central body 10.90 on the vacuum casing.

7. **Shaft sealing 053:**

Coat with grease the sliding surfaces of the shaft protection sleeves. Screw the pipe union of the by-pass line 70.10 into the vacuum casing. Push the previously assembled vacuum casing 10.60 (anti-clockwise rotating pump) or 10.70 (clockwise rotating pump) onto the shaft 21.00. When doing so insert the pipe of the by-pass line 70.10 into the pipe union. Put the gland 45.20 into the stuffing box housing 45.10.

**Shaft sealing BHE:**

Screw the pipe union of the by-pass line 70.10 into the vacuum casing. Push the vacuum casing 10.60 (anticlockwise rotating pump) or 10.70 (clockwise rotating pump) and the casing for mechanical seal 44.10 onto the shaft 21.00 and join them. When doing so insert the pipe of the by-pass line 70.10 into the pipe union.

8. Press into the bearing housing 35.01 the radial shaft seal ring 42.11, the open side must point upwards. Insert the cylindrical pin 56.20 and the bearing 32.01 in the bearing housing 35.01 and subsequently centre on the casing for mechanical seal 44.10 or on the gland 45.20 and tighten with screws 91.40. Press the radial shaft seal ring

42.10 into the bearing cover 36.00 and screw on with screws 90.10. Mount the V-ring 41.01. Insert the tie bolts 90.50 and tighten manually.

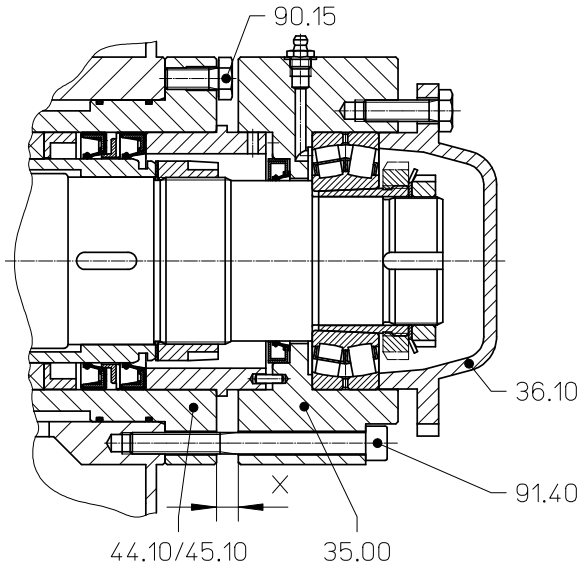
9. Then rotate the pump carefully through 180° so that the drive side points downward.
10. **Shaft sealing 053:**

    Mount the second complete shaft sealing unit (see point 4.1 to 4.6). Tighten the previously assembled stuffing box housing 45.10 at the vacuum casing 10.60 (clockwise rotating pump) or 10.70 (anti-clockwise rotating pump). Put the gland 45.20 into the stuffing box housing 45.10.

    **Shaft sealing BHE:**

    Mount the second casing for mechanical seal 44.10 (see point 5). Join the casing for mechanical seal 44.10 with the vacuum casing 10.60 (clockwise rotating pump) or 10.70 (anticlockwise rotating pump).
11. Press into the bearing housing 35.00 the radial shaft seal ring 42.11, the open side must point upwards. Insert the cylindrical pin 56.20 and the bearing 32.02 in the bearing housing 35.00 and subsequently centre on the casing for mechanical seal 44.10 or on the gland 45.20 over the cylindrical pin 56.20. Slip on the shaft 21.00 the withdrawal sleeve 52.80 and secure with the shaft nut 92.21 and the safety tab washer 93.11. Tighten the bearing cover 36.10.
12. Place the pump horizontally. Align the pump feet on a plane base and tighten crosswise the tie bolts 90.50. Tighten the pipe unions of the by-pass line 70.10.
13. *Adjustment of the play:*

    The rotor play is measured (dial gauge at the front side of the shaft end) by moving back and forth the rotor until the stops between the guide discs. The rotor is pushed to the thrust bearing side with the aid of two screwdrivers which are put into the gap „x“ between bearing housing 35.00 and casing for mechanical seal 44.10 or stuffing box housing 45.10. For that purpose the screws 91.40 have to be loosened. Tightening the screws 91.40 makes the movement of the rotor towards the drive side.
14. *Determination of the thickness of the disc spacers:*




    Unscrew the screws 91.40. Pull the rotor to the non-drive side by unscrewing the hexagonal screws 90.15. Measure the distance between bearing housing 35.00 and casing for mechanical seal 44.10 or stuffing box housing 45.10 (dimension x) at the screwing points. Trim the spacer discs 50.90 to the dimension x less half the play. Screw in the hexagonal screws 90.15 without any force. Insert the spacer discs and tighten the screws 91.40.
15. Mount the drain pipe 70.30. Insert the key 94.01 into the groove of the shaft 21.00, put on the coupling half or pulley and after lubrication (see chapter 7.7.1) and testing the pump (see chapter 7.8) install the pump in the plant.

### 7.6.4 Check possibility of the gaps in mounted condition

The gaps can be measured by means of a feeler gauge through an open branch.

Should the gaps be not equal at both sides, it is possible to correct this as set out in chapter 7.6.3 point 13.

## 7.7 Bearings

### 7.7.1 Lubrication

Initial lubrication or lubrication after the cleaning of the bearing and the free chambers.

The bearing is completely filled whereas the free chamber in the casing are only partly filled with grease that means between 30 and 50%.

Grease type as set out in chapter 7.3.

### 7.7.2 Replacement of the bearings

Prepare the disassembly as set out in chapter 7.5.1.

**SL B 2100 / 2700 / 3100:**

7.7.2.1. *Drive side bearing 32.01:*

Remove the key 94.01, the bearing cover 36.00 (with radial shaft seal ring 42.10) and the V-ring 41.01. Take off the bearing housing 35.01. Press the bearing 32.02 out of the bearing housing 35.01.

Assembly in reverse order.

Lubricate the bearing as set out in chapter 7.7.1.

7.7.2.2. *Non-drive side bearing 32.02:*

Remove the bearing cover 36.10. Loosen the shaft nut 92.21 and take off the lock washer 93.11. Loosen the withdrawal sleeve 52.80 by tightening the delivered shaft nut 92.31. Take off the withdrawal sleeve 52.80. Draw off the disc spacer 50.90 and the bearing housing 35.00 with the bearing 32.02. Press the bearing 32.02 out of the bearing housing 35.00.

Assembly in reverse order.

The following must be observed:

- The setting of the rotor must be remade as set out in chapter 7.6.3 point 13.
- The shaft nut 92.31 must not remain in the pump.

Lubricate the bearing as set out in chapter 7.7.1.

## 7.8 Testing

**ATTENTION**

Do not operate the pump without liquid.

After installation, make the following checks:

1. Check the ease of movement of the pump rotating parts by turning the free shaft end.
   Should the pump jam, the impeller is probably incorrectly adjusted. The mistake must be rectified.
2. Make a hydrostatic test. For a test with water the pressure should be 3 bar.
   Drain the pump.
3. Undertake a leak test (e.g. subject the pump with air to 0,5 bar overpressure and spray the sealing gaps with a foaming agent).

## 7.9 Replacement of the shaft sealing

Prepare the disassembly as set out in chapter 7.5.1. The disassembly of the bearings is made as set out in point 7.7.2.1 for the drive side and in point 7.7.2.2 for the non-drive side.

***Shaft sealing 053:***

Loosen the screws 91.41 and take off the stuffing box housing 45.10 with the complete shaft seal. Press out the radial shaft seal rings 42.12, the spacer ring 45.00, the lantern ring 45.80, the gland packing ring 46.10 and the bottom header 45.70.

The chamber between the radial shaft seal rings 42.12 and the parts in between have to be filled up with anti-friction grease.

***Shaft sealing BHE:***

Loosen the screws 91.41, remove the casing for mechanical seal 44.10 together with the static part of the mechanical seal 43.30. Loosen the shaft nut 92.20 and take off the lock washer 93.10 from the shaft. Draw off the shaft protection sleeve 52.40 together with the rotating part of the mechanical seal 43.30.

Assembly in reverse order.

Observe the following steps after the disassembly of the non-drive side:

- The setting of the rotor must be remade as set out in chapter 7.6.3 point 13.

Lubricate the bearing as set out in chapter 7.7.1.

## 8.0 Help in case of problems

Fault finding and elimination must be carried out only by trained and skilled staff.

## 8.1 Requirements

It is essential for the proper operation of the pump that the instructions for installation and starting-up of the pump set out in chapters 5 and 6, are followed.
The mode of operation of the pump is described in chapter 3.

## 8.2 Troubleshooting

| Problem | Cause | Elimination |
|---|---|---|
| **Insufficient suction volume flow in the pump** | Suction line leaking. | Check the flange connections and if necessary retighten them.<br>If necessary replace the seal. |
| | Suction volume flow decreases as result of increased service liquid temperature (Values indicated in the manual refer to water at 15 °C) | Regulate the temperature of the service liquid by increasing the make-up liquid flow or by increasing the cooling liquid flow in the heat exchanger (if necessary use a circulating pump). |
| | Deposit formation in the pump | Check the pump for contamination and deposits.<br>Clean the pump.<br>If necessary, take precautions to inhibit deposit formation. |
| | Slip / backlash of the belts | Retighten the belts, if necessary replace them. In case of contamination clean the discs. |
| **Pump causes creaking noise (cavitation)** | The pump runs at considerably lower suction pressures than indicated in the manual. | Connect a vacuum ventilation valve. |
| | The service liquid temperature is higher than determined in the annex. | Regulate the temperature of the service liquid by increasing the make-up liquid flow or by increasing the cooling liquid flow in the heat exchanger (if necessary use a circulating pump). |
| **Liquid at the gas outlet $M_{II}$** | Make-up liquid flow F too great | Throttle the make-up liquid flow. |
| | Drain liquid flow A too small, overflow clogged | Check the overflow for sufficient clearance/any clogging, eliminate the blockage. |
| **Escape of liquid out of the shaft sealing** | Shaft sealing leaking. | Replace the shaft sealing (assembly and disassembly as set out in chapter 7). |

## 9.0 Technical data

## 9.1 Service liquid flow

In the annex the service liquid flows B are set out for combined operation and circulating liquid operation when using water as service liquid.

The indicated liquid flows are applicable for the compression of dry gases. If condensing vapours are compressed, the liquid flows increase because, in addition, the latent heat released on condensation must be eliminated.

## 9.2 Operating limit data

- For Category 2 operation, the operating limits set out in section 9.5.2 must be observed.
- For Category 1 operation, the additional operating instruction **Ex 1G/2G** must be applied and observed.

| Pump type | | unit | SL. 2100 | SL. 2700 | SL. 3100 |
|---|---|---|---|---|---|
| min. suction pressure | | mbar | 150 | | |
| permissible discharge overpressure | | bar | 1,5 | | |
| permissible pressure difference | max. | mbar | 1500 | | |
| between suction and discharge side | min. | | 200 | | |
| max. gas inlet | dry | ℃ | 160 | | |
| temperature | vapour saturated | ℃ | 80 | | |
| max. speed | | rpm | 1600 | | |
| min. permissible diameter of pulley for vacuum operation | | mm | 236 | | 300 |
| min. permissible diameter | $p_2$=0,5 bar | mm | 236 | 236 | 300 |
| of pulley | $p_2$=1,0 bar | | 236 | 300 | 300 |
| for compressor operation | $p_2$=1,5 bar | | 300 | 350 | 400 |
| service liquid | max. | ℃ | 60 | | |
| temperature | min. | ℃ | 10 | | |
| max. service liquid density | | kg/m$^3$ | 1200 | | |
| max. service liquid viscosity | | mm$^2$/s | 90 | | |

Absolute pressures [mbar]

Overpressures [bar]

Table 9.2: Operating limits

**ATTENTION**

The surface temperatures on the outside surfaces of the pumps result from the temperature of the pumping medium or of the service liquid. Depending on the operating conditions, the temperature rise of the service liquid will be about 5 – 20 C when passing through the pump.

## 9.3 Permitted nozzle loadings

| | Forces Fx, Fy, Fz [N] | Moments Mx, My, Mz [Nm] |
|---|---|---|
| SL. 2100 / 2700 / 3100: | 500 | 180 |

(is not applicable for pipework uncoupled due to reasons relative to vibration)

## 9.4 Type codes

The following table sets out the Sterling SIHI-type code (extract from the standard delivery programme).

| range + size | bearings + direction of rotation | shaft seal | materials | casing sealing |
|---|---|---|---|---|
| | B• two antifriction bearings<br>E• two antifriction bearings and evaporation cooling<br>•O anticlockwise rotating pump<br>•N clockwise rotating pump | 053 special sealing<br>BHE mechanical seal | 0B Main parts of cast iron, without non-ferrous metal | 1 O-ring sealing |
| SL B 2100<br>SL B 2700<br>SL B 3100 | BO, BN, EO, EN | 053, BHE | 0B | 1 |

## 9.5 Explosion protection

### 9.5.1 Pump internals

It is possible that occasionally, inflammable media may be present in the pump and that in such circumstances, conformity with Category 2 of Directive 94/9/EG is required. The operator must then ensure that the following limits are not exceeded:

- - Gas inlet temperature $\mathbf{t_{1,max}}$
  - Gas outlet temperature $\mathbf{t_{2,max}}$
  - Service liquid temperature $\mathbf{t_{B,max}}$.
- The temperature limits are quoted in section 9.5.2 independent of the requested temperature class.
- The temperature data is valid for water as service liquid.
  When using service liquids other than water, the operator must ensure that at all operating points of the compressor, the media temperature does not approach its ignition temperature.

If monitoring the service liquid supply is used for safety control for category 2 (see chapter 3), the service liquid flow must not fall below the following min. permissible flow.

|  | Minimum permissible service liquid flow<br>$B_{min}$ [m³/h] |
|---|---|
| SL. 2100 / 2700 / 3100: | 0,80 |

### 9.5.2 Temperature Class

In the table, the temperature classes (according to EN 13463-1) are set out as well as the corresponding maximum permissible temperature of the medium being evacuated and/or of the service liquid.

|  | Maximum permitted gas inlet temperature $\mathbf{t_{1,max}}$ | Maximum permitted gas outlet temperature $\mathbf{t_{2,max}}$<br>or<br>Maximum permitted service liquid temperature $\mathbf{t_{B,max}}$ |
|---|---|---|
| T3 | 150 ℃ *) | 100 ℃ *) |
| T4 | 100 ℃ | 100 ℃ |
| T5 | 80 ℃ | 80 ℃ |
| T6 | 65 ℃ | 65 ℃ |

*) The limits in section 9.2 must also be observed.

## 10.0 Annex

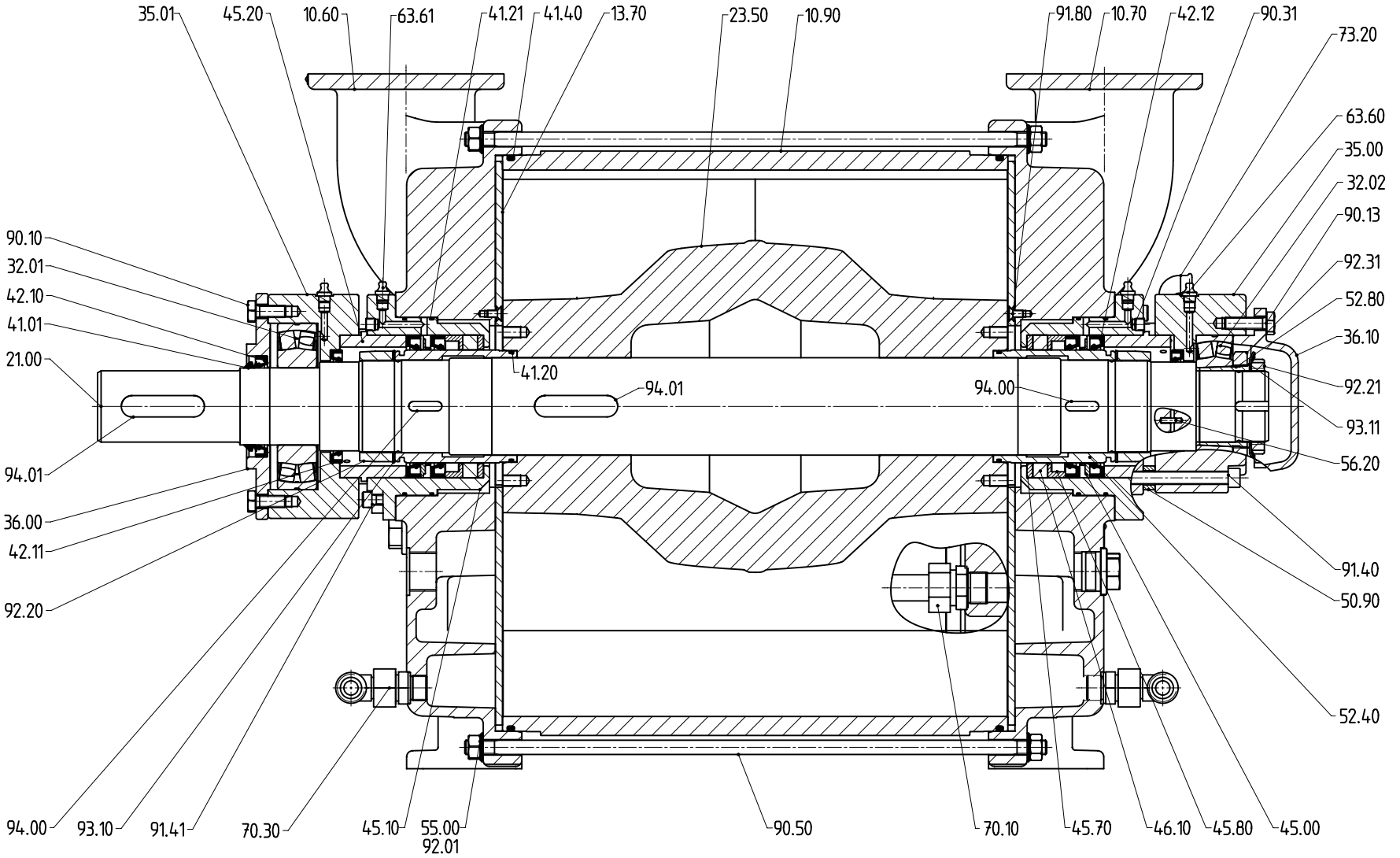
- Sectional drawings
- Dimension tables
- Operating data, fresh water flows
- Certificate of conformity

sectional drawing | Schnittzeichnung | plan-coupe | dibujo de corte

pumps | Pumpen | pompes | bombas

Sterling SIHI GmbH

# SL B 2100/2700/3100




| Rev. | Date | Name |
|---|---|---|
| | | |

| | Date | Name |
|---|---|---|
| Drawn | 15.1.09 | Hinz |
| Checked | | |
| Manuf. | | |

Supersedes:

Supersedes by:

SZ50863

# dimensional table

Masstafel

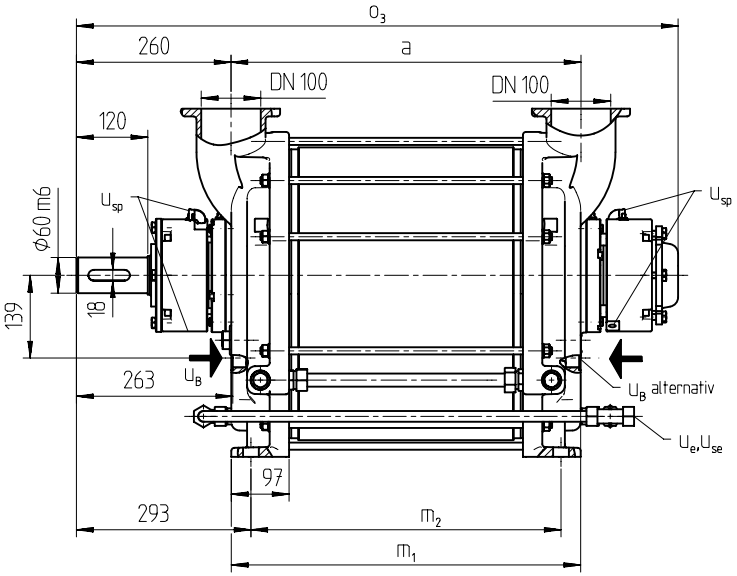
table de dimensions
tabla de dimensiones

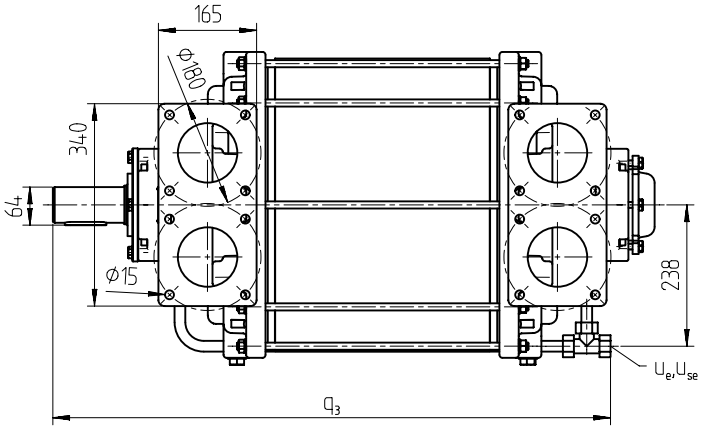
pumps
Pumpen

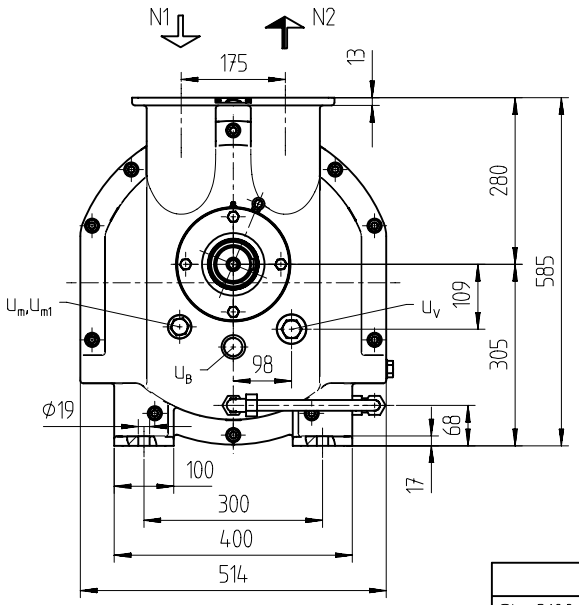
pompes
bombas

Sterling SIHI GmbH

## SL B 2100/2700/3100




Wasserdruckpruefung 3 bar
hydrostatic test 3 bar

Massangaben in mm
dimensions in mm

| | a | $m_1$ | $m_2$ | $o_3$ | $q_3$ | kg |
|---|---|---|---|---|---|---|
| SL 2100 | 463 | 462 | 396 | 886 | 809 | 315 |
| SL 2700 | 533 | 532 | 466 | 956 | 879 | 335 |
| SL 3100 | 588 | 587 | 521 | 1011 | 934 | 365 |

| | | | |
|---|---|---|---|
| $u_B$ | G1 | Anschluss fuer Betriebsfluessigkeit | connection for service liquid |
| $u_e$, $u_{se}$ | 18x1 | Anschluss Entleerung / Schmutzentleerung | connection for draining / dirt draining |
| $u_m$ | G1 | Anschluss fuer Manometer | connection for pressure gauge |
| $u_{m1}$ | G1 | Anschluss fuer Entleerungsventil oder Fuellstandssensor | connection for drain valve or liquid level sensor |
| $u_{sp}$ | G 1/4 | Anschluss fuer Spuelgas | connection for flushing gas |
| $u_v$ | $G1\frac{1}{4}$ | Anschluss fuer Verdampfungskuehlung | connection for evaporation cooling |

Massaenderung durch technischen Fortschritt vorbehalten
dimensions subject to alterations

| Rev. | Date | Name |
|---|---|---|
| | | |
| | | |
| | | |

| | Date | Name |
|---|---|---|
| Drawn | 12.11.08 | Hinz |
| Checked | | |
| Manuf. | | |

Supersedes:
Supersedes by:

MT50864

# Operating data for handling vapor saturated air at 20 °C, service liquid: water at 20 °C .

| SL 2100 | | power consumption in kW | | | | | |
|---|---|---|---|---|---|---|---|
| | | vacuum operation ($p_2$=1013 mbar) | | | compressor operation ($p_1$=0 bar) | | |
| pump speed rpm | suction volume flow m³/h | 200 mbar kW | 400 mbar kW | 600 mbar kW | 0,5 bar kW | 1,0 bar kW | 1,5 bar kW |
| 1600 | 2190 | 72 | 68 | 64 | 76 | 93 | 110 |
| 1400 | 1930 | 55 | 52 | 48 | 58 | 72 | |
| 1200 | 1660 | 41 | 38 | 35 | 44 | 58 | |
| 1000 | 1370 | 30 | 28 | 25 | 32 | 44 | |
| 800 | 1010 | 23 | 20 | 18 | 24 | | |

| SL 2700 | | power consumption in kW | | | | | |
|---|---|---|---|---|---|---|---|
| | | vacuum operation ($p_2$=1013 mbar) | | | compressor operation ($p_1$=0 bar) | | |
| pump speed rpm | suction volume flow m³/h | 200 mbar kW | 400 mbar kW | 600 mbar kW | 0,5 bar kW | 1,0 bar kW | 1,5 bar kW |
| 1600 | 2700 | 86 | 84 | 83 | 87 | 110 | 136 |
| 1400 | 2400 | 66 | 63 | 62 | 70 | 85 | |
| 1200 | 2080 | 49 | 47 | 43 | 53 | 66 | |
| 1000 | 1720 | 36 | 33 | 31 | 38 | 50 | |
| 800 | 1350 | 26 | 24 | 21 | 27 | 35 | |

| SL 3100 | | power consumption in kW | | | | | |
|---|---|---|---|---|---|---|---|
| | | vacuum operation ($p_2$=1013 mbar) | | | compressor operation ($p_1$=0 bar) | | |
| pump speed rpm | suction volume flow m³/h | 200 mbar kW | 400 mbar kW | 600 mbar kW | 0,5 bar kW | 1,0 bar kW | 1,5 bar kW |
| 1600 | 3080 | 95 | 94 | 93 | 103 | 122 | 145 |
| 1400 | 2700 | 72 | 71 | 70 | 79 | 96 | |
| 1200 | 2320 | 54 | 51 | 49 | 60 | 74 | |
| 1000 | 1910 | 39 | 36 | 35 | 43 | 56 | |
| 800 | 1360 | 28 | 26 | 24 | 30 | 39 | |

## Service liquid flow:

| | | service liquid flow in m³/h | | | | | |
|---|---|---|---|---|---|---|---|
| | | vacuum operation ($p_2$=1013 mbar) | | | compressor operation ($p_1$=0 bar) | | |
| pump: | pump speed rpm | 200 mbar | 400 mbar | 600 mbar | 0,5 bar | 1,0 bar | 1,5 bar |
| SL 2100<br>SL 2700<br>SL 3100 | 800 ... 1600 | 4,1 | 3,4 | 2,7 | 2,9 | 4,6 | 6,0 |

Service liquid flow dependent on suction or compression pressure.

The indicated parameters are applicable to standard conditions, where the service liquid is supplied under compression pressure $p_2$ (in case of vacuum operation: atmospheric pressure) . In circulating liquid operation and when using a liquid pump the values must not be lower than the indicated ones.

# CE EC Declaration of Conformity

**The manufacturer:**

Sterling SIHI GmbH
Lindenstraße 170
D-25524 Itzehoe

**declares herewith that the product**

Pump: LEM
LRM

Serial number: XXX

**fulfils all relevant provisions of the Directive Machinery 2006/42/EC.**

**Furthermore the aforementioned product complies with the provisions of the EC Directives:**

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**Harmonised standards used:**

EN 1012-1/2
DIN EN ISO 12100-1
DIN EN ISO 12100-2
EN 1127-1
EN 13463-1
EN 13463-5/8

**Other technical standards and specifications used:**

---

**Person authorised to compile the technical file:**

Bernd Wenckebach
Sterling SIHI GmbH
Lindenstraße 170
D-25524 Itzehoe

**Place, date:**

XXX, XX.XX.XXXX

**Person empowered to draw up this declaration:**

Product Line Manager Operation Manager

# CE EC Declaration of Conformity

**The manufacturer:**

Sterling SIHI GmbH
Lindenstraße 170
D-25524 Itzehoe

**declares herewith that the product**

| | |
|---|---|
| Pump: | LEM – equipped with a motor suitable to ATEX,<br>LEL<br>LOH LPH LEH<br>SL |
| Serial number: | XXX |

**fulfils all relevant provisions of the Directive Machinery 2006/42/EC.**

**Furthermore the aforementioned product complies with the provisions of the EC Directives:**

- **Explosion Protection 94/9/EC (ATEX) as follows:**

Pump: ⟨Ex⟩ XXX

**Harmonised standards used:**

EN 1012-1/2
DIN EN ISO 12100-1
DIN EN ISO 12100-2
EN 1127-1
EN 13463-1
EN 13463-5/8

**Other technical standards and specifications used:**

---

**Person authorised to compile the technical file:**

Bernd Wenckebach
Sterling SIHI GmbH
Lindenstraße 170
D-25524 Itzehoe

**Place, date:**

XXX, XX.XX.XXXX

**Person empowered to draw up this declaration:**

Product Line Manager Operation Manager