Instruction Manual
for
Liquid Gas Centrifugal Pump

LIN IC Pump P71100 - P71200

Pump - Type	:	CL4-13/EM-7,5
Sefco Ref. No.	:	05.044/1-2
Customer	:	Air Liquide AGS GmbH
Customer Ref. No.	:	Order. No.: 4500023387 of 11.01.2005 Project: K70101 Project name: "ASU Košice"

Contents CL4 - 13

	Title-Page	No. E10500 -1
1	**Declaration by the Manufacturer**	**No. E10863 -1**
2	**Introduction**	**No. E10501 -1**
3	**Safety**	
	3.1 Notes and symbols	No. E10864 -1
	3.2 General notes about dangers	No. E10954 -2
	3.3 Important notes for operation	No. E10864 -3
4	**Machinery Description**	**No. E10955 -1**
	4.1 Pump	No. E10955 -1
	4.2 Seal /-Purge gas regulation	No. E10955 -1
5	**Additional Subsystems**	**No. E10571 -1**
	5.1 Cold-end	No. E10571 -1
	5.2 Additional control-subsystems	No. E10571 -1
6	**Machinery and Subsystems Data**	**No. E10572 -1-2**
	6.1 Machinery data	No. E10572 -1-2
	6.2 Additional subsystems and components	No. E10572 -2
7	**Pump Preparation**	**No. E10520 -1**
	7.1 Before delivery	No. E10520 -1
	7.2 On arrival at customer site	No. E10520 -1
	7.3 Handling	No. E10520 -1
8	**Pump Installation**	**No. E10956 -1-2-3**
	8.1 Correct suction-line	No. E10956 -1
	8.2 Piping system and components	No. E10956 -2-3
	8.3 Pump protection	No. E10956 -3
	8.4 Electrical connections	No. E10956 -3
	8.5 Purge and seal gas control	No. E10956 -3
9	**Suction Pressure- (NPSH) Required**	**No. E10510 -1-2-3**

10	**Pump Operation Start- Up**	
10.1	Before start-up	No. E20095 -1
10.2	Operation start-up	No. E20095 -1
10.2.1	Seal and purge gas control	No. E20095 -2
10.2.2	Cool-down of the pump (Cold-end)	No. E20095 -2-3
10.2.3	Operation of the pump	No. E20095 -3
10.2.4	Stop of the pump	No. E20095 -3
10.3	Operation disturbances	No. E10574 -4-5
11	**Overhaul and Maintenance**	**No. E10725 -1**
11.1	General requirements	No. E10725 -1
11.2	Lubrication	No. E10725 -1
11.3	Repairs and spare parts	No. E10725 -1
12	**Pump Disassembling**	**No. E10892 -1-2**
13	**Pump Assembling**	**No. E10893 -1-2-3**
	Max. Nozzle Loading / Forces-Moments	No. 414911
	Connection for Squirrel Cage Induction Motors	No. E10669 -1
	Installation Schematic	No. E10225 -1
	Seal /-Purge Gas Regulation Scheme	No. 410205
	Control-Box Labyrinth-Seal External Dimensions	No. 410199
	Cold-End Drawing	No. 014135
	Spare-Parts List Cold-End	No. E10312 -1-2-3-4
	Checklist	No. 412809

ANNEX

ANNEX: CL4-13

Arrangement drawing		No. 05.044
Accessories		No. 05.044/14
Parts list of accessories		No. 05.044/13
Data sheet suction strainer DN50		No. 3 14851
Suction strainer assembling		No. 4 11366
Temperature control at the pump		No. 4 13700
Performance curves		No. 229-04/5
Data sheet RTD's for seal leakage detection		No. 4 14034
Control box seal-/purge gas regulation		No. 4 10199
P&ID diagram		No. 05.044/11
Instrument list seal-/purge gas regulation		No. 05.044/12
Flow-control seal gas		No. 4 10214
Data sheet pressure gauge PI		
Data sheet diff. pressure gauge PDI		
Data sheet pressure regulator PDC		No. E10605
Data sheet flow- indicator FI		
Data sheet ring sensor FAL		
Data sheet switch amplifier		

E-Motor wiring diagram		No. 05.044/28
E-Motor temperature control		No. 4 13577
U-f characteristics		No. 05.044/09
Torque curve		No. 05.044/10
E-Motor operating and maintenance instructions		

Certificates		
Delivery certificate	for P71100	No. 05.044/1
Delivery certificate	for P71200	No. 05.044/2
Test certificate for suction hose		
Test certificate for discharge hose		
Certificate of conformity E Motor		

1 Declaration by the Manufacturer

(according CE Directive 98/37/EEC, Article 4.2. and Annex II, sub B.)
Prohibition to put into service

Manufacturer : SEFCO AG

Address : Wuhrmattstrasse 15, Postfach
CH-4103 Bottmingen

Herewith declares, that

the Centrifugal Cryogenic Pump(s)

- **Type:** CL4-13/EM-7,5
- **Ref. No.:** 05.044/1-2
- **Tag No.:** P71100 - P71200
- **Customer :** Air Liquide AGS GmbH
- **Order No.:** 4500023387 of 11.01.2005
- **Project name:** "ASU Košice"

is/are designed and manufactured according to the standards:
- EN 13275 Cryogenic vessels - Pumps for cryogenic service
- EN 809 Pumps and pump units for liquids - Common safety requirements
and is/are intended to be incorporated into machinery or to be assembled with other machinery covered by Directive 98/37/EEC, as amended;

and furthermore declares, that it is not allowed to put the machinery into service until the machinery into which it is to be incorporated or of which it is to be a component has been found and declared to be in conformity with the provisions of Directive 98/37/EEC and with national implementing legislation, i.e. as a whole, including the machinery referred to in this declaration.

This declaration becomes unvalid by modifications of original parts or by use of foreign products.

Bottmingen, May 10. 2005

G. Lachenmaier, Responsible technique

ppa.

2 Introduction

This instruction manual is based on a long theoretical and practical experience of SEFCO AG. It is helpful to the operating personnel to get familiar with the installation and operation of the delivered machines and components. Moreover, it points to possible dangers in connection with the use of these machines, and the means to avoid them. This manual must all time be available at the operating place of the machine.

Evidently, this instruction manual cannot cover all possible installation and operation conditions with the associated security precautions. In case of doubt, please consult SEFCO for further advice and guidance.

It is recommended by SEFCO that the owner/plant operator gives a profound training to his personnel according to the instruction manual; at the same time he makes sure, that the given instructions are understood and will be observed. Additional training at SEFCO is recommended.

It is expected that these machines/components will be operated exclusively by responsible and trustworthy professionals.

The responsibility of the owner/operator for installation, operation and safety (also in case of fire) will by no means be diminished through this instruction manual or a training at SEFCO.

In all cases the owner/operator is obliged to observe the current laws, regulations, instructions and recommendations.

In case of resale, modifications and/or alterations of the machine/installation, the information in the manual will have only limited validity; therefore a consultation of SEFCO is strongly recommended.

Spare parts must correspond with the technical requirements defined by SEFCO. This is guaranteed by original spare parts due to on-going quality systems. The use of spare parts of another origin can be a risk for safety. Spare parts of another origin can possibly change the features of the installation defined by design and cause significant defects and risks, SEFCO is not responsible for.
If for a product like electric motors a specific operation manual is attached to this manual it is relevant.

This manual was put together with greatest care. If you still need more information please contact:

SEFCO AG
Wuhrmattstrasse 15 / Postfach
CH-4103 Bottmingen
Switzerland

Tel: +41 (0)61 421 94 60
Fax: +41 (0)61 421 57 75

3 Safety

3.1 Notes and symbols

The dangers are classified into several grades. The following list shows a summary of symbols, grades of danger, signal words for dangers and possible consequences.

Symbol	Damage for...	Signal word	Definition	Consequences are...
	Persons	**DANGER!**	Immediately threatening danger	Death or heavy injuries
	Persons	**DANGER!**	Immediately threatening danger by voltage	Death or heavy injuries
	Persons	**WARNING!**	Possibly dangerous situation	Possible middle to light injuries
	Goods	**CAUTION!**	Possibly dangerous situation	Possible damage to - product - its surrounding
		Note! Information! Recommendation!	Notes for application or other useful informations and recommendations	efficient operation

3.2 General notes about dangers

Observe local regulations for accident prevention with all kind of work at liquid gas centrifugal pumps!

DANGERS!

- Cryogenic fluids:

Cryogenic fluids cause blisters in case of contact with the skin. Always wear appropriate protective clothes and glasses. Touching extremely cold subjects with bare hands one gets stuck. Always wear suitable gloves!

- Liquid oxygen:

For transferring liquid oxygen, **pumps made of stainless steel are not allowed!** By handling liquid oxygen **danger of fire** may exist. All parts coming in contact with liquid oxygen **have to be free of oil and grease**. This also applies to workshops, spare parts as well as tools in use and hands ! Attention with oxygen saturated clothing! The increased concentration of oxygen in clothing can be stable over a longer period and is therefore a significant risk of fire together with possible sources of ignition like cigarettes a.o.

- Liquid hydrocarbon:

By handling liquid hydrocarbons exists the danger of explosion! Observe the relevant regulations; only use non sparking tools.

- Works at pump:

High pressures represent a high danger potential!

For all works at the pump make sure that the driving motor is standing still and a start up can be excluded under all circumstances! Start working only when the pump is no longer pressure containing and has warmed up to ambient temperature (to avoid ice formation by humidity)

- Sprinkling liquid:

Make sure that sprinkling liquid (leaking seals) doesn't come in contact with persons! Wear protective clothes and glasses! There is danger of burning the skin.

3.3 Important notes for operation

CAUTION!

- Operational data's:

On the pump's data sheet of this manual (§ 6) the specific operational data's are listed. These data's describe an admissible range of operation for the pump. Operating outside of this range needs the approval by SEFCO!

- Parallel Operation:

To secure an optimum operation, the following points have to be observed:

- stable pump performance curve
- separated suction lines
- pumps of the same type
- consultation of SEFCO

- Series Operation:

Only after consultation of SEFCO!

4 Machinery description

4.1 Pump

The machinery-design suits the heavy duty industrial requirements and is characterised as following:

- Several stage vertical centrifugal pump, directly driven by electric motor.
- Support with hood, permanently purged between motor and pump.
- Additional purge-gas chamber at motor shield.
- Motor shaft and pump shaft are coupled with a special adjustable coupling.
- Centrifugal pump (cold-end) which consists of a one-piece casing, wherein the pump inner parts are inserted and fixed (barrel-design).
- The pump shaft is sealed with a contactless labyrinth seal.
- The rotating parts are carefully balanced. The critical clearances between impeller and casing are kept large (simple assembling, secure operation).

Material used

Cold-End : - all pump inner parts are of bronze-alloy (Cu-content > 80 %), required for oxygen operation.
- pump external casing and screwing are stainless-steel.

Support : - stainless-steel

Pump shaft : - stainless-steel

4.2 Seal gas control

The supplied seal-/purge gas control box has all components built in. On this box all necessary connections for piping between pump and box as well as necessary electrical connections are provided.

The standard version of SEFCO corresponds to drawing No. 4 10199 and adjusts, after completed setting of the pressure regulator, automatically the required seal gas pressure to the operational conditions. (see schematic No. 4 10205)

5 Additional subsystems

The following subsystems can be provided on customer special demand. Appropriate connections are available on the machinery unit.

5.1 Cold-End

Seal- and purge gas control-box for automatic control.

5.2 Additional control-subsystems

- Motor-monitoring-system:
  - Temperature control of winding by means of built-in PTC- sensors, alternative by RTD's (PT 100)
  - Temperature control of bearings by means of built-in PTC- sensors, alternative by RTD's (PT 100)
- Delivery-pressure monitoring-system:
  Machine shut down at a pressure falling below a set limit (pressure drop caused by cavitation), or at rising above a set limit (e.g. VFD operation)
- Seal leakage detection :
  Machine shut down in case the temperature at the labyrinth-seal is falling below a set limit.
- Other subsystems on customer request.

6 Machinery and Subsystems data

6.1 Machinery Data

Fluid	:	LIN
Specific weight (kg/l)	:	0.72

Centrifugal pump

Type	:	CL4-13
Material / Cold end	:	bronze
Material / Impeller	:	bronze
Number of stages	:	4
Impeller diameter / standard (mm)	:	4x 130/3.8
Impeller diameter / nominal (mm)	:	4x 130
Nominal speed (min^{-1})	:	4870
Differential head Δ H (m)	:	237.5
Differential pressure Δ p (bar)	:	16.78
Flowrate (lit/min.)	:	101.3
Required NPSH (m)	:	0.7

Sealgas-labyrinth-sealsystem

Sealgas :

Medium	:	Dry nitrogen (< 2ppm)
Temperature (°C)	:	15-20
Required sealgas pressure (bar g)		
- at the seal	:	6.5
- at the control box inlet	:	8
Sealgas capacity (Nm^3/h)		
oil-and dustfree, completely dry (< 2ppm)	:	approx. 13

Purgegas :

Medium	:	Dry nitrogen
Temperature (°C)	:	15-20
Required purgegas pressure (bar g)		
- at the purge chamber	:	min. 0,2 max. 1
- at the control box inlet	:	approx. 4
Purgegas capacity (Nm^3/h)		
(oil-and dustfree, dew point min. -50°C)	:	approx. 1

Electric motor

Manufacture	:	Theo Halter GmbH
Type	:	DDA 132 SB2
Frame Size	:	132S
Design-Form	:	IMV1
Rated Power (kW)	:	7.5
Rated current (A)	:	13.8
Rated Frequency (Field weakening point) - (Hz)	:	81
Rated Rotating Speed (min^{-1})	:	4700 / max. admissible: 5400
Protection / Insulation Class	:	IP55 / F used B
Max. ambient temperature / installation altitude (°C /m above sea level)	:	40 / 1000
Y - Voltage / Frequency / Phases (V / Hz)	:	400 / 81 /3
Motor fixing device, drawing No.	:	-

Variable Frequency Drive (VFD)

Manufacture	:	)
Type	:	)
Protection	:	)
Ambient Temperature (°C)	:	) Air Liquide supply
Mains Voltage / Frequency / Phases (V / Hz)	:	)
Rated output Current (A)	:	)
Rated output Frequency (Hz)	:	) / max. admissible:
Max. Cable Length to the Motor (m)	:	)

6.2 Additional Subsystems and Components

- Suction strainer DN50
- Flexible suction hose DN40 PN16
- Flexible discharge hose DN32 PN40
- Seal leakage detection RTD's
- Control box labyrinth-seal

7 Pump preparation

7.1 Before delivery

- Hydrostatic pressure test of cold-end casing at 1.5 times the maximum admissible discharge pressure of the pump.
- Thorough mechanical checkouts
- Standardwise degreased for oxygen operation (independent of pumped liquid and application)
- Cold-test with liquid nitrogen

7.2 On arrival at customer site

- Check for transportation damage

CAUTION!

If unit is not put immediately into operation:

„STORE IN DRY AND CLEAN ROOM"
protected from oil, dust and moisture

Keep material sealed/packed until required for use!

7.3 Handling

- Prepare suitable tools and hoists. Pay attention to the weight!

WARNING!

- Too poor dimensioned or damaged lifting equipment could tear!
- Always check the lifting equipment for correct size and faultless condition!
- Take care that no built up equipment is damaged by lifting

8 Pump installation

See installation-schematic No. E10225-1

8.1 Correct suction-line:

NOTE!

- **short** and well **insulated**.
- **simple** and **straight** ducting, without narrow bends and sudden section-changes.
- **continuous down-flow** towards pump, **no gas accumulation on suction side**.
- **optimum section** to minimise pressure-loss and heat-input.

Attention on errors!

- Narrow bends and sudden section-changes = higher pressure-loss.
- Long, narrow and poorly-insulated pipe = higher pressure-loss and heat-input.

CAUTION!

Higher pressure-loss and heat-input
↓
„Poor NPSH (§ 9)“
↓
Low suction performance, gas-formation, cavitation
↓
Poor pump performance, pressure-fluctuation, pump vibration
↓
„Pump and seal damage“

WARNING!

- Installation of a **strainer**, especially for oxygen operation!
  foreign particles may damage the pump and could cause fire or explosion.
- Installation of a **safety-valve** between main closing-valve up-stream and pump inlet (set about 1,5 bar above operational suction pressure), to avoid inadmissible pressure build-up.

8.2 Piping system and components:

We recommend a piping-system according to schematic No. E10225-1.

CAUTION!

„Piping forces on the pump casing have to be kept at a minimum"
(see list „Maximum nozzle loading")

The pump unit must be mounted and aligned with joined damping elements

NOTE!

Suction- and pressure pipes should be straightened and adjusted!
Take care of pipe-shortening due to cold (contraction).

Accordingly install **„Fix points"** and use **„Flexible Pipes"** on the pump suction- and pressure side.

Minimise flow disturbances at pump-inlet.

NOTE!

To assure proper cool-down and degassing, the pump casing vent must be connected and operated during the cool-down and priming. After priming, the vent is closed.

NOTE!

Piping system:

Schematic E10225-1 illustrates the typical installation (piping and components) for a centrifugal pump unit. The required and recommended components are indicated there.

8.3 Pump protection

RECOMMENDATION!

- In every case: put a cover over the pump to protect it against dripping water. Splashing the pump with water has to be avoided.

8.4 Electric connections

DANGER!

These works are to be carried out only by authorised professionals.

The motor connections are to be installed according to the information on the motor plate as well as schematic E 10669-1. For differing installations the schematics in the annex are valid.

CAUTION!

For VFD operated motors, make sure not to exceed the maximum admissible speed of the pump or the motor!

8.5 Purge-and seal gas control

Drawing 4 10205 shows a typical installation schematic, corresponding to the SEFCO-standard-solution. All versions supplied by SEFCO which may differ depending on the application can be found in the joined schematics in the annex.

RECOMMENDATION!

Minimum equipment should include at least the following components:

- Main valve **1**
- Non-return valve **4**
- Control valve **3**
- Differential pressure regulator (PDC)
- Differential pressure gauge (PDI)

9 Suction pressure - NPSH required

For secure start up and running of the pump, a minimum suction pressure is required (according to design, flow rate and rpm).

Liquid gases have an equilibrium pressure, usually close to the vaporisation pressure p_D Thus, a static pressure p_S greater than p_D is necessary at the pump inlet, to **avoid or minimise vaporisation and gas-formation** at a critical point of the pump.

This critical point of a centrifugal pump is commonly the leading edge of the impeller blade, where the flow is accelerated to the maximum relative velocity. Local stall will lead to even higher velocity, causing a **minimum static pressure** p_{crit} at the blade leading edge, which should **not be smaller** than the local **liquid vaporisation-pressure** p_D.

Hence, with respect to the fluid mechanics entering the pump (losses, acceleration), a static pressure p_S at the suction flange is required such that the following condition at the pump critical point is satisfied:

CAUTION!

$p_S > p_{crit} > p_D$ (p_D at critical point of the pump)

If this condition is not met, gas-formation and cavitation will occur in the impeller: the flow will stall, causing pressure-drop, vibration and pump damage.

The „NPSH"

The NPSH (**Net Positive Suction Head)** expresses the required pressure difference (p_S - p_D) above vaporisation pressure p_D at the pump suction flange. This pressure difference being divided by the liquid specific weight γ_S at suction flange, gives:

$$NPSH = \frac{p_S - p_D}{\gamma_S} = Liquid - Height$$

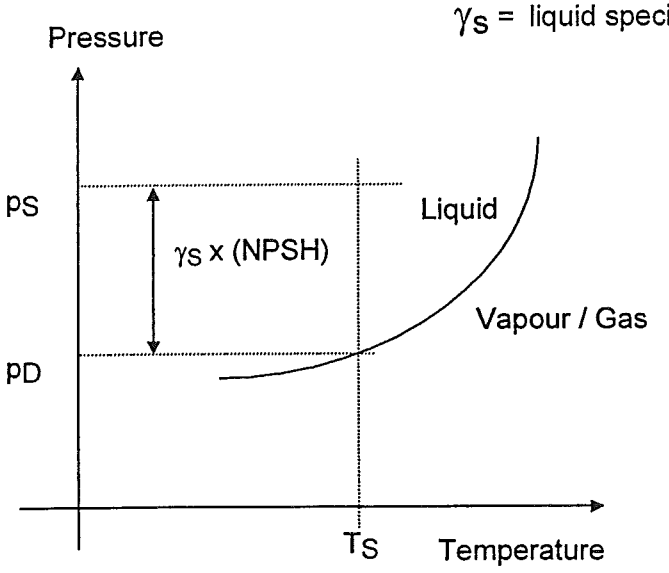
CAUTION!

For secure start-up and running of the pump, the **NPSH must be such, that p_{crit} is greater than** p_D at the pump critical point!

The NPSH is always given in „metres" at the pump suction flange

The following figure represents the NPSH in the vapour-pressure curve:

p_S = static pressure at suction flange
p_D = local vapour-pressure = f (T)
T_S = effektive flow temperature at suction flange
γ_S = liquid specific weight at suction flange = f (T_S)



According to performance and design, the machinery manufacturer determines experimentally the required NPSH for each pump type:

NPSH = f (flow rate, rpm)

NOTE!

To improve the NPSH:

- Increase the flow suction head.
- Increase the tank pressure (only efficient for a short time, as temperature will adapt again to the pressure level).
- Subcool the liquid (decrease vapour-pressure)
- Insulate the suction pipe and minimise pressure losses well
- Add an inducer (axial impeller) to increase the flow static pressure at the radial impeller leading-edge

10 Pump operation start-up

10.1 Before start-up

NOTE!

Motor without auxiliary fan

- **Rotate** machine by hand, acting on :
  - motor fan-blade or
  - hex. cap screw located in the centre of the motorshaft NDE, to check the shaft for free rotating.
- **Check rotational sense** (only on **cooled-down pump**) for correct electric-motor connection as following:

  Short electric motor-start. The observer stands above the motor looking in direction cold-end: the pump-impellers must rotate in counter clockwise direction.

Motor with auxiliary fan

- Remove separate fan and its hood and **rotate** machine by hand, acting on :
  - hex. cap screw located in the centre of the motorshaft NDE, to check the shaft for free rotating.
- **Check rotational sense** (only on **cooled-down pump**) for correct electric-motor connection as following:

  Short electric motor-start. The observer stands above the motor looking in direction cold-end:

  - The main motor and the pump-impellers must rotate in counter clockwise direction.

  Mount separate fan and its hood on main motor:

  - The separate fan must rotate in counter clockwise direction

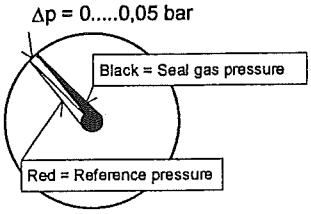
10.2 Operation start-up (see schematic No. E10225-1 and 4 10205)

CAUTION!

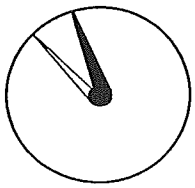
Pump should not run dry, otherwise labyrinth seal will be damaged!
During cool-down or warm up it is possible that the pump is slightly turning.
The rotational speed should not exceed 150 rpm.

10.2.1 Seal-/ purge gas control (Schematic 4 10205)

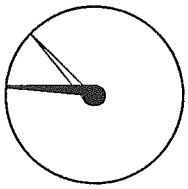
Prior, during and after pump operation, the **seal gas pressure** should be 0..... 0,05 bar above the reference-pressure (PDI) :



Optimum



Seal gas pressure too high
⇒ Pollution of pumped fluid possible



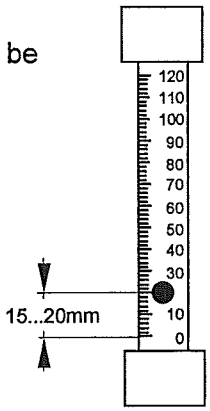
Seal gas pressure too low
⇒ Pump is leaking

Before starting the pump, the sealing-chamber must be under seal gas-pressure for at least 60 minutes, in order to evacuate air and moisture which could condense and freeze.

This will be satisfied by opening the main-valve **1** and by adjusting of the above given pressure-difference on the Differential pressure regulator (PDC).

Prior, during and after pump operation, the **purge gas pressure** should be approx. 0,01 .... 0,05 bar. Pressure adjusted with valve 3; the purge gas flowrate should be approx. 0,5 Nm^3/h.

This adjustment corresponds with approx.15...20mm on the flowmeter (FI-2) as in the annexed sketch.



10.2.2 Cool-down of the pump (cold-end) Schematic E10225-1

WARNING!

Observe chapter 3 „ Safety " when operating the pump.

- Start purge-and seal gas system. (see § 10.2.1)
- Open bypass-valve **10**, fully open Suction-valve **1**.
- Valve **7** and **8** closed
- Actuate pressure build-up system (if available), in case of low suction pressure (NPSH, see § 9): open valve **11** for a short or longer time and observe pressure build-up on pressure gauge **4**.
- Observe frost formation on cold-end casing.(if visible)
- Pump is sufficiently cooled down for start-up, once it is completely filled with liquid and degassed; Check the presence of liquid by short opening of degassing-valves **8** and **14**. Eventually measure the temperature at the pump casing before start release.

  Standard cool down time: 30 minutes with good liquid through-flow.

CAUTION!

Actuate degassing valve 14 (customer supply) on the pump support before start. (Connection at fitting G on cross sectional drawing)

Slightly throttle bypass-valve **10** and start-up motor! After a short delay the pump will come to operation and reach operating pressure. Control the by-pass valve **10** accordingly so that the maximum admissible performance of the electric motor according to the design-flowrate is not exceeded.

CAUTION!

- Do never fully open the bypass valve **10**, as there is low counter-pressure downstream. Valve **10** must act as a throttle-valve!

  At fully open valve **10**, the flowrate and hence the electric power largely exceed allowable values: the electrical overload protection should immediately shut-down the power supply, otherwise the pump through-flow will stall, causing dangerous cavitation and vibrations!
- Should the pump not come to operation pressure at first start-up, stop motor immediately, cool-down and degas the pump further (2-3 minutes), then start-up again.

10.2.3 Operation of the pump

- Close slowly bypass valve **10** and open progressively valve **7** to consumer.
- Bypass valve **10** completely closed.
- Adjust valve **7** to meet design-pressure **9** and flowrate: a reference value is the flow measurement or the electric motor power consumption which can be controlled with an amperemeter.

CAUTION!

Do not use suction valve 1 for regulation purpose! A reduction of the suction pressure could cause cavitation (bad NPSH!)

Fluctuations in pressure and flow (pulsations) as well as impacts of liquids lead to an increased and uncontrollable load on the bearings as well as to an extreme stress for the labyrinth- and driving parts.

10.2.4 Stop of the pump

- Cut off electric current to motor.
- Open bypass valve **10**, close valves **7** and **1**.
- Use valve **12** to release tank pressure.
- Close valve **10**. Release pipe pressure with valve **8**.
- Close valve **7**.
- Close main valve **1** of purge-/seal gas control once the pump has come **completely** to ambient temperature. **(avoid condensation)**.

10.3 Operation disturbances

WARNING!

Observe chapter 3 „ Safety " when operating the pump.

Disturbance	Possible reason	Correction pump *not operating*
Pump does not perform (Pressure and Flowrate)	Wrong direction of rotation Insufficient suction pressure Gas formation Suction filter blocked	Reverse motor pole connection Raise tank pressure Cool-down/degas pump well Clean suction filter
Pressure and Flowrate too low	Gas-liquid mixture (bad NPSH) Suction filter blocked Impeller- Labyrinth-clearance excessive Impeller damaged Inducer damaged	Check suction piping (see § 8.1) Raise tank pressure Clean suction filter Replace wear-rings Replace impeller Replace inducer
Power consumption too high	Electrical defects	Check electrical system
Pump vibration	Gas-liquid mixture / cavitation (flowrate too high or low) Unbalance caused by damaged impeller, inducer or shaft	Check suction-piping (increase required NPSH) Replace damaged parts or possibly re-balance. (SEFCO)
Unusual noises	Motor bearing damage Bad bearing lubrication Unbalance External tubing forces too high for the pump casing	Replace bearings Regrease or replace life greased bearing Replace impeller or inducer or possibly re-balance (SEFCO) Check fix points Exactly align pump and tubing (see § 8.2)

Operation disturbances (continuing)

Disturbance	Possible reason	Correction pump *not operating*
Unusual bearing temperature	Motor bearings damage	Replace bearings
	Bad motor bearings lubrication	Regrease or replace life greased bearings
Pump leaks	Seal gas supply insufficient Seal gas pressure too low	Check seal gas supply. Adjust with differential pressure regulator: (Seal gas pressure between 0.....0,05 bar > Reference pressure)
	Purge gas pressure too high	Throttle valve 3 (15...20mm)
	Ice formation or dirt in the labyrinth seal	Check seal gas if it is dry (< 2ppm) and clean
	Seal worn out	Replace labyrinth seal
	Leak in the seal gas supply	Leak detection, tighten fittings
	Seal-/purge gas connections incorrect	Check connections (see schematic 4 10205)

Disturbance	Possible reason	Correction pump *operating*
Power consumption too high	Max. flowrate exceeded	Reduce flowrate
Pump vibration	Gas-liquid mixture / cavitation (flowrate too high or low)	Check suction-piping (increase required NPSH) Adjust flowrate
Unusual noises	Flowrate too high or low	Adjust flowrate
Pump leacks	Seal gas supply insufficient Seal gas pressure too low	Check seal gas supply. Adjust with differential pressure regulator: (Seal gas pressure between 0.....0,05 bar > Reference pressure)
	Purge gas pressure too high	Throttle valve 3 (15...20mm)
	Ice formation or dirt in the labyrinth seal	Check seal gas if it is dry (< 2ppm) and clean
Pressure and Flowrate too low	Low rotation speed	Check rotation speed

11 Overhaul and maintenance

Repair and service must only be done by **qualified** and **especially trained** personnel.. Such training can be provided at SEFCO.

11.1 General requirements

at electric motor overhaul or other disturbances:

- Dismantle the pump
- Clean all parts and degrease carefully for oxygen operation
- Check and replace all worn-out parts
- Inspection of the electric motor:
  - Check the condition of the bearings
  - Check the insulation resistance

11.2 Lubrication

CAUTION!

- Motors without regreasing device are life greased and don't need any servicing. (Recommendation: preventive bearing change approximately every 20.000 operating hours).
- Motors with regreasing device: Intervals, grease amount and grease type according to specific tagging on the motor.
- Do not regrease during standstill or at rotating speeds above 3500 rpm.
- Electric motor bearing grease: Klüber Isoflex Alltime SL 2

11.3 Repairs and Spare parts

It is most recommended to hold spare parts stored:
Fast replacement / repairs without delay (see spare-parts list).

Indicate on spare-parts order:

- **Pump type**
- **Customer-Ref. No.**
- **Sefco Ref.-No.**
- **Part name and position** (according to spare parts list)

For larger repairs and complete overhaul, we recommend to send the machine to SEFCO. (for planning purposes and shipping formalities, please contact SEFCO first).

12 Pump Disassembling (Drawing No. 0 14135)

WARNING!

Observe chapter 3 " Safety " when working at the pump.

- The machine is electrically dead and checked for de-energizing. All tubing is at ambient temperature and not pressurized.
- Remove suction- and pressure pipe.
- Disconnect seal, purge gas and vent connections at support **13**.
- Put **Pump/Motor** unit in vertical position, with motor below.
  (for motors with frame size ≥ 250 dismantle first fan and fan hood)
- Remove screws **80**, washers **81**, nuts **82** and hood **78**.
- Remove flexible pipes (connections A, B, C, D, E, F) and pump vent **86** (connection G).
- If mounted, disconnect RTD's for cool down at motor terminal box and disconnect PI pick-up at connection **107**.
- Remove screws **14**, washers **15** and lift off casing **70**.
- Remove PTFE seal **49** (handle carefully!).
- Remove end cover **69** with diffusor **68**, then remove metallic O-Ring **48**.
- By removing screws **60**, the diffusor **68** and the end cover **69** are separated.
- Remove screws **50** and wear ring **47** from diffusor **68** only if necessary to change. **(using take-off device)**
- Remove circlip **67**, safety screw **66**, screw **65** and strain washers **64**.
- Draw-off impeller cap **63**, impeller **43** and remove keys **56**, shim **62**, bushing **51** and spring washer **40** from shaft.
- Remove intermediate casing **61** with diffusor **57**, then remove metallic O-Ring **48** and shaft sleeve **54**. (¤)
- By removing screws **60**, the diffusor **57** and the intermediate casing **61** are separated. (¤)
- Remove screws **50** and wear ring **46** from intermediate casing **61** only if necessary to change **(using take-off device)**. (¤)
- If necessary press out DU-bushing **55**. (¤)
- Remove bushing **54**, draw off impeller **43** and remove keys **52**, shim **62** bushing **51** and spring washer **40** from shaft.
- (¤) Repeat 2x these operations
- Draw-off impeller **43** and remove keys **52**, suction lid **44**, shim **45**, inducer **42**, shim **62**, press bushing **41**, and spring washer **40** from shaft.
- Remove union **84**, screws **34** and extract shaft-/ labyrinth unit from coupling **30**.

CAUTION!

For this dismounting procedure the coupling must be heated up to approx. 60° - 80°C at the shaft -seat.

- Remove adjusting nut **31** from shaft.
- Loosen screw **112** and remove press nut **32** from shaft
- Extract vertically shaft **12** from pump cover-/ labyrinth unit **39 + 16 + 24**.
- Remove swirl wheel **21**, labyrinth bushing **20**, labyrinth wheel **17** and shim **53**.
- Dismount labyrinth-holder **16,** not to be further dismantled. Part should be sent to manufacturer for maintenance.
- If replacement is required, remove screws **28**, strain washers **29** and dismount cover bushing **27** carefully.
- Remove screws **2** and dismount front slinger disc **3**.

  If support 13 should be dismounted, mark its position to motor-shield before removal; same condition applies to motor-shield and motor.
- If mounted disconnect RTD's for leakage survey at motor terminal box then remove nuts **11**, screws **9**, washers **10**, **114**, and dismount support **13**.
- Remove screws **8**, washers **7** and dismount purge chamber **6**.
- Remove distance-ring **4** and rear slinger-disc **3**.
- If necessary remove screw **33** and draw off coupling **30** from motor shaft. Remove keys **36**.

CAUTION!

For this dismounting procedure the coupling must be heated up to approx. 120° C at the shaft -seat.

13 Pump Assembling (Drawing No. 0 14135 and Checklist No. 4 12809)

WARNING!

Observe chapter 3 „ Safety " when working at the pump.

- **Prior to assembling, all parts must be carefully degreased** and checked for damages. **Spare parts shall remain originally packed until they are used.**
- **Do not use lubricants to assemble.**
- Position tolerance for electric motor:
  - Running tolerance of shaft (at Ø 25) : 0,015 mm (checklist § A-4)
  - Co-axial motorflange-concentricity : 0,020 mm (checklist § A-5)
  - Motorflange plane-run : 0,030 mm (checklist § A-6)

  Measurement according to DIN 42955
- Mount wear-rings **46** in suction lid **44** and intermediate casing **61** and secure with screws **50**. Mount wear rings **47** in diffusor **57** and diffusor **68** and secure with screws **50**. Slightly hammer screw-thread to secure.
- Mount diffusor **57** on intermediate casing **61** and secure screws **60** with circlip **59**.
- Mount diffusor **68** on end cover **69** and secure screws **60** with circlip **59**.
- Place keys **36** and pull up coupling **30** on motor shaft.

CAUTION!

For this mounting procedure the coupling must be heated up to approx. 120°C at the shaft -seat.

- Secure with screw **33**.
- Coupling check according to checklist 4 12809/B
- Mount rear slinger-disc **3** on motor shaft with screws **2**. (align screws to flattened areas)
- Mount purge-chamber **6** on support **13** then mount support on motor flange (observe position and adjust it according to checklist § C1 / C2)

Pump casing preload adjustment:

- Place pump cover **39**, shim **45**, suction lid **44**, intermediate casings **61**, end cover **69** and pump casing **70** on support **13** without placing any metallic O-Rings.
- Tighten screws 14 (4x) up to 25 Nm for prestressing the casing parts
- Adjust measure **6,15 ±0.05 mm** through peeling of shim **45** (see checklist 4 12809 § E1) This shim consists of sheet-metal layers (0,05 mm thickness) which can be peeled off separately.
- Remove pump casing **70**, end cover **69**, intermediate casings **61** and suction lid **44**.

- Place distance-ring **4** and mount second slinger-disc **3**. (align screws **2** to flattened areas)
- Heat cover-bushing **27** to 50-60°C, slip on labyrinth-cover **24** and secure with screws **28**.
- Place softened seal-washer **19** in labyrinth-cover **24**. (observe position)
- Place O-Ring **18** on labyrinth-holder **16**, introduce the unit carefully in labyrinth-cover **24** and tighten uniformly with screws **23**. **Observe positioning pin!** It is most important that these screws are uniformly tightened.
- Introduce swirl wheel **21** in labyrinth-holder **16** and place the unit vertically on a flat face with swirl wheel below.
- Introduce labyrinth-bushing **20**, shim **53** and place labyrinth-wheel **17**.
- Adjust measure **2,5 ±0.1 mm** through peeling of shim **53** (see checklist 4 12809 § F1) This shim consists of sheet-metal layers (0,05 mm thickness) which can be peeled off separately.
- Mount labyrinth-cover-unit **24** in Pump cover **39**
- Insert slowly shaft **12**, screw and tighten nut **32**, screw nut **31** and place keys **37** on shaft.
- Insert obtained shaft-unit in support **13** and coupling **30**.
- Adjust with nut **31** that the top of swirl wheel **21** and the top of labyrinth-holder **16** are on the same level.

Impeller position adjustment:

- Replace spring washers **40** by 4 rings with the following dimensions: 33 x 24.5 x 2 mm.
- Place press bushing **41**, shim **62**, shim **45** and suction lid **44**.
- Place inducer **42**, keys **52** and 1st impeller **43**. Adjust measure **1,5 ±0.1 mm** through peeling of shim **62** (see checklist 4 12809 § G) This shim consists of sheet-metal layers (0,05 mm thickness) which can be peeled off separately.
- Place shaft sleeve **54**, ring **40**, bushing **51**, shim **62**, and intermediate casing **61**.
- Place 2nd impeller **43**. Adjust measure **1,5 ±0.1 mm** through peeling of shim **62** (see checklist 4 12809 § G) This shim consists of sheet-metal layers (0,05 mm thickness) which can be peeled off separately.
- Repeat operations until last impeller. For last impeller use keys **56**.
- Remove all parts above labyrinth-holder **16** from pump shaft **12**.
- Loosen nut **31** and pull out pump shaft unit.

Final assembly:

- Place metallic O-Ring **48** in pump cover **39** by securing it in place until mounting.
- Insert shaft unit **12** in support **13** and coupling **30** then screw nut **31**.
- Place spring washer **40**, press bushing **41**, shim **62**, shim **45** and suction lid **44**.
- Place inducer **42**, keys **52** and 1st impeller **43**.
- Press DU bushings **55** in diffusors **57**.

- Place shaft sleeve **54**, place metallic O-Ring **48** in intermediate casing **61** by securing it in place until mounting, place spring washer **40**, bushing **51**, shim **62**.
- Place keys **52** and 2nd impeller **43**.
- Repeat operations until last impeller. For last impeller use keys **56**.
- Place impeller cap **63**. **Observe position!** and tighten screw **65** with approx. 40 Nm. Secure with screw **66** and circlip **67**.
- Place metallic O-Ring **48** in end cover **69** by securing it in place until mounting.
- Connect pipes between support **13** and pump.
- Place PTFE axial seal **49** on support **13** and mount carefully pump casing **70** including insulation plate. **Observe position pin!**
- Tighten screws **14** with 75 Nm.

NOTE!

It is most important that these screws are preloaded uniformly

CAUTION!

During the whole tightening process, check shaft for free rotation.

Same control of free-rotating after impeller axial clearance adjusting, pump installation and before motor-start

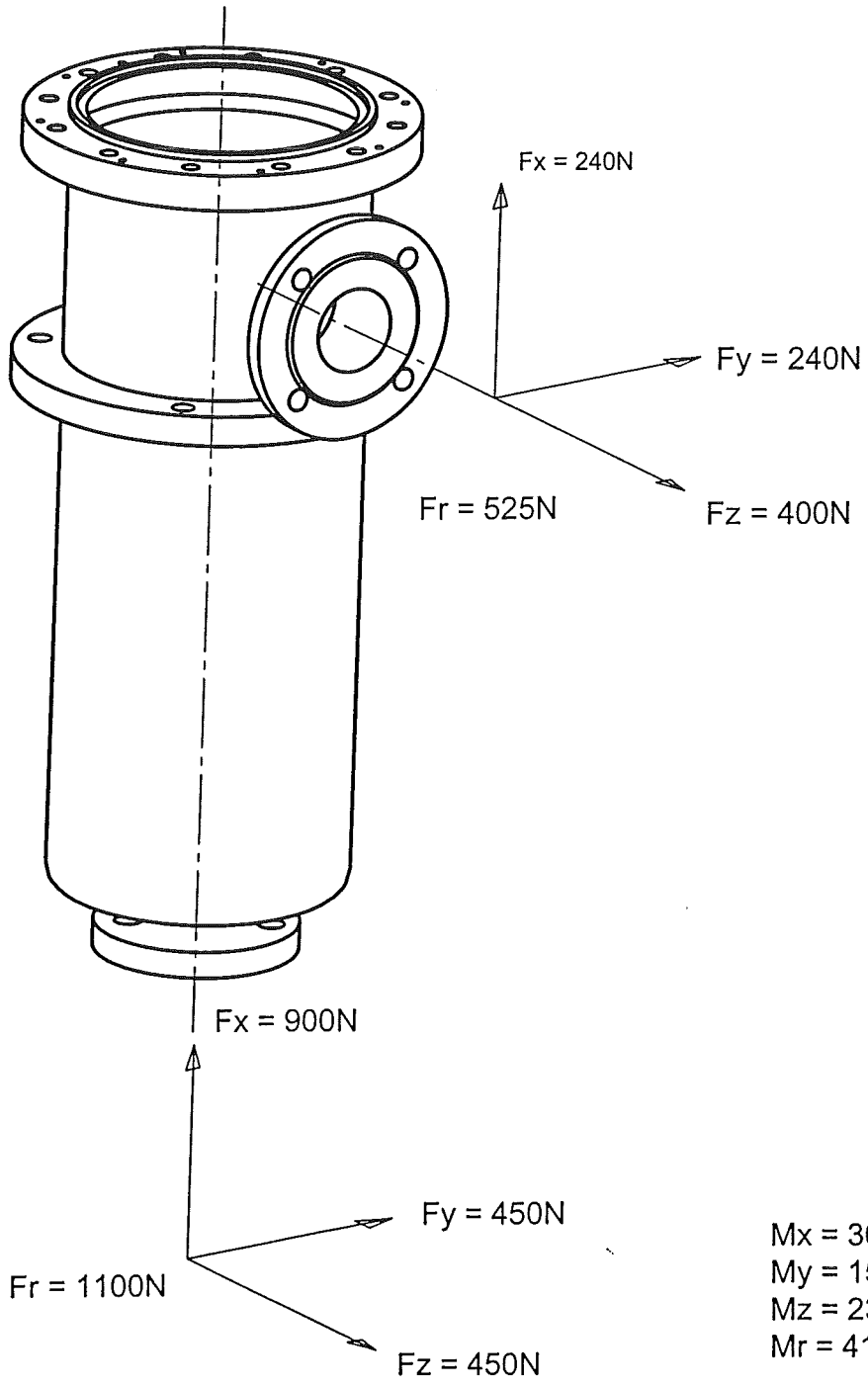
- By means of nut **31** adjust the axial clearance of the impellers approx. in the middle, and finally lock nut with screws **34**.
- Mount hood **78** and tighten with screws **80**.

sefco

4 14911

Maximale Flanschbelastung / Kräfte - Momente
Max. Nozzle loadings / Forces - Moments
Efforts max. aux brides / Forces - Moments

Pumpen-Typ :
Pump-Type : **CL(n) - 13**
Pompe-Type :



Mx = 300 Nm
My = 150 Nm
Mz = 230 Nm
Mr = 410 Nm

r = Resultierende, Resultant, Resultante

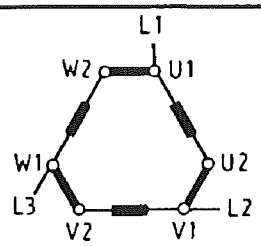
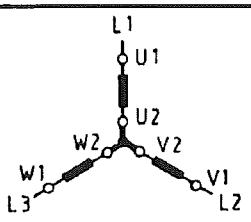
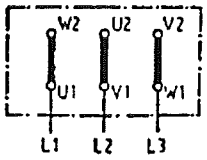
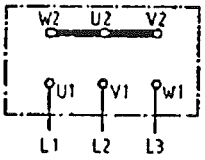
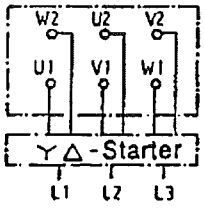
Connection for squirrel cage induction motors

Squirrel-cage induction motors are connected to the three-phase conductors L1, L2, L3. The rated voltage of the motor in the running connection must agree with the phase-to-phase voltage of the supply system.

Single speed motors:
For direct on-line starting, the running connection of the motor may be the star connection or delta connection. (For star/delta starting, the running connection must be the delta connection).

Motor winding arranged for	Supply voltage V	Running connection	
		Direct on-line starting in	Y / Δ-starting
230 Δ / 400 Y	230 400	230 Δ 400 Y	230 Δ not possible
400 Y 400 Δ	400	400 Y 400 Δ	not possible 400 Δ
500 Y 500 Δ	500	500 Y 500 Δ	not possible 500 Δ
400 Δ / 690 Y	400 690	400 Δ 690 Y	400 Δ not possible
690 Y 690 Δ	690	690 Y 690 Δ	not possible 690 Δ

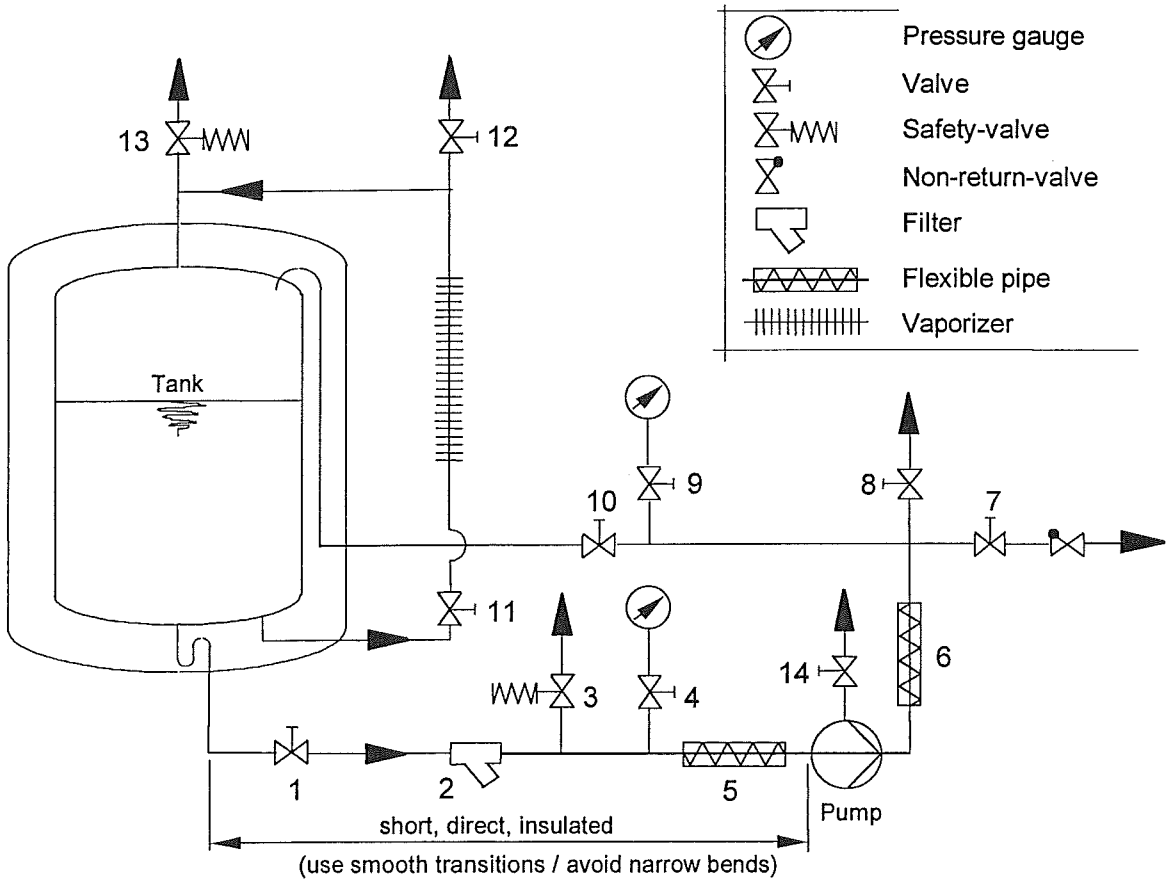
The connection of links and lines on the terminal board are dependant of the rated voltage and winding phase; e.g. for a squirrel cage induction motor with winding phase for 230 V Δ / 400 V Y with one speed the following connections must be done:

	Running connection		
	Direct-on-line starting in		Y Δ - starting
	230 V	400 V	230 V
Connection of the winding phases			The ends of the 3 windings are connected to the Y-Δ starter
Connection of links and lines	 Δ-connection	 Y-connection	

Instead of star-delta-starter preferably an electric soft-starter can be used.

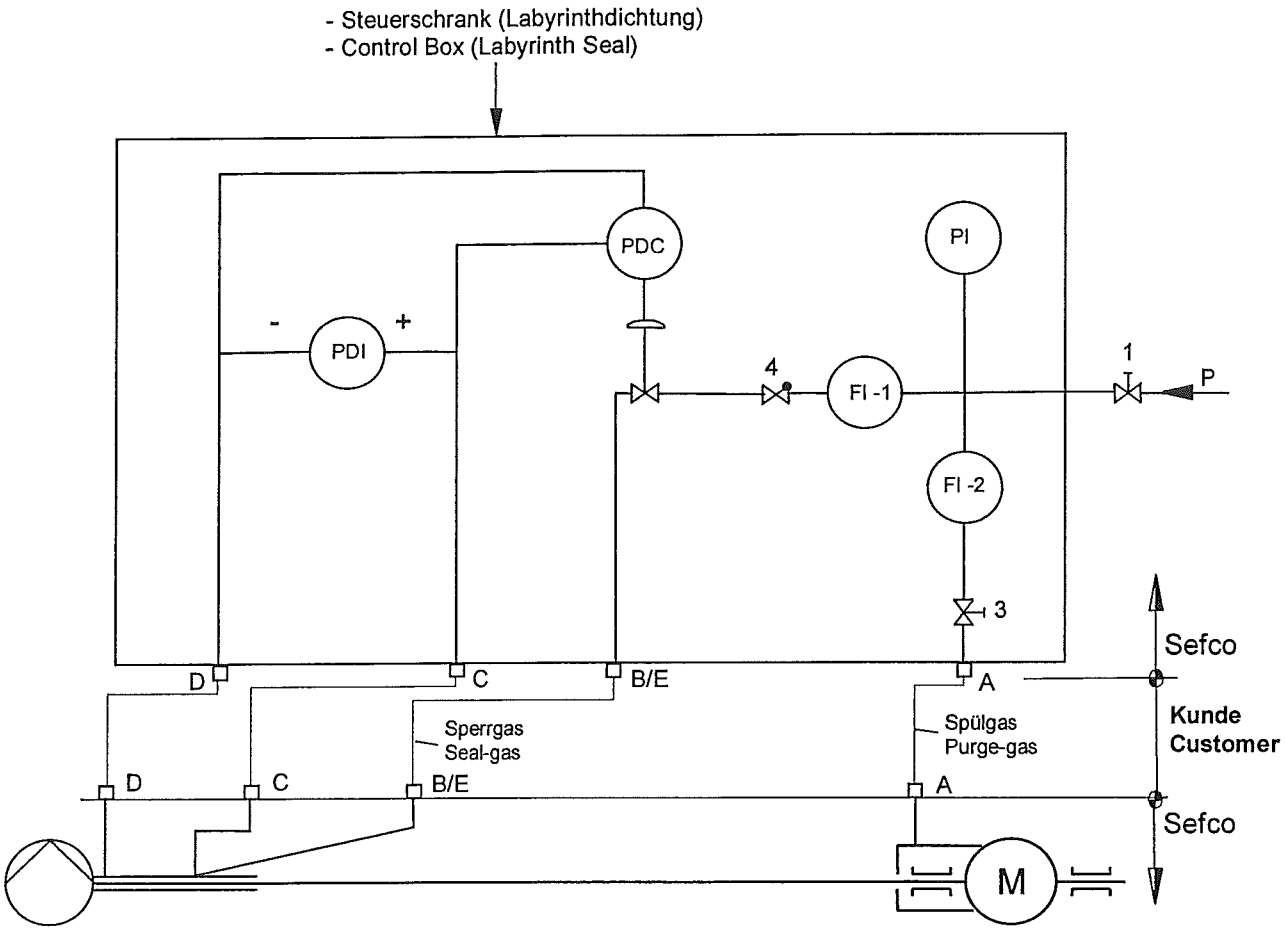
Installation schematic for centrifugal pump

The present schematic illustrates a typical system-installation for liquid-gas centrifugal pump operation, and can be extended according to needs. Accessories should at this stage be reduced to a minimum.



Pos.	Designation	Required	Recommended
1	Suction-Valve	X	
2	Filter	X	
3	Safety-Valve (Suction line)	X	
4	Pressure gauge (Suction line)		X
5	Flexible Pipe (Suction line)	X	
6	Flexible Pipe (Discharge line)	X	
7	Pressure- and Non-return-valve (to consumer)	X	
8	Degassing-Valve (Discharge line)	X	
9	Pressure gauge (Discharge line)		X
10	Bypass-Valve	X	
11	Pressure build-up System (Tank)		X
12	Degassing-Valve (Tank)	X	
13	Safety-Valve (Tank)	X	
14	Degassing-Valve (Pump casing)	X	

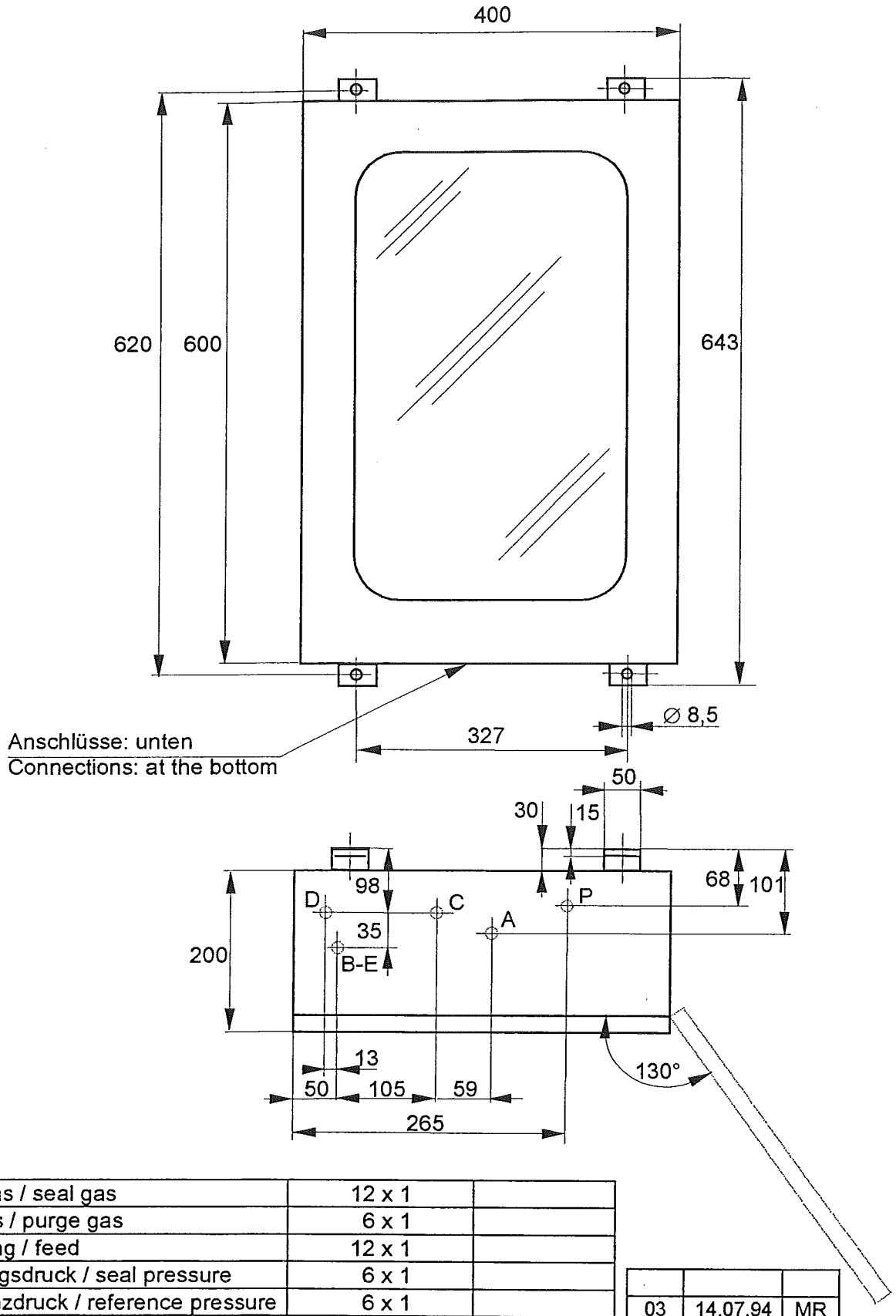
Schema Sperr- Spülgasregulierung / Scheme seal- purge gas Regulation



sefco

STEUERSCHRANK LABYRINTHDICHTUNG
CONTROLBOX LABYRINTH- SEAL

4 10199



B-E	Sperrgas / seal gas	12 x 1	
A	Spülgas / purge gas	6 x 1	
P	Speisung / feed	12 x 1	
C	Dichtungsdruck / seal pressure	6 x 1	
D	Referenzdruck / reference pressure	6 x 1	
		Rohr ∅ / Tube ∅	

03	14.07.94	MR
Rev.	Date	dwg