



**Johnston  
Pump**

A Sulzer Brand

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## JP Vertical Propeller Pumps

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Project Name: \_\_\_\_\_

Customer: \_\_\_\_\_

End User: \_\_\_\_\_

Size/Model: \_\_\_\_\_

Serial Number: \_\_\_\_\_

Customer Tag: \_\_\_\_\_

DS-V03-000 REV: 0 DATE 08/21

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## Installation, Operation & Maintenance Manual

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# TABLE OF CONTENTS

## INTRODUCTION

1.0 - 1.2	GENERAL .....	1
1.3	HOW TO USE THIS MANUAL .....	1
1.4	SYMBOLS USED IN THIS MANUAL .....	1
1.5	SPECIAL SYMBOLS .....	2
1.6	ADDITIONAL LABELING .....	2
1.7	DESCRIPTION .....	3
1.8	FEATURES .....	3
1.9	PERFORMANCE FACTORS .....	4
1.10	EXPLOSIVE ENVIRONMENT DESIGNATION .....	5
1.11	WARRANTY .....	6
1.12	LOGBOOK .....	6

## SAFETY

2.0 - 2.6	GENERAL SAFETY INFORMATION .....	7
2.7	GUIDELINES, LAWS & STANDARDS .....	7
2.8	WORK AREAS & HAZARDOUS AREAS .....	7
2.9	SYMBOLS USED .....	8
2.10	DUTIES OF THE OPERATING COMPANY .....	9
2.11	OBLIGATIONS OF THE OPERATING COMPANY .....	10
2.12	ADDITIONAL OBLIGATIONS OF THE OPERATING COMPANY .....	10
2.13	QUALIFICATION & TRAINING OF PERSONNEL .....	11
2.14	PERSONNEL REQUIREMENT .....	11
2.15	UNAUTHORIZED PERSONS IN THE HAZARDOUS AREA & WORK AREA .....	12
2.16	TRAINING & INSTRUCTION .....	12
2.17	DANGER IN NON-OBSERVANCE OF THE SAFETY REGULATIONS .....	12
2.18	SAFETY INSTRUCTIONS FOR THE OPERATING COMPANY .....	13
2.19	SAFETY INSTRUCTIONS FOR MAINTENANCE, INSPECTION & ASSEMBLY JOBS .....	14
2.20	PROHIBITION OF UNAUTHORIZED REBUILDING MEASURES OR ALTERATIONS .....	14
2.21	INADMISSIBLE OPERATING MODES .....	14
2.22	EXPLOSION PROTECTION .....	15
2.23	PUMP MEDIA-RELATED HAZARDS .....	15
2.24	AUXILIARY MATERIALS .....	16
2.25	GENERAL DANGERS IN THE WORKPLACE .....	17
2.26	DANGER DUE TO HYDRAULIC POWER .....	18
2.27	HAZARDS ASSOCIATED WITH HOT & COLD COMPONENTS .....	18
2.28	FIRE HAZARDS .....	19
2.29	PERSONAL PROTECTIVE EQUIPMENT .....	20
2.30	SAFETY DEVICES .....	21
2.31	EMERGENCY STOP SOLUTION .....	21
2.32	SECURING AGAINST BEING SWITCHED BACK ON .....	21
2.33	PROCEDURE WITH MAIN SWITCH (OPTIONAL) .....	21
2.34	PROCEDURE WITH EMERGENCY STOP SWITCH (OPTIONAL) .....	22
2.35	WHAT TO DO IN THE EVENT OF A FIRE OR ACCIDENT .....	23
2.36	SIGNAGE .....	23
2.37	PROHIBITION SIGNS .....	23
2.38	OTHER SIGNAGE .....	24
2.39	ENVIRONMENTAL PROTECTION .....	25

## TRANSPORT, RECEIVING, & STORAGE

3.0	SAFETY ADVICE FOR TRANSPORT, RECEIVING, & STORAGE .....	27
3.1	TRANSPORTING PACKAGED PUMPS / PACKAGED UNITS .....	27
3.2	INSPECTION .....	31
3.3	STORAGE .....	32
3.4	RECORDS .....	34
3.5	ADDITIONAL REQUIREMENTS .....	34
3.6	REMOVING PACKAGING .....	35
3.7	TRANSPORTING AN UNPACKED PUMP / UNPACKED UNIT .....	35

## INSTALLATION

4.0	INSTALLATION .....	36
4.1	SAFETY INSTRUCTIONS FOR INSTALLATION .....	36
4.2	GENERAL .....	38
4.3	FOUNDATION PREPARATION .....	39
4.4	INSTALLATION .....	39
4.5	SOLEPLATE INSTALLATION (IF SUPPLIED) .....	41
4.6	GROUT SELECTION & APPLICATION .....	44
4.7	SOLEPLATE GROUTING & SECURING .....	46
4.8	INSTALLATION OF THE BASKET STRAINER (IF PROVIDED) .....	47
4.9	INSTALLATION OF AN ASSEMBLED PUMP .....	48
4.10	SUCTION & DISCHARGE PIPEWORK .....	51
4.11	AUXILIARY PIPING & EQUIPMENT .....	56
4.12	MINIMUM FLOW DEVICE .....	63
	INSTALLATION SEQUENCE CHECK LIST .....	65

## ALIGNMENT

5.0	ALIGNMENT SAFETY INSTRUCTIONS .....	67
5.1	MISALIGNMENT TYPES .....	68
5.2	ALIGNMENT .....	69
5.3	REALIGNMENT .....	73

## OPERATION

6.0	OPERATION SAFETY INSTRUCTIONS .....	74
6.1	CHECK LIST .....	76
6.2	GENERAL .....	77
6.3	COMMISSIONING .....	77
6.4	PUMP STARTUP & OPERATION .....	79
6.5	STANDBY SERVICE .....	82
6.6	INADMISSABLE OPERATING MODES .....	83
6.7	SHUT DOWN OBSERVANCE SEQUENCE .....	83
6.8	RE-START PROCEDURE .....	85
6.9	SERVICE CONTROL .....	86
	PRE-START UP REQUIREMENTS CHECKLIST .....	89

## MAINTENANCE

7.0	MAINTENANCE SAFETY INSTRUCTIONS .....	91
7.1	RECORDS & ANALYSIS .....	95
7.2	GENERAL DISASSEMBLY .....	96
7.3	SHAFT SEAL CHANGEOUT .....	98
7.4	INTEGRAL THRUST BEARING CHANGEOUT .....	99
7.5	PREPARATION FOR MAJOR DISASSEMBLY .....	99
7.6	SHIPPING FROM SITE .....	99

## ASSEMBLY AND DISASSEMBLY

8.0	ASSEMBLY SAFETY INSTRUCTIONS .....	100
8.1	PREPARATION .....	103
8.2	RECORD/ANALYZE BEFORE DISASSEMBLY .....	103
8.3	DISASSEMBLY .....	104
8.4	PUMP REMOVAL .....	107
8.5	PUMP DISASSEMBLY – PRODUCT LUBRICATED .....	110
8.6	LINE SHAFT COUPLING .....	111
8.7	PUMP DISASSEMBLY – ENCLOSED LINESHAFT .....	111
8.8	BOWL UNIT DISASSEMBLY .....	112
8.9	INSPECTION .....	115
8.10	BUSHING REPLACEMENT .....	116
8.11	GENERAL ASSEMBLY .....	117
8.12	ASSEMBLY OF PUMP .....	119
	TYPICAL PUMP SECTIONAL & PARTS LIST .....	129

## INTENTIONALLY LEFT BLANK

9.0	INTENTIONALLY LEFT BLANK .....	131
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## REPLACEMENT PARTS

10.0	SPARE PARTS .....	132
10.1	PARTS ORDERS .....	132
10.2	TYPICAL CROSS SECTION .....	133
10.3	SPARE PARTS STORAGE .....	133

## ADDENDUM NO. 2

	TORQUE VALUES .....	136
--	---------------------	-----

## ADDENDUM NO. 4

	TROUBLESHOOTING .....	155
--	-----------------------	-----

## ADDENDUM NO. 11

	LONG TERM STORAGE PROCEDURES .....	163
--	------------------------------------	-----

## ADDENDUM NO. 13

	BEARING ISOLATOR INSTALLATION INSTRUCTIONS .....	169
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# INTRODUCTION

## 1.0 GENERAL

- 1.1 This manual is prepared for operation and maintenance personnel. It provides SAFETY, INSTALLATION, OPERATION, AND MAINTENANCE instructions for the Johnston Type JP large vertical propeller pumps (>24"). It contains important information on how to operate the pump safely, properly and most efficiently. Observing these instructions will help to avoid danger, to reduce repair costs and downtimes, and increase the reliability and life of the pump.



### WARNING!

Read all of the instructions carefully before performing any tasks or operating the pump.

- 1.2 Use this manual with the Cross-section drawing, Parts list, and General Arrangement drawing supplied with the order. See the auxiliary equipment section of the manual for instructions on auxiliary equipment manufactured by others and supplied by Sulzer.

## 1.3 HOW TO USE THIS MANUAL

The operating manual must always be available wherever the pump is in use. These instructions must be read and applied by any person in charge of carrying out work with and on the pump, such as transport, storage, installation, operation and maintenance.



### NOTICE!

This manual should be used in conjunction with the Cross-section drawing, Parts list, and General Arrangement drawing supplied with the order so that there is accurate information of your pump. Do not start or operate this pump unless you have complete understanding of the pump system and all auxiliary systems.

## 1.4 SYMBOLS USED IN THIS MANUAL

### 1.4.1 Definition of signal words and symbols

In these operating instructions, safety instructions are identified by symbols. The safety instructions are prefaced by signal words that express the extent of the hazard.



### DANGER!

This combination of symbol and signal word indicates an immediate danger that will cause death or serious injury if not averted.



### WARNING!

This combination of symbol and signal word indicates a potentially dangerous situation that may cause death or serious injury if not averted.

# INTRODUCTION



## CAUTION!

This combination of symbol and signal word indicates a potentially dangerous situation that may cause moderate or minor injury if not averted.



## NOTICE!

This combination of symbol and signal word indicates a potentially dangerous situation that may cause material damage if not averted.



This symbol highlights useful tips and recommendations as well as information for efficient and trouble-free operation.

## 1.5 SPECIAL SYMBOLS

Symbols are used in safety instructions to draw attention to particular dangers. A failure to observe such instructions may result in serious injury or even death.



## WARNING!

This combination of symbol and signal word indicates content and instructions for proper use of the pump in potentially explosive areas.



## WARNING!

This combination of symbol and signal word indicates a hot surface or hot substances hazard.



## ENVIRONMENT!

### Incorrect handling of ecologically hazardous substances

This combination of symbol and signal word indicates a potentially dangerous situation that may cause significant environmental damage if not averted.

## 1.6 ADDITIONAL LABELING

The following labels are used to highlight lists, references and other elements in these instructions:

Label	Explanation
•	Lists without specified order
[Button]	Control elements (e.g. buttons, switches), display elements (e.g. signal lights)
'Display'	Screen elements (e.g. buttons, assignment of function keys)
Figure 1/5	Reference to Figure 1, item number 5
Nuts (920.02)	Name of a part (part number according to section drawing)

# INTRODUCTION

## 1.7 DESCRIPTION

- 1.7.1** The JP is Johnston's "Engineered to Order" large vertical axial flow propeller pump. It is a single-entry single stage pump, available in sizes from 24" to 70" (610mm to 1778mm), Ns 14,500. The JP is specifically designed for power and water applications.



### NOTICE!

The JP is designed to handle water from  $-15^{\circ}$  C to  $85^{\circ}$  C ( $5^{\circ}$  F to  $185^{\circ}$  F).

## 1.8 FEATURES

- 1.8.1 Suction Bell & Bowl:** The suction bells are cast construction, offered with a tail bearings and anti-vortex ribs on all sizes. The propeller bowls are also cast construction with coated bowl fluid passages, free of foundry imperfections and other detrimental defects. The bowls are flanged and bolted together with capscrews to provide maximum strength, maximum life and simplified maintenance. A replaceable cylindrical cased liner (optional) can be mounted in the bowl to increase life when abrasive fluids are pumped for continuous operations as well as lower the maintenance cost. A galvanized basket type clip on strainer (optional) can be provided.
- 1.8.2 Bowl Bearing Bushings and Lubrication:** The bowl assembly shall have bronze or cutless rubber bearing bushings in each intermediate bowl to assure rotor rigidity and support. Other bearing bushing materials are available to suit the application. The bearing bushings are designed for lubrication by the pumpage. The suction bell tail bearing will have sealed for life grease packed bearing bushing to minimize shaft deflection at the propeller. For abrasive fluid applications, the tail bearing can be equipped with a lubrication grease line (optional) from the baseplate to prolong the bearing bushing life.
- 1.8.3 Propeller:** The open propellers are cast construction. The propeller is mounted on the pumpshaft with an axial retaining ring and circumferential key to provide a nonslip engagement and to allow easy disassembly. The propeller is statically and dynamically balanced to reduce vibration and will be polished for maximum performance.
- 1.8.4 Shafting:** The shafts of the pump unit shall be of ample size to transmit maximum torque required by the pump over the entire range of operation and operate without objectionable distortion or vibration. The shaft will be made of Stainless Steel, as standard, that is turned ground and polished. The lineshaft section shall be 10 ft. max (3 Meters max). Lineshaft couplings are threaded for shaft diameters up to 2.69" (68.3mm). For larger sizes the coupling will be a sleeve, key and split ring type.
- 1.8.5 Column:** The column assembly, when required, will be either threaded (up to 12" or DN 300) or flanged construction. The bearing spiders will be fabricated into the column pipe and house the rubber (or other suitable material) bearing bushings. Bearing spiders will be provided at each column joint. Product lubricated column assemblies are offered as standard. Oil lubricated or clean water flush column assemblies, when required will be supplied with an enclosing tube that is either threaded or flanged (size dependent). One enclosing tube stabilizer of rubber will be provided per 30 ft. (9 meters) of column assembly.
- 1.8.6 Discharge Head:** The discharge head will be made of a fabricated construction. These heads are offered with a flanged or plain end connection and have a built-in

# INTRODUCTION

driver stand to support the driver. The discharge elbow will be of long-sweep type consisting of at least three welded fabricated sections to allow minimal loss. The discharge nozzle can be positioned either above or below ground.

- 1.8.7 Shaft Sealing:** For the product lubricated column assembly a cast stuffing box will be provided with a throttle bushing, lantern ring, split gland and as a minimum 5 rings of graphite packing providing positive seal and minimum maintenance. A by-pass stuffing box will be provided when discharge pressure exceeds 175 psi (12 Bar). A cartridge type mechanical seal is also offered as an option. These stuffing box assemblies are offered as standard with a headshaft sleeve. For the enclosed lineshaft column assemblies, the shaft sealing is accomplished by packing below the tube tension nut. A tube tension plate will be provided to keep the shaft enclosing tube under tension.
- 1.8.8 Drive Coupling:** For solid shaft motors, a steel flanged adjustable coupling (Rigid Coupling) will be furnished to connect the pump's top shaft to the motor shaft and facilitate vertical adjustment of the impeller while assuring proper clearances. This coupling also provides clearance for the mechanical seal replacement. When a mechanical seal is required, a spacer will be provided to accommodate the removal of the seal without the removal of the driver. All rigid couplings, for 500 HP and larger units operating at speed over 2500 rpm, will be dynamically balanced. If a thrust bearing is present, a steel membrane type flexible coupling will be furnished to connect the pump's top shaft to the motor shaft. When a mechanical seal is required, a spacer will be provided to accommodate the removal of the seal without the removal of the driver.
- 1.8.9 Thrust Bearing Assembly (option in U.S. Pumps):** The pump unit may be equipped with an integral thrust bearing to carry all hydraulic axial and static loads. Thrust bearing assemblies are available to fit the entire large vertical pump range. Standard bearing life – L10 life of 25,000 Hours (Rated Flow), L10 life of 16,000 Hours (Min. Flow).
- 1.8.10 Soleplate:** The pump unit may be equipped with a separate soleplate.
- 1.8.11 Auxiliary Piping:** Auxiliary piping may be required for vent and drain connections. Factory installed piping and required external connections are noted on the General Arrangement drawing and any referenced piping drawing(s).



Additional equipment such as vent valves and expansion joint are not supplied.

## 1.9 PERFORMANCE FACTORS

Centrifugal pumps are supplied designed for a specific service. Any change in fluid specific gravity, viscosity, pump operating speed, or NPSHA (net positive suction head available), can result in loss of performance or damage.



### CAUTION!

Do not change operating conditions from the original specification without contacting a Sulzer representative.

# INTRODUCTION

## 1.10 EXPLOSIVE ENVIRONMENT DESIGNATION



Pumps supplied in the European Union (EU), or the European Free Trade Association (EFTA) may be subject to the requirements of EU directive 94/9/EC (ATEX) and will be marked with an appropriate nameplate. The pump designation will allow their use in the following areas.

Group II			
Category 2		Category 3	
G (zone 1)	D (zone 21)	G (zone 2)	D (zone 22)

**G – potentially explosive gas atmosphere**

**D – potentially explosive dust atmosphere**

**1.10.1 Temperature classes** Ensure that the pumps are classified according to their group and provided with the appropriate certificates. Each group is determined by the ambient gas or ambient dust and temperature class, at a maximum ambient temperature of 40 °C (104 °F).



**WARNING!**

The maximum temperature permissible for the conveyed material must also be observed for the temperature class in question. The responsibility for observing the conveyed material temperature always lies with the operator.

Temperature class	T1	T2	T3	T4	T5
Maximum temperature	450 °C (842 °F)	300 °C (572 °F)	200 °C (392 °F)	135 °C (275 °F)	100 °C (212 °F)
Max. medium temperature	430 °C (806 °F)	280 °C (536 °F)	180 °C (356 °F)	115 °C (239 °F)	80 °C (176 °F)

### 1.10.2 Example of pump component designation



**II 2 G T3**

Group \_\_\_\_\_

Category \_\_\_\_\_

Temperature class \_\_\_\_\_

### 1.10.3 Example of EX Label



Note the CE declaration of conformity in the Appendix.

## 1.11 WARRANTY

**1.11.1** Warranty is assumed according to the contractual agreements. The normal Sulzer warranty covers manufacturing or material defect, it does not cover the damage caused by improper storage conditions, incorrect installation, operation and using against designated use.

# INTRODUCTION

**1.11.2** During the warranty period, modifications, disassembly or repairs can only be worked out by our service personnel or with our written approval.

Any warranty claim shall become void in the event of:

Unsuitable or improper use of the pump/unit

Non-observance of these instructions

Incorrect assembly or commissioning by the purchaser or third party

Unauthorized modification or alteration of the pump/unit

Unauthorized interventions that are not described in these instructions

The use of non-original spare or replacement parts.

Normal wear and tear

Incorrect or negligent handling

Defective construction work

Unsuitable operating materials

Unsuitable foundation ground

Chemical, electro-chemical or electrical influences - unless this is the responsibility of Sulzer

## 1.12 LOGBOOK

Sulzer recommends keeping a logbook for pump operation. This logbook is used for recording operating data, for logging and documenting important work, such as maintenance, and for filing completed logs.

# SAFETY

## 2.0 GENERAL SAFETY INFORMATION

2.1 This section of the manual contains an overview of all the important safety aspects for personal protection as well as installation, commissioning, operation, and maintenance of the pump/unit. Additional task related safety instructions can be found in sections concerning the individual lifecycle phases.



### WARNING!

This manual must be available at all times on site for the use of service, or site personnel. It must also be read prior to commissioning and/or assembly or disassembly of the pump/unit.

- 2.2 Residual risks arising from the pump and other components of the unit, even when used as intended, are identified in this section. To reduce the risk of personal injury and property damage and avoid dangerous situations, observe the safety instructions listed in here and the safety instructions in the additional sections of this manual.
- 2.3 Specific safety instructions for the individual lifecycle phases precede the corresponding sections of this manual.
- 2.4 Additional task-related warning notices can be found in the sections concerning the individual lifecycle phases.
- 2.5 For a machinery and equipment safety concept to be effective, the operating company must ensure that the operating personnel are suitably qualified. The personnel requirements section (2.14) explains what qualifications are required for the work described in this manual.
- 2.6 Proper use also requires compliance with all the specifications within this manual. Any other use or wider application shall be considered misuse.



### WARNING!

#### Pump misuse!

Incorrect use of the pump may result in death, serious injury or significant property damage.

- Never operate the pump dry.
- Never use the pump to pump unauthorized pump media. If in doubt, contact Sulzer Pumps.
- Never operate the pump in the wrong direction of rotation.
- Never operate the pump with insufficient bearing lubrication or incorrect lubricant.
- Observe all of the limit values for operation specified in the data sheet.

## 2.7 GUIDELINES, LAWS AND STANDARDS

Local accident prevention regulations and general safety rules apply with regard to the field of application of the pump/unit.

## 2.8 WORK AREAS AND HAZARDOUS AREAS

2.8.1 The work area refers to the user side of the pump. The user side is identified in the layout plan.

# SAFETY

2.8.2 The hazardous area is the entire chamber around the unit. Only authorized persons may remain in the hazardous area

## 2.9 SYMBOLS USED



### Flammable materials

Keep all ignition sources away from the pump medium (e.g. naked flames, hot heat sources, non-explosion-proof electrical equipment).

Welding, cutting and grinding work must not be performed



### Hot surface

Hot surfaces, such as hot machine components, containers or materials, and even hot liquids, cannot always be detected. Do not touch without protective gloves.



### Cold Surfaces

Frostbite on hands, feet and eyes is a particular risk. Wear cold-resistant protective clothing.



### Radioactive materials

Only work with radioactive materials or ionising radiation after authorization by the radiation safety officer.

Follow radiation protection instructions and wear appropriate protective clothing when working.

During work, a radiation safety officer must be continually present or within immediate reach.



### Corrosive materials

A chemical burn to the eyes can cause irreparable eye damage. A chemical burn to skin and other human tissue can cause serious injury.

For any work involving corrosive substances, wear chemical-resistant protective clothing and use corrosion-resistant tools or containers (e.g. bottles, vessels).

Unauthorized persons and persons without corrosion-resistant protective clothing may not enter the workplace.



### Explosive materials

All boxes, packages and containers containing explosive materials are labelled with this warning symbol.

Keep all ignition sources away from the potentially explosive area (e.g. naked flames, hot heat sources, non-explosion-proof electrical equipment).

Welding, cutting and grinding work must not be performed.

# SAFETY



## **Hazardous or irritant substances**

These substances can irreparably damage health, trigger allergies or irritate mucous membranes.

Observe specifications on the packaging and containers.

Keep these substances away from food and feed.



## **Poisons**

Only persons authorized by the operating company can handle poisonous hazardous substances.

A failure to observe operating instructions can seriously injure health or lead to death.

Hazardous substances with poisonous properties must always be kept in rooms or cabinets that are sealed and inaccessible to unauthorized persons.

Keep away from food and feed. Observe hygienic measures

Avoid contact with skin. In the event of an accident or ill health, contact a physician immediately.



## **Electrical voltage**

Only qualified electricians are permitted to access and work in areas featuring this sign.

Unauthorized persons must not enter work areas featuring this sign or open cabinets bearing this sign.



## **Improper transportation!**

Improper transportation can endanger personnel as well as cause damage to the goods being transported.

Proceed carefully when unloading transportation items and transporting goods internally and observe the symbols and instructions on the packaging.



## **Danger of being pulled in by moving components!**

Being pulled in by moving components can cause serious injury.

Observe the stopping time: ensure the components are no longer moving before opening covers.



## **Explosive environment designation**

Pumps supplied in the European Union (EU), or the European Free Trade Association (EFTA) may be subject to the requirements of EU directive 94/9/EC (ATEX) and will be marked with an appropriate nameplate. This equipment is subject to either an explosive gas or dust atmosphere.

## 2.10 DUTIES OF THE OPERATING COMPANY

2.10.1 The operating company is considered to be the owner/individual who, for commercial or business purposes, operates the pump/unit or relinquishes it for use/application by a third

# SAFETY

party and who bears legal responsibility for protecting the users, personnel or third parties during operation of the product.



## WARNING!

It is the responsibility of the operating company to install any guards and protective devices to detect short circuits and isolate all phase connections.

## 2.11 OBLIGATIONS OF THE OPERATING COMPANY

**2.11.1** The pump is used in a commercial area. Because of this the operating company is subject to the statutory regulations governing health and safety at the workplace.

**2.11.2** In addition to the safety instructions contained in these operating instructions, the pertinent HSE regulations for the pump's field of application must be complied with.

This applies particularly to the following:

- The operating company must ensure that personnel are fully informed of all pertinent industrial health and safety regulations and must perform a risk assessment to identify any additional hazards specific to the pump site. They must implement these in the form of operating instructions for pump operation.
- During the entire time the pump is in use, the operating company must check that the operating instructions prepared by them meet the current version of the set of rules, and adapt them as necessary.
- The operating company must explicitly regulate and assign responsibilities for installation, operation, fault clearance, maintenance and cleaning.
- The operating company must ensure that all personnel handling the pump have read and understand these instructions. They must also provide regular training for personnel and ensure that they are fully informed about the hazards involved.
- The operating company must provide personnel with the necessary protective equipment and ensure that they wear it.
- The operating company must inform personnel about special hazards associated with the pump medium and provide safety instructions on handling it.
- The operating company must put up applicable prohibition signs in a highly visible location at the pump site.
- The operating company is responsible for ensuring that the pump remains in perfect working order at all times. The following therefore applies:
- The operating company must ensure adherence to the maintenance intervals stipulated within the operating instructions.
- The operating company must arrange for regular inspections of all safety systems to ensure that they are fully functional and complete.

## 2.12 ADDITIONAL OBLIGATIONS OF THE OPERATING COMPANY

**2.12.1** The operating company must comply with additional obligations for Directive 99/92/EC, which sets out the minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres. This includes complying with additional organizational measures, such as:

Labelling potentially explosive areas

Preparing an explosion protection document for each zone

Issuing access prohibition for unauthorized persons

Clear signage for all prohibitions

# SAFETY

## 2.13 QUALIFICATION AND TRAINING OF PERSONNEL

The personnel who service, maintain, inspect, and assemble the equipment described in this manual must have the necessary qualifications for these jobs. Range of responsibility, competence, and monitoring of personnel must be established by the operating company. The operating company must ensure that adequate training is provided. If requested and coordinated by the operating company, the equipment supplier may undertake training and instruction. Further, the operating company must ensure their personnel have a complete understanding of the contents of the manufacturer's instruction manual.



### WARNING!

- Before commencing any work, all personnel must read these instructions carefully and ensure that they understand them. To ensure that work is completed safely, it is essential that personnel comply with all safety instructions, warning notices and handling instructions contained in this manual.
- Personnel shall only be permitted to work if they can be relied upon to perform their work correctly. Anyone whose reactions are impaired through drug use, alcohol or prescription medication, for instance, must not be permitted to work with the pump.

## 2.14 PERSONNEL REQUIREMENTS



### WARNING!

- Any unqualified personnel working on the pump or situated within the hazardous area of the pump are at risk of causing serious injury or significant material damage.
- All activities must be performed by appropriately qualified personnel only. Keep unqualified personnel away from hazardous areas.

Following is a list of the qualifications required by personnel working in the various different areas:

### 2.14.1 Electrician

Electricians with an additional qualification in explosion protection are trained for the special task area in which they are active, and they know the relevant standards and provisions. Electricians with an additional qualification in explosion protection can work on electrical systems or partial components in explosive areas thanks to their expert training and experience, and independently detect and avert potential dangers.

### 2.14.2 Piping construction specialists

Piping construction specialists with additional qualifications in explosion prevention are trained for the specialized field in which they are active, and they are familiar with the pertinent standards and provisions. Based on their technical training and experience, specialists in piping construction with an additional qualification in explosion prevention can work on piping in explosive areas and independently detect and avert potential dangers.

### 2.14.3 Pump specialists

Pump specialists with additional qualifications in explosion prevention are trained for the specialized field in which they are active, and they are familiar with the pertinent standards and provisions. Based on their technical training and experience, specialists in pump installation and operation with additional qualifications in explosion prevention can work on pump units in explosive areas and independently detect and avert potential dangers.

### 2.14.4 Specialists

# SAFETY

Specialists for potentially explosive areas have the specialist training, knowledge and experience of pertinent standards and regulations to perform work on systems or sub-components in a potentially explosive area. Specialists for potentially explosive areas are able to detect potential dangers and avoid hazards.

## 2.14.5 Sulzer personnel/personnel trained by Sulzer

Certain tasks may only be performed by experts of Sulzer Pumps or by personnel trained and authorized by Sulzer Pumps. Other personnel are not authorized to perform these tasks.

## 2.14.6 System operator

The system operator has the necessary training, knowledge and experience, plus a sound knowledge of the pertinent standards and legal provisions, to be able to perform their specific functions properly. The system operator is able to detect possible dangers resulting from operation of the pump and avoid hazards.



### CAUTION!

When selecting personnel, please observe any age and job-specific provisions applicable at the system site.

## 2.15 UNAUTHORIZED PERSONS IN THE HAZARDOUS AREA AND WORK AREA



### WARNING!

- Unauthorized persons who do not fulfil the necessary requirements are not familiar with the dangers in the work area and are therefore at risk of death or serious injury.
- Keep unauthorized persons out of the hazardous area and work area.
- In case of doubt, speak to the person and send them out of the hazardous area and work area.
- Stop all work until all unauthorized persons have left the hazardous area and work area.

## 2.16 TRAINING AND INSTRUCTION

The operating company must provide regular training and instruction for personnel. To keep track of training, a training record containing the following information, at the very least, must be kept:

- Date of training
- Name of the employee receiving training
- Content of training
- Name of instructor
- Signatures of the trainee and the instructor

## 2.17 DANGER IN NON-OBSERVANCE OF THE SAFETY REGULATIONS

**2.17.1** Non-observance of the safety regulations may endanger persons as well as machinery and the environment. It may also invalidate claims for damages.

**2.17.2** Non-observance may lead to the following dangers:

- Failure of important functions of equipment/plant
- Failure of required procedures of maintenance and repair
- Endangerment to personnel by chemical, electrical, and/or mechanical means
- Endangering of environment by leakage of dangerous materials

# SAFETY

- The noise level in the work area can cause serious damage to hearing
- Slipping on fluid that has pooled on the floor can cause fall-related injuries
- Contact with hot surfaces or fluids may cause serious burns to the skin
- Contact with cold surfaces or fluids may cause serious damage to the skin

## 2.18 SAFETY INSTRUCTIONS FOR THE OPERATING COMPANY

- 2.18.1** The safety regulations given in this operation manual, national and state regulations on accident prevention, as well as company safety regulations issued by the user, must be observed.



### WARNING!

It is the responsibility of the operating company to install any guards and protective devices to detect short circuits and isolate all phase connections.

- 2.18.2** It is the responsibility of the operating company to install necessary provisions in the event of power loss. In such a case, control must disconnect all connecting lines. The pump must be allowed to slow down naturally until it stops. Device shall not move in an uncontrolled manner upon power restoration.
- 2.18.3** During out of range conditions, the pump may induce excessive vibrations. It is the responsibility of the operating company to assess this risk to and install a control system to react accordingly. If such a system is installed, qualified personnel must be trained on monitoring it.
- 2.18.4** Special precautions are required around pumps installed with oil mist lubrication. When used in enclosed spaces, oil mist removal and/or PPE must be used near source. Applicable PPE includes safety shoes, protective clothing, protective gloves, and respiratory protection. Also observe specifications of oil mist manufacturer.
- 2.18.5** When installed in subzero temperatures, pump can be hazardous to touch. Personnel are to wear safety gloves and clothing as appropriate.
- 2.18.6** Safety guards for rotating parts (e.g. coupling, mechanical seal area) may not be removed from equipment while in operation.
- 2.18.7** If pumpage contains radioactive elements, the operating company is responsible to ensure that all components that have been in service are fully decontaminated prior to any work commencing.
- 2.18.8** Leakages (e.g. from mechanical seal) of dangerous fluids (e.g. explosive, toxic, hot etc.) have to be disposed of in such a way as to prevent endangerment of personnel and the environment. Legal regulations must be observed. Observe all Safety Data Sheets (SDS) from manufacturers of consumables used.
- 2.18.8** Electrical hazards (including potential Lightning strikes on outdoor equipment) have to be excluded (details see example in the regulations of national, state and/or local energy suppliers).
- 2.18.9** If any non-standard flanges are used, it is the responsibility of the manufacturer to include any special instructions from the flange and gasket supplier.
- 2.18.10** Special safety instructions in the following paragraphs of this operating manual must be observed.

# SAFETY

## 2.19 SAFETY INSTRUCTIONS - MAINTENANCE/ INSPECTION/ ASSEMBLY JOBS

- 2.19.1 Work on the equipment must be carried out only during shutdown of the equipment. The procedure described in the operating manual for the shutdown of the equipment has to be strictly adhered to. The equipment has to be guarded against unauthorized or involuntary start-up.
- 2.19.2 Employees with long hair must tie it back. No loose clothing or jewelry, including rings should be worn. There is a risk of injury if such objects are caught or pulled into rotating equipment during operation.
- 2.19.3 Equipment operating with liquids hazardous to health must be decontaminated before being worked on.
- 2.19.4 If pumpage contains any biological or microbiological hazards, personnel shall wear safety clothing, gloves, and glasses as appropriate.
- 2.19.5 Upon completion of work, all safety and protective devices must be reattached.
- 2.19.6 On a repeated start-up, all points given in the section on commissioning must be observed.

## 2.20 PROHIBITION OF UNAUTHORIZED REBUILDING MEASURES OR ALTERATIONS

Alterations or rebuilding measures on the equipment are only admissible in agreement with the manufacturer. Original spare parts and auxiliary equipment authorized by the manufacturer are meant to guarantee safety. The use of other parts may lead to a loss of the manufacturer's liability for the consequences.



### WARNING!

#### Only use original spare parts or spare parts authorized by Sulzer Pumps!

- The use of incorrect or faulty spare or replacement parts may put personnel at risk as well as cause damage, malfunctions or total equipment failure.
- If there are questions, always contact Sulzer Pumps.
- Obtain spare and replacement parts directly from Sulzer Pumps.
- If unauthorized spare or replacement parts are used, the warranty of Sulzer Pumps becomes void.

## 2.21 INADMISSIBLE OPERATING MODES

- 2.21.1 Incorrect use of the pump may result in death, serious injury or significant property damage.



### WARNING!

#### Pump misuse!

- Never operate the pump dry.
- Never use the pump to pump unauthorized pump media. If in doubt, contact Sulzer Pumps.
- Never operate the pump in the wrong direction of rotation.
- Never operate the pump with insufficient bearing lubrication or incorrect lubricant.

- 2.21.2 The operational safety of the delivered equipment is only guaranteed by proper use according to the data sheet of this operating manual.
- 2.21.3 The limits given in the data sheet or nameplate must not be exceeded in any case.

# SAFETY

## 2.22 EXPLOSION PROTECTION



### WARNING!

- Any designation of the pump refers to the pump component only. Shaft coupling, driver (e.g. electric motor) and auxiliary systems (shaft sealing, lubricating oil system, etc.) must be looked at separately.
- Exposure to ignition sources, such as sparks, naked flames and hot surfaces, can cause an explosion in areas with a potentially explosive atmosphere. This may result in death, serious injury or significant material damage.

- 2.22.1** Improper operating methods that result in the specified temperatures being exceeded (exceeding or falling short of the operating data, falling short of the minimum delivery flow, reduction or failure of cooling water or circulation delivery, etc.) should be avoided at all costs.
- 2.22.2** Before starting the pump, ensure that the pump system (suction pipe, pump casing and shaft seal) is completely full of fluid. This prevents the existence of any potentially explosive atmosphere in the system.
- 2.22.3** Monitor the pumps operation regularly. Instruments that can be used include, but are not limited to, manometers, thermometers, speed counters, ammeters, etc.
- 2.22.4** Maintain the pump properly. Only equipment that is in good technical condition can guarantee safe operation.

## 2.23 PUMP MEDIA-RELATED HAZARDS



### DANGER

#### Radioactive pump medium!

Contact with the pump medium, or presence in its vicinity, can cause serious radiation damage and even death.

- Follow all the radiation protection instructions.
- Appropriate protective clothing must be worn when performing work.
- All work must be supervised by a radiation safety officer.
- If radioactive material is released, contain it or prevent it from escaping any further. Inform the radiation safety officer immediately.
- Unauthorized persons must not have access to the workplace.



### DANGER

#### Poisonous pump medium!

Direct contact with the pump medium through physical contact, inhalation or skin puncture can lead to serious damage and even death.

- Avoid contact with the pump medium.
- When handling the pump medium, wear the personal protective equipment provided in addition to that mentioned here.



### WARNING

#### Pump medium is a health hazard!

Direct contact with the pump medium through physical contact, inhalation or skin puncture can lead to serious damage and even death.

- Avoid contact with the pump medium.

# SAFETY

- When handling the pump medium, wear the personal protective equipment provided in addition to that mentioned here.

## **WARNING!**

### **Hot pump medium!**

Direct contact with hot pump medium through physical contact, inhalation or skin puncture can lead to serious burns and even death.



- Avoid contact with the pump medium.
- Allow pump medium to cool.
- When handling the pump medium, wear the personal protective equipment provided in addition to that mentioned here.

## **WARNING!**

### **Cold pump medium**

Direct contact with the pump medium through physical contact, inhalation or skin puncture can lead to serious frostbite injuries and even death



- Avoid contact with the pump medium.
- Allow pump medium to warm to ambient temperature.
- When handling the pump medium, wear the personal protective equipment provided in addition to that mentioned here.

## **WARNING!**

### **Highly flammable pump medium!**

Contact with sources of ignition can ignite the pump medium and cause serious burns or even death.



- Keep all ignition sources away from the pump medium (e.g. naked flames, hot heat sources, non-explosion-proof electrical equipment).
- Welding, cutting and grinding work must not be performed.

## **WARNING!**

### **Corrosive pump medium!**

A chemical burn to the eyes can cause irreparable eye damage. A chemical burn to skin and other human tissue can cause serious injury.



- Avoid contact with the pump medium.
- For any work with corrosive substances, chemical-resistant protective clothing must be worn and corrosion-resistant tools or containers (e.g. bottles, vessels) used.
- Corrosive pump medium must not enter the sewage system, surface water or ground water. Contact the responsible authorities if the sewage system, waterways or ground become contaminated.

## 2.24 AUXILIARY MATERIALS

At certain points where indicated in the text, the use of auxiliary materials not included in the scope of delivery is recommended to perform various tasks. This includes the use of:

Lubricant (for sealing rings)

# SAFETY

- Lubricant (for threads)
- Sealant (for metal surfaces or plastic gaskets)
- Solvent (for dirty surfaces)
- Rust inhibitor (for uncoated metal surfaces)
- Preservative (for storage of components)

Observe the corresponding manufacturer's safety data sheet (SDS) and the manufacturer's safety instructions detailed on the products themselves.

## 2.25 GENERAL DANGERS IN THE WORKPLACE

### WARNING!

#### Electricity related hazards!



- Risk of death from electrical shock.
- Lightning strike on outdoor equipment
- When the electric motor is energized.
- When electronic sensing equipment is energized

### WARNING!

#### Noise during operation!



- The noise level in the work area can cause serious hearing damage.
- Always wear ear protection when working.
- Only enter the hazardous area if necessary.

### CAUTION!

#### Pooled fluid on the floor



- Slipping on fluid that has pooled on the floor can cause fall-related injury.
- Remove pools of fluid immediately using suitable means.
- Wear slip-resistant safety shoes.
- Attach warning notices and mandatory signs at areas where fluid could pool on the floor.

### WARNING!

#### Danger of being pulled in by moving components!



- Being pulled in by moving components can cause serious injury.
- Do not handle moving components during operation.
- Do not grasp moving components during operation.
- Never open covers during operation.
- Observe the stopping time: ensure that the components are no longer moving before opening the covers.
- Wear closely fitting protective clothing with a low tear resistance in the hazardous area.

# SAFETY

## WARNING!

**Improper transportation can endanger personnel as well as cause damage to the goods being transported!**



Loads can swivel out and fall during lifting operations. This can cause serious injury or even death.

Packages can have an eccentric center of gravity. If anchored incorrectly, the package can tip and fall. Falling can cause serious injury.

Set the load down on a sufficiently stable and flat surface after leaving the workplace.

## 2.26 DANGER DUE TO HYDRAULIC POWER

### WARNING!

**Pressure in the hydraulic systems!**

Work on the hydraulic system that is performed improperly may result in serious accidents and injuries.



- Wear slip-resistant safety equipment
- Work on the hydraulic system must be performed only by pump specialists
- Depressurize the hydraulic system completely before commencing work on it.
- Never open covers during operation

### DANGER!

**Fluid escaping at high pressure!**

Fluid can escape at high pressure if lines or components are defective. This escaping liquid can sever body parts, causing extremely serious injury and even death.



- Never expose body parts of objects to this escaping fluid. Keep persons out of the hazardous area.
- Activate the emergency stop button immediately. If necessary, take additional measures to reduce pressure and stop the fluid escaping.
- Absorb the escaping fluid/pump media properly and dispose of it.
- Have faulty components repaired immediately.

## 2.27 HAZARDS ASSOCIATED WITH HOT AND COLD COMPONENTS



### WARNING!

**Hot surfaces!**

Component surfaces can become very hot during operation. Contact with hot surfaces will cause serious burns to the skin.

- Always wear heat-resistant protective clothing and protective gloves when working in the vicinity of hot surfaces.

# SAFETY

- Before commencing any work, make sure that all surfaces have cooled to the ambient temperature.



## **WARNING!**

### **Hot operating fluids!**

Operating fluids, such as hydraulic or lubricating oils, can reach high temperatures during operation. Contact with hot operating fluids can cause serious burns or scalds.

- Always wear heat-resistant protective clothing and protective gloves when working with operating fluids.
- Before commencing any work with operating fluids, check whether they are hot. Allow them to cool if necessary.

## **WARNING!**

### **Cold surfaces!**

Component surfaces can become very cold during operation or shutdown. Contact with cold surfaces can cause serious frostbite injury to the skin.



- Always wear cold-resistant protective clothing and protective gloves when working in the vicinity of cold surfaces.
- Before commencing any work, make sure that all surfaces have warmed to the ambient temperature.

## 2.28 FIRE HAZARDS

### **WARNING!**

#### **Restricted or improper fire-fighting**

If, in the event of a fire, the fire extinguisher is not ready for operation or is unsuitable for the specific fire class, death, serious injury or significant material damage may result.



- Ensure that only fire extinguishers suitable for the fire class are available for use.
- The fire extinguisher should be checked every 2 years to make sure it is ready for operation.
- Refill the fire extinguisher after every use.
- Only use extinguishing agents, propellants and spare parts that match the recognized sample specified on the fire extinguisher.
- Observe the safety and operation instructions on the fire extinguisher.
- Observe the operating temperature range.

### **WARNING!**

#### **Flammable materials!**

Flammable operating materials and pump media may catch fire and cause death, serious injury or significant material damage.



- Smoking is prohibited within the hazardous area and its immediate vicinity.
- Handling naked flames, fire and ignition sources of any kind is prohibited.
- Have suitable fire extinguishing agents available (fire blanket, fire extinguisher).
- Notify the authorities about any suspicious substances, fluids or gases.

# SAFETY

- Stop work immediately in the event of fire. Leave the hazardous area until the all-clear is given and alert the fire service.

## 2.29 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) is used to protect personnel from dangers to safety and health while working. Personnel must wear personal protective equipment for performing various tasks with and at the pump. Special reference to the equipment required is made in the individual sections of these operating instructions. A description of the different items of personal protective equipment that may be required is provided below.



### **Chemical-resistant protective gloves**

Chemical-resistant protective gloves are used to protect the hands from aggressive chemicals.



### **Ear protection**

Ear protection serves to guard against hearing damage due to noise.



### **Face protection**

Face protection is used to guard the eyes and face from spraying fluid/contact with the pump medium, as well as hot particles or exhaust fumes.



### **Goggles**

Goggles are used to protect the eyes from flying debris and spraying fluid.



### **Industrial safety helmet**

Industrial safety helmets protect the head from falling objects, swinging loads and impacts on fixed objects.



### **Protective clothing**

Protective clothing refers to closely fitting work clothing with low tear resistance, close-fitting sleeves and no loose hanging parts.



### **Protective gloves**

Protective gloves protect the hands from friction, abrasion, punctures or deeper cuts and from contact with hot surfaces.



### **Safety shoes**

Safety shoes protect the feet from crushing, falling parts and slipping on slippery sub-surfaces.

# SAFETY

## 2.30 SAFETY DEVICES



### WARNING!

#### **Non-functional or disabled safety devices present a risk of serious injury or even death!**

If the pump is switched back on by an unauthorized person or in an uncontrolled manner it may result in serious injury or even death.

- Before commencing work, check that all safety devices are fully functional and installed correctly.
- Never disable safety devices.
- Ensure that all safety devices are always accessible.

### 2.30.1 Coupling guard

The coupling guard is used as a separating guard between personnel and the moving parts of the coupling. Make sure that the coupling guard is properly installed before operating the pump.

### 2.30.2 Mechanical seal chamber guard

2.30.2.1 The guard around the mechanical seal chamber is used as a separating guard between personnel and moving parts of the shaft. Before the pump is operated, it must be ensured that the guard has been installed properly around the mechanical seal chamber. To facilitate visual inspection of the mechanical seal, the guard is designed as a mesh screen. A version with shroud is available as an option.

2.30.2.2 The openings of the mechanical seal chamber are fitted with protective screens or shrouds. If the mechanical seal is faulty, the medium may escape at high pressure through the mesh of the screen or around the sides of the shroud. Face protection or goggles and chemical-resistant protective gloves must be worn.

## 2.31 EMERGENCY STOP SOLUTION

Integration into an emergency stop concept is essential. The pump is intended to be used within a system. It does not have its own controller and does not have an autonomous emergency stop function.

Install the emergency stop devices for the pump and integrate them into the safety chain of the control system before the pump is operated.

Connect the emergency stop devices such that if the power supply is interrupted or is re-activated after an interruption, there is no danger to persons or property.

The emergency stop devices must be freely accessible at all times.

The emergency stop device must be in accordance with Machinery Directive 2006/42/EC.

## 2.32 SECURING AGAINST BEING SWITCHED BACK ON



### WARNING!

#### **Unauthorized or uncontrolled switching on again!**

If the pump is switched back on by an unauthorized person or in an uncontrolled manner it may result in serious injury or even death.

- Before switching back on, make sure that all safety devices are installed and in full working order and that there is no danger to persons.
- Always comply with the process to secure against switching on again.

## 2.33 PROCEDURE WITH MAIN SWITCH (OPTIONAL)

- Switch off the power supply. To do so, rotate the main switch to the "0" position.

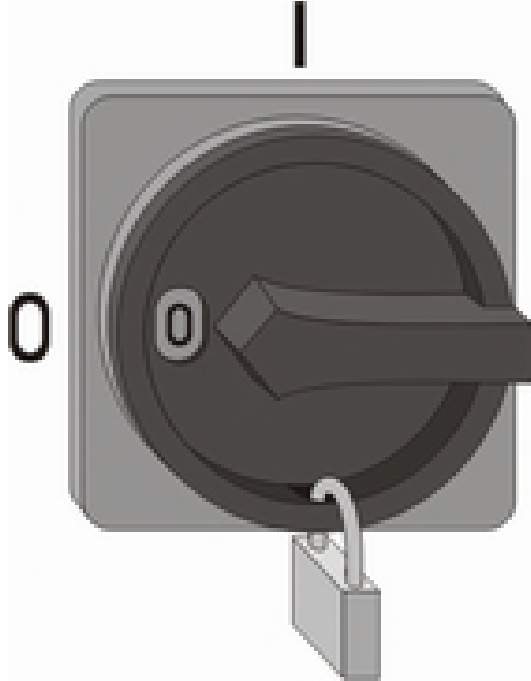
## SAFETY

- Secure the main switch with a padlock.
- Give the key to the lock to a responsible member of staff.



Attach a sign indicating who is permitted to switch the power supply on and off.

- On completion of all work, ensure that there is no danger to persons.
- Ensure that all safety devices and guards are installed and in full working order.
- Remove the lock from the main switch.



**FIGURE. 2.1: SECURING THE MAIN SWITCH**

### 2.34 PROCEDURE WITH EMERGENCY STOP SWITCH (OPTIONAL)

- Switch off the power supply.
- Inform those responsible about any work taking place in the hazardous area.
- Attach a sign to the pump indicating that work is taking place in the hazardous area and that the pump must not be switched on. The sign should provide the following information:
  - Date switched off
  - Time switched off
  - Switched off by
- On completion of all work, ensure that there is no danger to personnel or material.
- Ensure that all safety devices and guards are installed and in full working order.
- Remove the sign.

As an alternative, a work permit procedure with the same effect can be defined and implemented. The procedure must be known to all parties involved.

# SAFETY

## 2.35 WHAT TO DO IN THE EVENT OF A FIRE OR ACCIDENT



### WARNING!

If, in the event of a fire, the fire extinguisher is not ready for operation or is unsuitable for the specific fire class, death, serious injury or significant material damage may result.

### 2.35.1 Preventive measures

- Always be prepared for fire and accidents.
- Keep first aid equipment (first aid box, covers, etc.) and fire extinguisher equipment in good working order and easily accessible.
- Familiarize personnel with accident reporting, first aid and rescue equipment.
- Keep access routes free for emergency vehicles.

### 2.35.2 Action to take in the event of a fire or accident.

- Immediately activate the emergency stop.
- If there is no threat to your health, rescue others from the danger zone.
- If necessary, start administering first aid.
- Notify the fire service and/or emergency services.
- In the event of a fire: If there is no threat to your health, fight the fire with fire extinguishing equipment until the fire service arrives.
- Inform the site managers.
- Prepare access routes for emergency vehicles.
- Admit the emergency vehicles.

## 2.36 SIGNAGE

The following signs and symbols (see previous section 2.9) can be used in and around the work area. They refer to the immediate surroundings where they are displayed.



### WARNING!

#### Illegible signage!

Over time, adhesive labels and signs may become soiled or otherwise damaged rendering them illegible and preventing people from being aware of risks or from following necessary instructions. This presents a risk of injury.

- Always keep all safety, warning and operation instructions in good condition to ensure their legibility at all times.
- Replace damaged signs or adhesive labels immediately.

## 2.37 PROHIBITION SIGNS



### No access to unauthorized persons

The hazardous area may only be entered by persons authorized by the operating company.


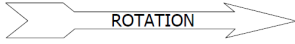
# SAFETY

## 2.38 OTHER SIGNAGE



### Direction of rotation arrow

The direction of rotation arrow is located near the coupling and indicates the prescribed direction of rotation of the pump. Arrow may be cast on the case or a tag.

⊕	SERIAL NO. <input type="text"/>	FLUID <input type="text"/>	⊕
	EQUIPMENT NO. <input type="text"/>		
	APPLICATION <input type="text"/>	MAWP <input type="text"/>	
	TYPE <input type="text"/>	SIZE <input type="text"/>	STAGES <input type="text"/>
	HEAD <input type="text"/>	CAPACITY <input type="text"/>	SP.GR. <input type="text"/>
	RPM <input type="text"/>	BHP <input type="text"/>	TEMP <input type="text"/>
	IMPELLER LIFT <input type="text"/>	HYDRO TEST <input type="text"/>	
	<input type="text"/>		
	<input type="text"/>		
			
	A Sulzer Brand	140 Pond View Drive, Meriden, CT USA 06450 Phone 203-238-2700 www.sulzer.com www.johnstonpump.com	
⊕			⊕

DWG 304302574

### Vertical Pump Name Plate

The vertical pump name plate is located on the discharge head and lists the key operating data for the pump.



### EX Label

The EX label shows the explosive environment this pump is suitable for. Note the CE declaration of conformity in the Appendix.

# SAFETY

## 2.39 ENVIRONMENTAL PROTECTION

- 2.39.1** Implement suitable measures immediately when ecologically hazardous substances are accidentally released into the environment. In case of doubt, inform the responsible local authority about the damage and ask what actions need to be taken.



### ENVIRONMENT!

#### **Incorrect handling of ecologically hazardous substances!**

Always follow the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- 2.39.2** The following ecologically hazardous substances are used.

**Pumped fluid** may be harmful due to high temperature and possible poisonous components when ingested. Fire/explosion may occur if fluid is flammable. Follow the safety requirements of operating company.

**Lubricants** such as grease and oils contain poisonous substances. They must not be released into the environment. Disposal must be performed by a specialist disposal operation. Observe SDS of manufacturer of consumables used.

**Corrosion protection** may be used for conservation during shipment and storage, which may be harmful to health in the case of skin/eye contact, and is poisonous when ingested.

Observe SDS of manufacturer of used corrosion protection agents. Adhere to local regulations regarding flushing and cleaning/commissioning.

**Coolant or Anti-freeze** may contain poisonous and ecologically hazardous substances. They must not be released into the environment. Disposal must be performed by a specialist disposal operation. Observe SDS of manufacturer of consumables used.

**Process chemicals** pumped with the pump are hazardous substances for which there are special requirements for disposal. To ensure proper disposal, locally applicable requirements must be complied with, through regulations, laws, technical regulations, etc. as well as the SDS for each material.

**Buffer Fluid** of the mechanical seal may be harmful due to high temperature and possible poisonous components when ingested. Fire/explosion may occur if fluid is flammable. Observe SDS of manufacturer of consumables used.

**Primer and paint** may be harmful to health in case of skin/eye contact and is poisonous when ingested. Observe SDS of paint manufacturer.

**Thermal or noise insulation** fibers of insulation are potentially dangerous when inhaled or touched by skin. Observe manufacturer instructions and SDS.

## **SAFETY**

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# TRANSPORT, RECEIVING, AND STORAGE

## 3.0 SAFETY ADVICE FOR TRANSPORT, RECEIVING AND STORAGE

**3.0.1** This section provides an overview of all-important safety aspects for transporting packaged and unpackaged pumps and units.

**3.0.2** Transportation devices (including vehicles) must be checked for the admissible load weight. For total weight of the delivered goods see dispatch documents or the General Arrangement drawing. The load must be secured against shifting while in transport.



### **WARNING!**

#### **Suspended loads!**

**Loads can swivel out and fall during lifting operations. This can cause serious injury or even death.**

- Never stand under or in the swivel range of suspended loads.
- Only move loads under supervision.
- Only use approved lifting tools and anchorage means with sufficient load carrying capacity.
- Do not use torn or abraded lifting tools (ropes and belts).
- Do not lay lifting tools such as ropes and belts on sharp edges and corners and do not tie or twist them.
- Set the load down on a sufficiently stable and flat surface after leaving the workplace.



### **WARNING!**

#### **Falling or tipping packages!**

**Packages can have an eccentric center of gravity. If anchored incorrectly, the package can tip and fall. Falling or tipping packages can cause a serious injury.**

- Note the markings and specifications about the center of gravity on the packages.
- When transporting by crane, position the crane hooks above the center of gravity of the package.
- Carefully raise the package and observe if it tips. If necessary, change the anchorage.



### **WARNING!**

#### **Improper transportation!**

**Improper transportation can endanger personnel as well as cause damage to the goods being transported.**





- Proceed carefully when unloading transportation items and transporting goods internally, and observe the symbols and instructions on the packaging.
- Only use the anchorage points provided.
- Only remove packaging shortly before assembly.
- If any transportation damage is detected, contact Sulzer Pumps and do not commission the pump.

## 3.1 TRANSPORTING PACKAGED PUMPS/PACKAGED UNITS

**3.1.1 Fastening of ropes to sling crates** Points for fastening sling ropes to closed crates are marked on the side of the crate. Since the center of gravity cannot be seen on closed crates. Sling rope fastening must always be done at the marked locations. See Figures 3.1 and 3.2. Crates can be lifted and transported with a forklift.

## TRANSPORT, RECEIVING, AND STORAGE

**3.1.2** The packaging features the following symbols. Always observe these symbols when transporting.

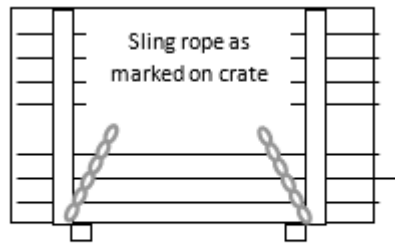
	This way up	The arrows point to the top of the package. These must always point upward; otherwise the contents can be damaged.
	Centre of gravity	Designates the center of gravity of packages. Observe the center of gravity position when lifting and transporting.
	Protecting from moisture	Protect packages from moisture and keep them dry.
	Anchor here	Only attach lifting accessories (sling chain, lifting strap) at the points marked with this symbol.

### 3.1.3 Transporting packages by crane

Packages can be transported directly by crane under the following conditions:

- The crane and lifting tools must be appropriate for the total weight of the package indicated on the shipping documents plus all handling and lifting equipment supported by the crane (lifting beam, slings, shackles etc.).
- Load spreaders should be used to protect the sides of the crate during lifting.
- The user must be authorized to operate the crane.
- Undamaged ropes and lifting devices must be used.
- Arrange slings or other hoisting devices to maintain a level lift, see Figures 3.1 and 3.2.
- Arrange slings to avoid damage to piping or other components.
- The anchorage points for fastening sling ropes to closed crates are marked on the side of the crate. Ensure that the package hangs straight. Note the center of gravity that may be marked on package.

## TRANSPORT, RECEIVING, AND STORAGE



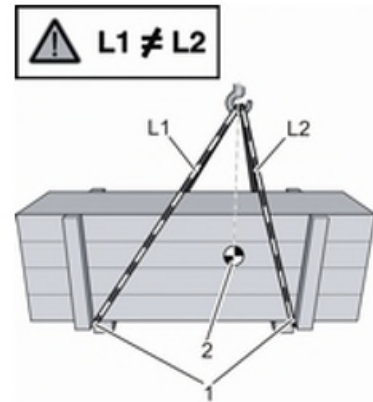
**FIGURE 3.1**

Below refers to Figure 3.2

L1, L2 = Rope, belt or multi-point suspension.

1 = Anchorage points

2 = Center of Gravity



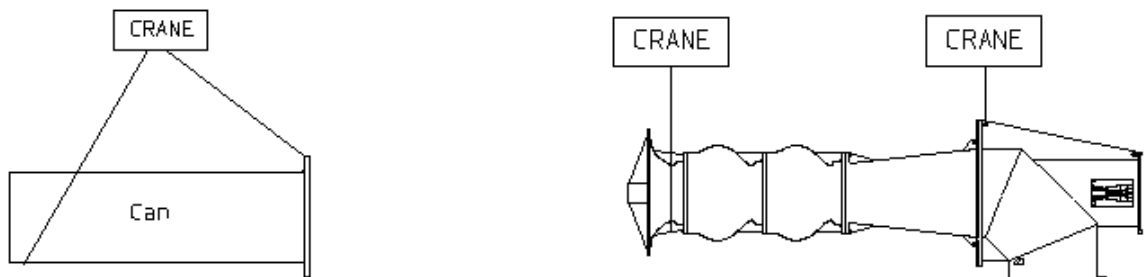
**FIGURE 3.2 ECCENTRIC CENTER OF GRAVITY**

**3.1.4 Fastening spots for units** In case lifting lugs or bars are attached at the pump, the unpacked unit has to be fastened at these spots by shackling the sling. The pump can also be lifted by slings which are laid around certain parts of the pump. See Figure 3.3 and 3.4.



The General Arrangement drawing will also show appropriate lifting points.

Typical example: pump shape may vary due to pump type ordered.



**FIGURE 3.3 (FASTENING SPOTS FOR HORIZONTAL TRANSPORT)**



**NOTICE!**

Long pumps with narrow diameters may require additional support to prevent bending during horizontal lift. This could be achieved by positioning an extra sling down the middle of the pump or by using two cranes with additional slings. Always arrange all slings or other hoisting devices to maintain a level lift.

## TRANSPORT, RECEIVING, AND STORAGE

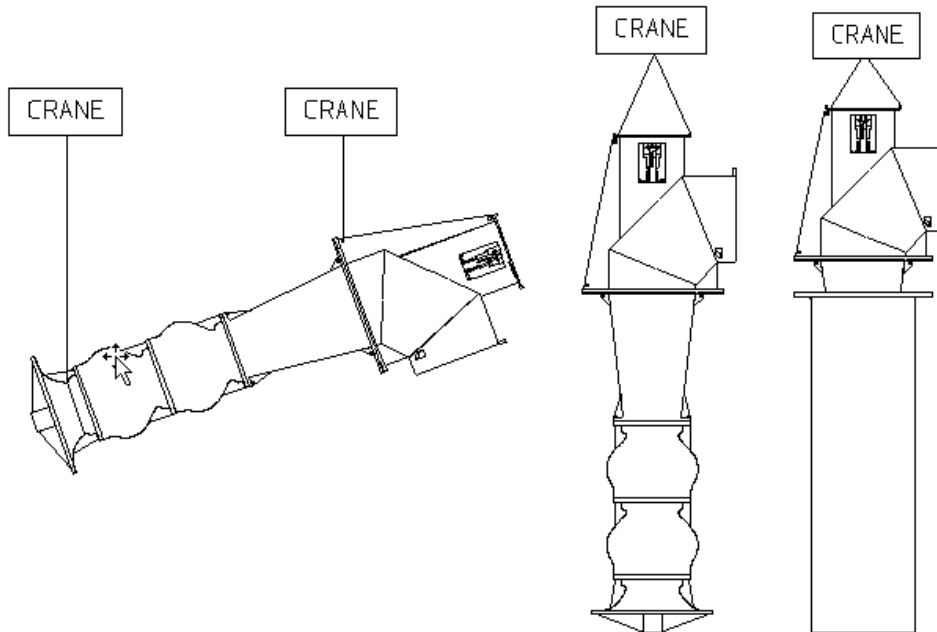


FIGURE 3.4 (FASTENING SPOTS FOR VERTICAL TRANSPORT AND INSTALLATION)



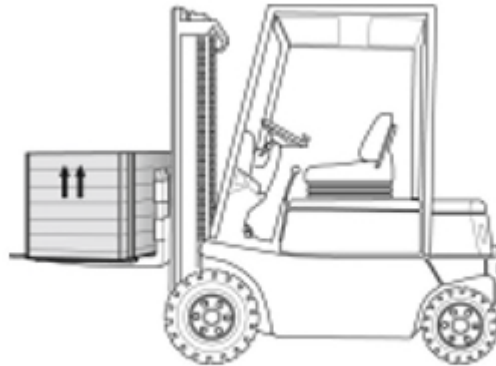
### WARNING!

Inappropriate transportation or the wrong lifting tools can damage the measuring instruments or the auxiliary piping.

Avoid contact of lifting tools with the measuring instruments or auxiliary piping.

**3.1.5** Support the equipment on skids or timbers on a sufficiently stable and flat surface to ease later relocation to installation site or to storage. Prevent flex by providing a sufficient number of supports under the package.

### 3.1.6 Transporting packages by forklift truck



SKETCH 3.5 LIFTING PACKAGES BY FORKLIFT TRUCK

## TRANSPORT, RECEIVING, AND STORAGE

Packages can be transported by forklift truck under the following conditions:

- The forklift must be appropriate for the weight of the package indicated on the shipping documents.
- The package must have tie bars.
- The forklift driver must be authorized to operate industrial trucks using a driver seat or driver stand in accordance with the national applicable regulations.
- Drive the forklift truck with the forks between or under the tie bars of the package.
- Drive the forks far enough under that they stick out of the opposite side.
- Ensure that the package cannot shift if it has an eccentric center of gravity.
- Lift the package and begin transport.
- Support the package on skids or timbers on a sufficiently stable and flat surface to ease later relocation to installation site or to storage. Prevent flex by providing a sufficient number of supports.

### 3.1.7 Transportation Personnel

- Personnel
  - Qualified specialists
- Protective equipment:
  - Protective clothing
  - Protective gloves
  - Industrial safety helmet
  - Industrial safety shoes

## 3.2 INSPECTION

### 3.2.1 Inspection Upon Arrival

- 3.2.1.1 The products supplied by Sulzer received a final inspection in the factory. To ensure the product has not been damaged in transit, inspect upon arrival and note findings on the carrier's ticket. If during inspection there is noticeable damage or missing components report damage or shortage immediately to the carrier and a representative of Sulzer.
- 3.2.1.2 Inspect the preservative coating on the various parts. If necessary, renew the preservative in areas where it has been rubbed off or scraped. Inspect all painted surfaces. If necessary, touch up the areas where paint has been chipped or scraped.
- 3.2.1.3 The rotor is shipped in a blocked position. Do not remove blocking until unit is to be installed. This will minimize bearing loads and rotor distortion.
- 3.2.1.4 Inspect all covers over pump openings and piping connections. If covers or seals for the covers are damaged or loose, they are to be removed, and a visual inspection made of the accessible interior areas for accumulation of foreign materials or water. If necessary, clean and recoat the interior parts with preservative as noted to restore the parts to the "as shipped" condition. Install or replace covers and fasten securely.

### 3.2.2 External visible transportation damage

In the event of externally visible transportation damage, proceed as follows:

- Do not accept the shipment or accept it only with reservations.
- Note the extent of the damage on the transportation documentation or on the carrier's shipment note. Get the carrier to countersign the note.

## TRANSPORT, RECEIVING, AND STORAGE

- Photograph all damage to the pump, the unit and/or the ancillary equipment.
- Immediately inform the transportation company, the shipping insurer and Sulzer Pumps about missing parts and any form of damage.
- Start the complaints procedure.



**Claim for each defect as soon as you detect it. Damage claims can only be made within the applicable claim periods.**

### 3.3 STORAGE



#### **CAUTION!**

**Regardless of whether storage is inside or outside, the storage area should be vibration-free. All boxes marked for inside storage should be stored indoors.**

#### 3.3.1 Storage time

- 3.3.1.1 The following storage instructions are applicable to units stored 30 days to two years after shipment. Contact Sulzer for recommended long-term (greater than two years) storage procedures and when a conflict in storage procedures occurs.
- 3.3.1.2 Make sure to follow all markings, instructions, and warnings on containers and packaging.
- 3.3.1.3 Follow vendor instructions for all other components of the pump system.
- 3.3.1.4 Rubber parts such as spare O-rings have a shelf life of up to 3 years if stored in original heat-sealed packing and adequately protected from air, light, ozone, radiation, excessive temperature (120 degrees F), contamination and physical damage.



#### **CAUTION!**

**Storage instructions apply only to the pump!**

**The following storage instructions apply only to the pump and may not be appropriate to furnished auxiliary equipment.**

- For replacement parts storage, see REPLACEMENT PARTS section.
- Follow vendor instructions for all other components of the pump system.
- Contact Sulzer when a conflict in storage procedures occurs.

#### 3.3.2 Storage requirements

Prior to shipment, the pump and its components are prepared for outside storage. The following additional requirements should be followed by the operating company.



#### **NOTICE!**

**External machined surfaces (i.e.; discharge nozzle flange face, etc.) have not been painted but coated with a rust preventive.**

## TRANSPORT, RECEIVING, AND STORAGE



### CAUTION!

If the pump is stored vertical, the rotor is to be lifted and blocked to the dimension shown on the Name Plate.



Under certain circumstances, the packaging will feature storage instructions above and beyond the requirements mentioned here. Comply with these accordingly.

- Do not remove shaft blocking material on horizontally stored units until installation.
- Store off the ground on skids or cribbing so that no water will accumulate around the unit.
- Protect pump and attachments with a vinyl-coated nylon tarpaulin. Lash the tarp down flat so that water does not collect in pools on the tarp surface. Maintain sufficient air circulation with a 3 inch (8 cm) minimum clearance between tarp and pump.
- Locate in an area (indoor or outdoor as marked on the packaging) and is free from blowing sand or dirt.
- Do not stack equipment.
- Prevent animal entry by keeping connections sealed.
- Maintain rust prevention coatings.
- Install or maintain drying agent (desiccant).

### 3.3.3 Approved Storage Material

The following materials are recommended for maintenance use:

- Drying Agent: Use Cortec 110 or 111 VpCI Emitter, or equivalent vapor corrosion inhibitor emitter.
- Nozzle Covers: Use metal nozzle covers equipped with rubber gaskets if prolonged storage is anticipated.
- Weather Protection: Vinyl coated nylon tarpaulin.
- Corrosion Protection Coatings: Use “Cortec 329, 368 or 377” vapor inhibitor coating, or equivalent, rust preventive.
- Protective Wrap: Use “Cortec Cor-Pak VpCI film”, or equivalent wrap.  
{“Cortec” products are manufactured by the Cortec Corporation}



### CAUTION!

Adhere to local regulations regarding flushing and cleaning / commissioning.

### 3.3.4 Inspection and Maintenance

- 3.3.4.1 Visually inspect the equipment and packaging every four weeks. Repair any damage to weather protection.

## TRANSPORT, RECEIVING, AND STORAGE



The individual packages are packed according to expected transportation conditions. Where possible, environmentally friendly materials are used for packaging.

The packaging is designed to protect individual components from transport damage, corrosion and other damage until assembly. Therefore, do not destroy the packaging and do not remove it until shortly before assembly.

3.3.4.2 Perform the following maintenance every year:

- Remove protective tarpaulin.
- Remove nozzle cover(s). Drying agent will be attached to cover(s). Replace the drying agent and reseal the protective cover(s).
- Pumps shall not be rotated. (Do not remove shaft blocking material.)
- Inspect surfaces that require rust preventive protection. Clean surfaces, and recoat as required.
- Examine loose parts and unpainted machined surfaces that are wrapped in Cortec VpCI film. Re-wrap as required.
- Replace and lash protective tarpaulin.



### NOTICE!

#### Improper removal of packaging

Improper removal of packaging can expose the interior of the pump to dirt, thus damaging it.

- Remove the packaging with the utmost care.
- Leave the covers on the connection flanges.

Personnel:

- Specialist

Protective equipment:

- Protective clothing
- Protective gloves
- Safety shoes

## 3.4 RECORDS

3.4.1 Keep an inspection record with equipment.

- Date of inspection.
- Name of person performing inspection or maintenance.
- Results of inspection.
- Date of maintenance.
- Description of maintenance performed.
- Amount and type of drying agent replaced.

## 3.5 ADDITIONAL REQUIREMENTS

3.5.1 When the pump is removed from storage it is recommended that the seals and bearings are inspected. If rolling element bearings show any signs of contamination, replace prior to start-up. Refer to BEARING ASSEMBLY Maintenance Manual for specific instructions.

## TRANSPORT, RECEIVING, AND STORAGE



### CAUTION!

At no time during storage or handling is the pump to be rotated on or supported by the suction bell (138.111)

### 3.6 REMOVING PACKAGING

Dispose of packaging materials according to applicable legal regulations and local instructions.



### NOTICE!

#### Incorrect disposal of packaging materials

Packaging materials are valuable raw materials and can be further used in many cases, or reasonably processed and recycled. Incorrect disposal of packaging materials poses a hazard to the environment.

- Dispose of packaging materials in an environmentally friendly way.
- Observe locally applicable disposal provisions. If necessary, authorize a specialist operation for the disposal.
- Always follow the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

### 3.7 TRANSPORTING AN UNPACKED PUMP/UNPACKED UNIT

Unpacked units, pumps or pump components may be transported as detailed in sections 3.1.2 through 3.1.6 under the following conditions:

- All lifting tools must be appropriate for the weight of the item indicated on the shipping documents or layout plans.
- The user must be authorized to operate the lifting equipment.
- Undamaged ropes and lifting devices must be used.
- Do not lay lifting tools such as ropes and slings on sharp edges and corners.
- Do not tie or twist lifting tools such as ropes and slings.
- Arrange slings or other hoisting devices to maintain a level lift.
- Arrange slings to avoiding damage to piping or other components.
- Ensure the lifted item is secured against shifting, especially if it has an eccentric center of gravity.
- Place the item on a sufficiently stable and flat surface if not directly to be installed.



### CAUTION!

#### Damage to auxiliary piping or measuring instruments

Inappropriate transportation or the wrong lifting tools can damage the measuring instruments or the auxiliary piping.

- Avoid contact of lifting tools with the measuring instruments or auxiliary piping.

# INSTALLATION

## 4.0 INSTALLATION

This section deals with installing, attaching and aligning the pump and the unit, as well as the assembly of adjacent components (piping, fittings and measuring instruments). For more information on installation, refer to the general arrangement drawing and the piping and instrument diagram(s).



Use the INSTALLATION SEQUENCE checklist on the last page of this section to ensure all events are completed in the correct order.

## 4.1 SAFETY INSTRUCTIONS FOR INSTALLATION



### WARNING!

**Risk assessment of the work area shall be carried out by qualified and competent personnel!**

**Machinery intended for use in potentially explosive areas must satisfy the “Ex” protection requirements. Check documentation and nameplates relating to the pump and any accessories or equipment.**

- Any designation of the pump refers to the pump component only. Shaft coupling, driver (e.g. electric motor) and auxiliary systems (shaft sealing, lubricating oil system, etc.) must be looked at separately.
- Exposure to ignition sources, such as sparks, naked flames and hot surfaces, can cause an explosion in areas with a potentially explosive atmosphere. This may result in death, serious injury or significant material damage.



### WARNING!

**Electricity related hazards!**

**Danger of death from electrical shock.**

- When the electric motor is energized.
- When electronic sensing equipment is energized.
- If there is damage to the insulation, switch off the power supply immediately and have it repaired.
- Never bypass or disable fuses. When replacing fuses, make sure that the correct amperage is used.
- Keep moisture out of electrically charged components. This can cause a short circuit.



### WARNING!

**Unqualified personnel**

- Any unqualified personnel working on the pump or situated within the hazardous area of the pump are at risk of causing serious injury or significant material damage.
- All activities must be performed by appropriately qualified personnel only. Keep unqualified personnel away from hazardous areas.

# INSTALLATION



## **WARNING!**

### **External Influences – Lightning Strike!**

#### **Possibility of lightning strike when machines are operated outdoors.**

- Before operation check the machine for damages ensuring that all safety devices are installed and in full working order and that there is no danger to persons.
- If necessary, repair all damages before switching on again.

## **4.1.1 Requirements for the set-up site**

- Obtain a written work permit before commencing work in an area with a potentially explosive atmosphere.
- Lightning strike prevention equipment must be installed for outdoor equipment.
- Make sure that the set-up site is designed to support the weight of the pump / unit: see the layout plan.
- Make sure that the foundation or any other required brickwork is completed, hardened, and dry.
- Provide appropriate door and wall openings for transport to the assembly area.
- Only lift loads using suitable lifting equipment via the designated attachment points.
- Note the space required for the unit and connections, as well as the mounting positions in accordance with the layout plan, and prepare accordingly.
- Provide a pressure-free drain for leakage from the shaft seal, pump drainage, and cooling water drainage (in an open system).
- Ensure the installation site is tidy and clean. Components and tools that are loosely stacked on top of each other or lying around can cause accidents.
- Secure components so that they cannot fall or tip over.
- Be careful when handling open, sharp-edged components.
- Leave the covers on the connection flanges of the pump until shortly before the pump is connected to the piping. Dirt can get into the pump due to uncovered flanges.
- Only use tools permitted for use in areas with a potentially explosive atmosphere.
- Make sure there is good lighting available as well as sockets for hand-held lamps.
- Assemble the components correctly. Observe the prescribed fastener tightening torques.
- Work on electrical equipment (driver, measurement and control equipment, etc.) must be performed by qualified electricians only.
- Align the base plate correctly otherwise vibrations will occur during operation; this will impose strain on mechanical components and the noise created may damage hearing.
- Connect the drive machine in accordance with the prescribed direction of rotation for the pump. Observe the direction of rotation arrow on the pump. If the pump is driven against the prescribed direction of rotation, there is a risk of material damage culminating in a total pump failure.
- Only allow specialists in pipe layout to design and carry out any piping installation activities.
- Clean the installation site.

# INSTALLATION



## WARNING!

### Explosive atmosphere!

Prior to and during maintenance, ensure that the atmosphere is not potentially explosive.

Stop all work immediately if any danger arises.

4.1.2 Before commissioning, observe the following:

- Ensure that all work is carried out and completed according to the data and notices in these instructions.
- Ensure that no unauthorized personnel are in the danger area.

## 4.2 GENERAL

4.2.1 Good planning and preparation result in fast, simple and correct installation. Safe running conditions with maximum accessibility are assured. When preparing for installation of the machine, it is necessary to take the following aspects into account:

4.2.2 Suitable lifting devices must be available for installation and repair work. Good lighting is important and sockets for portable lights should be available.

4.2.3 The main dimensions, connections, position of fixing bolts etc., are shown on the general arrangement drawing.

4.2.4 The pump should be readily accessible from all sides.

4.2.5 The pump foundations and type of installation should be designed so that vibration is kept to a minimum both during operating and when the pump is at rest, otherwise the pump life will be reduced.

4.2.6 A drain must be provided so that gland leakage, cooling water (open system) and liquid drained from the pump during overhaul can be led away.



## CAUTION!

Drainage from the pump must not lead to the endangerment of personnel and or the environment.



## ENVIRONMENT!

### Incorrect handling of ecologically hazardous substances!

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective equipment when handling ecologically hazardous substances.

4.2.7 Following manufacture, the pump flanges and external taps are protected by plastic plugs which should not be removed before the pipework is ready to be attached to the pump. The pump should be protected if further site work is necessary nearby.

4.2.8 The foundation or any other necessary building work must be finished, set and dried. Roughen and clean the foundation. All preliminary work for erection must be completed. With large units, suitable door and wall openings are to be provided for transport to the installation site.

# INSTALLATION

## 4.3 FOUNDATION PREPARATION



### WARNING!

Explosive atmosphere!

Machinery intended for use in potentially explosive areas must satisfy the “Ex” protection requirements. Check documentation and nameplates relating to the pump and any accessories or equipment.

**4.3.1 Site** Install near the fluid source. Allow adequate space for operation, maintenance, and inspection.

**4.3.2 Design** The foundation must give adequate system support and meet external piping requirements. The foundation must also inhibit vibration. Surface must be level within 0.003 in./ft. (0.25 mm/m). Reinforced concrete is the most satisfactory foundation. The combined resonant frequency of the pump/motor assembly is based upon a rigid foundation/support system (i.e. one that provides no lateral deflection to the combined assembly).

## 4.4 INSTALLATION



### CAUTION!

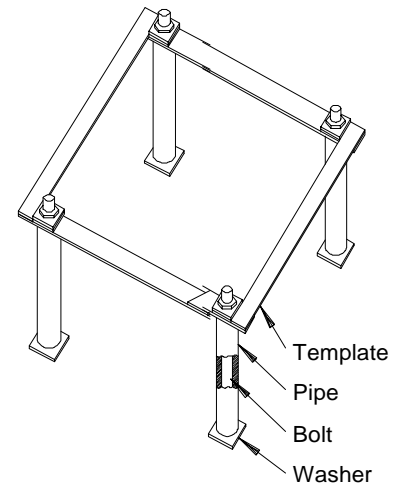
Provide adequate support to prevent misalignment caused by yielding or springing of the structure or baseplate.

**4.4.1 Soleplate Foundation** Construct a template to position the foundation bolts to match the baseplate hold-down holes shown on the general arrangement drawing. The template should be rigid enough to hold foundation bolt assemblies in place during the foundation pour.

**4.4.2 Foundation Bolts** Each foundation bolt should be surrounded by a pipe sleeve with an inside diameter approximately three times the bolt diameter. By doing this, the pipe is held solidly in concrete while allowing later minor bolt adjustment.



The general arrangement drawing provides pump hold-down dimensions necessary for the foundation design.



**Figure 4.1**

**4.4.2.1** The bolts should extend above the top of the pipe sleeves far enough to allow 25-50 mm (1 to 2 in.) of grouting between the base plate bottom and the foundation.

## INSTALLATION



Take care to maintain the correct vertical offset between the base plate/soleplate and the installation site elevation as shown in the general arrangement.

- 4.4.2.2 Tack weld bolts, washers, and pipe together before installing on the template.  
Pack rags or stuffing around bolts to center them within the sleeves.

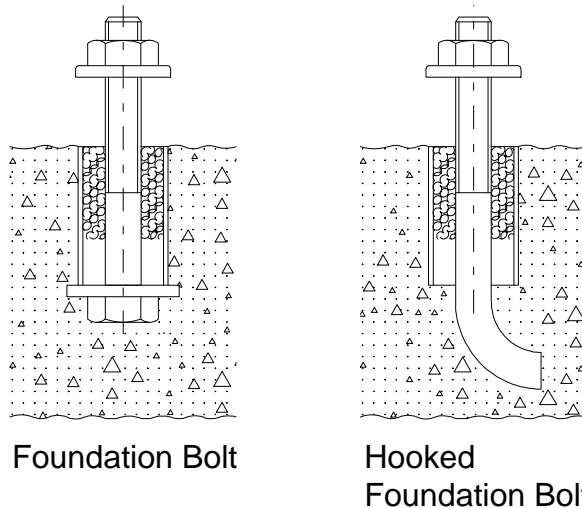


Wax leveling screws to prevent grout adhesion and to allow removal after the grout has hardened.



### NOTICE!

**Hooked foundation bolts are useful for installation on existing construction, or where the pier height is limited. This type of bolt has greater mechanical hold capability and is less sensitive to vibration.**



**Figure 4.2**

### 4.4.3 Concrete Curing

- 4.4.3.1 It is essential that the concrete be fully cured before mounting the soleplate. (Refer to the manufacturer's recommendations.) After the foundation has cured, remove water and packing material from the foundation bolt sleeves and dry the entire foundation.
- 4.4.3.2 Prepare the foundation surface for grout by scraping with a chipping hammer. As noted in API RP 686 Chapter 4, Fig. B-3 remove 13-25 mm (1/2 to 1 in.) minimum \* of foundation material to eliminate the low strength, high porosity surface concrete and to insure proper bonding for grout.

## INSTALLATION



\* This distance can vary depending on curing time, proper placement, and depth of sound aggregate. Doing so creates high porosity surfaces and eliminates low strength concrete foundations prior to grouting.



### WARNING!

#### Dust formation from compressed air!

When working with compressed air, dust may be stirred up; this can get into the eyes or airways. Side effects may range from severe irritation to blindness.

- When working with compressed air, wear goggles and a face mask or respirator.

4.4.3.3 If grout must be applied to damp concrete, thoroughly coat the concrete with a penetrating sealer at least four hours in advance of pouring the grout. Remove any loose particles, dirt, or oil-soaked concrete.



### ENVIRONMENT!

#### Incorrect handling of ecologically hazardous substances!

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

## 4.5 SOLEPLATE INSTALLATION



### WARNING!

#### Explosive atmosphere!

Prior to and during the installation ensure that the atmosphere is not potentially explosive.

Welding, burning, and grinding should only be carried out on the pump where specifically authorized, e.g. there may be a risk of fire and/or explosion. Use care with solvents.

Stop all work immediately if any danger arises.



### WARNING!

#### Suspended loads!

Loads can swivel out and fall during lifting operations. This can cause serious injury or even death.

- Never stand under or in the swivel range of suspended loads.
- Only move loads under supervision.
- Only use approved lifting tools and anchorage means with sufficient load carrying capacity.
- Do not use torn or abraded lifting tools (ropes and belts).
- Do not lay lifting tools such as ropes and belts on sharp edges and corners and do not tie or twist them.
- Set the load down after leaving the workplace.

# INSTALLATION

Personnel:	Pump Specialists
Protective equipment:	Protective clothing
	Protective gloves
	Industrial safety helmet
	Safety shoes
	Goggles

4.5.1 Depending on the size of the pump and other factors, the pump may be shipped assembled or partially assembled.



### CAUTION!

Do not let any foreign material enter the pump. This is essential, since the internal parts of the pump could be damaged by any debris passing through the unit.

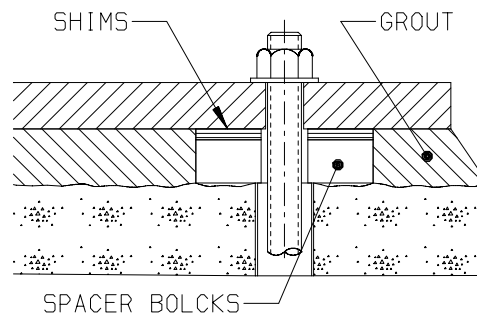


Figure 4.3

4.5.2 The soleplate should have been supplied separate from the pump unit.

4.5.3 Lift the soleplate by slinging with the eyebolts in tapped holes provided on the soleplate face.



### WARNING!

Do not attempt to sling the soleplate from other lifting points. Do not allow the slings to foul pipework, instruments etc. when lifting the soleplate.

Do not use pump component eyebolts for lifting the complete unit!

Component eyebolts are meant for the lifting of loosened parts during assembly and disassembly only.

If the eyebolts break during transportation/lifting, the soleplate can fall and cause serious accidents.

4.5.4 Clean the underside of the soleplate and surfaces that will be in contact with grout. Remove rust, oil, paint or any other extraneous material.



### ENVIRONMENT!

Incorrect handling of ecologically hazardous substances!

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective equipment when handling ecologically hazardous substances.

## INSTALLATION



### CAUTION!

Do not use oil base solvents for soleplate cleaning. The residue can prevent grout adherence.

- 4.5.5 When epoxy grout has been specified, the underside of the soleplate will have been coated with a catalyzed epoxy primer.



### CAUTION!

Take care not to damage these painted surfaces when cleaning mechanically, or using solvents.

- 4.5.6 Position the soleplate over the foundation at the predetermined elevation, aligning with the foundation bolts set in the concrete block.



Take care to maintain the correct vertical offset between the base plate and the installation site elevation as shown in the general arrangement.

- 4.5.7 Place spacer blocks 4 to 6 in. (100-150 mm) long, 2 to 3 in. (50-80 mm) wide and thick enough to allow for proper grouting clearance adjacent to each hold-down bolt, but not in the way of the leveling screw holes.



### NOTICE!

Wax the spacer blocks, shims and leveling screws to prevent grout adhesion and to allow removal after grout has hardened.

- 4.5.8 Lower the soleplate over the foundation bolts and set it down on the spacer blocks as shown in Figure 4.3.

- 4.5.9 Install the leveling screws at the jacking points in the soleplate.

- 4.5.10 Place a precision level on the surface of the mounting plate and check for leveling in two directions. Refer to API RP 686, Chapter 5, Annex C. Note that the mounting plate's function is to assure that the pump is plumb, as this style of pump is not involved in the alignment of the driver to the pump.

- 4.5.11 Adjust with the leveling screws and add shims on the underside of the soleplate to achieve the degree of levelness required: 0.003 in./ft. (0.25 mm/m).



**Sulzer's soleplates are designed to be compliant with API RP 686, Chapter 5, section 3.9.4.5's requirement of 0.003 in/foot of baseplate size, only. This is an overall levelness tolerance.**



### NOTICE!

On large units it may be necessary to adjust the levelness over its length by using anchor bolts and jackscrews to manipulate the shape.

- 4.5.12 Wrench tighten the foundation bolts. Recheck the leveling, and adjust the shims as necessary until the foundation bolts are fully tightened and the mounting plate is secure and level.

# INSTALLATION



## CAUTION!

### Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for connection fasteners.
- Tightening torque and sequence is to be done in accordance with Addendum No. 2.

## 4.6 GROUT SELECTION AND APPLICATION

### 4.6.1 Selection

Select a non-shrinking grout that is resistant to damage by any chemicals that may be spilled, and compatible with the highest temperature to which it may be exposed.

### 4.6.2 References

#### 4.6.2.1 ASTM

- C109 Test Method of Compressive Strength of Hydraulic Cement Mortars (Using 50 mm (2 in.) Cube Specimens).
- C531 Test Method for Linear Shrink-age & Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing.
- C579 Test Methods for Compressive Strength of Chemical-Resistant Mortars & Monolithic Surfacing.
- C827 Test Method for Early Volume Change of Cementitious mixtures.

#### 4.6.2.2 US ARMY CORPS OF ENGINEERS

- CRD C611 Test Methods for Flow Grout Mixtures (Flowcone Method).
- CRD C621 Corps of Engineers Specification for Non-Shrink Grout.

### 4.6.3 Minimum Characteristics for Cementitious Grouts

- 4.6.3.1 Shall not bleed (no water run off) while the grout is being transported or placed.
- 4.6.3.2 Shall not shrink and shall expand no more than 4.0 percent when tested according to ASTM C827 (before set) and no more than 1.0 percent when tested according to CRD C621 (after set).
- 4.6.3.3 Shall be of the minimum strengths specified by CRD C621 (minimum of 34.47 MPa [5000 psi] at 28 days).

### 4.6.4 Minimum Characteristics for Epoxy Grout

- 4.6.4.1 Shall not shrink and shall expand no more than 4.0 percent when tested according to ASTM C827 (before set) and no more than 1.0 percent when tested according to CRD C621 (after set).
- 4.6.4.2 The minimum allowable compressive strength of an epoxy grout at 7 days shall be 41.37 MPa (6000 psi) when measured according to ASTM C579.

## INSTALLATION

- 4.6.4.3 The peak exotherm of a cylinder of epoxy grout 50 mm (2 in.) in diameter and 100 mm (4 in.) tall, tested at a material and laboratory temperature of 24° C (75° F), shall not exceed 35°C (95°F).
- 4.6.4.4 The coefficient of thermal expansion for an epoxy grout shall not exceed  $54 \times 10^{-6}$  mm/mm/°C ( $30 \times 10^{-6}$  in/in/°F) when tested according to ASTM C531.
- 4.6.4.5 Epoxy grouts shall emit no odor or highly volatile inhalation irritants.

### 4.6.5 Types

- 4.6.5.1 High fluidity grouts as defined by CRD-C621 and CRD-C611, shall be within the range of 20-30 sec efflux from a standard flow cone.
- 4.6.5.2 Flow-able grout, as defined per ASTM C-109 shall be within the range of 124-145% with five drops.
- 4.6.5.3 Standard dry packing using moist sand and cementitious materials is acceptable.

### 4.6.6 Placement

- 4.6.6.1 Refer to API RP 686 Chapter 5 – Grouting. High fluidity grouts shall be placed by pouring down an inclined plane into forms around the mounting plate. Pouring should be from one side only, and sufficient material should be poured to overflow the forms. In locations that are difficult to reach, placement with steel strapping is recommended.
- 4.6.6.2 Where special placement requirements must be met, pumping of high-fluidity grouts can also provide acceptable placement.
- 4.6.6.3 Flow-able grouts normally require movement into position. The use of steel straps or a well and plunger is recommended. Placement with a chain is not recommended because of the possibility of air entrainment in the links.
- 4.6.6.4 Dry packing requires manual placement followed by compaction using a round-end rod. Care should be taken to avoid over packing.



#### **CAUTION!**

**The use of vibrators to aid placement can cause water and grout to separate and is therefore not recommended.**



Consult a grout manufacturer for further information on selection, preparation, and placement.

# INSTALLATION

## 4.7 SOLEPLATE GROUTING AND SECURING



### WARNING!

Do not attempt to sling the soleplate from other lifting points. Do not allow the slings to foul pipework, instruments etc. when lifting the unit.

Do not use pump component eyebolts for lifting the complete unit!

Component eyebolts are meant for the lifting of loosened parts during assembly and disassembly only.

If the eyebolts break during transportation/lifting, the pump unit can fall and cause serious accidents.



### NOTICE!

If forms are placed on rough concrete surface, seal the form bottom with a stiff sand and cement mortar, flush with the form inside face. This should be done immediately before placing grout because mortar shrinkage can result in leakage.



Take care to maintain the correct vertical offset between the base plate and the installation site elevation as shown in the general arrangement.

Personnel:

Specialists

Protective equipment:

Protective clothing

Protective gloves

Industrial safety helmet

Safety shoes

Goggles

**4.7.1** Refer to API RP 686 Chapter 5, Annex G. Build a wooden dam around the soleplate perimeter. Forms must be strong enough to withstand the grout pressure and must be sealed and made watertight by caulking between the forms and the foundation. Attach a chamfer strip on the form inside, at grout grade elevation, to provide a beveled edge.



### NOTICE!

If forms are placed on a rough concrete surface, seal the form bottom with a stiff sand and cement mortar, flush with the form inside face. This should be done immediately before placing grout because mortar shrinkage can result in leakage.

**4.7.2** Apply two heavy coats of paste wax, or one coat of shellac and one heavy coat of paste wax to the forms. Plastic sheeting is acceptable, but it must be stretched tightly to prevent wrinkling.

**4.7.3** Cover the wedges with caulk or plastic tape if later removal is desired. Mark wedge positions on the mounting flange, to locate after the grout pour.

## INSTALLATION

**4.7.4** Force the grout under the edge of the mounting flange. Fill the void under the mounting flange completely, probing as necessary to ensure proper distribution of the grout.



### CAUTION!

The concrete must neither dry out nor freeze during the first 48 hours. During this time the temperature of the foundation should not fall below 10°C. The optimum temperature for the setting process is 20°C +/-10°C.

**4.7.5** After the grout has thoroughly hardened, remove the forms and back off the leveling screws to remove any load on the screws. Fill holes with grout.



### ENVIRONMENT!

**Incorrect handling of ecologically hazardous substances!**

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective equipment when handling ecologically hazardous substances.



### WARNING!

Do not continue to the next phase of the installation until the grout under the baseplate has thoroughly cured as prescribed by the grout material manufacturer.

**4.7.6** Torque the foundation bolts in accordance with ADDENDUM No. 2 of this manual.



### CAUTION!

**Incorrect fastener tightening torques!**

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fastened connections.

## 4.8 INSTALLATION OF THE BASKET STRAINER (IF PROVIDED)



### NOTICE!

There are a number of methods for installing strainers, but the following steps are among the most practical and common.

## INSTALLATION

### 4.8.1 Basket Strainer – Clip on Type

- 4.8.1.1 Place the strainer against the bottom of the suction bell.
- 4.8.1.2 Place the clips, slotted end down, over the outside diameter of the suction bell.
- 4.8.1.3 Insert the cap screws through the slots in the clips. Thread into the strainer and tighten in accordance with ADDENDUM No. 2 of this manual.



#### CAUTION!

##### Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fastened connections.

## 4.9 INSTALLATION OF AN ASSEMBLED PUMP



#### WARNING!

##### Explosive atmosphere!

Prior to and during the installation ensure that the atmosphere is not potentially explosive. Stop all work immediately if any danger arises.

Welding, burning, and grinding should only be carried out on the pump where specifically authorized, e.g. there may be a risk of fire and/or explosion.



#### WARNING!

Do not attempt to sling the pump from other lifting points. Do not allow the slings to foul pipework, instruments etc., when lifting the unit.

Do not use the pump component eyebolts for lifting the complete unit!

Component eyebolts are meant for the lifting of loosened parts during assembly and disassembly only.

If the eyebolts break during transportation/lifting, the pump unit can fall and cause serious accidents.



#### NOTICE!

Pumps 40 feet or less in length are usually shipped assembled.

Personnel:

Pump Specialists

Protective equipment:

Protective clothing

Protective gloves

Industrial safety helmet

Safety shoes

Goggles

## INSTALLATION

- 4.9.1** Refer to the OPERATION section for pre-start procedure before commencing the installation.
- 4.9.2** Check all nuts and bolts for tightness.



### CAUTION!

#### Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fastened connections.

- 4.9.3.** Check the mounting flange of the pump and the matching flange on the foundation for burrs and nicks. These must be smoothed with a mill file.
- 4.9.4** Attach a lifting device to the upper end of the assembled pump and raise it to a vertical position over the foundation opening. Refer to the TRANSPORT, RECEIVING, and STORAGE Section of this manual for lifting illustrations (Figures 3.3 and 3.4).



### WARNING!

Do not attempt to sling the pump from other lifting points. Do not allow the slings to foul pipework, instruments etc., when lifting the unit.

Do not use the pump component eyebolts for lifting the complete unit!

Component eyebolts are meant for the lifting of loosened parts during assembly and disassembly only.

If the eyebolts break during transportation/lifting, the pump unit can fall and cause serious accidents.



### CAUTION!

#### Strainer Care!

When a strainer is attached to the suction end of the pump, use care not to damage the strainer when raising the assembly to the vertical position. Do not allow the suction end to drag or support the total weight of the assembled pump.



### NOTICE!

With pump in the vertical position, remove the lifting device at the bottom of the pump, and install the pump into the sump.

- 4.9.5** Carefully lower the unit and hand guide it so that it does not strike the sides of the soleplate or foundation and watch for any binding of the pump or obstructions which can be felt through your hands.
- 4.9.6** Stop lowering the unit when the head mounting plate is still a few inches above the foundation. Rotate the pump to align the discharge flange with the discharge piping and the mounting holes with the anchor bolts or soleplate holes.
- 4.9.7** Slowly lower the pump onto the foundation or soleplate and install nuts to anchor bolts, or bolts to the soleplate but do not tighten.

## INSTALLATION

- 4.9.8** Orient discharge flange to discharge piping and connect piping. All piping must be carefully aligned and supported to prevent exterior stresses from being transferred to the pump.
- 4.9.9** Tighten the discharge flange bolting, being sure the flanges mate without forcing, then tighten the anchor bolts to the soleplate in accordance with ADDENDUM No. 2 of this manual.

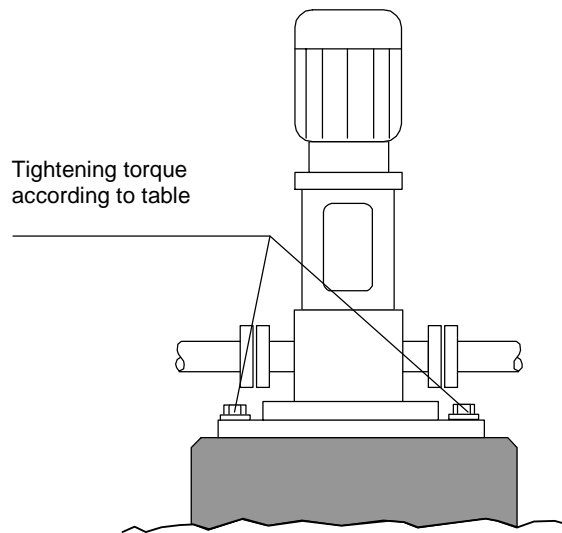


### CAUTION!

#### Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fastened connections.



**Figure 4.4**

- 4.9.10** Clean the mounting flange on top of the discharge head, checking for burrs or nicks. Use a flat file, if necessary. Thoroughly clean with solvent, then wipe a thin layer of light oil over the surface to help prevent rust and to facilitate driver alignment.



### ENVIRONMENT!

#### Incorrect handling of ecologically hazardous substances!

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective equipment when handling ecologically hazardous substances.



### CAUTION!

When the pump is fitted with external lines such as grease, by-pass, flush etc., extreme care must be used not to damage these lines while raising or lowering the assembly.

## INSTALLATION



### WARNING!

**Explosive atmosphere!**

**Seal up foundation holes to prevent the entering of explosive gases and/or fill the space between pump case (barrel/can) and foundation holes with a suitable filling material.**

- 4.9.11** When the head-shaft is shipped separately with VHS Motors, clean the threads and install the head-shaft. Hand-tighten only.



### NOTICE!

**The coupling threads are left hand.**

- 4.9.12** Mount the driver and align the pump in accordance with the ALIGNMENT Section of this manual.



### CAUTION!

**When connecting piping to the pump do not put a strain on the pump as this may cause misalignment.**

## 4.10 SUCTION AND DISCHARGE PIPEWORK



### WARNING!

**Explosive atmosphere!**

**Prior to and during the installation ensure that the atmosphere is not potentially explosive. Stop all work immediately if any danger arises.**

**Welding, burning, and grinding should only be carried out on the pump where specifically authorized, e.g. there may be a risk of fire and/or explosion.**



### WARNING!

**Incorrect installation of the piping can lead to serious injury and considerable property damage.**

**Exceeding the permitted branch loads can lead to the sudden escape of pump medium.**

- Only allow experts in pipe layout to design and carry out any piping installation activities.
- Carefully clean the piping before and after installation, removing all impurities and foreign bodies.
- Remove welding beads and welding streaks in the case of welding construction.
- Piping must always be installed under no load.
- Observe the permitted tolerances during installation.

# INSTALLATION

Personnel:	Pump specialist Piping construction specialists
Protective equipment:	Protective clothing Protective gloves Industrial safety helmet Safety shoes

- 4.10.1 General** Pipe diameters will have already been determined at the planning stage and many factors unknown to the pump manufacturer will have been taken into account. As a general rule, the liquid velocity should not exceed 1.8 m/s (6 ft./sec) in the suction pipework and 4.6 m/s (15 ft./sec) in the discharge pipework.



**CAUTION!**

**Incorrect installation of the piping!**

**Undesirable tension on the discharge lines may cause abnormal vibrations, premature wear or pump breakdowns.**

- 4.10.2** It is good engineering practice to increase the size of the suction and discharge pipes at the pump nozzles in order to decrease the head loss from friction. For this reason, piping should be arranged with as few bends as possible and even then bends should be made with as long of a radius as possible. Useful hints given below should be observed when the pipework is installed.



**CAUTION!**

**If the possibility of dangerous recirculation occurs after shut-down of the pump, back-flow preventers (check valve) must be built-in.**

**Typically this occurs with an "emergency trip out" (or power failure).**

### 4.10.3 Assembly



**CAUTION!**

**Incorrect installation of the piping!**

**The pipework must be supported in an adequate manner to ensure that no inadmissible bending moments or stresses caused by the weight of the pipework or thermal expansion are transmitted to the pump flanges (install an expansion piece).**

- 4.10.3.1 The piping systems, including supports and restraints should have been designed to restrict loads imposed on the machinery to acceptable levels (typically indicated on the pump outline drawing). If not on the outline drawing or order documentation, refer to API 610 11<sup>th</sup> Edition, Table 5.
- 4.10.3.2 All supports and expansion equipment must be installed before making connections to the pump flanges. Ensure that the correct gasket is used at all flanged joints and that the gasket is mounted concentric with the bore of the pipe.

## INSTALLATION



### WARNING!

New gaskets must be used at this time. Failure to do so may result in leakage creating hazardous conditions!

4.10.3.3 **Stress-free pipe connection** The stress free pipe connection is to be checked (cold condition, pump empty) as follows:

4.10.3.3.1 The pipe must be suspended over the pump flange and there must be enough space to easily build in the sealing gasket.

4.10.3.3.2 The supports have to be designed in such a way that the weight of the pipe and fluid are compensated for, and that weight will not put unfavorable high pressure loads on the pump branch.

**Notice and Observe** nozzle loads in the installation plan.



### CAUTION!

#### Excessive Nozzle Loads!

Higher than the given maximum admissible nozzle loads may lead to a sudden leakage of medium delivered. Life threatening conditions may occur.

4.10.3.3.3 If the pipe supports (especially fixed points) are not near the pump with 1 or 2 elbows (45 or 90° direction change), the pipe can be considered as flexible. In such cases, the following tolerances can be used for "stress free connections."

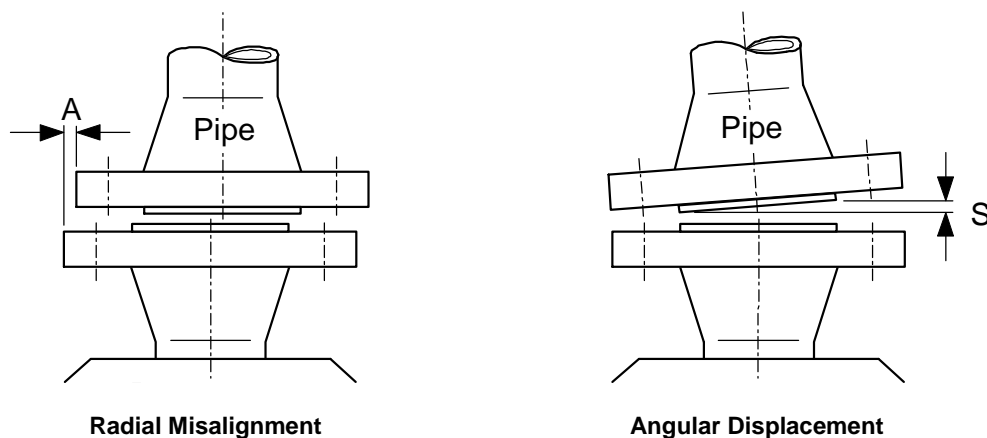


Figure 4.5

Stress free connection for flexible suction and discharge pipes (cold condition)		
Pipe Nominal Diameter	up to 8 in. (200mm)	Over 8 in. (200mm)
Radial Misalignment	A	max. 0.02 in. (0.5mm)

## INSTALLATION

<b>Angular Displacement</b>	<b>S</b>	max. 0.008 in. (0.2mm)	max. 0.016 in. (0.4mm)
-----------------------------	----------	------------------------	------------------------

4.10.3.3.4 If the pipe is considered as "not flexible", then 50% of the tolerances of flexible piping can be used. Be sure the maximum admissible nozzle loads (see installation plan) are not exceeded.



### CAUTION!

Adjustments must be made to the piping to prevent resulting damage to the pump. If these limits are exceeded, serious damage to the pump may occur.

### 4.10.4 Pipe fittings

4.10.4.1 **Discharge line** A check valve and a shut-off valve should be installed in the discharge line. The check valve, placed between the pump and the shut-off valve, is to protect the pump from reverse flow and excessive back pressure.



The shut-off valve is used in priming, starting and when shutting down the pump.

4.10.4.2 **Suction line** In the suction line, a shut-off valve should be installed for extended shut downs, repairs and for pump draining. It must be fully open during operation, and must not be used for pump regulating.



### CAUTION!

Fittings having the same nominal bore of the pipework should be used. If the pump branches have a smaller nominal bore than the fittings, a suitable taper pieces should be installed.

4.10.4.3 **Suction pipe** On flooded suction applications, the horizontal sections of the pipework should descend towards the pump and on suction lift applications they should steadily rise towards the pump to prevent air locking.

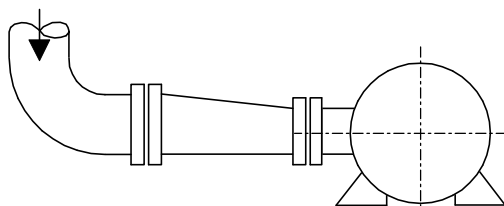


Figure 4.6 Flooded Suction (Suction head)

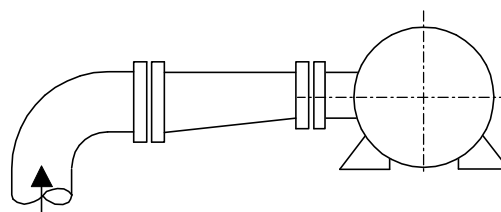


Figure 4.7 Suction lift

### 4.10.4.4 General Rules for Pipe Fittings:

- The pieces should be designed and constructed so as not to obstruct the free flow of liquid.
- The transition from small to large pipe diameters must be gradual.
- As a general guide the length of a concentric taper piece must be 5-7 times the difference in pipe diameters.

## INSTALLATION

- Sudden reductions in pipe cross sectional area and sharp bends should be avoided especially in the suction or inlet pipework, as these greatly increase the frictional resistance within the pipework.
  - Install a straight pipe with a length of 5 to 8 times the pipe diameter between flow disturbances such as fittings or elbows.
  - A high frictional resistance within the suction or inlet pipework leads to reduced pressure available at the suction branch.
  - Too low of a pressure at the suction branch leads to cavitation at the impeller inlet.
- 4.10.4.5 To prevent turbulent flow into the pump, do not position the shut-off valve in the suction piping adjacent to the pump suction nozzle. The suction valve should be positioned with the hand wheel horizontally or vertically downwards to prevent air pockets from forming.
- 4.10.4.6 Multi-pump installations should have separate suction pipes to each pump. The exception is duty and standby pumps which may have common suction pipework since only one pump operates at any time.

### 4.10.5 Cleaning the Pipework



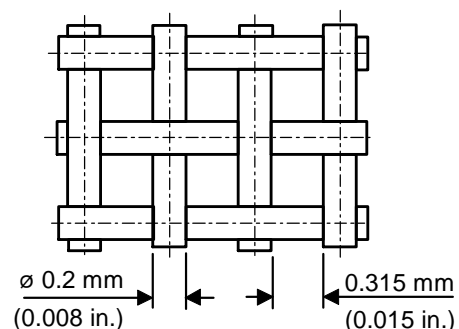
#### CAUTION!

Before a pump set is commissioned, all traces of foreign bodies and impurities must be carefully flushed out of the supply tank and pipework.

Where pipework has been welded, all welding slag, etc. must be removed.

- 4.10.5.1 **Suction Strainer** In order to prevent any of the above impurities from entering the pump, it may be necessary to install a suction strainer made of stainless steel in the inlet pipework.

- 4.10.5.2 The strainer insert should consist of a supporting strainer (plate with round holes, 5 to 8 mm, (0.2 to 0.32 in.) to which a wire screen (wire cloth 0.315 x 0.2 mm, (0.0125 x 0.008 in.) is fixed by welding.



**Figure 4.8 Wire Mesh**

- 4.10.5.3 The effective area of passage of this strainer must be at least 1.5 to 2 times the pipe diameter. Monitor the pressure drop across the strainer by a differential pressure gauge. If at any time, a reduction in pump suction pressure is observed, the strainer should be removed and cleaned.



#### WARNING!

Use of finer mesh screens than described may result in insufficient flow to the pump and subsequent damage. Contact a Sulzer representative before proceeding.

## INSTALLATION



### WARNING!

The suction strainer will not stop particles smaller than the mesh opening size so it is imperative that the system be cleaned thoroughly to prevent coast down seizures associated with particles of a size greater than pump internal clearances entering the pump. Small particulate that would not affect an operating pump can lodge between rotating/stationary parts as the rotation slows and torque diminishes.



### CAUTION!

NPSHa at the suction branch is reduced by the maximum admissible differential pressure at the strainer whereas NPSHa has always to exceed NPSHr. The below given values are differential pressure limits for strainer loads. Lower regulation limits for ALARM / SHUT OFF may have to be set accordingly.

Max Pressure	Result	Preventive Action / Cause
≥0.35 bar (5 psi)	Causes ALARM	Clean strainer
≥0.5 bar (7 psi)	The pump is SHUT OFF	Higher differential pressures may lead to damage to the strainer resulting in serious damage to the pump.



### CAUTION!

The pipework should be pressure tested in accordance with the statutory regulations.

## 4.11 AUXILIARY PIPING AND EQUIPMENT



### WARNING!

**Explosive atmosphere!**

Prior to and during the installation ensure that the atmosphere is not potentially explosive. A "Permit to Work" system is recommended.

Stop all work immediately if any danger arises.

Welding, burning, and grinding should only be carried out on the pump where specifically authorized, e.g., there may be a risk of fire and/or explosion.



### WARNING!

Any designation of the pump refers to the pump component only. Shaft coupling, driver (e.g., electric motor) and auxiliary systems (shaft sealing, lubricating oil system, etc.) must be looked at separately.

Exposure to ignition sources, such as sparks, naked flames and hot surfaces, can cause an explosion in areas with a potentially explosive atmosphere. This may result in death, serious injury or significant material damage.

# INSTALLATION



## WARNING!

### Measurement and control equipment is energized!

#### Pump operation is monitored electrically. Danger of death from electric shock.

- Work on measurement and control equipment should only be performed by qualified electricians with an additional qualification in explosion protection.
- If there is damage to the insulation, switch off the power supply immediately and have it repaired.
- Never bypass or disable fuses. When replacing fuses, make sure that the correct amperage is used.
- Keep moisture out of electrically charged components. This can cause a short circuit.



## WARNING!

### Incorrect installation of the auxiliary piping!

#### The incorrect installation of the auxiliary piping can lead to serious injury and considerable property damage.

- Any installation of auxiliary piping must be carried out by pump specialists.
- Carefully clean the auxiliary piping before and after installation, removing all impurities and foreign bodies.
- Remove welding beads and welding streaks in the case of welding construction.
- Auxiliary piping must always be installed under no load.
- Observe the permitted tolerances during installation.



## WARNING!

### Incorrect installation of fittings and instruments!

#### Incorrect installation of fittings and instruments can lead to severe injury and considerable property damage.

- All activities associated with installing fittings and instruments must be carried out by technical pump specialists.
- Make sure that the fittings have exactly the same nominal width as the piping. With pump connectors having a smaller nominal width, install conical transition pieces between the pump and the fittings.
- Observe the specified connection points and measuring points according to the layout plan, piping and instrument diagram and section drawing in the Appendix.



The installation location positions are included on the section drawing and the layout plan. The scope of delivery for the measuring instruments is identified in the piping and instrument diagram.

The types of measuring instruments are defined in the equipment list.



Details of the auxiliary piping required can be found in the layout drawing.

# INSTALLATION

Personnel:	Pump specialist Electrician
Protective equipment:	Protective clothing Protective gloves Industrial safety helmet Safety shoes

**4.11.1** Auxiliary equipment is used to monitor the pump by measuring pressure, temperature, etc. The auxiliary piping will maintain the operating systems including cooling, flushing and sealing. The equipment and piping will vary depending on the application and installation requirements. For type, position, and dimensions of the auxiliary connections, refer to the general arrangement drawing.



**CAUTION!**

Failure of any auxiliary device (e.g., cooling, circulation) may lead to inadmissible pressure build-up in the pump. Suitable safety devices (i.e., alarm, emergency shut-down switch, gauges, etc.) must be installed prior to pump operation.



**CAUTION!**

Do not mix up connections after initial installation and following shutdowns for maintenance purposes, check the pipe runs.



**CAUTION!**

Electrical connection tests on motors and controlling devices may be performed only by trained personnel.

The applicable standards and guidelines for terminal connections must be observed. If provided on the mounting plate, the ground must be connected.

## 4.11.2 Auxiliary Pipework

4.11.2.1 The following instructions may be used as a guide but they will vary depending on the system supplied.



**CAUTION!**

Perfect tightening of all flanges and connections with proper bolts should be checked according to the torque table in ADDENDUM No.2 of this manual during installation and maintenance, and prior to operation.

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fastened connections.

## INSTALLATION

- 4.11.2.2 **Drainage** of the pump casing can be affected by leading a pipe into a drain collection pipe. Isolating valves must be installed in the drain pipe and must have a pressure rating at least equal to the rating of the casing. The drain of the can must be done with a suction device (vacuum pump). For the position of the can drain connection, see the installation plan.



### CAUTION!

All pressure relief safety valves need to be installed in a vertical position for them to work properly. Review and install in accordance with the manufacturer's instructions.



### ENVIRONMENT!

The draining of the pump from toxic, explosive, hot or otherwise dangerous fluids must not lead to any danger to operator(s) or environment!

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective equipment when handling ecologically hazardous substances.

- 4.11.2.3 **Discharge Head Venting** of the pump is affected by leading a pipe to the supply tank, or to the flare. See Pump Venting Options illustration for position of pump vent connection (and General Arrangement Drawing).

- 4.11.2.3.1 **Option 1:** Venting to a supply tank.



### CAUTION!

To prevent a gas or vapor bubble build-up in the inlet area of the pump during operation, there must be a continuous vent to evacuate the gas entering the pump by the liquid pumped. For this, the venting valve must be "locked open" before commissioning (continuous vent).

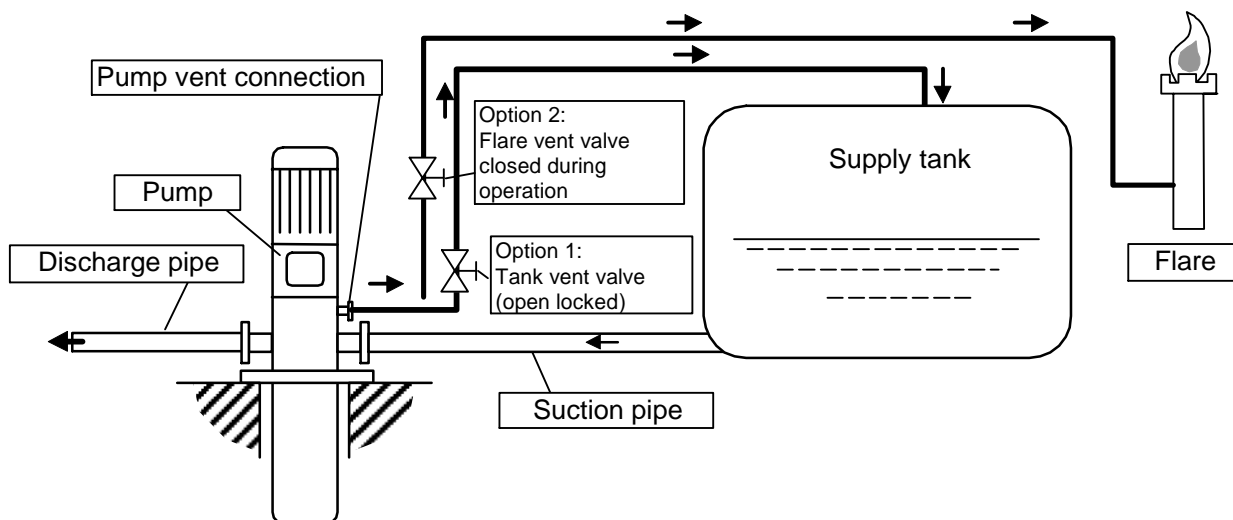
- 4.11.2.3.2 **Option 2:** Venting to a flare. Precondition: Vapor or gas bubbles must not enter the pump suction during operation.



### CAUTION!

Venting will be effected via the vent piping, which leads from the pump to the flare. The valve in the vent line is used for manual venting and should be closed during pump operation.

## INSTALLATION



**FIGURE 4.9 PUMP VENTING OPTIONS**



### CAUTION!

The venting pipe is not supplied by the pump manufacturer. It must be provided by the operator. The pipe must always lead from the pump to the highest point of the supply tank or to the flare (see Figure 4.9 Pump Venting Options illustration).

For shut-down and disconnection for maintenance, a shut-off valve must be fitted in the venting line.

Isolating valves must have a pressure rating at least equal to the rating of the pump suction side (suction flange or pump can). The vent pipe must always be laid as a separate pipe.



### CAUTION!

The Pipe-work should be pressure tested in accordance with the statutory regulations.



### ENVIRONMENT!

**Incorrect handling of toxic or ecologically hazardous substances!**

The leakage of dangerous fluids has to be drained or quenched in such a way as to prevent any damage to persons or the environment!

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective equipment when handling ecologically hazardous substances.



### NOTICE!

**Gland leakage!**

Gland leakage from the shaft seal can also be led into the drip tray or collection pipe.

- 4.11.2.4 **Cooling** of the pump is affected through cooling liquid. For connections and scope, see the installation plan or separate drawing respectively.

# INSTALLATION



## NOTICE!

Do not confuse cooling inlet and outlet connections. (Inlet = lowest; outlet = highest point of cooling housing).

For the adjustment of cooling water quantity, regulating valves are installed in the supply piping. At open system lead the drain piping over a funnel.

- 4.11.2.5 **Heating** of the pump is affected through connections (for scope see installation plan or separate drawing respectively).



## NOTICE!

Do not confuse heating inlet and outlet connection. (Inlet= highest; outlet= lowest point of heating housing).

In the supply piping, regulating valves are installed. Lead reflux in a collection piping, if necessary via a steam trap.



## CAUTION!

The pipework should be pressure tested in accordance with the statutory regulations.

- 4.11.2.6 **Flushing and / or sealing of the shaft seal** For connections and scope see the installation plan or separate drawing respectively. For piping which leads to a heat exchanger, pressure transmitter or supply reservoir, a vent possibility is provided at the highest point. In case of thermosyphon revolution the biggest pipework diameter possible will be used. Supply piping is laid evenly ascending and without any sharp bends.
- 4.11.2.7 **Quench** In case the necessity arises to quench any leakage from the mechanical seal.

### 4.11.3 Pressure measuring equipment

- 4.11.3.1 The start-up and monitoring of the operating point of the pump is made easier with pressure gauges. Pressure gauges should be mounted on a common gauge panel and connected to the taps in the pump branches or adjacent pipework using a hydraulic tube with an expansion loop.



## NOTICE!

Pressure measuring equipment must be installed at startup and for operation to monitor the performance of the pump.

- 4.11.3.2 Isolating and vent valves should be installed in the pipework for ease of maintenance.
- 4.11.3.3 In case of external flushing of the shaft seal, pressure gauges are installed in these pipes for monitoring the pressure.

### 4.11.4 Temperature measuring instruments

- 4.11.4.1 If a pump operates near the vaporization point of the liquid, thermometers are recommended for control of liquid temperature. In the pipework, installation of thermometers should be submersed in at least 40 mm (1.5") into the fluid. At pressures over 16 bar, use a protection tube (DIN 43763).

## INSTALLATION

- 4.11.4.2 If technically required, temperature control of circulation fluid for mechanical seal is executed to avoid vaporization in the sealing range. At heating, the maximum temperature of the heat carrier has to be controlled. A measuring possibility of cooling water outlet temperature is favorable, as the adjustment of outlet temperature smaller than 40°C (104°F) to avoid deposits in the cooling water pipes.
- 4.11.4.3 Pumps with high loaded bearings require numerous controls of bearing or oil temperature. If necessary, control by means of a contact thermometer or PT 100. For execution and measuring points, see the pipework scheme or installation plan. Limit values. It is useful to control temperature under sound insulation covers with tele-indication. Align so that oil or bearing temperature respectively of pump and driver cannot exceed the permitted limit.



### WARNING!

The applicable standards and guidelines for terminal connections must be observed. The ground must be connected if provided on the pump unit and/or the soleplate.



### CAUTION!

Electrical connections for motors and controlling devices may only be implemented by skilled personnel. The instructions of the electrical equipment manufacturers have to be observed as well as the valid national regulations on electrical installations and the legal regulations of the local power suppliers.

- 4.11.5 Bearing Monitoring** (impact impulse measurement, only possible with antifriction bearings). Advancing bearing damage can be recognized and monitored by means of impact impulse measurement. This requires a special measuring unit which is connected near the bearing through screw fittings (e.g., SKF connecting nipple No. 1649013 and SKF measuring unit MEPA 21 A).
- 4.11.6 Flow indication or flowmeters** According to technical requirements, flow indicators are installed in the reflux of supply pipework. Do not start-up the pump before auxiliary piping is open and the liquid stream can be determined on a flow indicator. If there is danger of mechanical seal failure due to too low circulation, a flowmeter is installed in the circulation piping. The meter activates an alarm when circulation / quantity decreases which subsequently shuts down the pump.
- 4.11.7 Filter / strainer / cyclone separator** Filter / strainer / cyclone separators are absolutely necessary at rinsing of mechanical seal with spoiled rinsing liquid.



### CAUTION!

Attention in case of operation with a strainer or filter (this is not valid in case of cyclone separator). If the pump may not be shut-down for change of filter, switchable, parallel, arranged filters are installed.

Rising temperature at the cover of mechanical seal or inadmissible high differential pressure between measuring points in front of and behind the filter indicate a dirty filter. Exchange or clean filter immediately.

For operation safety reasons it is recommended to carry out the surveillance of the filter not only locally, but also by tele-indicator in the central switch office.

# INSTALLATION

## 4.12 MINIMUM FLOW DEVICE



### NOTICE!

In accordance with local-safety standards, these instructions must form part of every operating manual's safety instructions for pumps which operate in the partial load region.

The following information may be disregarded, if the pump supplied never runs in the partial load region.



### CAUTION!

In the partial load region (when operating the pump near zero flow) almost the total pump power is imparted to the flow as thermal energy. If this flow is less than a certain minimum rate, heating will occur and continue until the liquid boils, causing severe damage to the impellers and wear rings, leading to eventual breakdown of the pump.

To avoid this there must always be a certain flow of liquid through the pump.



### WARNING!

If the shut-off device in the delivery pipe is tightly throttled or closed during pump operation, the delivery fluid inside the pump will heat up after just a short time. This may cause the surface temperature on the pump casing to rise above the permissible temperature class.

If necessary, provide the equipment with appropriate safety systems (i.e., remote temperature monitoring equipment with an emergency switch-off switch).



The minimum flow device may not be included in the Sulzer scope of delivery.

**4.12.1 General** A device must be fitted in the discharge pipe immediately after the pump, which guarantees minimum flow even with closed discharge valve. The following devices have proved successful in use:

**4.12.1.1 Automatic leak-off non-return valves** operate such that as the flow decreases the minimum flow line automatically opens and an integral throttle element controls the minimum flow. The contrary happens on increasing the capacity. The minimum flow line is directly flanged to the automatic leak-off non-return valve.

**4.12.1.2 Constant by-pass.** A by-pass line is fitted between the pump and the discharge valve, which also leads back to the suction tank. A throttle is built into the pipe which determines the flow rate. With this type it should be remembered that the by-pass quantity also flows with the discharge valve open, which reduces the efficiency of the pump. It must be considered carefully whether it is worth buying an automatic leak-off non-return valve.

**4.12.1.3 Minimum flow line or by-pass**

## INSTALLATION



### CAUTION!

The minimum flow line is not supplied by the pump manufacturer. It must be provided by the operator. The pipe must always lead from the pump to the suction tank. For shut-down and disconnection for maintenance, a shut-off valve must be fitted in the minimum flow line, but must be locked open before commissioning. If several pumps are installed to operate in parallel and the minimum flow pipework connects into a common header, it is necessary to install a non-return valve in each feed piping.



### CAUTION!

Never operate below pump minimum flow. Operation at minimum flow should be maintained for no longer than 2 hours in any 24 hours of operation.

# INSTALLATION

## INSTALLATION SEQUENCE CHECK LIST

CUSTOMER \_\_\_\_\_ ORDER NO. \_\_\_\_\_ PRODUCT \_\_\_\_\_

TEMP (°F) \_\_\_\_\_ SPECIFIC GRAVITY \_\_\_\_\_ ROTATION: CW  CCW  RPM \_\_\_\_\_

RATED HEAD (FT) \_\_\_\_\_ FLOW (USGPM) \_\_\_\_\_ SUCTION PRESSURE (PSIG) \_\_\_\_\_

DRIVER \_\_\_\_\_ COUPLING \_\_\_\_\_ MECH. SEAL \_\_\_\_\_

### EVENT

- Foundation Construction
- Prepare Foundation
- Place Spacer Blocks
- Set Soleplate over Foundation Bolts
- Level Soleplate using Jack Screws and Shim Pack
- Snug-Up Foundation Bolt Nuts
- Check Leveling of Soleplate
- Grout Soleplate
- Final Torque Foundation Bolts after Grout Cures
- Erection and Installation of Pump
- Installation of Driver
- Install Main Piping

## INSTALLATION

- Align Driver to Pump
- Connection of Auxiliary Piping Systems
- Installation of Instrumentation and Control Equipment
- Connection of Driver to Pump
- Fill System

**Check off when satisfactorily completed**

# ALIGNMENT

## 5.0 ALIGNMENT SAFETY INSTRUCTIONS



### WARNING!

**If the Sulzer scope of supply does not include the coupling / coupling protection, ensure that only approved materials and designs are used for applications in potentially explosive areas!**

Exposure to ignition sources, such as sparks, naked flames and hot surfaces, can cause an explosion in areas with a potentially explosive atmosphere. This may result in death, serious injury or significant material damage.



### WARNING!

**Improper operation can lead to serious injury and considerable property damage!**

Ensure that all work is carried out and completed according to the data and notices in these instructions.

- Before starting work, make sure there is sufficient assembly space.
- Ensure that the assembly area is tidy and clean! Components and tools that are loosely stacked on each other or lying around can cause accidents.
- Be careful when handling open, sharp-edged components.
- Secure components so that will not fall or tip over.
- Assemble the components correctly. Observe the prescribed fastener tightening torques.
- Ensure that no one is in the danger area.



### WARNING!

**Unauthorized or uncontrolled switching on again!**

**Before alignment, lock power breakers to the off position prior to performing work on the coupling and display appropriate safety signage!**

If the driver is switched back on by an unauthorized person or in an uncontrolled manner it may result in serious injury or even death.

- Before switching back on, make sure that all safety devices are installed and in full working order and that there is no danger to persons.
- Always comply with the process to secure against switching on again.



### CAUTION!

**Before aligning the shaft, and with the pump and driver uncoupled, check to assure that the direction of rotation of the driver corresponds with the direction of rotation arrow on the pump.**



### CAUTION!

**Pump and motor bearings must be lubricated before attempting to turn the rotor. Avoid any unnecessary turning of machine rotors.**



### CAUTION!

**Whenever practical, the pump must be filled with product before turning by hand.**

# ALIGNMENT



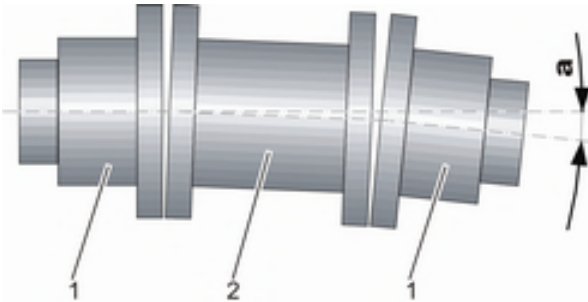
## CAUTION!

If initial alignment is performed with cold pumpage, when hot pumpage is introduced, the alignment must be re-checked and corrected if required.

This section describes recommended procedures for aligning the motor (driving machine) to the pump (driven machine) for the pump set supplied.

## 5.1 MISALIGNMENT TYPES

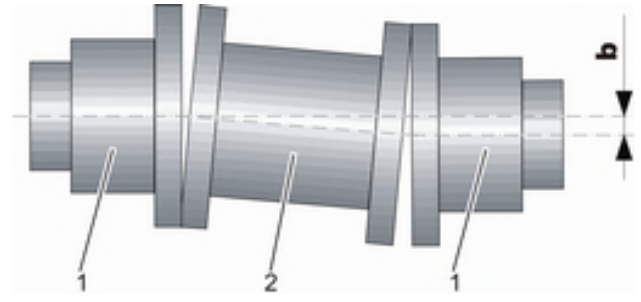
There are three basic misalignment types between the pump and driver shafts.



**Figure 5.1, Angular Misalignment**

Shafts with axes that intersect at a point

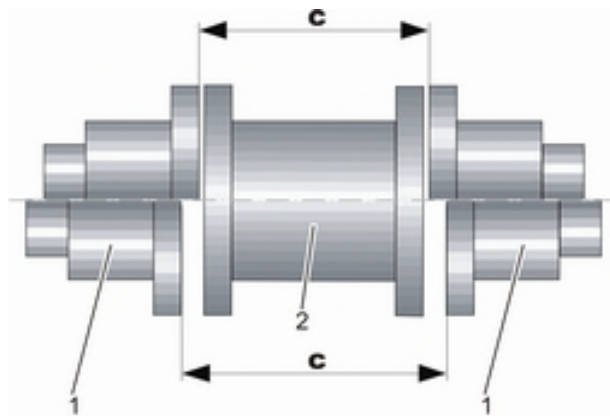
- 1 = Coupling half
- 2 = Coupling spacer
- a = Angular offset



**Figure 5.2, Parallel Misalignment**

Shafts with axes parallel, but with an offset

- 1 = Coupling half
- 2 = Coupling spacer
- b = Parallel offset



**Figure 5.3, Coupling Spacer Gap**

Shafts coaxial, but with wrong spacer distance

- 1 = Coupling half
- 2 = Coupling spacer
- c = Axial clearance

# ALIGNMENT

## 5.2 ALIGNMENT



**WARNING!**

Unauthorized or uncontrolled switching on again!  
Lock power breakers to the off position prior to performing coupling assembly work!



**WARNING!**

If the Sulzer scope of supply does not include the coupling / coupling protection, ensure that only ATEX compliant or approved materials and designs are used for applications in potentially explosive areas.



**CAUTION!**

Avoid Dry Pump Rotation!  
Before alignment, the pump must be filled with product before turning by hand.



**WARNING!**

Before aligning the coupling, and with the pump and driver uncoupled, verify that the direction of rotation of the driver corresponds with the direction of rotation arrow on the pump!

Personnel:	Electrician Specialist Pump specialists
Protective equipment:	Protective clothing Protective gloves Industrial safety helmet Safety shoes

### 5.2.1 Coupling Spacer Gap Distance



**NOTICE!**

It is recommended that the coupling spacer gap and shaft alignment is checked even when the original pump and drive motor is being re-fitted after pump overhaul.

5.2.1.1 The axial distance between the coupling halves must be observed. Please see the General Arrangement Drawing for the proper coupling spacer gap. Refer also to the coupling manufacturer's instructions.

5.2.1.2 Measure the gap between the pump and motor half coupling hubs. Adjust the pump shaft nut to assure correct pump rotor lift before starting.

### 5.2.2 Angular and Parallel Alignment Check

# ALIGNMENT



Figure 5.4

## 5.2.2.1 Driver shaft run-out

- 5.2.2.1.1 Inspect all coupling components for dirt, burrs or any other imperfections.
- 5.2.2.1.2 For solid shaft vertical motors, it is important to check driver shaft run-out, and side to side movement prior to pump & motor alignment. In case of an apparent out-of-tolerance driver, consult a Sulzer Pumps representative or the driver manufacturer.
- 5.2.2.1.3 Maximum face run-out is 0.006 inch (0.15 mm) TIR for a 16 ½ inch and larger base diameter.
- 5.2.2.1.4 Maximum face run-out is 0.004 inch (0.10 mm) for below 16 ½ inch base diameter.
- 5.2.2.1.5 Maximum shaft run-out is 0.002 inch (0.05 mm) TIR.
- 5.2.2.1.6 When the driver shaft run-out has been checked, lift the driver onto the driver stand. Install the driver cap screws finger-tight.



### WARNING!

Do not attempt to sling the driver from other lifting points. Do not allow the slings to foul pipework, instruments etc. when lifting the driver.

Do not use driver component eyebolts for lifting the complete unit!

Component eyebolts are meant for the lifting of **loosened** parts during assembly and disassembly only.

If the eyebolts break during transportation/lifting, the driver can fall and cause serious accidents.

## 5.2.3 Shaft Misalignment Tolerances

Maximum TIR		
Operating Speed (RPM)	Angular (measured with axial clock) @ 12 in. (305 mm) Radius	Parallel (measured with radial clock)
1800 & slower	0.004 in. (0.10 mm)	0.006 in. (0.15 mm)
1800 to 3600	0.002 in. (0.05 mm)	0.003 in. (0.08 mm)

## 5.2.4 Angular and Parallel Alignment Check



### CAUTION!

Avoid Dry Pump Rotation!

Before alignment, the pump must be filled with product before turning by hand.

## ALIGNMENT

5.2.4.1 Clock Gauge Alignment (w/ Dial Indicators) for use **when the pump has an integral thrust bearing.**

5.2.4.2 Alignment should be carried out with dial indicators in the axial direction and radial directions as shown in Figure 5.5. Ensure that the supports for each indicator are sufficiently rigid to eliminate any sag that may cause spurious readings. All readings are determined every 90° while both shafts are simultaneously turned.

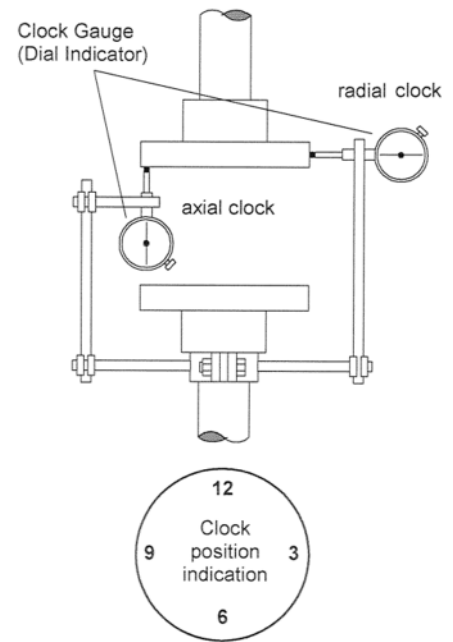
5.2.4.2.1 Position the dial indicator probe at 12 o'clock and set the gauge reading to zero.

5.2.4.2.2 Turn both shafts by 90° so that the dial indicator probe is at the 3 o'clock position. Record the reading on the dial indicator gauge.

5.2.4.2.3 Repeat the above step for the 6 o'clock and 9 o'clock positions of the dial indicator probe.

5.2.4.2.4 Finally turn both shafts to the 12 o'clock position. The dial indicator gauge should now read zero.

5.2.4.2.5 Acceptable limits are given in the table in section 5.2.3.



**Figure 5.5**



### NOTICE!

If opposite readings are plus and minus, the readings are added together to determine the maximum reading.

5.2.4.3 Optical Alignment for use **when the pump has an integral thrust bearing.**



### CAUTION!

**Avoid Dry Pump Rotation!**

Before alignment, the pump must be filled with product before turning by hand.

Legend for Figure 5.6

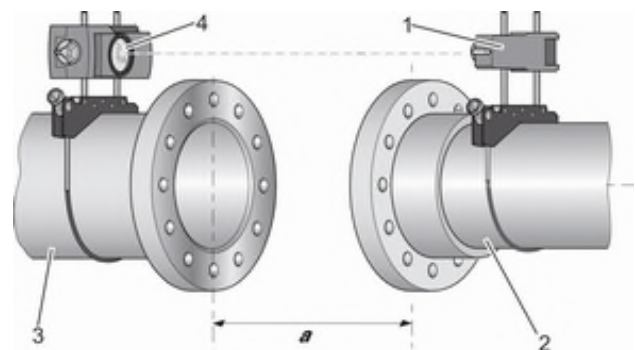
1 = Reflector

2 = Pump coupling flange

3 = Drive coupling flange

4 = Laser Diode

**a** = Coupling flange distance



**Figure 5.6**

## ALIGNMENT

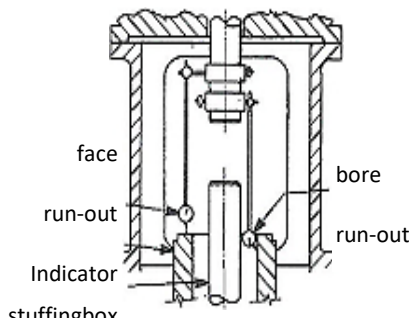
5.2.4.4 Instead of using a dial indicator, optical (laser) alignment equipment may be used. Laser optical alignment is the most exact shaft aligning method.

5.2.4.4.1 The transmitter is a laser diode mounted on one side of the coupling and the prism is mounted on the other side. The laser beam emitted by the laser diode is reflected by the prism to the localizer. The offset can be detected by rotating the shafts.

5.2.4.4.2 Because of the wider range of equipment available, these are not described in detail. Acceptable limits are given in the table in section 5.2.3.

5.2.4.4.3 Refer to the equipment manufacturer's information.

5.2.4.5 Alignment of the motor to the seal housing or stuffing box bore **when the thrust bearing is in the driver.**



**Figure 5.7**



**CAUTION!**

**Avoid Dry Pump Rotation!**

**Before alignment, the pump must be filled with product before turning by hand.**

5.2.4.6 Align the driver to the pump stuffing box. Mount a dial indicator to check face run-out. 0.002 inches (0.05mm) is the maximum Total Indicator Run-out (TIR). Adjust the TIR by placing shims between the driver base and driver stand.

5.2.4.6.1 Mount a dial indicator to check the bore run-out. 0.002 inches (0.05mm) is the maximum allowable TIR.

5.2.4.6.2 Secure the driver to the driver stand. See **TORQUE VALUES, ADDENDUM No. 2** of this manual for torque values and tightening sequence.



**CAUTION!**

**Incorrect fastener tightening torques!**

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Tightening torque and sequence is to be done in accordance with Addendum No. 2.

5.2.4.6.3 Recheck the vertical and horizontal run-out.

5.2.4.6.4 Install the coupling safety guard.

## ALIGNMENT



### CAUTION!

#### Coupling Safety Guard!

The pump must only be operated with mounted coupling safety guard. After each alignment check the coupling guard must be refitted immediately.  
Check for correct assembly and fastening distance to the rotating coupling.

**5.2.5 Taper pins** It is recommended that the drivers have taper pins installed after final alignment and before initial operation.

5.2.5.1 Drill and ream the flanges of the driver and the driver stand for acceptance of taper pins only after the coupling is in place and alignment is rechecked.

## 5.3 REALIGNMENT

- 5.3.1 If realignment is required (mounting a new driver, etc.), Remove the driver flange taper pins.
- 5.3.2 Loosen the driver hold-down bolts and perform the alignment.
- 5.3.3 Ream the existing taper pin holes for the next size taper pin or, if required, drill new holes.
- 5.3.4 Repeat the alignment check.
- 5.3.5 Secure the driver to the driver stand. See TORQUE VALUES, ADDENDUM No. 2 of this manual for torque values and tightening sequence.
- 5.3.6 Install the coupling safety guard.



### CAUTION!

#### Hot Fluid Start-up!

An alignment must be re-done or alignment should be checked and corrected when the pump becomes operational with hot fluid, or if there is a hot fluid start-up.



### CAUTION!

#### Coupling Safety Guard!

The pump must only be operated with mounted coupling safety guard. After each alignment check the coupling guard must be refitted immediately.  
Check for correct assembly and fastening distance to the rotating coupling.

# OPERATION

## 6.0 OPERATION SAFETY INSTRUCTIONS



### WARNING!

Risk assessment of the work area shall be carried out by qualified and competent personnel!

Machinery intended for use in potentially explosive areas must satisfy the “Ex” protection requirements. Check documentation and nameplates relating to the pump and any accessories or equipment.

- Any designation of the pump refers to the pump component only. Shaft coupling, driver (e.g. electric motor) and auxiliary systems (shaft sealing, lubricating oil system, etc.) must be looked at separately.
- Exposure to ignition sources, such as sparks, naked flames and hot surfaces, can cause an explosion in areas with a potentially explosive atmosphere. This may result in death, serious injury or significant material damage.
- Welding, burning, and grinding should only be carried out on the pump where specifically authorized, e.g. there may be a risk of fire and/or explosion.



### WARNING!

Explosive atmospheres!

Exposure to ignition sources, such as sparks, naked flames and hot surfaces, can cause an explosion in areas with a potentially explosive atmosphere. This may result in death, serious injury or significant material damage.

- Obtain a written work permit before commencing work in an area with a potentially explosive atmosphere.
- Only perform work if a potentially explosive atmosphere can be excluded.
- Only use tools permitted for use in areas with a potentially explosive atmosphere.



### WARNING!

Incorrect operation!

Incorrect operation can cause serious injury and significant material damage.

- Before operation, ensure that all installation work has been performed and completed according to the data and notices in these instructions.
- Perform all required tests before operation.
- Before operation, ensure that no one is in the hazardous area.
- Be careful when handling open, sharp-edged components.
- Operation should be performed by Sulzer personnel or by personnel trained and authorized by Sulzer Pumps.
- Be ready to use the emergency stop function to immediately shut down the pump in the event of an emergency.

## OPERATION



### DANGER!

Electric motor, measurement and control equipment is energized!

Danger of death from electric shock.

- Work on electrical components must be performed by qualified electricians only.
- If there is damage to the insulation, switch off the power supply immediately and have it repaired.
- Never bypass or disable fuses. When replacing fuses, make sure that the correct amperage is used.
- Keep moisture out of electrically charged components. This can cause a short circuit.



### WARNING!

Danger of being pulled in by moving components!

Being pulled in by moving components can cause serious injury.

- Do not handle moving components during operation.
- Do not grasp moving components during operation.
- Never open covers during operation.
- Observe the stopping time: ensure that the components are no longer moving before opening the covers.
- Wear closely fitting protective clothing with a low tear resistance in the hazardous area.



### WARNING!

External Influences – Lightning Strike!

Possibility of lightning strike when machines are operated outdoors.

- Before operation check the machine for damages ensuring that all safety devices are installed and in full working order and that there is no danger to persons.
- If necessary, repair all damages before switching on again.



### DANGER!

Fluid escaping at high pressure!

Fluid can escape at high pressure if lines or components are defective. This escaping liquid can sever body parts, causing extremely serious injury and even death.

- Never expose body parts or objects to this escaping fluid. Keep personnel out of the hazardous area.
- Activate the emergency stop measures immediately. If necessary, take additional measures to reduce pressure and stop the fluid escaping.
- Absorb the escaping fluid/pump media properly and dispose of it.
- Have faulty components repaired immediately.

## OPERATION



### WARNING!

#### Incorrect installation of fittings and instruments!

Incorrect installation of fittings and instruments can lead to severe injury and considerable property damage.

- All activities associated with installing fittings and instruments must be carried out by technical pump specialists.
- Observe the specified connection points and measuring points according to the general arrangement drawing, piping and instrument diagram and section drawing in the Appendix.



### CAUTION!

#### Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fastener connections.



### NOTICE!

#### Operation in wrong rotation direction

If the pump is driven against the prescribed direction of rotation, there is a risk of material damage culminating in a total pump failure.

- Connect the drive machine in accordance with the prescribed direction of rotation for the pump. Observe the direction of rotation arrow on the pump.



### ENVIRONMENT!

#### Incorrect handling of ecologically hazardous substances

Incorrect handling of ecologically hazardous substances can cause significant damage to the environment.

- Always follow the information provided by the manufacturer when handling and disposing of ecologically hazardous substances.
- Implement suitable measures immediately if ecologically hazardous substances are accidentally released into the environment. In case of doubt, inform the responsible local authority about the damage and ask what action needs to be taken.

Personnel:

- System operator
- Pump specialist
- Electrician

Protective equipment:

- Protective clothing
- Protective gloves
- Industrial safety helmet
- Safety shoes

## 6.1 CHECK LIST

- 6.1.1** Use the PRE-START UP REQUIREMENTS CHECK LIST at the end of this section to ensure all procedures are being followed and preparations for start-up are controlled.

# OPERATION

## 6.2 GENERAL



### WARNING!

When starting the pump, be prepared to execute an emergency shutdown in case of failure of the pump or auxiliary system.



### CAUTION!

#### Avoid Dry Pump Rotation!

Before alignment, the pump must be filled with product before turning by hand. Stainless steel fitted pumps are particularly susceptible to “pick-up” and turning by hand should be avoided whenever possible.

- 6.2.1 The following recommended start-up and operating procedures apply to the pump only. For information on any other equipment (i.e., driver, shaft coupling, shaft sealing system) refer to manufacturers' instructions.
- 6.2.2 Do not start or operate the pump unless:
- 6.2.2.1 The installation is verified to be correct and all safety and control functions have been checked.
  - 6.2.2.2 Operator has a complete understanding of the location and function of all components of the pump aggregate including valves and any upstream and downstream equipment that may affect the flow of medium to or from the pump.
  - 6.2.2.3 Operator has a complete understanding of all the auxiliary mechanical, electrical and hydraulic systems, as well as the functions of all monitoring gauges and warning devices.

## 6.3 COMMISSIONING



### CAUTION!

The items described individually have to be carried out, as far as applicable, step-by-step during commissioning.



### WARNING!

With electric drives, qualified personnel must assure that the necessary protection measures are in working order. Grounding, re-set, residual current failure, operated device, etc. have to be ready for service according to and approval by skilled personnel.

- 6.3.1 **Check the Following Before Commissioning:**



### CAUTION!

If there is danger of frost, protect the pump casing, bearing housing and cooling chambers against solidification. Also, insulate the Discharge Head to protect it against solidification of the product.

- 6.3.1.1 **Connections:** Check bolted connections and plugs. Inspect ancillary pipe-work for correct installation.

## OPERATION

6.3.1.2 **Lube:** Rinse the bearing housing with light oil and allow it to drain. Fill with lubricating oil, see also table for recommended lubricants in this manual.



### WARNING!

#### Pooled fluid on the floor!

Slipping on fluid that has pooled on the floor can cause fall-related injury.

- Remove pools of fluid immediately using suitable means.
- Wear slip-resistant safety shoes.
- Attach warning notices and mandatory signs at areas where fluid could pool on the floor.



### WARNING!

#### Eye or skin contact with oil

Contact with oil can cause inflammation of the eyes and irritation of the skin.

- Follow the instructions on the safety data sheet from the supplier.
- Wear appropriate protective gloves and face shield when handling lubricating oil.



### ENVIRONMENT!

#### Incorrect handling of ecologically hazardous substances!

All lubrication fluid must be collected and disposed of in accordance with the current environmental regulations to prevent endangering people or the environment.

- Wear appropriate protective gloves when handling the lubricating material.

6.3.1.3 **Alignment:** Remove the coupling guard. Check the alignment of the coupling per the ALIGNMENT Section of this manual.

6.3.1.4 **Shaft Seal:** Check the shaft seal.

6.3.1.4.1 In case of a double acting mechanical seal, fill and vent the sealing system (refer to the manufacturer's instructions).

6.3.1.4.2 If the pump has a packed gland there must be some leakage from the gland. Gland nuts should initially be finger-tight only. Leakage should take place soon after the stuffing box is pressurized.

6.3.1.5 **Filling the Pump:** In case of hot (or cold) product:



### CAUTION!

To prevent thermal shock, the pump should be filled slowly. Controlled fill-up with slow fill-up rate so that the pump case and internals can be warmed-up (or cooled-down) uniformly is necessary.

6.3.1.5.1 Slowly open the shut-off valve in the inlet line.

6.3.1.5.2 Vent the suction line and pump casing. Venting will be effected via the vent piping which leads from the pump to the highest point at supply reservoir (continuous vent).

6.3.1.5.3 Fully open the shut-off valve in the inlet line.

6.3.1.6 **Minimum Flow Line (if fitted):** Open and lock the valve in the minimum flow line.



### CAUTION!

Before starting the pump: The suction piping, suction barrel, shaft seal housing and discharge line must be completely filled with liquid. It is important that the discharge line be full before the pump is started to avoid the mechanical seal running dry, which will damage the seal faces.

# OPERATION

## 6.4 PUMP STARTUP AND OPERATION



### CAUTION!

#### Equalize the Product to Case Temperature!

Failure to adequately equalize the product to case temperature before start-up can cause damage from thermal shock. Acceptable temperature difference is dependant on pump type, metallurgy, etc. Set switches to alarm and the acceptable differential (delta) values and shut down at 10°F (6°F) above that value.



### WARNING!

#### Pump System Must Be Completely Full!

Pump operation is on the assurance that the pump system is always completely full of delivery fluid. This prevents any potentially explosive mixture in the pump. If this cannot be guaranteed appropriate safety systems must be equipped.



### WARNING!

#### Incorrect operation!

Incorrect operation can cause serious injury and significant material damage.

- Before operation, ensure that all installation work has been performed and completed according to the data and notices in these instructions.
- Perform all required tests before operation.
- Before operation, ensure that no one is in the hazardous area.
- Be careful when handling open, sharp-edged components.
- Operation should be performed by Sulzer personnel or by personnel trained and authorized by Sulzer Pumps.
- Be ready to use the emergency stop function to immediately shut down the pump in the event of an emergency.



### DANGER!

#### Fluid escaping at high pressure!

Fluid can escape at high pressure if lines or components are defective. This escaping liquid can sever body parts, causing extremely serious injury and even death.

- Never expose body parts or objects to this escaping fluid. Keep personnel out of the hazardous area.
- Activate the emergency stop measures immediately. If necessary, take additional measures to reduce pressure and stop the fluid escaping.
- Absorb the escaping fluid/pump media properly and dispose of it.
- Have faulty components repaired immediately.



### CAUTION!

#### Noise During Operation!

The noise level in the work area can cause serious hearing damage.

- Always wear ear protection when working.
- Only enter the hazardous area if necessary.

## OPERATION



### ENVIRONMENT!

#### Incorrect handling of ecologically hazardous substances!

All lubrication fluid must be collected and disposed of in accordance with the current environmental regulations to prevent endangering people or the environment.

- Wear appropriate protective gloves when handling the lubricating material.

Personnel:

- System operator
- Pump specialist
- Electrician

Protective equipment:

- Protective clothing
- Protective gloves
- Industrial safety helmet
- Safety shoes

**6.4.1 Auxiliary Equipment:** If available, put auxiliary equipment into operation (i.e., cooling, heating, sealant pressure). Open the valves in the ancillary pipe-work (open quench after pump start-up). Vent pressure gauge.

### 6.4.2 Start-up with Non-Pressurized System



#### WARNING!

Verify the level of fluid in the suction can by checking the suction pressure values against the project datasheets in order to guarantee the NPSHA value per design and to avoid operation under full cavitation which could damage the equipment.



#### NOTICE!

Temperature shock when filling!

Rapid filling of the pump with hot or cold pump medium can severely damage internal components.

6.4.2.1 Close the shut-off valve in the discharge pipe (minimum flow must be guaranteed).

6.4.2.2 Start the driver and bring the pump rotor immediately to operating speed.



#### CAUTION!

Damage can occur if the pump is operating at less than design speed!

6.4.2.3 As soon as the pump begins to develop discharge pressure, open the discharge valve slowly until the differential pressure drops to the value given on the data sheet. Avoid an abrupt change in discharge flow rate to prevent surging in the piping. Surging can cause serious damage.



#### CAUTION!

Do not operate against a closed discharge valve or below recommended flow. Do not throttle the suction valve. To do so, may incur damage through cavitation!

Non-observance may result in an unacceptable temperature increase and cause the pump to run dry. In extreme cases the pump casing may burst.

### 6.4.3 Start-up with Pressurized System (Precondition is non-return valve in discharge pipe)

## OPERATION



### CAUTION!

#### Temperature shock when filling!

Where a significant temperature difference exists between the stationary pump and the product, failure to allow the pump casing temperature and product temperature to equalize at the specified rate to within specified limits before pump start up can cause damage to the pump from thermal shock.



### CAUTION!

If possible, discharge pipe work upstream and downstream of the discharge isolating valve must be fully primed prior to start-up.

- 6.4.3.1 Vent the pump and main pipe work system of trapped air. When all air is expelled, and an air-free flow of product is obtained, ensure the vent valves are closed.
- 6.4.3.2 When applicable, open instrument isolation and vent connections. Close the vent connections when an air-free flow of product is obtained.
- 6.4.3.3 Start the driver with open discharge valve and bring the pump rotor immediately to operating speed.



### CAUTION!

Pump should produce pressure at discharge as soon as rated operating speed is reached. If not, shut down immediately and vent the pump system.



### WARNING!

The differential pressure must not fall below the design point even with plants that have fluctuating system pressure.



### CAUTION!

Do not operate against a closed discharge valve or below recommended flow. Do not throttle the suction valve. To do so, may incur damage through cavitation!

Non-observance may result in an unacceptable temperature increase and cause the pump to run dry. In extreme cases the pump casing may burst.

- 6.4.4 Ensure that any required mechanical seal flushing / cooling / quenching liquid supply is available and selected **ON** before starting the pump. Refer to the seal manufacturer's information and vent the mechanical seal and associated equipment as required. Ensure that vent connections are closed when an air-free flow of liquid is obtained.
- 6.4.5 Ensure that any required thrust bearing cooling liquid supply is available and selected **ON**. Refer to the cooling equipment manufacturer's information and vent the cooler(s) and associated equipment as required. Ensure that vent connections are closed when an air-free flow of liquid is obtained.
- 6.4.6 **Packed Gland:** The pump should be run for 30 minutes with steady leakage and the gland nuts tightened by 10 degrees at a time until leakage is reduced to an acceptable level; normally a minimum of 120 drops per minute is required. Bedding in of the packing may take another 30 minutes.

## OPERATION



### CAUTION!

The gland must be adjusted evenly to give visible leakage and concentric alignment of the gland to avoid excess temperature. If no leakage takes place the packing will begin to overheat. If overheating takes place the pump should be stopped immediately and allowed to cool before being restarted. When the pump is re-started, check to ensure leakage is taking place at the packed gland.

- 6.4.7 **Observe Ammeter Reading** The full load amps given on the rating plate of the motor must not be exceeded.
- 6.4.8 **Pump / Driver Speed** Check operating speed remains within specified parameters.
- 6.4.9 **Cooling water Circuit and Lube Water Inlet (typically found on Thrust Bearings)** Check cooling water lube water flow rate. Monitor flow rates until they stabilize.
- 6.4.10 **Bearing Temperature (if applicable)** Monitor bearing temperatures until they stabilize and ensure that they do not exceed the maximum allowable value. Shut down the pump set if the temperature limit is significantly exceeded.
- 6.4.11 **Adjustments** The pump capacity can be adjusted by the discharge valve.



### CAUTION!

Do not operate against a closed discharge valve or below recommended flow.  
Do not throttle the suction valve.  
To do so, may incur damage through cavitation.

## 6.5 STANDBY SERVICE (STARTING OF A STAND-BY PUMP OR STARTING A PARALLEL WORKING PUMP)

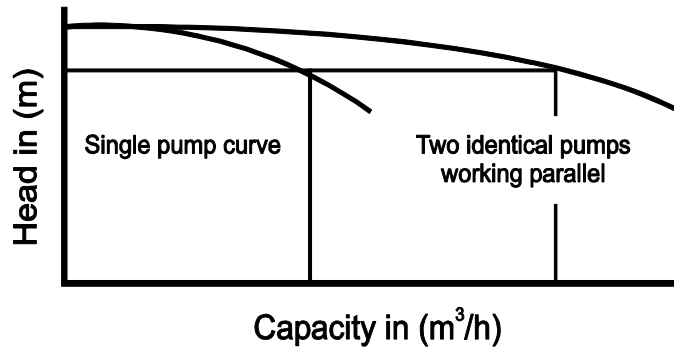


### NOTICE!

If a stand-by pump should replace the function of another one (operating pump), both pumps have to run parallel for a short time.

- 6.5.1 Proceed with preliminary work for the stand-by or parallel working pump as given in the previous sections 6.2 General and 6.3 Commissioning.
- 6.5.2 Start-up the pump as given in the previous Section 6.4 Pump Start-up and Operation; check discharge pressure. Operate both pumps in parallel.
- 6.5.3 Standby pump. After running in full operation, the first operating pump can be shut down. Refer to the following section 6.7 Shut Down procedure.
- 6.5.4 **Parallel working pumps** Both pumps remain in operation. Each (identical) pump delivers only half of the capacity delivered (see pump curves below). Non-identical pumps can also operate in parallel but selection must be done very carefully.

## OPERATION



### 6.6 INADMISSIBLE OPERATING MODES



#### CAUTION!

Overloads have to be avoided by all means as they may lead to a failure of parts due to too stringent mechanical requirements. Overloads occur if the pump is run beyond its original application range. The following are some examples:

- Exceeding the maximum admissible speed.
- Remaining at the minimum speed—low speed rotation, (e.g., by turbine drive, high-velocity flushing through the pump, damage or discharge non-return valve causing serious damage to the pump).
- Exceeding or remaining under the operating range of the pump.
- Exceeding the maximum admissible inlet pressure.
- Running of the pump without proper venting of the pump interior.
- Running of the pump without required safety devices (safety valves, electrical overload protection, etc.)
- Operating the pump with closed or throttled shut-off device in the inlet line (dry running).
- Operating the pump with closed or strongly throttled shut-off device in the discharge line without having a minimum flow device (exception: during start-up) (dry running).
- Operating the pump for the delivery of fluids for which the pump is not suitable (chemical, solids, gas content).
- Operating the pump with wrong rotation.
- Operating the pump with inadmissible bearing lubrication or with wrong lubricant.



#### WARNING!

Operating modes in any of the above mentioned ways may lead to heavy damage to the pump and other parts of the plant. Danger may arise due to the bursting of pressure-holding parts and people within are susceptible to injury if these and other operating modes are not followed. Hot, toxic or otherwise aggressive fluids can cause mortal harm.

### 6.7 SHUT DOWN OBSERVANCE SEQUENCE



#### NOTICE!

If a non-return valve is fitted in the discharge pipe, the discharge valve can remain open if the shut-down is for a short time only.

For lengthy shut-downs, for repairs, and where there is no non-return valve, the discharge valve must be closed.

## OPERATION

- 6.7.1** Close the discharge valve **slowly** and switch off the driver. When doing this pay attention to whether the rotor runs down smoothly.
- 6.7.2 Standby Service – Auxiliary** systems such as cooling, sealing, and quench systems are operational. Standby pumps should be started at regular intervals to ensure their readiness for immediate service. We recommend to start-up the pump unit once every two weeks and run for 20 minutes.
- 6.7.3 Extended Shutdown**
- 6.7.3.1 If the pump works on a suction lift and is not to be left ready for start-up, the suction valve should also be closed.
- 6.7.3.2 If existing, close quench piping.
- 6.7.3.3 If fitted, close the valves in the auxiliary pipes with the exception of the cooling water which should only be switched off when the pump has cooled down.
- 6.7.4 Freeze Damage Preservation**
- If there is the danger of frost, prevent liquid from freezing within the pump. Drain all cooling jackets, including external heat exchangers and piping.



**CAUTION!**

If there is danger of frost, protect the pump casing, bearing housing and cooling chambers against solidification. Also, insulate the Discharge Head to protect it against solidification of the product.

**6.7.5 Emergency Shutdown of the Pump**



**NOTICE!**

The following procedure assumes that a local 'Emergency Stop' or 'Stop' button, and a local discharge valve control are available for the manual operation of the pump set. The emergency shut-down procedure may be controlled by automatic systems (by others).

- 6.7.5.1 Press the 'Emergency Stop' (if available) or 'Stop' button to stop the driver immediately. Check that it runs down smoothly.
- 6.7.5.2 Close the discharge valve.
- 6.7.5.3 Isolate the pump set in preparation for fault finding and possible rectification.



**CAUTION!**

The pump must not be returned to normal service until the reason for the emergency shut-down has been investigated and rectified.

- 6.7.5.4 Before re-starting the unit again, follow the section 6.8 Re-start Procedure.

# OPERATION

## 6.8 RE-START PROCEDURE



### WARNING!

#### Pump System Must Be Completely Full!

Pump operation is on the assurance that the pump system is always completely full of delivery fluid. This prevents any potentially explosive mixture in the pump. If this cannot be guaranteed appropriate safety systems must be equipped.



### WARNING!

#### Unauthorized or uncontrolled switching on again!

Lock power breakers to the off position prior to performing work on the driver!

If the driver is switched back on by an unauthorized person or in an uncontrolled manner it may result in serious injury or even death.

- Before switching back on, make sure that all safety devices are installed and in full working order and that there is no danger to persons.
- Always comply with the process to secure against switching on again.



### WARNING!

If the pump is switched off by emergency shutdown or trip, do not re-start before the causes of the emergency have been found and removed!



### WARNING!

Leakage from the pump must not lead to the endangerment of personnel and or the environment.



### ENVIRONMENT!

#### Incorrect handling of ecologically hazardous substances!

Always follow the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective gloves when handling the lubricating material.

Personnel:

- Electrician
- Pump specialists

Protective equipment:

- Protective clothing
- Protective gloves
- Industrial safety helmet
- Safety shoes

- 6.8.1** Before restarting, check to make sure that the pump shaft is at a standstill. If the non-return valve in the discharge pipe is leaky, the pump shaft may rotate in reverse direction due to the backflow of the medium delivered.

## OPERATION



### CAUTION!

The pump must not be switched on when the pump shaft is rotating in reverse direction as this may damage the pump.

- 6.8.2 Proceed with restart as given in previous Section 6.4, Pump Startup and Operation.

## 6.9 SERVICE CONTROL

- 6.9.1 **General:** A pump must be looked after and carefully supervised to ensure trouble free running. During the first 24 hours of operation, supervision should be intensive. Read and check the operating parameters every hour. During the next period of operation (first week), supervision should be done every 24 hours. During normal use, checking should be done together with the regular inspections at least once every week.



### WARNING!

If any vibrations, unusual noises or faults are observed, stop the pump unit immediately. Refer to the Troubleshooting Section for operating faults.

- 6.9.2 **Number of Starts:** The pumps are designed for continuous operation. Too many and too frequent starts can accelerate depreciation and result in abnormally high wear and short life time of the driver.



### CAUTION!

#### Electric Motor:

- Verify the driver rotation matches the nameplate direction (see nameplate on suction and discharge head with the rotation arrow).
- Verify timing and number of starts allowed by the motor manufacturer.

- 6.9.3 **Checking the Duty Point (design point) of the Pump**



### NOTICE!

Checking the duty point is particularly important at initial startup.

- 6.9.3.1 Check the speed.
- 6.9.3.2 Read the discharge pressure and subtract the suction pressure.
- 6.9.3.3 Convert this pressure (generated pressure) to a head and compare it with the generated head shown on the pump duty plate at the corresponding speed.

## OPERATION

$$\text{Generated head (m)} = \frac{\text{generated pressure (bar)} \times 10,200}{\text{density of liquid (kg/m}^3\text{)}}$$

### Metric Units

$$\text{Generated pressure (bar)} = \frac{\text{generated head (m)} \times \text{density of liquid (kg/m}^3\text{)}}{10,200}$$

$$\text{Generated head (ft.)} = \frac{\text{generated pressure (psi)} \times 2.31}{\text{Specific gravity}}$$

### US Units

$$\text{Generated pressure (psi)} = \frac{\text{generated head (ft.)} \times \text{specific gravity}}{2.31}$$



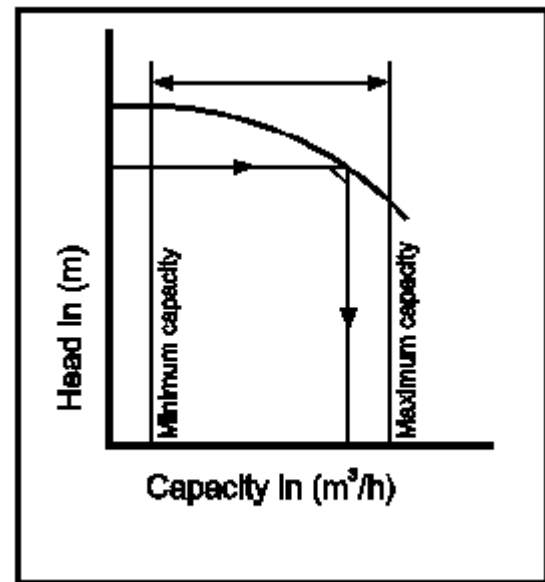
#### CAUTION!

The generated pressure must not fall below the value given in the pump data sheet, otherwise the maximum allowable capacity could be exceeded, the driver could be overloaded, or the suction pressure could fall below the minimum required by the pump.

### 6.9.4 Checking the Capacity of the Pump

- 6.9.4.1 The capacity is determined from the pump performance curve and the generated head (m or ft.) as calculated in 6.9.3 above.
- 6.9.4.2 Find the calculated value of the generated head on the vertical axis of the performance curve\*.
- 6.9.4.3 Draw a horizontal line through this point until it intersects the curve. The corresponding capacity is read on the horizontal axis vertically below the point of intersection.

*\* If the characteristic curve sheet only includes the pressure of one stage, divide the head by the number of stages of the pump supplied.*



**Pump Characteristic Curve**

### 6.9.5 Checking the Integral Thrust Bearing (If Fitted)

## OPERATION

- 6.9.5.1 **Cooling coil assembly for thrust bearing:** Check the cooling device for the thrust bearing to ensure it is properly installed and that the correct torque has been applied to all flanges and connective bolting.
- 6.9.5.2 Tighten fasteners as indicated by the tightening values and sequence shown in ADDENDUM 2 of this manual.



### **CAUTION!**

#### **Incorrect fastener tightening torques!**

**If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.**

- **Never exceed the maximum permissible fastener tightening torque.**
- **Always observe the applicable guidelines and design criteria for connection fasteners.**
- **Tightening torque and sequence is to be done in accordance with Addendum No. 2.**

### **6.9.6 Checking the Vibration Levels**

- 6.9.6.1 Ensure the vibration levels do not exceed the recommended levels on the data sheet.

## OPERATION

### PRE-START UP REQUIREMENTS CHECK LIST

CUSTOMER \_\_\_\_\_ ORDER NO. \_\_\_\_\_ PRODUCT \_\_\_\_\_  
TEMP (°C or °F) \_\_\_\_\_ SPECIFIC GRAVITY \_\_\_\_\_ RPM \_\_\_\_\_  
RATED HEAD (m or ft) \_\_\_\_\_ FLOW (m<sup>3</sup>/hr or GPM) \_\_\_\_\_ SUCTION PRESSURE (bar or PSIG) \_\_\_\_\_  
DRIVER \_\_\_\_\_ COUPLING \_\_\_\_\_ MECH. SEAL \_\_\_\_\_  
\_\_\_\_\_

- Leveling and Grouting of Suction Can Mounting Plate or Base-plate
- Strainer in Suction
- Minimum Flow Orifice
- Warm Up Orifice
- Suction Gage
- Discharge Gage
- Pipe Strain
- Check Pump End Play \_\_\_\_\_
- Check Coupling Hub Run-out (Pump & Motor)
- Oil Level Checked
- Rotation and No Load of Driver have been Checked
- Open Suction Valve
- Vent Pump or Warm Up Pump, if Required
- Purge Seal Flush
- Close Vent Valves
- Set Discharge Valve
- Suction Pressure at Start Up \_\_\_\_\_
- Discharge Pressure at Start Up \_\_\_\_\_
- Check the Integral Thrust Bearing, if equipped, to see that the temperature stabilizes.

## OPERATION

Check Vibration Horizontal Max. \_\_\_\_\_ Vertical Max. \_\_\_\_\_

**Note:**  Check off when satisfactorily completed.

# MAINTENANCE

## 7.0 MAINTENANCE SAFETY INSTRUCTIONS

This section will be followed by additional sections dealing with specific and detailed instructions addressing each major assembly.



### WARNING!

#### Explosive atmospheres!

Exposure to ignition sources, such as sparks, naked flames and hot surfaces, can cause an explosion in areas with a potentially explosive atmosphere. This may result in death, serious injury or significant material damage.

- Obtain a written work permit before commencing work in an area with a potentially explosive atmosphere.
- Only perform work if a potentially explosive atmosphere can be excluded.
- Only use tools permitted for use in areas with a potentially explosive atmosphere.



### WARNING!

Machinery intended for use in potentially explosive areas must satisfy the “Ex” protection requirements. Check documentation and nameplates relating to the pump and any accessories or equipment.

- Any designation of the pump refers to the pump component only. Shaft coupling, driver (e.g. electric motor) and auxiliary systems (shaft sealing, lubricating oil system, etc.) must be looked at separately.
- Welding, burning, and grinding should only be carried out on the pump where specifically authorized, e.g. there may be a risk of fire and/or explosion.



### WARNING!

#### Incorrect operation!

Incorrect operation can cause serious injury and significant material damage.

- Before operation, ensure that all installation work has been performed and completed according to the data and notices in these instructions.
- Perform all required tests before operation.
- Before operation, ensure that no one is in the hazardous area.
- Be careful when handling open, sharp-edged components.
- Operation should be performed by Sulzer personnel or by personnel trained and authorized by Sulzer Pumps.
- Be ready to use the emergency stop function to immediately shut down the pump in the event of an emergency.

## MAINTENANCE



### WARNING!

**Unauthorized or uncontrolled switching on again!**

**Lock power breakers to the off position prior to performing work on the driver!  
If the driver is switched back on by an unauthorized person or in an uncontrolled manner it may result in serious injury or even death.**

- Before switching back on, make sure that all safety devices are installed and in full working order and that there is no danger to persons.
- Always comply with the process to secure against switching on again.



### WARNING!

**Always use new gaskets during reassembly after maintenance!**



### DANGER!

**Electric motor, measurement and control equipment is energized!**

**Danger of death from electric shock.**

- Work on electrical components must be performed by qualified electricians only.
- If there is damage to the insulation, switch off the power supply immediately and have it repaired.
- Never bypass or disable fuses. When replacing fuses, make sure that the correct amperage is used.
- Keep moisture out of electrically charged components. This can cause a short circuit.



### WARNING!

**External Influences – Lightning Strike!**

**Possibility of lightning strike when machines are operated outdoors.**

- Before operation check the machine for damages ensuring that all safety devices are installed and in full working order and that there is no danger to persons.
- If necessary, repair all damages before switching on again.



### WARNING!

**Unqualified personnel**

- Any unqualified personnel working on the pump or situated within the hazardous area of the pump are at risk of causing serious injury or significant material damage.
- All activities must be performed by appropriately qualified personnel only. Keep unqualified personnel away from hazardous areas.

## MAINTENANCE



### **WARNING!**

#### **Hot Work Environment!**

**Long-term close proximity to the pump should be avoided.**

**High product temperature and therefore high pump discharge head temperature is harmful to health due to the hot work environment.**

**Contact with hot surfaces will cause serious burns or scalds to the skin!**

- Always wear heat-resistant protective clothing and protective gloves when working in the vicinity of hot surfaces or fluids.
- Refer to pump specifications/data sheets for pumpage temperature.
- Indicate hot environment with warning signs and labels.



### **WARNING!**

#### **Hot pump medium!**

**Direct contact with the pump medium through physical contact, inhalation or skin puncture can lead to serious burns and even death.**

- Avoid contact with the pump medium.
- Allow pump medium leakages to cool.
- When handling the pump medium, wear the personal protective equipment provided in addition to that mentioned here.



### **WARNING!**

#### **Solidification of Pumped Liquid**

**Restoration of energy supply following interruption (Restarting conditions – Conditions for restarting pump after sudden stop.**

- Pump and pumped media must be adequately heated in order that the pump does not become blocked by solidification of the pumped liquid.
- Molten Salts solidifies when it is cooled to below 240 Deg C.



### **WARNING!**

#### **Hot surfaces and operating fluids!**

**Component surfaces and operating fluids, such as hydraulic or lubricating oils can become very hot during operation. Contact with hot surfaces will cause serious burns or scalds to the skin!**

- Always wear heat-resistant protective clothing and protective gloves when working in the vicinity of hot surfaces or fluids.



### **CAUTION!**

#### **Hazardous Nitrogen Gases**

**Avoid contact with or inhaling hazardous gases.**

**The shaft seal system is braded packing which will allow some leakage.**

**Small quantities of the nitrogen gas purge will escape this area and displace CO<sub>2</sub> and O<sub>2</sub>.**

- Use this purge system in an open air environment, avoid use in a confined space.

## MAINTENANCE



### CAUTION!

#### Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for connection fasteners.
- Tightening torque and sequence is to be done in accordance with Addendum No. 2.



### WARNING!

#### Pooled fluid on the floor!

Slipping on fluid that has pooled on the floor can cause fall-related injury.

- Remove pools of fluid immediately using suitable means.
- Wear slip-resistant safety shoes.
- Attach warning notices and mandatory signs at areas where fluid could pool on the floor.



### WARNING!

#### Danger of being pulled in by moving components!

Being pulled in by moving components can cause serious injury.

- Do not handle moving components during operation.
- Do not grasp moving components during operation.
- Never open covers during operation.
- Observe the stopping time: ensure that the components are no longer moving before opening the covers.
- Wear closely fitting protective clothing with a low tear resistance in the hazardous area.



### ENVIRONMENT!

#### Incorrect handling of ecologically hazardous substances

Incorrect handling of ecologically hazardous substances can cause significant damage to the environment.

- Always follow the information provided by the manufacturer when handling and disposing of ecologically hazardous substances.
- Implement suitable measures immediately if ecologically hazardous substances are accidentally released into the environment. In case of doubt, inform the responsible local authority about the damage and ask what action needs to be taken.
- Wear appropriate protective gloves when handling potentially hazardous material.

# MAINTENANCE

- |                       |   |
|-----------------------|---|
| Personnel:            | <ul style="list-style-type: none"><li>• Pump specialist</li><li>• Electrician</li></ul>   |
| Protective equipment: | <ul style="list-style-type: none"><li>• Protective clothing</li><li>• Protective gloves</li><li>• Industrial safety helmet</li><li>• Safety shoes</li></ul> |

## 7.1 RECORDS AND ANALYSIS

### 7.1.1 Maintenance schedule

- 7.1.1.1 The maintenance work described in the following sections is required for optimum and trouble-free operation of the pump and its components.
- 7.1.1.2 Maintenance activities should be planned and scheduled to ensure safe operation of the equipment.
- 7.1.1.3 If increased wear or abnormal measurement values are detected during regular inspection, refer to the TROUBLESHOOTING section of this manual (Addendum No. 3) for the consequences in terms of how maintenance work is to be adjusted. If you have questions about maintenance work and schedules, contact Sulzer Pumps; see contact information at the beginning of this manual.



#### Specifications for the maintenance intervals

The intervals specified apply on the condition that all limit values for operation specified in the data sheet are observed and the maximum permissible pump starts are not exceeded. If there are deviations, contact Sulzer Customer Service to find out about the shortened interval.

### 7.1.2 Performance Record

- 7.1.2.1 An ongoing performance record will assist troubleshooting and pump service decisions. Long shutdowns and unnecessary expense can be avoided.
- 7.1.2.2 Pressure indicators can be installed into tapped openings in the suction and discharge nozzles to provide much of the data required for performance analysis.
- 7.1.2.3 Periodic vibration recordings are necessary to diagnose excessive vibration levels.

### 7.1.3 Troubleshooting

- 7.1.2.1 Analyze performance before disassembly. A problem could be corrected externally without disassembling the pump. A performance record will help narrow the possible causes, and determine whether the problem is mechanical or hydraulic.
- 7.1.2.2 Hydraulic problems typically originate in the suction system. Incorrect control adjustments should be eliminated. See the OPERATION Section before further troubleshooting.
- 7.1.2.3 Mechanical and hydraulic problems often are interrelated and the source can be difficult to trace. See the TROUBLESHOOTING Addendum No. 3 at the end of this manual.

# MAINTENANCE

## 7.2 GENERAL DISASSEMBLY



### WARNING!

#### Explosive atmosphere!

Prior to and during maintenance, ensure that the atmosphere is not potentially explosive.

Stop all work immediately if any danger arises.



### WARNING!

#### Unqualified personnel

- Any unqualified personnel working on the pump or situated within the hazardous area of the pump are at risk of causing serious injury or significant material damage.
- All activities must be performed by appropriately qualified personnel only. Keep unqualified personnel away from hazardous areas.



### WARNING!

#### Hot Work Environment!

Long-term close proximity to the pump should be avoided.

High product temperature and therefore high pump discharge head temperature is harmful to health due to the hot work environment.

Contact with hot surfaces will cause serious burns or scalds to the skin!

- Always wear heat-resistant protective clothing and protective gloves when working in the vicinity of hot surfaces or fluids.
- Refer to pump specifications/data sheets for pumpage temperature.
- Indicate hot environment with warning signs and labels.



### CAUTION!

#### Hazardous Nitrogen Gases

Avoid contact with or inhaling hazardous gases.

The shaft seal system is braded packing which will allow some leakage.

Small quantities of the nitrogen gas purge will escape this area and displace CO<sub>2</sub> and O<sub>2</sub>.

- Use this purge system in an open air environment, avoid use in a confined space.

Personnel:

- Pump specialist
- Electrician

Protective equipment:

- Protective clothing
- Protective gloves
- Industrial safety helmet
- Safety shoes

**7.2.1 References:** Refer to the specific general arrangement drawing, cross section drawings and parts list.

## MAINTENANCE

**7.2.2 Power:** Lock power breakers to the off position.



**WARNING!**

**Unauthorized or uncontrolled switching on again!**

**Lock power breakers to the off position prior to performing any work!**

**7.2.3 Piping:** Be certain the pump system pressure has been isolated. Close all suction, discharge, and auxiliary piping valves.



**DANGER!**

**Fluid escaping at high pressure!**

**Fluid can escape at high pressure if lines or components are defective. This escaping liquid can sever body parts, causing extremely serious injury and even death.**

- Never expose body parts or objects to this escaping fluid. Keep personnel out of the hazardous area.
- Absorb the escaping fluid/pump media properly and dispose of it.



**WARNING!**

**Pooled fluid on the floor!**

**Slipping on fluid that has pooled on the floor can cause fall-related injury.**

- Remove pools of fluid immediately using suitable means..
- Wear slip-resistant safety shoes.
- Attach warning notices and mandatory signs at areas where fluid could pool on the floor.



**ENVIRONMENT!**

**Check for toxic or otherwise harmful fluids before loosening bolted joints or pipe connections!**

**Collect and dispose of toxic or otherwise harmful fluids in accordance with the current environmental regulations to prevent endangering people or the environment.**

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective gloves when handling hazardous material.

**7.2.4 Coupling:** Remove both the coupling spacer, between the pump and driver hubs, and the pump-coupling hub.



**WARNING!**

**Hot surfaces, pumpage and operating fluids!**

**Component surfaces, pumped fluids and operating fluids, such as hydraulic or lubricating oils can become very hot during operation.**

**Contact with hot surfaces will cause serious burns or scalds to the skin!**

- Avoid Contact with the Pump parts during operation.
- Use a thermometer to verify surface temperature of pump parts and piping prior to servicing.
- Always wear heat-resistant protective clothing and protective gloves when working in the vicinity of hot surfaces or fluids.

## MAINTENANCE

**7.2.5 Drain:** Open the vents and drain the pump case by removing the drain plugs or opening the valves.



### ENVIRONMENT!

**Check for toxic or otherwise harmful fluids before loosening bolted joints or pipe connections!**

**Collect and dispose of toxic or otherwise harmful fluids in accordance with the current environmental regulations to prevent endangering people or the environment.**

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective gloves when handling hazardous material.

**7.2.6 Tools and Procedures:** A variety of equipment is required for disassembly. Refer to each assembly section for specific requirements.



### WARNING!

**Check the pump rotation!**

**Note that certain threaded shaft components are tightened against rotation and may be left-hand thread.**

## 7.3 SHAFT SEAL CHANGEOUT



### WARNING!

**Mechanical seals intended for use in potentially explosive areas must satisfy the “Ex” protection requirements**



### CAUTION!

**Hazardous Nitrogen Gases**

**Avoid contact with or inhaling hazardous gases.**

**The shaft seal system is braded packing which will allow some leakage.**

**Small quantities of the nitrogen gas purge will escape this area and displace CO<sub>2</sub> and O<sub>2</sub>.**

- Use this purge system in an open air environment, avoid use in a confined space.

### 7.3.1 Mechanical Seal



### WARNING!

**Hazardous gases (Nitrogen gas purge)!**

**Contact with or inhaling nitrogen gas may cause respiratory damage.**

**Use this purge system in an open air environment. Avoid use in a confined space.**

7.3.1.1 The mechanical seal can be removed for inspection and replacement without disturbing the case. Removal of auxiliary piping, bearings, bearing housings, spacer coupling, and pump coupling hub is required. See also the ASSEMBLY AND DIASSEMBLY module in this manual.

## MAINTENANCE

- 7.3.1.2 Be sure to follow the Seal Manufacturer's maintenance instructions. See Seal Manufacturer's drawing for correct assembly and disassembly procedures, materials, and seal setting. New packing, O-rings, springs, and faces (if necessary) should be installed when the seal is serviced.

### 7.4 INTEGRAL THRUST BEARING CHANGEOUT

The integral thrust bearing, if installed, can be removed for inspection and bearing replacement without disturbing the pump or motor. Draining of the oil and removal of the auxiliary components, flexible coupling spacer and pump coupling is required. See also the ASSEMBLY AND DISASSEMBLY Module in this manual.

### 7.5 PREPARATION FOR MAJOR DISASSEMBLY

Refer to the ASSEMBLY AND DISASSEMBLY Module in this manual for the extent of work necessary to deal with the key components.

### 7.6 SHIPPING FROM SITE

- 7.5.1 All equipment must be completely drained and decontaminated before removal from site.



#### **ENVIRONMENT!**

**Check for toxic or otherwise harmful fluids before loosening bolted joints or pipe connections!**

#### **Incorrect handling of toxic or ecologically hazardous substances!**

- Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.
- Implement suitable measures immediately if ecologically hazardous substances are accidentally released into the environment. In case of doubt, inform the responsible local authority about the damage and ask what action needs to be taken.
- Wear appropriate protective gloves when handling hazardous material.

- 7.5.2 Shipments received at any Sulzer facility that have not been so treated will be returned to site at the owner's expense.

# ASSEMBLY AND DISASSEMBLY

## 8.0 ASSEMBLY SAFETY INSTRUCTIONS

This section gives directions for the disassembly, inspection of parts and reassembly of the rotating element including the opening and closing of the volute case.



### WARNING!

#### Explosive atmospheres!

Exposure to ignition sources, such as sparks, naked flames and hot surfaces, can cause an explosion in areas with a potentially explosive atmosphere. This may result in death, serious injury or significant material damage.

- Obtain a written work permit before commencing work in an area with a potentially explosive atmosphere.
- Only perform work if a potentially explosive atmosphere can be excluded.
- Only use tools permitted for use in areas with a potentially explosive atmosphere.



### WARNING!

Machinery intended for use in potentially explosive areas must satisfy the “Ex” protection requirements. Check documentation and nameplates relating to the pump and any accessories or equipment.

- Any designation of the pump refers to the pump component only. Shaft coupling, driver (e.g. electric motor) and auxiliary systems (shaft sealing, lubricating oil system, etc.) must be looked at separately.
- Welding, burning, and grinding should only be carried out on the pump where specifically authorized, e.g. there may be a risk of fire and/or explosion.



### WARNING!

#### Incorrect operation!

Incorrect operation can cause serious injury and significant material damage.

- Before operation, ensure that all installation work has been performed and completed according to the data and notices in these instructions.
- Perform all required tests before operation.
- Before operation, ensure that no one is in the hazardous area.
- Be careful when handling open, sharp-edged components.
- Operation should be performed by Sulzer personnel or by personnel trained and authorized by Sulzer Pumps.
- Be ready to use the emergency stop function to immediately shut down the pump in the event of an emergency.



### WARNING!

#### Unauthorized or uncontrolled switching on again!

Lock power breakers to the off position prior to performing work on the driver! If the driver is switched back on by an unauthorized person or in an uncontrolled manner it may result in serious injury or even death.

- Before switching back on, make sure that all safety devices are installed and in full working order and that there is no danger to persons.
- Always comply with the process to secure against switching on again.

## ASSEMBLY AND DISASSEMBLY



### WARNING!

#### Unqualified personnel

- Any unqualified personnel working on the pump or situated within the hazardous area of the pump are at risk of causing serious injury or significant material damage.
- All activities must be performed by appropriately qualified personnel only. Keep unqualified personnel away from hazardous areas.



### WARNING!

#### Hot pump medium!

Direct contact with the pump medium through physical contact, inhalation or skin puncture can lead to serious burns and even death.

- Avoid contact with the pump medium.
- Allow pump medium leakages to cool.
- When handling the pump medium, wear the personal protective equipment provided in addition to that mentioned here.



### WARNING!

#### Hot surfaces and operating fluids!

Component surfaces and operating fluids, such as hydraulic or lubricating oils can become very hot during operation. Contact with hot surfaces will cause serious burns or scalds to the skin!

- Always wear heat-resistant protective clothing and protective gloves when working in the vicinity of hot surfaces or fluids.



### WARNING!

#### Pooled fluid on the floor!

Slipping on fluid that has pooled on the floor can cause fall-related injury.

- Remove pools of fluid immediately using suitable means.
- Wear slip-resistant safety shoes.
- Attach warning notices and mandatory signs at areas where fluid could pool on the floor.



### WARNING!

#### Danger of being pulled in by moving components!

Being pulled in by moving components can cause serious injury.

- Do not handle moving components during operation.
- Do not grasp moving components during operation.
- Never open covers during operation.
- Observe the stopping time: ensure that the components are no longer moving before opening the covers.
- Wear closely fitting protective clothing with a low tear resistance in the hazardous area.

## ASSEMBLY AND DISASSEMBLY



### ENVIRONMENT!

#### Incorrect handling of ecologically hazardous substances

Incorrect handling of ecologically hazardous substances can cause significant damage to the environment.

- Always follow the information provided by the manufacturer when handling and disposing of ecologically hazardous substances.
- Implement suitable measures immediately if ecologically hazardous substances are accidentally released into the environment. In case of doubt, inform the responsible local authority about the damage and ask what action needs to be taken.
- Wear appropriate protective gloves when handling potentially hazardous material.



### CAUTION!

#### Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fastened connections.



### WARNING!

#### Suspended loads!

Loads can swivel out and fall during lifting operations. This can cause serious injury or even death.

- Never stand under or in the swivel range of suspended loads.
- Only move loads under supervision.
- Only use approved lifting tools and anchorage means with sufficient load carrying capacity.
- Do not use torn or abraded lifting tools (ropes and belts).
- Do not lay lifting tools such as ropes and belts on sharp edges and corners and do not tie or twist them.
- Set the load down on a sufficiently stable and flat surface after leaving the workplace.



### WARNING!

Always use new gaskets during reassembly after maintenance!

## ASSEMBLY AND DISASSEMBLY

Personnel:	Pump specialist Electrician
Protective equipment:	Protective clothing Protective gloves Industrial safety helmet Safety shoes

### 8.1 PREPARATION



#### **WARNING!**

**Explosive atmosphere!**

**Prior to and during maintenance, ensure that the atmosphere is not potentially explosive.**

**Stop all work immediately if any danger arises.**

Personnel:	Pump specialist
Protective equipment:	Protective clothing Protective gloves Industrial safety helmet Safety shoes

- 8.1.1** Study the Pump Cross-Section drawing and be familiar with the design details and assembly sequence.
- 8.1.2** Phase the operations and have equipment available for impeller/shaft sleeve mounting and dismantling, and also measuring devices, heating facilities and a torque wrench for case bolting.
- 8.1.3** Know the required heating temperatures, mounting and dismantling forces and torque values.

### 8.2 RECORD / ANALYZE BEFORE DISASSEMBLY

#### **8.2.1 Performance Record**

- 8.2.1.1 An ongoing performance record will assist troubleshooting and pump service decisions. Long shutdowns and unnecessary expense can be avoided.
- 8.2.1.2 Pressure indicators can be installed into tapped openings in the suction and discharge nozzles to provide much of the data required for performance analysis.
- 8.2.1.3 Periodic vibration recordings are necessary to diagnose excessive vibration levels.

#### **8.2.2 Troubleshooting**

- 8.2.2.1 Analyze performance before disassembly. A problem could be corrected externally without disassembling the pump. A performance record will help narrow the possible causes, and determine whether the problem is mechanical or hydraulic.
- 8.2.2.2 Hydraulic problems typically originate in the suction system. Incorrect control adjustments should be eliminated. See the OPERATION Section before further troubleshooting.

## ASSEMBLY AND DISASSEMBLY

8.2.2.3 Mechanical and hydraulic problems often are interrelated and the source can be difficult to trace. See the TROUBLESHOOTING Addendum No. 3 at the end of this manual.

### 8.3 DISASSEMBLY



#### WARNING!

**Explosive atmosphere!**

Prior to and during maintenance, ensure that the atmosphere is not potentially explosive.

Stop all work immediately if any danger arises.



#### WARNING!

**Unqualified personnel**

- Any unqualified personnel working on the pump or situated within the hazardous area of the pump are at risk of causing serious injury or significant material damage.
- All activities must be performed by appropriately qualified personnel only. Keep unqualified personnel away from hazardous areas.

Personnel:	Pump specialist Electrician
Protective equipment:	Protective clothing Protective gloves Industrial safety helmet Safety shoes

**8.3.1 References:** Refer to the specific general arrangement drawing, cross section drawings and parts list.

**8.3.2 Power:** Lock power breakers to the off position.



#### WARNING!

**Unauthorized or uncontrolled switching on again!**

Lock power breakers to the off position prior to performing any work!



#### ENVIRONMENT!

Check for toxic or otherwise harmful fluids before loosening bolted joints or pipe connections!

Collect and dispose of toxic or otherwise harmful fluids in accordance with the current environmental regulations to prevent endangering people or the environment.

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective gloves when handling hazardous material.

## ASSEMBLY AND DISASSEMBLY

**8.3.3 Tools and Procedures:** A variety of equipment is required for disassembly. Specific requirements differ according to location, physical surroundings, and size of each unit. Review the entire removal procedure in advance.

**8.3.4** Protect all parts. Place larger parts in a protected area and wrap in cloth or plastic. Place smaller parts in bags or boxes.



### NOTICE!

If servicing only the stuffing (packing) box or the thrust bearing, skip to step 8.3.7 or 8.3.8.

### 8.3.5 Driver Removal



### WARNING!

Unauthorized or uncontrolled switching on again!  
Lock power breakers to the off position prior to performing any work!

8.3.5.1 Disconnect the Power leads to the Driver/Motor **800.520**.

8.3.5.2 Remove any restraints from the Driver.

8.3.5.3 Uncouple the driver half coupling **861.020** from the pump coupling spacer **861.010**. See the coupling manufacturer's instructions for the correct procedure.



### CAUTION!

When unbolting the driver half coupling from the coupling spacer in a Rigid Coupling setup, the rotating element will lower until the impellers seat in their bowls. Care should be taken during this process. Once unbolted the rotating element will be lowered (*This does not apply for pumps with a Flexible Coupling and Thrust Bearing.*)



### NOTICE!

If the pump is fitted with a Thrust Bearing, it will feature a Flexible Coupling. See coupling manufacturer's instructions for correct procedure.

8.3.5.4 Loosen capscrews (Driver Alignment) **901.508**. Remove capscrews **901.523** securing driver **800.520** to top of Discharge Head **115.261**. Lift driver to storage or maintenance location.

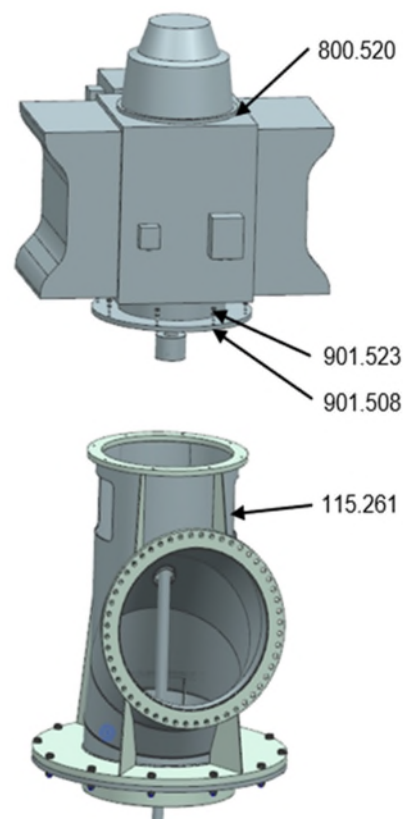


Figure 1



### NOTICE!

If size and configuration allows (no Thrust Bearing in the Pump), the Driver Stand and Motor may be removed together, without removing the Motor to Driver Stand fasteners.

## ASSEMBLY AND DISASSEMBLY



### NOTICE!

See manufacturer's information for correct driver handling, storage, and maintenance.

### 8.3.6 Couplings

8.3.6.1 Disconnect pump half coupling **861.020** and remove coupling spacer **869.030** (if installed).

8.3.6.2 Slide the pump half coupling **861.010** down the head shaft and remove the coupling spacer (if installed).

8.3.6.3 Unscrew the adjusting nut **924.326** and remove it from the pump's head shaft.

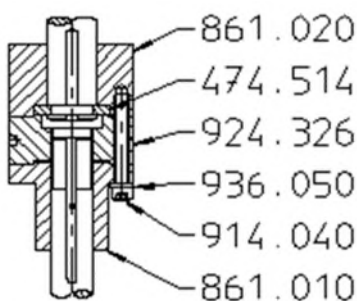


Figure 2

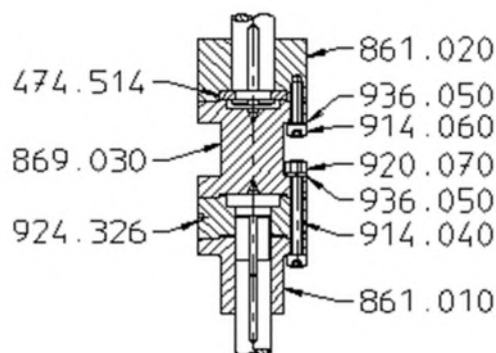


Figure 3



### CAUTION!

Unscrewing the adjusting nut will lower the rotating element until the impellers seat in their bowls. Care should be taken during this process. Once unbolted, the Rotating Assembly will be lowered.

8.3.6.4 Remove pump half coupling **861.010** and key **940.511**.

### 8.3.7 Integral Thrust Bearing (If fitted)

8.3.7.1 If pump is fitted with a thrust bearing, please refer to module VAL ASSY or VALS ASSY Module for Disassembly and Assembly procedure.

8.3.7.2 After disassembly and removal of thrust bearing, please continue to step 8.3.8 Stuffing Box.

### 8.3.8 Stuffing (Packing) Box (Shaft Sealing with Standard Stuffing Box.)

8.3.8.1 Unbolt stuffing box capscrews **914.448** from Discharge Head **115.261**.

8.3.8.2 Remove the stuffing box assembly **431.401**.



### NOTICE!

O-ring seals **412.445** and **412.446** should be replaced (not shown but in locations indicated in the illustration).

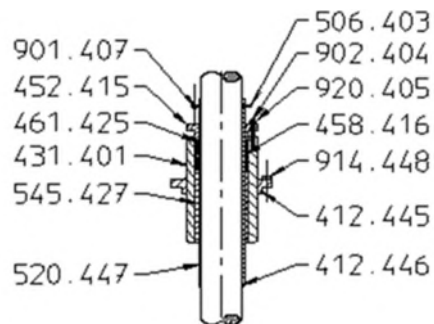


Figure 4

8.3.8.3 If there is just a need for packing change, remove the nuts **920.405** and slide the packing gland **452.415** up the shaft and then remove the socket head screw that holds the two gland halves together. Remove the Drip tray **463.402**, and then there will be access to the packing material.

## ASSEMBLY AND DISASSEMBLY



### WARNING!

#### Part handling!

Care in handling of components must be exercised to prevent damage or distortion of those components.

8.3.8.4 Remove the packing material **461.425**.

**8.3.9 Mechanical Seal (if fitted):** Shaft Sealing with an Original Equipment Manufacturer's (OEM, or other than Sulzer) Mechanical Seal.

8.3.9.1 Disconnect seal circulation lines at seal gland prior to seal removal. Cap ends of lines to prevent dirt entry.

8.3.9.2 Unbolt seal gland plate nuts **920.405** and studs **902.404** from the stuffing box **431.401**.

8.3.9.3 Remove the mechanical seal cartridge assembly **433.400**.

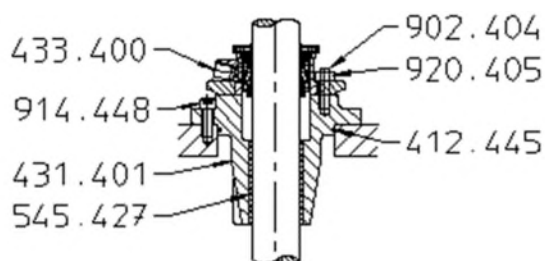


Figure 5

### 8.3.10 Piping

8.3.10.1 Be certain the pump system pressure has been isolated. Close the discharge and auxiliary valves.

8.3.10.2 For complete pump unit disassembly, it will be necessary to disconnect the discharge, and auxiliary piping.

8.3.10.3 If pump unit is to be removed, disconnect all piping and instrumentation.

8.3.10.4 Disconnect the discharge flange of the discharge head **115.261** flange at the customer pipe work.

## 8.4 PUMP REMOVAL



### WARNING!

#### Explosive atmospheres!

Exposure to ignition sources, such as sparks, naked flames and hot surfaces, can cause an explosion in areas with a potentially explosive atmosphere. This may result in death, serious injury or significant material damage.

- Obtain a written work permit before commencing work in an area with a potentially explosive atmosphere.
- Only perform work if a potentially explosive atmosphere can be excluded.
- Only use tools permitted for use in areas with a potentially explosive atmosphere.



### WARNING!

#### Unauthorized or uncontrolled switching on again!

Lock power breakers to the off position prior to performing work on the driver! If the driver is switched back on by an unauthorized person or in an uncontrolled manner it may result in serious injury or even death.

- Before switching back on, make sure that all safety devices are installed and in full working order and that there is no danger to persons.
- Always comply with the process to secure against switching on again.

## ASSEMBLY AND DISASSEMBLY



### WARNING!

Hot surfaces, pump medium and operating fluids!

Component surfaces, pump medium and operating fluids, such as hydraulic or lubricating oils can become very hot during operation. Contact with hot surfaces will cause serious burns or scalds to the skin!

- Always wear heat-resistant protective clothing and protective gloves when working in the vicinity of hot surfaces or fluids.

Personnel:	Pump specialist
Protective equipment:	Protective clothing
	Protective gloves
	Industrial safety helmet
	Safety shoes

- 8.4.1 Be certain the pump system pressure has been isolated. Close discharge, and auxiliary piping valves.



### DANGER!

Fluid escaping at high pressure!

Fluid can escape at high pressure if lines or components are defective. This escaping liquid can sever body parts, causing extremely serious injury and even death.

- Never expose body parts or objects to this escaping fluid. Keep personnel out of the hazardous area.
- Absorb the escaping fluid/pump media properly and dispose of it.



### ENVIRONMENT!

Check for toxic or otherwise harmful fluids before loosening bolted joints or pipe connections!

Incorrect handling of toxic or ecologically hazardous substances!

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

## ASSEMBLY AND DISASSEMBLY

### 8.4.2 Pump Removal Above Ground Discharge Head

- 8.4.2.1 Place lifting eyebolts in the lifting lug holes of the Discharge Head **115.261**.
- 8.4.2.2 Remove nuts **920.519** to separate the Discharge Head **115.261** from the soleplate **893.507** (if fitted).
- 8.4.2.3 Lift the entire pump out of the sump if there is sufficient headroom above the mounting surface. See the general arrangement drawing.



#### CAUTION!

Exercise caution when lowering the pump to a horizontal position. Support the full length to prevent excessive bowing and resultant damage. If there is insufficient headroom, the pump will be partially disassembled in the vertical position at the site.

### 8.4.3 Pump Removal Underground Discharge Head

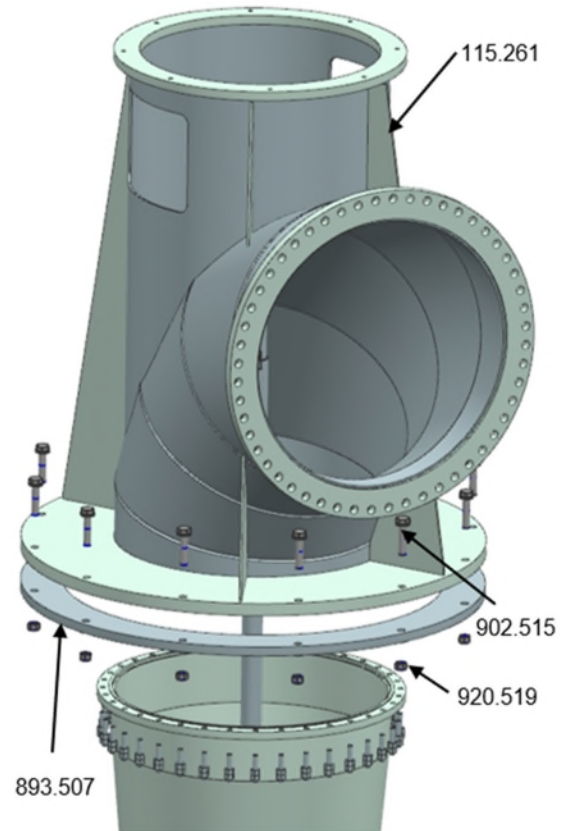


Figure 6



#### WARNING!

Explosive atmosphere!  
Prior to and during maintenance, ensure that the atmosphere is not potentially explosive.  
Stop all work immediately if any danger arises.

Personnel:	Pump specialist
Protective equipment:	Protective clothing
	Protective gloves
	Industrial safety helmet
	Safety shoes

## ASSEMBLY AND DISASSEMBLY



### CAUTION!

During the disassembly process, use handling procedures adequate to avoid bumping, hitting or springing the shafts. Support the shafts evenly over their entire length.



### NOTICE!

Mark all parts in their disassembling sequence.

- 8.4.3.1 Place lifting eye bolts in the lifting lug holes of the motor pedestal **341.501**.
- 8.4.3.2 Remove nuts **920.519** to break motor pedestal free from the soleplate (if installed) **893.507**.
- 8.4.3.3 Lift the entire pump from the foundation if there is sufficient headroom above mounting surface.

## 8.5 PUMP DISASSEMBLY – PRODUCT LUBRICATED

- 8.5.1 Remove the discharge head **115.261** from top column **711.202** by removing capscrews **901.252**.
- 8.5.2 Remove the top column **711.202** from the bottom column **711.201** by removing capscrews **901.216** and nuts **920.217**.
- 8.5.3 Carefully remove top column **711.202** taking care of the lineshaft bearing bushing **545.212**.
- 8.5.4 Remove the bottom column **711.201** from the propeller bowl **104.151** by removing capscrews **901.182** and nuts **920.183**.
- 8.5.5 Disassemble the two-piece shaft. See 8.6 for disassembly of couplings.

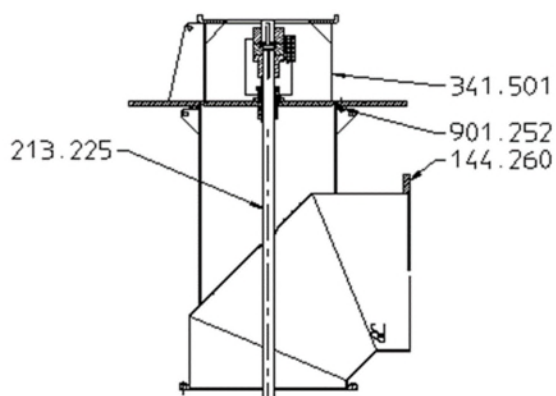


Figure 7

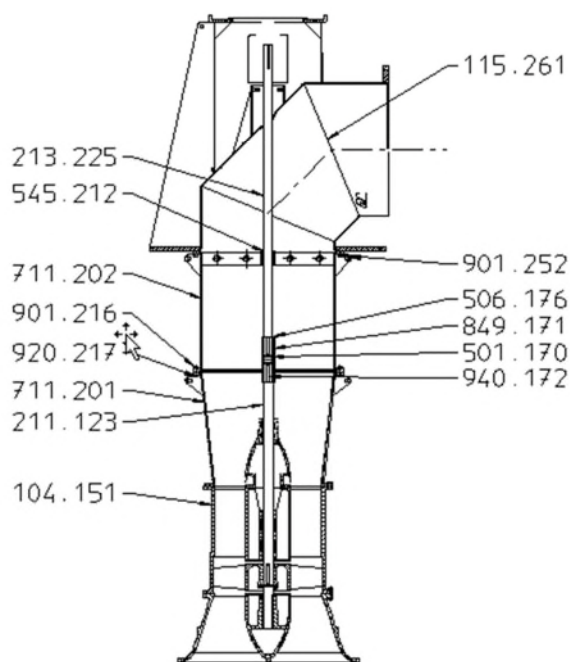


Figure 8

## ASSEMBLY AND DISASSEMBLY

### 8.6 LINE SHAFT COUPLING



#### CAUTION!

Rig hoist to support shafts 213.225 and 211.123 during shaft coupling disassembly.

#### 8.6.1 Threaded Coupling Removal

8.6.1.1 Remove threaded coupling **852.171**.

**Note:** Threads are Left Handed.

#### 8.6.2 Sleeve Coupling Removal

8.6.2.1 Remove the sleeve coupling **841.171** to free the head shaft **213.225** from the pump shaft **211.123**. Unsnap the retaining rings **506.176** and slide the sleeve coupling up the head shaft **213.225** to reveal the split ring **501.170** and keys **940.172**.

8.6.2.2 Remove keys **940.172** and split ring **501.170** and set the head shaft **213.225** aside.

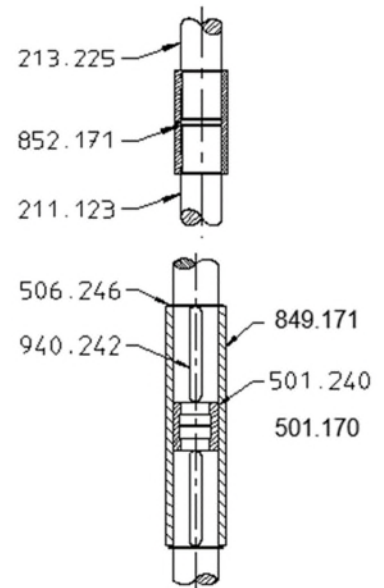


Figure 9

### 8.7 PUMP DISASSEMBLY - ENCLOSED LINESHAFT



#### NOTICE!

The following instructions follow pump removal step 8.4.3.3. It is vital that parts are numbered in sequence of disassembly.



#### CAUTION!

It is important not to distort any parts during the disassembly process.

## ASSEMBLY AND DISASSEMBLY

- 8.7.1 Remove lubrication piping **707.505** from the tube fitting **731.421**.
- 8.7.2 Loosen lubrication manifold **654.417** (tube tension nut).
- 8.7.3 For Water Flush, remove the gland **452.415** by removing capscrews and nuts. Remove all packing **461.425** and lantern ring **458.416** and remove lubrication manifold **654.417**.
- 8.7.4 Unbolt capscrews **901.448** from tension ring **515.401** and remove tension ring along with packing **461.425**.
- 8.7.5 Remove the discharge head **115.261** from column **711.201** by unbolting capscrews **901.252**.
- 8.7.6 Remove column **711.201** from top bowl **112.151** by unbolting capscrews **901.182** and nuts **920.183** to expose shaft protection tube **714.362**.
- 8.7.7 Find a joint on the shaft protection tube **714.362** and unscrew the tube from the Screwed Bushing **544.213**.
- 8.7.8 If a two-piece shaft exists, see section 8.6.
- 8.7.9 Repeat steps 8.7.6 through 8.7.8 as necessary until you arrive at the diffuser (tube adapter) **149.189** and discharge case **107.192**.
- 8.7.10 Unscrew the shaft protection tube **714.362** from screwed bushing **544.213**.

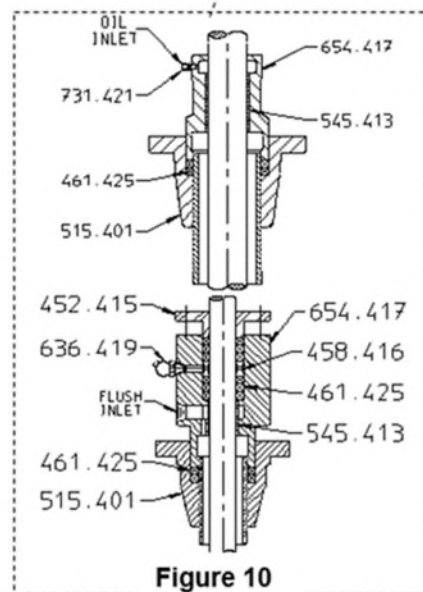
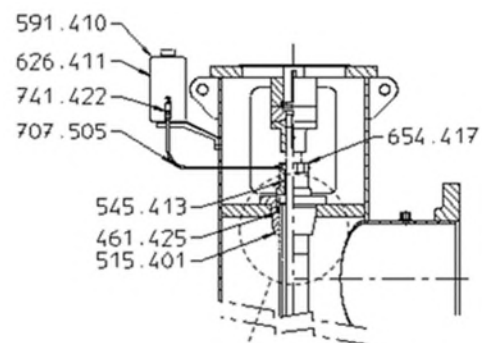


Figure 10



### NOTICE!

For Bowl Unit Disassembly, see section 8.8.

## 8.8 BOWL UNIT DISASSEMBLY

- 8.8.1 The bowl assembly should be disassembled in the maintenance shop where proper facilities are available.



### NOTICE!

As the dismantling proceeds the impellers, bowls, and wear parts should be marked as to their relative placement in the element in order that proper reassembly can occur. It is recommended that the pump be dismantled horizontally.



### CAUTION!

Care should be taken to avoid chipping or damaging the bushings in the bowl.

- 8.8.2 Prepared to catch grease, unbolt the threaded plug **903.116** from the suction bell **138.111** to drain grease.

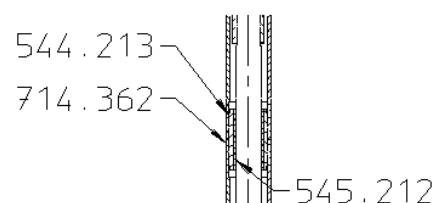


Figure 11

## ASSEMBLY AND DISASSEMBLY



### ENVIRONMENT!

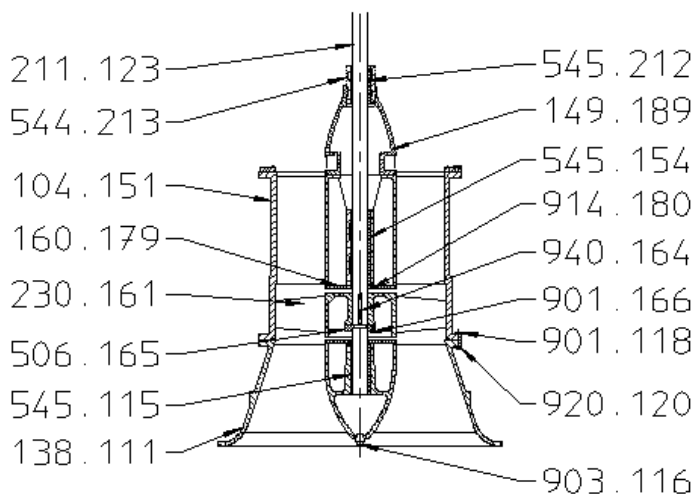
**Incorrect handling of ecologically hazardous substances!**

**Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.**

- **Wear appropriate protective gloves when handling hazardous material.**

**8.3.3** Disconnect suction bell **138.111** from propeller bowl **140.151** by removing capscrews **901.118** and nuts **920.120**.

**8.8.4** Remove retaining ring **506.165** by unbolting capscrews **901.166**. Then carefully slide propeller **230.161** off of the pump shaft **211.123**. Tapping with a stout piece of timber or a mallet may facilitate removal. It may be necessary to apply some heat in the disassembly process. For heating, use a gas torch fitted with a 25mm to 50mm (1" - 2") heating rosebud. Do not use a cutting torch.



**Figure 12**



### CAUTION!

**It must be emphasized that successful results using the following process requires experience or first-hand advice from a Sulzer representative. The components must be heated evenly across the component or permanent damage can result if the level and duration of heating is not properly controlled.**



### WARNING!

**Heated component!**

**Certain components are heated for expansion. Contact with hot surfaces or flames can cause severe burns.**

- **Always wear heat-resistant protective clothing and protective gloves when working in the vicinity of hot surfaces.**
- **Carefully read the operating instructions for the equipment that you will be using for heating.**

**8.8.5** Make sure 2 people are available for these steps. Each person must understand their assigned tasks for the removal process and be properly equipped.

**8.8.6** Heat the part evenly, all around and from the outside to the inside, spending proportionally more time on the impeller hub. 2 minutes of elapsed time is normally sufficient.

## ASSEMBLY AND DISASSEMBLY



### CAUTION!

Take care not to allow too much heat to soak into the shaft. If significantly more than 2 minutes elapsed during the heating cycle, stop heating, allow component to cool completely and start again!

If problems persist, contact a Sulzer representative.

- 8.8.7** The person not holding the torch must free the part. Grasp the part with gloved hands to withdraw the part from the shaft.



### NOTICE!

Tapping with a stout piece of timber or a mallet may facilitate removal but take care not to damage the impeller vanes in the process.

- 8.8.8** Remove the impeller key **940.164**.
- 8.8.9** Remove the threaded bushing **544.213** from diffuser **149.189**. Take care not to damage the bearing bushing **545.212** inside the threaded bushing.
- 8.8.10** Unbolt the diffuser **149.189** from propeller bowl **104.151** and remove the diffuser.



### WARNING!

#### Unstable components!

Components can swivel out and fall during lifting operations. This can cause serious injury or even death.

- Never stand under or in the swivel range of suspended loads.
- Only move loads under supervision.
- Only use approved lifting tools and anchorage means with sufficient load carrying capacity.
- Do not use torn or abraded lifting tools (ropes and belts).
- Do not lay lifting tools such as ropes and belts on sharp edges and corners and do not tie or twist them.
- Set the components down on a sufficiently stable and flat surface for inspection.

- 8.8.11** Carefully slide the propeller bowl **104.151** off of the pumpshaft **211.123**.



### CAUTION!

During the disassembly process, use handling procedures adequate to avoid bumping, hitting or springing the shafts. Support the shafts evenly over their entire length.

# ASSEMBLY AND DISASSEMBLY

## 8.9 INSPECTION



### WARNING!

#### Unstable components!

Components can swivel out and fall during lifting operations. This can cause serious injury or even death.

- Never stand under or in the swivel range of suspended loads.
- Only move loads under supervision.
- Only use approved lifting tools and anchorage means with sufficient load carrying capacity.
- Do not use torn or abraded lifting tools (ropes and belts).
- Do not lay lifting tools such as ropes and belts on sharp edges and corners and do not tie or twist them.
- Set the components down on a sufficiently stable and flat surface for inspection.



### ENVIRONMENT!

#### Incorrect handling of ecologically hazardous substances!

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective gloves when handling hazardous material.

Personnel:	Pump specialist
Protective equipment:	Protective clothing
	Protective gloves
	Industrial safety helmet
	Safety shoes

- 8.9.1 Clean & Inspect** After disassembly, clean all parts, except the mechanical seal (if fitted), in solvent and inspect for wear or damage. Inspect the bearings, shaft sleeves, seal parts, and bushings.



### WARNING!

**DO NOT clean mechanical seal in solvent!**



### CAUTION!

**Avoid Bumping, Hitting or Springing the Shaft!**

- 8.9.2** Check all running clearances (bearings, bushings etc.) for excessive wear. Damaged or excessively worn parts should not be re-used.
- 8.9.3** If the unit is not immediately reassembled, protect machined surfaces against rust. A thin application of light machine oil is normally adequate for short-term storage.
- 8.9.4 Mechanical Seal (If Fitted):** Mechanical seal rotating and stationary faces are highly polished and optically flat. Keep these surfaces clean and free from substances that would mar seal faces.

## ASSEMBLY AND DISASSEMBLY



### WARNING!

Mechanical seals intended for use in potentially explosive areas must satisfy the "Ex" protection requirements.



### NOTICE!

See the seal vendor literature for refurbishing procedure.

- 8.9.5 Propeller** Inspect the propeller **230.161** for wear or damage. Look for cavitation marks (pits) in the suction opening, erosion of vanes, and cracks in the shroud. Smooth minor irregularities with a fine file and crocus cloth. Check components to verify there is no distortion. The impellers should be replaced if damaged or excessively worn or pitted.



### NOTICE!

Verify propeller balance quality prior to re-assembly.

- 8.9.6 Propeller Bowl** Check propeller bowl **104.151** for burrs, chips, cracks or other damage. Minor irregularities may be smoothed with a fine file and crocus cloth.
- 8.9.7 Bushings** On a major overhaul, all bronze or rubber bushings should be replaced. See section 8.10 for bushing replacement.
- 8.9.8 Shafts** Remove burrs and smooth surface with crocus cloth. Protect shafts from damage.
- 8.9.8.1 Polish the shaft at the location of the impeller, seal, bearings, shaft sleeves, and coupling. Use crocus cloth or 400 grit emery paper.
- 8.9.8.2 Handle the shaft with care and support it evenly throughout its length to maintain straightness.



### CAUTION!

Avoid Bumping, Hitting or Springing the Shaft!

- 8.9.8.3 Rest the shafts **211.123** or **213.225** on precision rollers at shaft bearing locations. Use a dial indicator to determine total indicator reading.
- 8.9.8.4 Straighten or replace shafts if run-out exceeds specification maximum.
- 8.9.8.5 API Compliant Pumps require a shaft straightness of 0.0005 in./ft. (0.013 mm/0.305 m) TIR (total indicator runout), with a maximum allowable shaft runout of 0.003 in. (0.076 mm) over the total shaft length. Non-API Compliant CWP Pumps may have a shaft straightness of 0.0012 in./ft. (0.03 mm/0.305 m) TIR, with a maximum allowable shaft runout of 0.010 in. (0.25 mm) TIR for any shaft length.
- 8.9.9 O-Rings/Gaskets** Replace all O-Rings and gaskets during a major overhaul.

## 8.10 BUSHING REPLACEMENT

- 8.10.1** Pump units are normally equipped with bushings. The locations of the bushings are listed below with their DIN find numbers:

Suction Bell – <b>138.111</b>	Bushing: <b>545.115</b>
Propeller Bowl – <b>104.151</b>	Bushing: <b>545.154</b>
Bearing Spider Housing – <b>383.211</b>	Bushing: <b>545.212</b>
Stuffing Box: <b>431.401</b>	Bushing <b>545.427</b>

## ASSEMBLY AND DISASSEMBLY

### 8.10.2 Bushing Removal

- 8.10.2.1 Remove the applicable bushing by pressing bushing or breaking them out of their seat. Use care to avoid housing damage.

### 8.10.3 Bushing Installation

- 8.10.3.1 Use an arbor centering tool, a stepped arbor or mandrel and a hydraulic press to install the bushings. The arbor or mandrel ensures that the bushing is correctly positioned.
- 8.10.3.2 The small diameter should be 0.062" (1.6 mm) smaller than the inside diameter of the bushing. The large outside diameter of the arbor should be larger than the outside diameter of the bushing.
- 8.10.3.3 Surfaces X and Y must be parallel before and during pressing to insure correct final fit.
- 8.10.3.4 The bushing can be pressed in dry, but a dip coat of water will provide additional lubrication. During the press, pressure must be applied continuously.

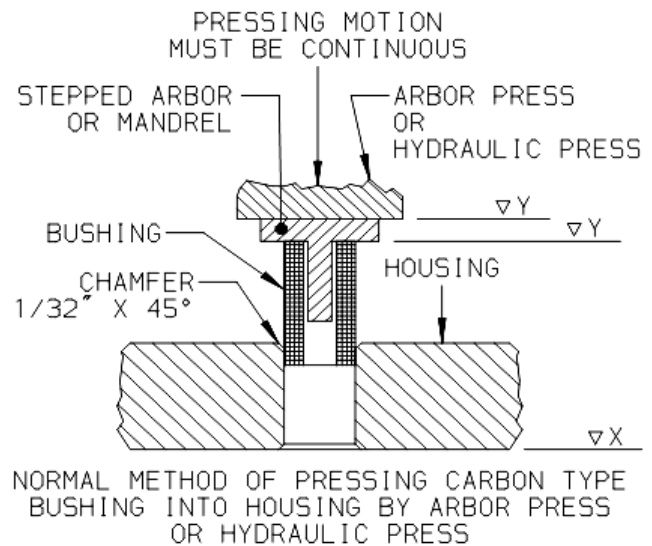


Figure 13



#### CAUTION!

##### Bushing Damage!

Bushings can be damaged if incorrectly installed. While installing the bushing, do not stop and start the press. Use continuous motion.



#### NOTICE!

The inside diameter of a bushing becomes smaller after installation due to reaction of press fitting. Wait 24 hours before measurement of inside diameter.

## 8.11 GENERAL ASSEMBLY



#### WARNING!

##### Explosive atmosphere!

Failure to remove any lodged item in the pump could result in damage to the pump unit and/or associated plant. If undetected during operation it could be a potential source of ignition!

- Exposure to ignition sources, such as sparks, naked flames and hot surfaces, can cause an explosion in areas with a potentially explosive atmosphere. This may result in death, serious injury or significant material damage.
- If anything is dropped into the pump unit, it must be removed and the pump checked completely to ensure that any loose item does not remain inside.

## ASSEMBLY AND DISASSEMBLY



### WARNING!

New case gasket must be available at this time. Failure to do so may result in leakage!

Only material from Sulzer has the proper composition for high pressure sealing and "crush" for proper internal clearances.



### ENVIRONMENT!

Incorrect handling of ecologically hazardous substances!

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Always wear protective clothing and protective gloves when working in the vicinity of hazardous materials.



### WARNING!

Suspended loads!

Loads can swivel out and fall during lifting operations. This can cause serious injury or even death.

- Never stand under or in the swivel range of suspended loads.
- Only move loads under supervision.
- Only use approved lifting tools and anchorage means with sufficient load carrying capacity.
- Do not use torn or abraded lifting tools (ropes and belts).
- Do not lay lifting tools such as ropes and belts on sharp edges and corners and do not tie or twist them.
- Set the load down on a sufficiently stable and flat surface after leaving the workplace.



### CAUTION!

Before re-assembly of the pump, it is good practice and recommended to check the fitting diameters, the resulting clearances as well as the resulting concentricity and run-outs on the registered fits of Column Pipes, Bowls and Discharge Head.



### CAUTION!

Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fasteners.

Personnel:

Pump specialist

Protective equipment:

Protective clothing

Protective gloves

Industrial safety helmet

Safety shoes

## ASSEMBLY AND DISASSEMBLY

### 8.11.1 Cleanliness

Assembled parts must be absolutely clean and free of oil or dust. Technical grade acetone is recommended for cleaning machined surfaces immediately before assembly. Air dry (use filtered, dry air) cleaned parts in a dust free area.



#### CAUTION!

Acetone is extremely volatile and flammable. Work only in a well ventilated area, away from heat or flame. A "No Smoking" rule must be strictly enforced, and sparks must be prevented.



#### ENVIRONMENT!

Incorrect handling of ecologically hazardous substances!

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Always wear protective clothing and protective gloves when working in the vicinity of hazardous materials.

**8.11.2 Use New Parts** Use new O-rings, gaskets and lockwashers. Replace gaskets with the same material and thickness as original.



#### WARNING!

New case gasket must be available at this time. Failure to do so may result in leakage!

Only material from Sulzer has the proper composition for high pressure sealing and "crush" for proper internal clearances.

**8.11.3 Torque Values** Prior to assembly, refer to suggested torque values table as referenced within the TORQUE VALUES, ADDENDUM No. 2 of this manual.

## 8.12 ASSEMBLY OF PUMP



#### CAUTION!

Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fasteners.



#### CAUTION!

During the assembly process, use handling procedures adequate to avoid bumping, hitting or springing the shafts. It is recommended that the pump is assembled horizontally. Support shafts evenly over their entire length.



#### NOTICE!

Use Non-Petroleum based jelly ONLY when required to coat the "O"-ring (if fitted) to hold it in place.

### 8.12.1 Bowl Assembly

## ASSEMBLY AND DISASSEMBLY



### NOTICE!

In the disassembly process, the parts should have been marked in their disassembly sequence. Reassemble the bowl assembly in reverse order of the disassembly sequence.

- 8.12.1.1 Place key **940.164** on the key slot on pumpshaft **211.123**.
- 8.12.1.2 Slide, from the bottom of the pumpshaft, the propeller **230.161** over key **940.164** on pumpshaft **211.123**. Align the eye (bottom) of the propeller with the groove on the pumpshaft.
- 8.12.1.3 Install the retaining ring **506.165** on the eye of propeller **230.161** with capscrews **901.166** to fix the impeller to pumpshaft. See the TORQUE VALUES, ADDENDUM No. 2 of this manual.

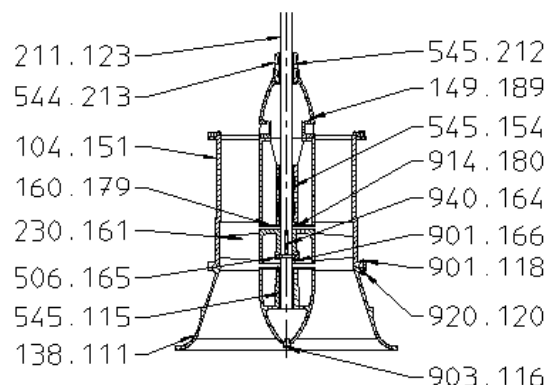


Figure 14



### CAUTION!

#### Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fasteners.

- 8.12.1.4 Install the suction bell **138.111**, with threaded plug installed.
- 8.12.1.5 Install the propeller bowl **104.151** and secure it to suction bell **138.111** with capscrews **901.118** and nuts **920.120**.



### CAUTION!

Care should be taken to avoid damaging the bushing in the bowl and suction bell.

- 8.12.1.6 Bolt the diffuser **149.189** to the top of the propeller bowl **104.151** using capscrews. See the TORQUE VALUES, ADDENDUM No. 2 of this manual.



### CAUTION!

#### Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fasteners.

- 8.12.1.7 Screw the threaded bushing **544.213**, with the installed bearing bushing **545.212** into the diffuser **149.189**.

## ASSEMBLY AND DISASSEMBLY



### CAUTION!

Check as the unit is assembled for freedom of rotation and that axial end play is not lost.

### 8.12.2 Assembly of Column and Discharge Head



### CAUTION!

During the assembly process, use handling procedures adequate to avoid bumping, hitting or springing the shafts. Support the shafts evenly over their entire length to prevent them from bending.

- 8.12.2.1 Connect the two-piece shaft with the coupling. See Section 8.12.3 for assembly of couplings.
- 8.12.2.2 Place "O"-ring **412.158** (if fitted) on the register of top bowl.
- 8.12.2.3 Slide the bottom column **711.201** over the pumpshaft **213.123** and into position on the top bowl flange. Be careful not to damage the headshaft.
- 8.12.2.4 Secure bottom column to top bowl with capscrews **901.216** and nuts **920.217**. See the TORQUE VALUES, ADDENDUM No. 2 of this manual.

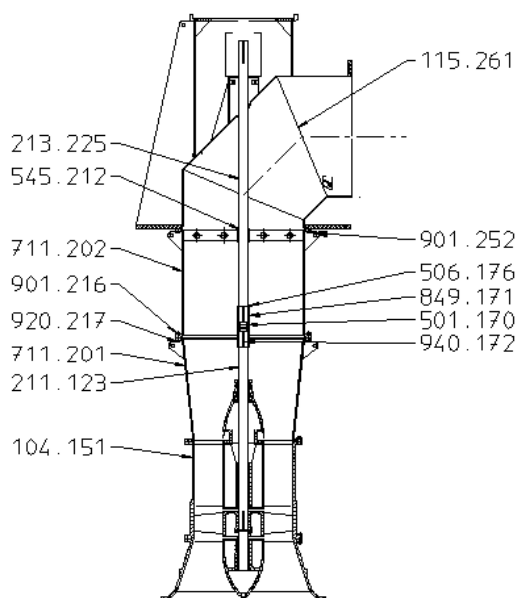


Figure 15



### CAUTION!

#### Incorrect fastener tightening torques!

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

Never exceed the maximum permissible fastener tightening torque.

Always observe the applicable guidelines and design criteria for fasteners.

- 8.12.2.5 Slide the top column **711.202** over the pumpshaft and into position on the bottom column flange and secure the two with capscrews **901.216** and nuts **920.217**. See the TORQUE VALUES, ADDENDUM No. 2 of this manual.
- 8.12.2.6 Fasten the discharge head **115.261** to the top column **711.202** using capscrews **901.252**. See the TORQUE VALUES, ADDENDUM No. 2 of this manual.
- 8.12.2.7 Install the stuffing box **431.401** and "O"-ring **412.445**, gland packing **461.425** to the discharge head. Secure with capscrews **914.448**. See the TORQUE VALUES, ADDENDUM No. 2 of this manual.

## ASSEMBLY AND DISASSEMBLY



### CAUTION!

Release the seal plate locking discs or spacers before tightening the seal plate nuts 920.405.



### NOTICE!

The remainder of the assembly should be carried out once the pump has been installed vertically at site. See the INSTALLATION Module within this IOM.

8.12.2.8 Install the driver and align it to the pump per section 8.12.4.

8.12.2.9 Install the drive coupling and set rotor axial adjustment per 8.12.5.

### 8.12.3 Line Shaft Sleeve Coupling Installation



### CAUTION!

Rig hoist to support shafts 213.225 and 211.123 during shaft coupling assembly.

#### 8.12.3.1 Threaded Coupling Installation

8.12.3.1.1 Join shafts with threaded coupling 852.171.

**Note:** Threads are Left Handed.

#### 8.12.3.2 Sleeve Coupling Installation

8.12.3.2.1 Slide sleeve coupling 849.171 on either shaft, past the keyway. Join shafts with split ring 501.170 and insert keys 940.172.

8.12.3.2.2 Slide the sleeve coupling 849.171 over keys and split ring and align sleeve ends with grooves on shafts. Slide the Gibb Key 943.173 into position and secure axially using the Socket Head Capscrews.

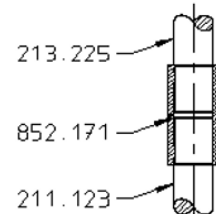


Figure 16

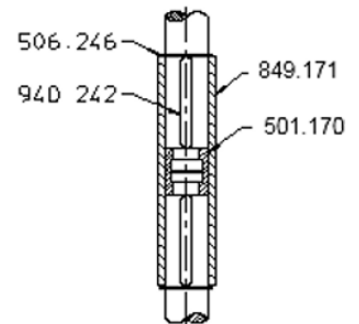


Figure 17

### 8.12.4 Pump Assembly Enclosed Lineshaft



### CAUTION!

Clean all threads, shaft ends, couplings, and mating surfaces with a solvent and wire brush just before making connections. Cleanse the line-shaft of all grease, oil, and foreign matter.



### NOTICE!

Pipe joint compound should be used on column threads. Non-metallic anti-seize compound should be used on the tube-connector threads and shaft threads.

## ASSEMBLY AND DISASSEMBLY



### ENVIRONMENT!

**Incorrect handling of ecologically hazardous substances!**

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Always wear protective clothing and protective gloves when working in the vicinity of hazardous materials.

8.12.4.1 Install shaft protection tube **714.362** onto screwed bushing **544.213**.

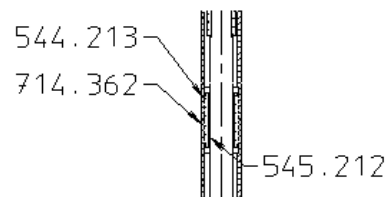
8.12.4.2 If a two-piece shaft is present, install second shaft with threaded coupling **852.241**.

8.12.4.3 Slide screwed bushing **544.213** down lineshaft and screw into shaft protection tube **714.362**. Then slide the next shaft protection tube over lineshaft and couple with screwed bushing **544.213**.

8.12.4.4 Repeat steps 8.12.4.2 and 8.12.4.3 as necessary. Once all shafts and shaft protection tubes have been installed, proceed to the next step.

8.12.4.5 Carefully guide the column **711.201** down the shaft protection tube **714.362** to the top bowl **112.151** and secure with capscrews **901.182** and nuts **920.183**. See the TORQUE VALUES, ADDENDUM No. 2 of this manual.

8.12.4.6 Carefully guide the discharge head **115.261** over the shaft and shaft protection tube and secure it to column **711.201** with capscrews **901.252**. See the TORQUE VALUES, ADDENDUM No. 2 of this manual.



**Figure 18**



### CAUTION!

**Incorrect fastener tightening torques!**

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

Refer to the coupling manufacturer's tightening recommendations.

8.12.4.7 Install the tube tension ring **515.401** using a tube tension plate wrench to tighten the ring to the top of the shaft protection tube **714.362**.

8.12.4.8 Adjust the tube tension by stretching the tube about 1/8" (3mm) for every 100 feet (30.5m) of tubing, or about 1-1/4 turns of the tube tension plate for every 100 feet (30.5m) of tubing after all slack is taken out of the tube.

8.12.4.9 Bolt the tension ring **515.401** to the discharge head **115.261**. Install the head-shaft through the tube tension ring **515.401** and hand-tighten.

8.12.4.10 Install two rings of packing in the tube tension ring **515.401**.

## ASSEMBLY AND DISASSEMBLY

- 8.12.4.11 For Water Flush, repeat steps 8.12.4.1 through 8.12.4.10 and follow steps 8.12.4.12 through 8.12.4.16.
- 8.12.4.12 Check to be sure the grease and water passages in the lubrication manifold **654.417** are clear. Install the lubrication manifold into the tension ring **515.401** and tighten.
- 8.12.4.13 Install three rings of packing **461.425** and place the lantern ring **458.416** with the threaded holes up.
- 8.12.4.14 Add the remaining three rings of packing **461.425** and screw the studs into the top of the lubrication manifold **654.417**.
- 8.12.4.15 Add the split gland **452.415**, clips and nuts for the studs and tighten the nuts finger tight.
- 8.12.4.16 Screw in the grease fitting and connect the water flush line to the fresh water supply.
- 8.12.4.17 For Oil Lube, follow steps 8.12.4.18 through 8.12.4.19.
- 8.12.4.18 Check to be sure the oil passages in the lubrication manifold **654.417** are clear. Install the lubrication manifold into the tension ring **515.401** and tighten.
- 8.12.4.19 Connect the lubrication piping to the tube fitting.

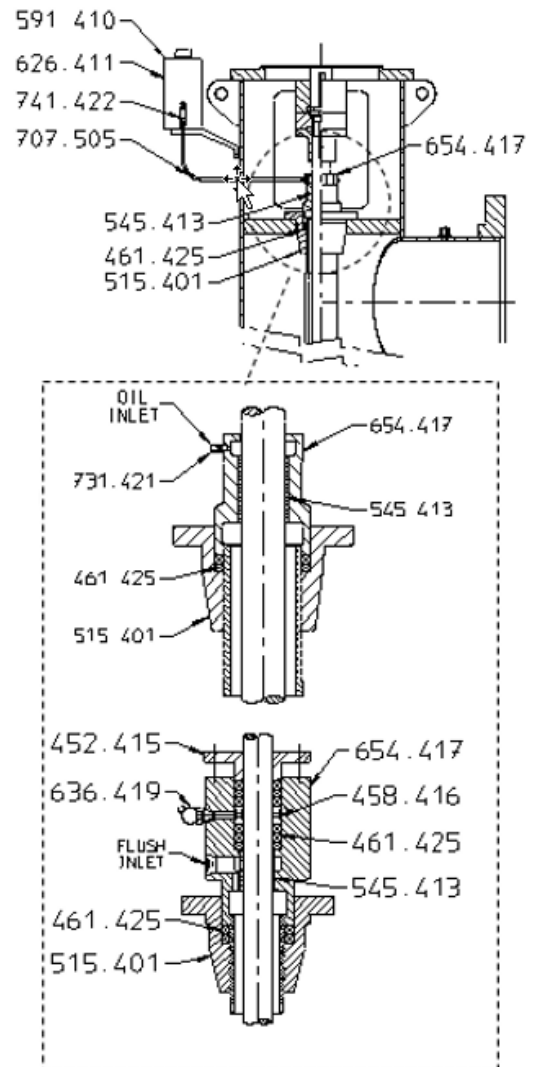


Figure 19

### 8.12.5 Driver Installation



#### CAUTION!

During field installation of the pump, there is a radial clearance between the motor flange and driver stand. The process of centering the pump shaft must be done properly. Center the shaft by using the Seal Box housing diameter with the coupling between pump and motor already assembled.

- 8.12.5.1 **Shaft run-out** (See the ALIGNMENT Module.) In the case of an apparent out-of-tolerance consult a Sulzer representative or the driver manufacturer.
- 8.12.5.2 Set the driver **800.520** onto the driver stand (if fitted) **341.501** or Discharge Head **115.261**. Install driver capscrews **901.523** "finger tight."
- 8.12.5.3 Align the driver to pump. (See the ALIGNMENT Module.) Adjust by using driver alignment capscrews **901.508**.

## ASSEMBLY AND DISASSEMBLY

- 8.12.5.4 Check seal housing face and bore runout to shaft before and after the seal housing is secured according to the TORQUE VALUES, ADDENDUM No. 2 of this manual.



**CAUTION!**

To check the run-out of the seal chamber to the pump shaft, the driver stand, driver and rigid coupling must be installed. See the ALIGNMENT Module.



**CAUTION!**

**Incorrect centering!**

Incorrect centering of components will cause material damage and possible pump failure.

- 8.12.5.5 Secure the driver to the discharge head or driver stand with Capscrews **901.523**. See the TORQUE VALUES, ADDENDUM No. 2 of this manual.
- 8.12.5.6 Connect motor wiring in accordance to motor manufacturer's instructions.



**CAUTION!**

Before installing the pump to driver coupling, momentarily start driver and verify correct rotation, (CCW when looking down from driver).

### 8.12.6 Coupling Installation



**WARNING!**

Unauthorized or uncontrolled switching on again!

Lock power breakers to the off position prior to performing coupling assembly work!



**WARNING!**

If the Sulzer scope of supply does not include the coupling / coupling protection, ensure that only ATEX compliant or approved materials and designs are used for applications in potentially explosive areas.



**NOTICE!**

Refer to the coupling manufacturer's installation instructions before installing the pump and driver coupling.

- 8.12.6.1 Insert key into driver shaft. Slide the driver coupling hub onto driver shaft until circular key seat on shaft is exposed. Holding hub in this position, install circular split key halves (thrust ring **474.523**). Slide driver coupling hub down until it stops against the thrust ring. The thrust ring locks the driver coupling hub to the driver shaft.

## ASSEMBLY AND DISASSEMBLY

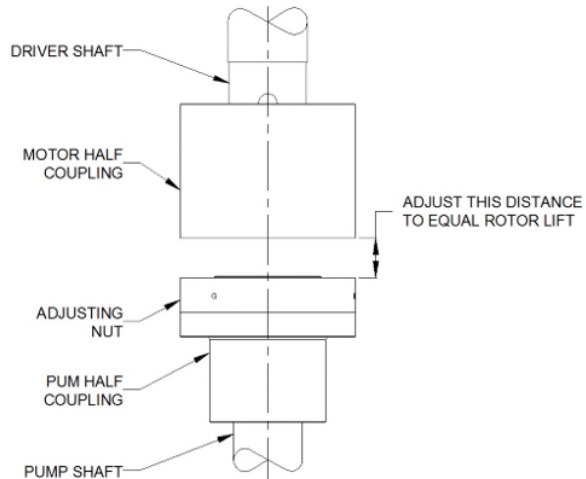


Figure 20



**NOTICE!**

Driver may be shipped from the factory with driver coupling hub already installed on the driver shaft.

- 8.12.6.2 Insert the key **940.511** into pump shaft **211.123**, then slide the pump coupling hub onto the pump shaft.
- 8.12.6.3 Pilot the spacer (if applicable) into driver hub and insert short bolts between hub and spacer. TORQUE per coupling manufacturer's instructions.
- 8.12.6.4 With rotor in the full down position, thread the adjusting nut on pump shaft until distance between the face of adjusting nut and face of motor half coupling, equals distance stamped on "rotor lift plate"; or shown on the general arrangement drawing. Use feeler gages. (Refer to Table 1.)



**NOTICE!**

With vertical pumps, the rotating element must be set (lifted) into its operating position. This is performed by turning the adjusting nut located within the coupling to raise the shaft a set amount.

- 8.12.6.5 Turn the adjusting nut downward on shaft to align bolt holes.
- 8.12.6.6 Insert four of the coupling bolts and tighten them progressively until secured, thereby closing the gap above the adjusting nut and raising the rotor to its running position. (Refer to Table 1.)

## ASSEMBLY AND DISASSEMBLY

Model	End Play		"X" Lift Setting	
	mm	in.	mm	in.
24PO	38.1	1.50	19.1	0.75
30PO	50.8	2.00	25.4	1.00
36PO	50.8	2.00	25.4	1.00
42PO	69.9	2.75	34.9	1.38
48PO	50.8	2.00	25.4	1.00
54PO	55.6	2.19	27.0	1.06
60PO	57.2	2.25	31.8	1.25
72PO	101.6	4.00	50.8	2.00

**Table 1 - Distance to Thread Adjusting Nut on to Pump Shaft**

8.12.6.7 Insert the remaining coupling bolts and tighten them securely.



**CAUTION!**

**Incorrect fastener tightening torques!**

If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.

Refer to the coupling manufacturer's tightening recommendations.

8.12.6.8 Turn the rotating element by hand to ensure free rotation.

8.12.6.9 Check runout of shaft below coupling. Shaft must be within 0.002 inch (0.051 mm) maximum TIR.

### 8.12.7 Integral Thrust Bearing and Driver Stand Assembly (If fitted)

8.12.7.1 Please refer to the VAL or VALS Modules for specific instructions on bearing assembly and lubrication.

8.12.7.2 For a **Flexible Coupling**, mount the pump and driver coupling assembly in accordance to coupling manufacturer's installation instructions.

### 8.12.8 Mechanical Seal Runout (If fitted)

## ASSEMBLY AND DISASSEMBLY

8.12.8.1 Once the rotating element has been set, install a dial indicator on the pump shaft as shown and check the seal chamber face runout and bore concentricity by turning the rotating element by hand.

8.12.8.2 Check the run out of the seal housing with the mechanical seal secured "finger tight" with studs **902.404**, nuts **920.405** and washers **554.592**. Then check the run out after the seal housing with the mechanical seal are secured according to TORQUE VALUES. See TORQUE VALUES, ADDENDUM No.2 of this manual.

8.12.8.3 **Seal Housing Bore Runout:** Provisions shall be made to center the Seal Gland and or Housing with an inside diameter register fit. The register fit shall be concentric to the shaft and shall have a total indicated runout of not more than 0.125 mm (0.005 in.).

8.12.8.4 **Seal Housing Bore Runout:** Provisions shall be made to center the Seal Gland and or Housing with an inside diameter register fit. The register fit shall be concentric to the shaft and shall have a total indicated runout of not more than 0.125 mm (0.005 in.).

8.12.8.5 **Seal Housing Face Runout:** Seal Housing face runout should not exceed 0.5 mm/mm (0.0005 in./in.) of seal chamber bore diameter.

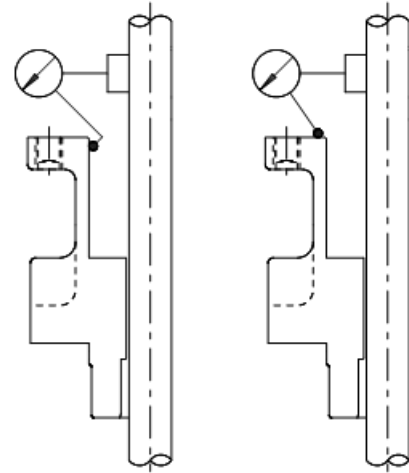


Figure 21



### CAUTION!

Release seal plate locking discs or spacers before tightening seal plate nuts **920.405**.

### 8.12.9 Piping

8.12.9.1 Reconnect the suction and discharge flanges.

8.12.9.2 Reconnect seal circulation lines, taking care caps are removed and pipe ends are clean.

8.12.9.3 Reconnect all instrumentation.



### ENVIRONMENT!

Incorrect handling of ecologically hazardous substances!

All lubrication fluid must be collected and disposed of in accordance with the current environmental regulations to prevent endangering people or the environment.

- Wear appropriate protective gloves when handling the lubricating material.

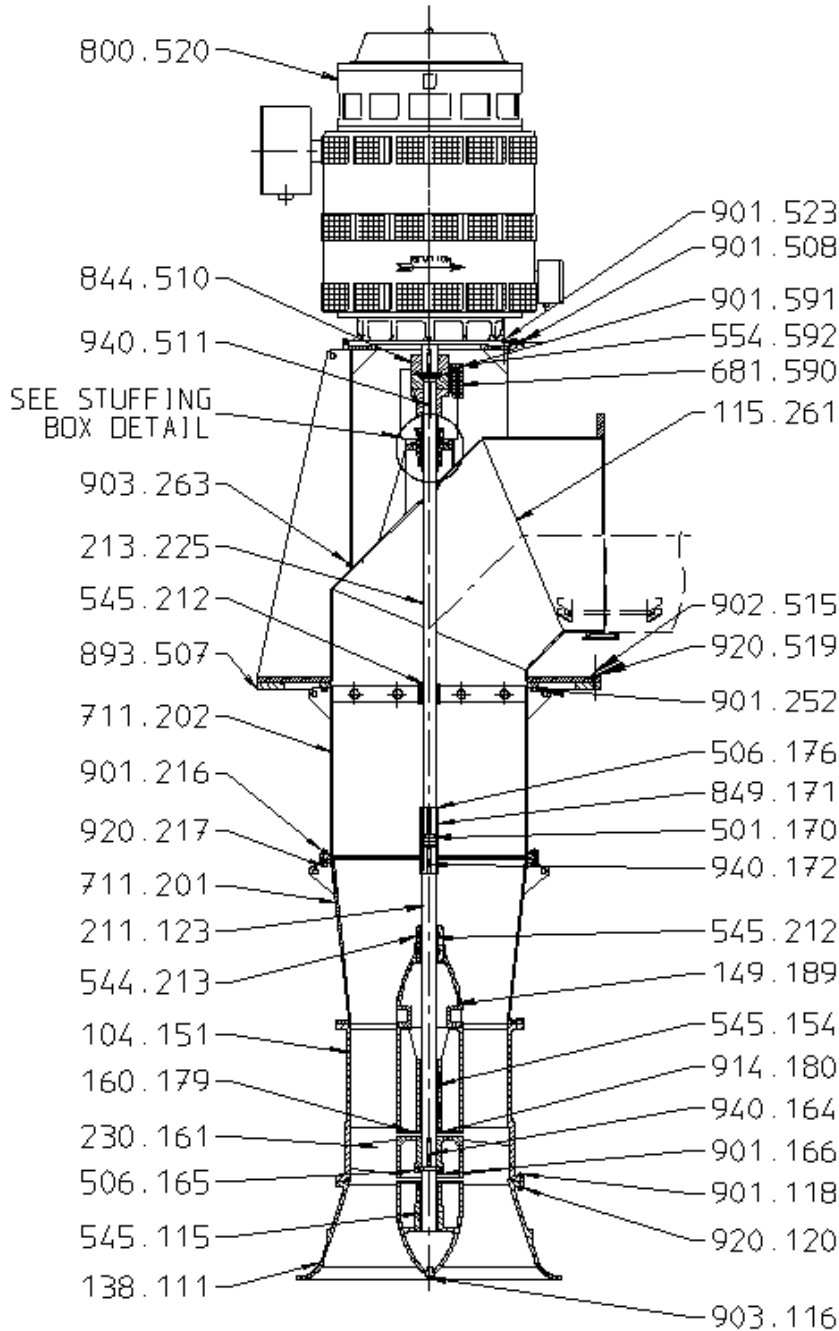
### 8.12.10 Start-Up

8.12.10 Add lubricant to integral thrust bearing, if equipped, and prepare for startup. See the VAL or VALS Assembly modules, and the INSTALLATION module of this manual. Install the oil filler plug and breather **637.335**.

# ASSEMBLY AND DISASSEMBLY

## TYPICAL CROSS SECTION

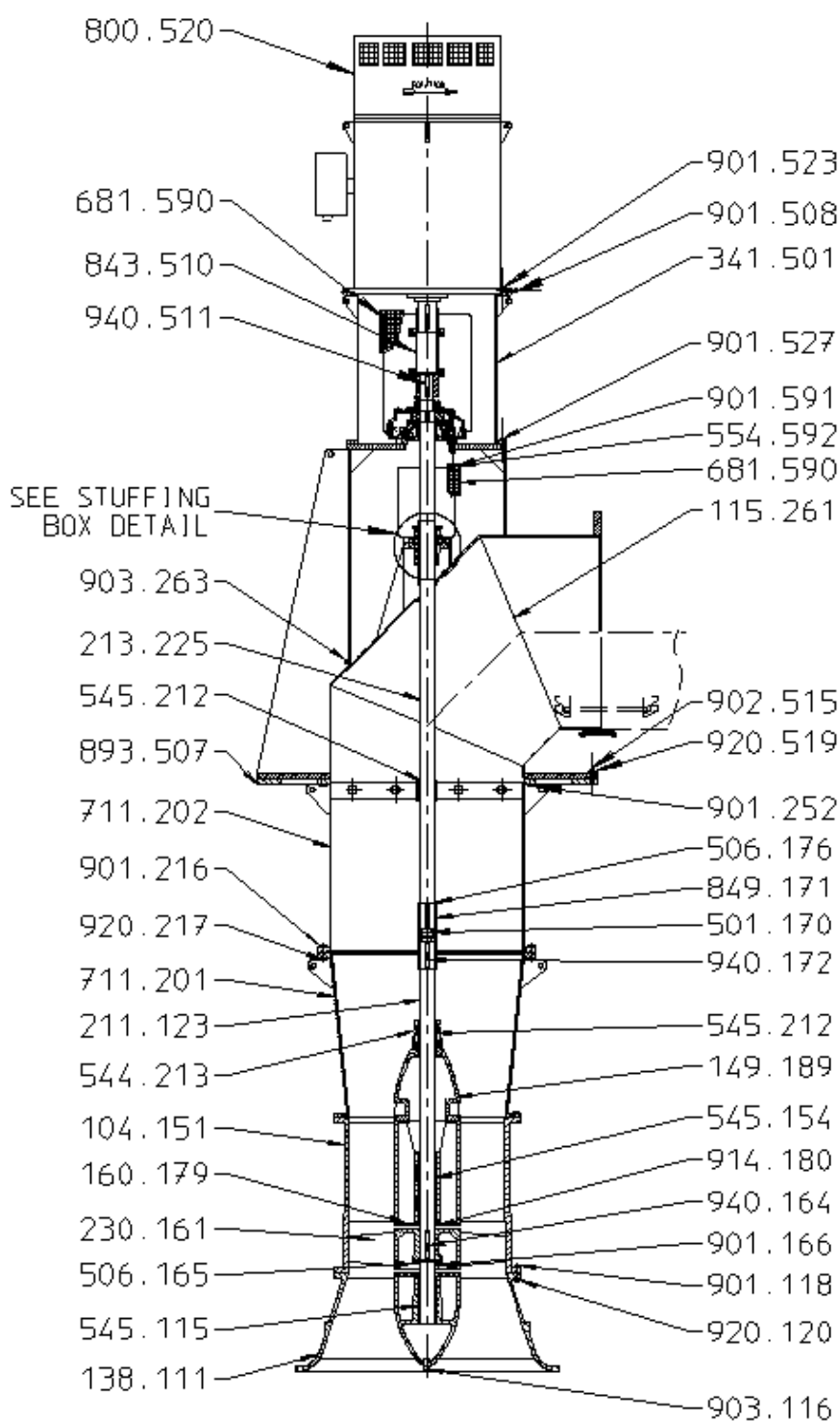
TYPICAL PUMP SECTION



Find No.	Description
138.111	Suction Bell
903.116	Threaded Plug
545.115	Bearing Bushing (Suction Bell)
901.118	Capscrew, Hex Hd (Suction Bell)
920.120	Nut (Suction Bell)
211.123	Pump Shaft
104.151	Propeller Bowl
545.154	Bearing Bushing (Bowl)
230.161	Propeller
940.164	Key (Impeller)
506.165	Ret Ring (Impeller)
901.166	Capscrew, Hex Hd (Retaining Ring)
501.170	Split Ring (Sleeve Coupling)
849.171	Sleeve Coupling
940.172	Key (Coupling)
506.176	Retaining Ring
160.179	Cover
914.180	Capscrew, Socket Hd (Cover)
149.189	Diffuser
711.201	Column, Bottom
711.202	Column, Top
545.212	Bearing Bushing (Lineshaft)
901.216	Capscrew, Hex Hd (Columns)
920.217	Nut (Column)
213.225	Head Shaft
901.252	Capscrew, Hex Head (Flange)
115.261	Discharge Head
903.263	Threaded Plug (Drain)
893.507	Sole Plate
901.508	Capscrew, Hex Hd (Driver Stand)
844.510	Rigid Coupling
940.511	Key (Coupling)
902.515	Studs (Sole Plate to Head)
920.519	Nuts (Sole Plate to Head)
800.520	Motor
901.523	Capscrew, Hex Hd (Driver)
681.590	Coupling Guard
901.591	Capscrew, Hex Hd (Cplg Guard)
554.592	Washer (Cplg Guard)

# ASSEMBLY AND DISASSEMBLY

## TYPICAL PUMP SECTION WITH PUMP THRUST BEARING AND DRIVER STAND



Find No.	Description
138.111	Suction Bell
545.115	Bearing Bushing (Suction Bell)
903.116	Threaded Plug
901.118	Capscrew, Hex Hd (Suction Bell)
920.120	Nut (Suction Bell)
211.123	Pump Shaft
104.151	Propeller Bowl
545.154	Bearing Bushing (Bowl)
230.161	Propeller
940.164	Key (Impeller)
506.165	Retaining Ring (Impeller)
901.166	Capscrew, Hex Hd (Retaining Ring)
501.170	Split Ring (Sleeve Coupling)
849.171	Sleeve Coupling
940.172	Key (Coupling)
506.176	Retaining Ring
160.179	Cover
914.180	Capscrew, Socket Hd (Cover)
149.189	Diffuser
711.201	Column, Bottom
711.202	Column, Top
545.212	Bearing Bushing (Threaded Bushing)
544.213	Threaded Bushing (Diffuser)
901.216	Capscrew, Hex Hd (Columns)
920.217	Nut (Column)
213.225	Head Shaft
901.252	Capscrew, Hex Head (Flange)
115.261	Discharge Head
903.263	Thd. Plug (Drain)
341.501	Driver Stand
893.507	Sole Plate
901.508	Capscrew, Hex Hd (Driver Stand)
843.510	Flexible Coupling
940.511	Key (Coupling)
902.515	Studs (Sole Plate-Hd)
920.519	Nuts (Sole Plate-Hd)
800.520	Motor
901.523	Capscrew, Hex Hd (Driver)
901.527	Capscrew, Hex Hd (Driver Stand)
681.590	Coupling Guard
901.591	CapScrew, Hex Hd (Cplg Guard)
554.592	Washer (Coupling Guard)

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# REPLACEMENT PARTS

## 10.0 SPARE PARTS



### WARNING!

Pump Safety can only be assured if repairs are carried out by trained specialists using Sulzer approved replacement parts!



### NOTICE!

If unauthorized spare or replacement parts are used, the warranty of Sulzer Pumps becomes void.

Obtain spare and replacement parts directly from Sulzer Pumps. See the front of this manual for contact details.



### NOTICE!

Bearing inventory must be of bearings that have only machined brass cages (type BECM or BECBM) and NOT pressed brass or steel cages (BECY or BECBY).

**10.0.1** Spare parts should be kept to reduce downtime. The service of a pump usually dictates the number of spare parts. The following parts should be stocked:

- Anti-Friction Bearings (1 set)
- Bearing Bushings
- Throttle Bushing (if applicable)
- Stationary Rings, Impeller Rings
- Gaskets and O-rings (1 set)
- Gland packing (1 set) if applicable
- Mechanical Seal and Shaft Protection Sleeve

**10.0.2** For pumps used in important service or if several identical machines are operating in the same plant, it is recommended that a complete pump be stocked at the job site.

## 10.1 PARTS ORDERS

Order parts through the local Sulzer field office identified in the front of this manual. Please provide the following information:

- Type of pump
- Pump serial number
- Cross section drawing number
- The number of part as shown on cross section drawing and the parts list
- Quantity and description of part

# REPLACEMENT PARTS

## 10.2 TYPICAL CROSS SECTION



### NOTICE!

The illustration Figure (appearing before the Table Of Contents, and also in the ASSEMBLY Section) may differ from your specific application. Parts orders and other assured identification must be made by using the specific cross section and parts list in the Attachments to this manual.

## 10.3 SPARE PARTS STORAGE



### WARNING!

**Follow vendor instructions for components of the pump system. Contact Sulzer when a conflict in storage procedures occurs!**



### WARNING!

#### Falling or tipping packages!

Packages can have an eccentric center of gravity. If anchored incorrectly, the package can tip and fall. Falling or tipping packages can cause a serious injury.

- Note the markings and specifications about the center of gravity on the packages.
- When transporting by crane, position the crane hooks above the center of gravity of the package.
- Carefully raise the package and observe if it tips. If necessary, change the anchorage.
- Set the package down on a sufficiently stable and flat surface in the storage area.

**10.3.1** All spare parts furnished by Sulzer are manufactured to the same close tolerances as the original equipment and shipped in a manner to maintain this condition.

**10.3.2** In handling these parts, care should be taken so as not to drop, bump or mark the surface finish.

**10.3.3** Upon arrival at the plant or storage site, the container or containers shall be visually inspected for shipping damage. Any damage shall be immediately reported to the carrier and Sulzer.



This way up

The arrows point to the top of the package. These must always point upward; otherwise the contents can be damaged.



Centre of gravity



Designates the center of gravity of packages. Observe the center of gravity position when lifting and transporting.



Protecting from moisture

Protect packages from moisture and keep them dry.

## REPLACEMENT PARTS

	This way up	The arrows point to the top of the package. These must always point upward; otherwise the contents can be damaged.
	Anchor here	Only attach lifting accessories (sling chain, lifting strap) at the points marked with this symbol.



### CAUTION!

**Make sure to follow all markings, instructions, and warnings on containers and packaging!**

- 10.3.4** Open container(s) and verify items and quantity by packing list.
- 10.3.5** All items shall be stored indoors.
- 10.3.6** All seal parts shall be stored indoors and in an area where the temperature is maintained at a uniform level.
- 10.3.7** Seal faces, rotating and stationary, shall be stored horizontally in the Styrofoam package if received in this type of package.
- 10.3.8** Rolling elements (ball bearings) should not be opened but left in manufacturer's package.
- 10.3.9** O-rings should not be taken out of their shipping bag.
- 10.3.10** Items received wrapped in paper should be stored with the paper removed, unless the paper contains rust preventative. If the paper contains rust preventative, it should not be removed until the part will be used.
- 10.3.11** Cortec corrosion-inhibitive wrapping or bags are acceptable for up to 24 months storage.




### CAUTION!

**Do not remove parts from colored corrosion-inhibitive plastic wrapping or bags!**

# ADDENDUM 2 - TORQUE VALUES

## 1.0 PURPOSE

- 1.1 This process establishes the method and values for torquing fasteners to produce properly stressed joints with a minimum probability of fasteners breaking or loosening. Joint distortion will be avoided by using the correct tightening sequence during torque development.


 **CAUTION!**  
**Incorrect fastener tightening torques!**  
If the fasteners are tightened with the incorrect tightening torque, components may become loose and cause personal injury and damage to property.


- Never exceed the maximum permissible fastener tightening torque.
- Always observe the applicable guidelines and design criteria for fastened connections.

 **NOTICE!**  
**Ensure torque wrenches and indicators carry current calibration stickers.**

## 2.0 METHOD

- 2.1 All fasteners are to be lubricated (if lubricants are permitted) with graphite and oil, molybdenum disulfide, or another anti-seize lubricant of comparable quality that is compatible with the fastener application. Cleaning specifications must be consulted to determine suitability or allowance of thread lubricant.

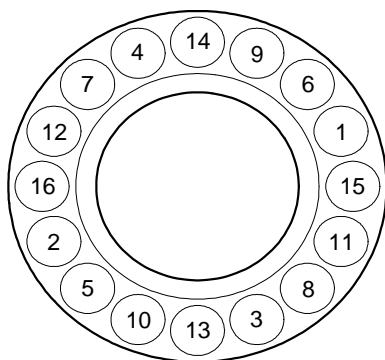
 **NOTICE!**  
**Apply anti-seize compound to all fasteners except the NPT fittings.**

 **ENVIRONMENT!**  
**Incorrect handling of ecologically hazardous substances!**  
Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

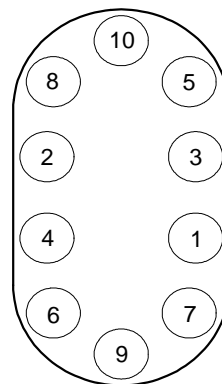
- Wear appropriate protective gloves when handling cleaning materials and thread lubricants.

- 2.2 Consult the Parts List (if applicable) to determine the fastener and component material for determining torque value, or for special torque requirements.
- 2.3 Consult the following Fastener Application guideline to determine the table to be used based on the fastener application.
- 2.4 Tighten opposing fasteners in an alternating sequence as illustrated below when developing required torque.

## ADDENDUM 2



Circular Multi-Bolt,  
Example Pattern



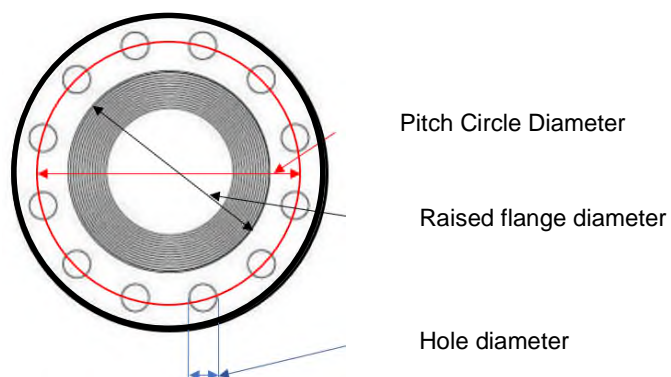
Non-Circular Multi-Bolt,  
Example Pattern

- 2.5 Lubricate and install fasteners finger-tight. Develop the required fastener torque value in a minimum of three steps, with a maximum of 30 percent of the torque value being reached on the initial pass.
- 2.6 After the last torque-development pass, a final "check pass" tightening to the required torque value should be performed in a clockwise bolt to bolt sequence.
- 2.7 Refer to vendor instructions for proper torque values on vendor-supplied equipment.
- 2.8 Look for a grade identification marking on the fastener, then refer to the appropriate column in Torque Table 1, if the fastener is not covered by another specific table.
- 2.9 The material into which the fastener is threaded must also be considered. For fastener materials that have strengths greater than the material that is tapped, see the Parts List (if applicable) for special torque requirements.
- 2.10 Where the material or fastener grade marking is unknown, and the application is for Table 1, use the values in column 9 (AISI 304, 316 or Monel material). Note that this applies to duplex fasteners. See E10.37.
- 2.11 Torque values in Tables 4 through 6 will be unchanged regardless of the fastener material.
- 2.12 Typical applications that could have either flat or raised face flanges include, but are not limited to: Bowl & column (vertical pump);, Discharge head to receiver can (vertical pump); Isolation chamber; seal housing, Reservoir; (J Unit application); Impeller retainer (Capscrew); Stuffingbox or Case Cover; End Covers (Suct. & Disch); Seal plate; Inner case (double case pump); Driver stand (vertical pump); Pump & driver mounting; Coupling; Bearing assembly and mounting components. Select either Table 1 or Table 3 as applicable, with Table 7 for a rigid coupling (vertical pump).

## ADDENDUM 2

<b>Fastener Application Guide:</b>	
Dynamic Coefficient Of Friction ( $\mu_d$ ) = 0.1	
<u>FASTENER APPLICATION</u>	<u>TABLE NUMBER</u>
Flat Face Flange Joint with Gasket	1 & 1M
Case-Parting Flange (horizontal split-case pump)	2
Raised Face Flange <sup>(i)</sup> Joint with Gasket / Seal Gland	3 & 3M
Pump Hold-Down	4 & 4M
Bearing Nut	5 & 5M
Pivot Shoe Bearing Nut	6
Rigid Couplings for Vertical Pumps	7 & 7M

(i) For the purpose of this standard the definition of a raised face flange is when the raised face diameter is less than the Pitch Circle Diameter minus the hole diameter except for the below: OHH case cover is classified as having a 'Raised face flange joint with gasket'. This applies in all cases, even for the high-pressure design with BD studs.



## ADDENDUM 2

**TABLE 1a: Flat Face Flange Joint with Gasket – US Customary**

Note: Material grades not listed or unidentifiable fasteners shall be fastened to Column 9.

COLUMN NO.	1		2		3		4		5	
MATERIAL & GRADE	SAE Gr 8 A&SA354 Gr BD		A&SA193 Gr B7 A&SA320 Gr L7 A&SA574		SAE Gr 5 A325 & A449 ASTM F468 - N05500 (Monel)		A193 Gr B6		A&SA193 Gr B7M A&SA320 Gr L7M	
FASTENER SIZE	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m
0.250 - 20 UNC	10	13	8	11	7	9	6	9	6	8
0.3125 - 18 UNC	19	26	15	21	14	18	13	17	12	16
0.375 - 16 UNC	32	44	26	36	23	32	21	30	20	28
0.4375 - 14 UNC	52	70	42	56	36	50	34	46	32	42
0.500 - 13 UNC	78	105	64	86	56	74	52	70	48	66
0.625 - 11 UNC	155	210	125	170	110	145	100	135	94	130
0.750 - 10 UNC	265	365	215	295	190	255	175	235	165	225
0.875 - 9 UNC	425	580	345	465	300	410	280	380	260	355
1.000 - 8 UNC	640	860	510	700	450	610	415	560	390	530
1.125 - 8 UN	920	1240	740	1000	570	780	600	820	570	770
1.250 - 8 UN	1280	1740	1040	1400	800	1080	840	1140	790	1060
1.375 - 8 UN	1720	2320	1380	1880	1060	1460	1120	1520	1060	1440
1.500 - 8 UN	2240	3040	1820	2460	1400	1900	1460	2000	1380	1880
1.625 - 8 UN	2900	3920	2340	3180	1300	1760	1900	2560	1780	2420
1.750 - 8 UN	3620	4900	2920	3960	1620	2180	2360	3200	2220	3020
1.875 - 8 UN	4460	6050	3600	4880	1980	2700	2920	3940	2740	3720
2.000 - 8 UN	5450	7350	4400	5950	2420	3280	3560	4820	3340	4540
2.250 - 8 UN	7800	10600	6300	8550	3480	4720	5100	6900	4800	6500
2.500 - 8 UN	10700	14600	8650	11800	4800	6500	7000	9500	6600	8950
2.750 - 8 UN	12700	17200	10500	14200	6400	8700	9400	12700	8850	12000
3.000 - 8 UN	16500	22400	13700	18500	8350	11300	12200	16600	11500	15600
3.250 - 8 UN	21100	28600	17400	23600			15600	21100	14700	19900
3.500 - 8 UN	26400	35800	21800	29600			19500	26500	18400	24900
3.750 - 8 UN	32500	44100	26900	36400			24000	32600	22600	30700
4.000 - 8 UN	39600	53600	32700	44300			29200	39600	27500	37300

## ADDENDUM 2

**TABLE 1b: Flat Face Flange Joint with Gasket – US Customary (cont.)**

Note: Material grades not listed or unidentifiable fasteners shall be fastened to Column 9.

COLUMN NO.	6		7		8		9	
MATERIAL & GRADE	A &SA193 Gr B8R		SAE Gr 2		SAE gr 1, ASTM A307 gr A or B		AISI 304, 316 ASTM A193 gr B8, B8M Monel	
FASTENER SIZE	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m
0.250 - 20 UNC	4	6	4	6	3	4	2	3
0.3125 - 18 UNC	8	11	8	11	5	7	4	6
0.375 - 16 UNC	14	19	14	19	9	12	8	10
0.4375 - 14 UNC	22	30	22	30	14	19	12	16
0.500 - 13 UNC	34	44	34	46	22	30	18	24
0.625 - 11 UNC	64	88	68	90	42	58	36	48
0.750 - 10 UNC	115	155	115	160	74	100	62	84
0.875 - 9 UNC	180	245	120	160	120	160	98	135
1.000 - 8 UNC	270	365	175	240	175	240	145	200
1.125 - 8 UN	390	530	255	345	255	345	210	290
1.250 - 8 UN	540	730	355	480	355	480	295	400
1.375 - 8 UN	730	990	475	640	475	640	395	540
1.500 - 8 UN	950	1280	620	840	620	840	520	700
1.625 - 8 UN	1220	1660			800	1080	670	910
1.750 - 8 UN	1520	2080			1000	1360	830	1120
1.875 - 8 UN	1880	2560			1240	1680	1020	1400
2.000 - 8 UN	2300	3120			1500	2040	1260	1700
2.250 - 8 UN	3300	4460			2160	2920	1800	2440
2.500 - 8 UN	4540	6150			2980	4040	2480	3360
2.750 - 8 UN	6050	8250			3980	5400	3320	4500
3.000 - 8 UN	7900	10700			5200	7000	4320	5850
3.250 - 8 UN	10100	13700			6600	8950	5500	7450
3.500 - 8 UN	12600	17100			8250	11200	6900	9350
3.750 - 8 UN	15600	21100			10200	13800	8500	11500
4.000 - 8 UN	18900	25600			12400	16800	10300	14000

## ADDENDUM 2

**TABLE 1Ma: Flat Face Flange Joint with Gasket – Metric**

Note: Material grades not listed or unidentifiable fasteners shall be fastened to Column 9.

COLUMN NO.	1		2		3		4		5	
MATERIAL & GRADE	SAE Gr 8 A&SA354 Gr BD		A&SA193 Gr B7 A&SA320 Gr L7		SAE Gr 5 A325 & A449 ASTM F468 - N05500 (Monel)		A193 Gr B6		A&SA193 Gr B7M A&SA320 Gr L7M	
FASTENER SIZE	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m
M6	8	11	7	9	6	8	5	7	5	7
M8	20	26	16	21	14	19	13	17	12	16
M10	40	54	32	42	28	38	26	34	24	32
M12	66	90	54	72	48	64	44	60	42	56
M14	105	145	84	115	74	100	70	94	64	88
M16	160	215	130	175	115	155	105	140	98	135
M18	225	305	180	245	160	215	145	200	135	185
M20	315	425	250	340	220	300	205	275	190	260
M22	415	570	335	455	295	400	270	370	255	345
M24	540	730	435	590	380	520	350	475	330	450
M27	790	1060	630	860	490	670	510	690	480	650
M30	1080	1460	860	1160	670	910	700	950	660	890
M33	1340	1820	1080	1460	840	1140	880	1200	830	1120
M36	1860	2520	1500	2020	1160	1580	1220	1640	1140	1540
M39	2380	3240	1920	2600	1500	2020	1560	2120	1460	1980
M42	2960	4020	2380	3220	1320	1800	1940	2620	1820	2460
M45	3700	5000	2960	4020	1640	2240	2420	3260	2260	3080
M48	4460	6050	3580	4860	1980	2700	2900	3940	2740	3700
M52	5700	7750	4580	6200	2540	3460	3720	5050	3500	4740
M56	7050	9600	5700	7700	3160	4280	4620	6250	4340	5900
M60	8700	11800	7000	9500	3880	5250	5700	7700	5350	7250
M64	10500	14300	8450	11500	4700	6400	6900	9350	6450	8750
M68	11200	15200	9250	12600	5650	7650	8250	11200	7800	10500

## ADDENDUM 2

**TABLE 1Mb: Flat Face Flange Joint with Gasket – Metric (cont.)**

Note: Material grades not listed or unidentifiable fasteners shall be fastened to Column 9.

COLUMN NO.	6		7		8		9	
MATERIAL & GRADE	A &SA193 Gr B8R		SAE Gr 2		SAE gr 1, ASTM A307 gr A or B		AISI 304, 316 ASTM A193 gr B8, B8M Monel	
FASTENER SIZE	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m
M6	4	5			2	3	2	3
M8	8	11			5	7	5	6
M10	17	23			11	15	9	12
M12	28	38			19	26	15	21
M14	44	60			30	40	24	32
M16	68	92			44	60	36	50
M18	94	130			62	84	52	70
M20	135	180			88	120	72	96
M22	175	240			115	160	96	130
M24	230	310			150	205	125	165
M27	335	450			220	295	180	245
M30	455	620			300	405	245	335
M33	570	770			375	510	310	415
M36	790	1060			520	700	425	580
M39	1020	1380			670	900	550	740
M42	1260	1700			830	1120	680	920
M45	1560	2120			1040	1400	840	1140
M48	1880	2560			1240	1680	1020	1380
M52	2420	3280			1600	2160	1300	1760
M56	3000	4060			1980	2680	1620	2200
M60	3700	5000			2440	3300	2000	2700
M64	4460	6050			2940	3980	2420	3260
M68	5350	7300			3540	4800	2900	3940

## ADDENDUM 2

**TABLE 1Mc: Flat Face Flange Joint with Gasket – Metric (cont.)**

Note: Material grades not listed or unidentifiable fasteners shall be fastened to Column 9.

COLUMN NO.	10		11		12		13		14		15	
MATERIAL & GRADE	Class 4.6		Class 8.8		Class 10.9		Class 12.9		A1, A2 & A4 Property Class 50		A1, A2 & A4 Property Class 70	
FASTENER SIZE	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m
M6	2	3	6	8	9	12	10	14	2	3	4	6
M8	5	7	14	19	21	28	24	32	5	6	10	13
M10	10	14	28	38	42	56	48	66	9	12	20	26
M12	18	24	48	64	70	96	82	110	16	21	34	46
M14	28	38	76	100	110	150	130	175	25	34	54	72
M16	42	58	115	155	170	230	195	265	38	50	80	110
M18	60	82	165	225	235	320	275	370	52	72	110	150
M20	84	115	230	310	330	445	385	520	74	100	155	215
M22	110	150	305	415	435	590	510	690	98	130	210	285
M24	145	195	395	540	570	770	660	900	125	170	270	365
M27	210	285	580	780	820	1120	960	1300	185	250		
M30	285	390	790	1080	1120	1520	1320	1780	250	340		
M33	360	490	990	1340	1420	1920	1660	2240	315	425		
M36	495	670	1360	1860	1940	2640	2280	3100	435	590		

## ADDENDUM 2

**TABLE 2: Case-Parting Flange (Horizontal Split-Case Pumps) – US Customary**

Note: Values based on Sulzer standard capnut OD (ref. E10.37.02)

MATERIAL & GRADE	SAE Gr 8 A&SA354 Gr BD		A&SA193 Gr B7 A&SA320 Gr L7		A&SA193 Gr B7M A&SA320 Gr L7M	
	lb*ft	N*m	lb*ft	N*m	lb*ft	N*m
FASTENER SIZE						
0.750 - 10 UNC	305	415	245	335	190	255
0.875 - 9 UNC	485	660	395	530	300	405
1.000 - 8 UNC	730	990	590	800	445	610
1.125 - 8 UN	1060	1420	850	1160	650	880
1.250 - 8 UN	1460	1980	1180	1600	900	1220
1.375 - 8 UN	1960	2660	1580	2140	1200	1640
1.500 - 8 UN	2560	3480	2080	2820	1580	2140
1.625 - 8 UN	3300	4480	2680	3620	2040	2760
1.750 - 8 UN	4120	5600	3340	4520	2540	3440
1.875 - 8 UN	5100	6900	4120	5550	3140	4240
2.000 - 8 UN	6200	8400	5000	6800	3820	5200
2.250 - 8 UN	8900	12100	7200	9750	5500	7450
2.500 - 8 UN	12300	16600	9900	13400	7550	10200
2.750 - 8 UN	14500	19700	12000	16300	10100	13700
3.000 - 8 UN	18900	25600	15600	21200	13100	17800
3.250 - 8 UN	24100	32700	19900	27000	16800	22700
3.500 - 8 UN	30200	40900	24900	33800	21000	28500
3.750 - 8 UN	37200	50400	30700	41600	25900	35100
4.000 - 8 UN	45200	61300	37300	50600	31400	42600

## ADDENDUM 2

**TABLE 3: Raised Face Flange Joint with Gasket / Seal Gland – US Customary**

Note <sup>(k)</sup>: Ensure that these values will allow adequate clamping pressure to seal the joint. Use referenced tools to determine resultant preload.

COLUMN NO.	1		2	
MATERIAL & GRADE	<u>Table 1 Col.1-5:</u> A193 B6,B7,B7M A320 L7,L7M SAE Gr 5, 8 A354 BD A325 & A449 B150 min F468 N05500(Monel)		<u>Table 1 <sup>(k)</sup> Col.6-8:</u> A320 B8,B8M AISI 304, 316 A193 B8R SAE Gr 1,2 A307 Gr A, B	
FASTENER SIZE	lb*ft	N*m	lb*ft	N*m
0.250 - 20 UNC	6	8	2	3
0.3125 - 18 UNC	11	15	4	6
0.375 - 16 UNC	19	26	8	10
0.4375 - 14 UNC	30	40	12	16
0.500 - 13 UNC	46	62	18	24
0.625 - 11 UNC	88	120	36	48
0.750 - 10 UNC	155	210	62	84
0.875 - 9 UNC	245	335	98	135
1.000 - 8 UNC	365	500	145	200
1.125 - 8 UN	530	720	210	290
1.250 - 8 UN	740	1000	295	400
1.375 - 8 UN	990	1340	395	540
1.500 - 8 UN	1300	1760	520	700
1.625 - 8 UN	1680	2260	670	910
1.750 - 8 UN	2080	2820	830	1120
1.875 - 8 UN	2560	3480	1020	1400
2.000 - 8 UN	3140	4260	1260	1700
2.250 - 8 UN	4500	6100	1800	2440
2.500 - 8 UN	6200	8400	2480	3360
2.750 - 8 UN	8300	11200	3320	4500
3.000 - 8 UN	10800	14600	4320	5850
3.250 - 8 UN	13800	18600	5500	7450
3.500 - 8 UN	17200	23300	6900	9350
3.750 - 8 UN	21200	28800	8500	11500
4.000 - 8 UN	25800	35000	10300	14000

## ADDENDUM 2

**TABLE 3M: Raised Face Flange Joint with Gasket / Seal Gland – Metric**

Note <sup>(k)</sup>: Ensure that these values will allow adequate clamping pressure to seal the joint. Use referenced tools to determine resultant preload.

COLUMN NO.	1		2	
MATERIAL & GRADE	<u>Table 1M Col.2,4,5,11-13:</u> Class 8.8 Class 10.9 Class 12.9 A193 B6 A193 B7,B7M A320 L7,L7M		<u>Table 1M <sup>(k)</sup> Col.6,9,14-15:</u> A1, A2 & A4 Property Class 50,70 304,316 A193 B8,B8M,B8R	
FASTENER SIZE	lb*ft	N*m	lb*ft	N*m
M6	5	6	2	3
M8	11	15	5	6
M10	23	30	9	12
M12	38	52	15	21
M14	60	82	24	32
M16	92	125	36	50
M18	130	175	52	70
M20	180	245	72	96
M22	240	325	96	130
M24	310	420	125	165
M27	450	610	180	245
M30	620	840	245	335
M33	770	1040	310	415
M36	1060	1440	425	580
M39	1380	1860	550	740
M42	1700	2300	680	920
M45	2120	2880	840	1140
M48	2560	3480	1020	1380
M52	3280	4440	1300	1760
M56	4060	5500	1620	2200
M60	5000	6800	2000	2700
M64	6050	8200	2420	3260
M68	7300	9900	2900	3940

## ADDENDUM 2

**TABLE 4a: Pump Hold-Down Bolts with thermal growth allowance – US Customary**

Applies to:

- Single pedestal pumps (BBS, BBT, OHH, etc.) with hot alignment features
  - Dual pedestal pumps (MSD) NDE Bolts with hot alignment features
- For all other hold down bolts, refer to Table 4b.

FASTENER SIZE	Lb-ft	N-m
0.500 - 13 UNC	10	14
0.625 - 11 UNC	20	28
0.750 - 10 UNC	36	48
0.875 - 9 UNC	56	76
1.000 - 8 UNC	84	115
1.125 - 7 UNC	120	160
1.125 - 8 UN	120	165
1.250 - 7 UNC	165	225
1.250 - 8 UN	170	230
1.375 - 6 UNC	220	295
1.375 - 8 UN	225	310
1.500 - 6 UNC	285	390
1.500 - 8 UN	295	405
1.625 - 8 UN	385	520
1.750 - 5 UNC	455	610
1.750 - 8 UN	475	650
2.000 - 4.5 UNC	680	920
2.000 - 8 UN	720	970
2.250 - 4.5 UNC	980	1320
2.250 - 8 UN	1020	1400
2.500 - 4 UNC	1340	1820
2.500 - 8 UN	1420	1920
2.750 - 4 UNC	1800	2440
2.750 - 8 UN	1900	2580
3.000 - 4 UNC	2360	3200
3.000 - 8 UN	2480	3360

## ADDENDUM 2

**TABLE 4b: Pump Hold-Down Bolts with no thermal growth allowance – US Customary**

Applies to:

- Single pedestal pumps (BBS, BBT, OHH, etc.) without hot alignment features
- Dual pedestal pumps (MSD) NDE Bolts without hot alignment features
- Dual pedestal pumps (MSD) DE Bolts, even if NDE has hot alignment features

Note: Bolting Material Yield Strength: hold-down bolt values below are based on ASTM A307 Gr A yield strength (100% Sb 36 ksi), values are validated per API 686 2<sup>nd</sup> Ed., Annex E.

FASTENER SIZE	Lb-ft	N-m
0.500 - 13 UNC	30	42
0.625 - 11 UNC	60	82
0.750 - 10 UNC	105	145
0.875 - 9 UNC	170	230
1.000 - 8 UNC	250	340
1.125 - 7 UNC	355	485
1.125 - 8 UN	365	495
1.250 - 7 UNC	500	670
1.250 - 8 UN	510	690
1.375 - 6 UNC	660	890
1.375 - 8 UN	680	920
1.500 - 6 UNC	860	1160
1.500 - 8 UN	890	1200
1.625 - 8 UN	1140	1560
1.750 - 5 UNC	1360	1840
1.750 - 8 UN	1440	1940
2.000 - 4.5 UNC	2040	2760
2.000 - 8 UN	2160	2920
2.250 - 4.5 UNC	2940	3980
2.250 - 8 UN	3080	4180
2.500 - 4 UNC	4020	5450
2.500 - 8 UN	4260	5800
2.750 - 4 UNC	5400	7300
2.750 - 8 UN	5700	7700
3.000 - 4 UNC	7100	9600
3.000 - 8 UN	7400	10100

## ADDENDUM 2

**TABLE 4Ma: Pump Hold-Down Bolts with thermal growth allowance – Metric**

Applies to:

- Single pedestal pumps (BBS, BBT, OHH, etc.) with hot alignment features
  - Dual pedestal pumps (MSD) NDE Bolts with hot alignment features
- For all other hold down bolts, refer to Table 4Mb.

FASTENER SIZE	Lb-ft	N-m
M12	9	12
M14	13	18
M16	20	28
M18	28	38
M20	40	54
M22	54	72
M24	68	94
M27	100	135
M30	135	185
M33	170	235
M36	235	320
M39	305	415
M42	380	510
M45	470	640
M48	570	770
M52	730	990
M56	900	1220
M60	1120	1500
M64	1340	1820
M68	1620	2200

## ADDENDUM 2

**TABLE 4Mb: Pump Hold-Down Bolts with no thermal growth allowance – Metric.**

Applies to:

- Single pedestal pumps (BBS, BBT, OHH, etc.) without hot alignment features
- Dual pedestal pumps (MSD) NDE Bolts without hot alignment features
- Dual pedestal pumps (MSD) DE Bolts, even if NDE has hot alignment features

Note: Bolting Material Yield Strength: hold-down bolt values below are based on ASTM A307 Gr A yield strength (100% S<sub>b</sub> 36 ksi), values are validated per API 686 2<sup>nd</sup> Ed., Annex E.

FASTENER SIZE	Lb-ft	N-m
M12	26	36
M14	42	58
M16	64	86
M18	90	120
M20	125	170
M22	165	225
M24	215	290
M27	315	425
M30	425	580
M33	540	730
M36	740	1000
M39	950	1280
M42	1180	1600
M45	1480	2000
M48	1780	2400
M52	2280	3080
M56	2820	3820
M60	3480	4700
M64	4200	5700
M68	5050	6850

## ADDENDUM 2

**TABLE 5: Bearing Nut**  
 Coefficient of Friction  $\mu = 0.10$   
 Coatings: Un-plated  
 Lubricant: Lightly oiled

LOCKNUT DESIGNATION	7300 SERIES ANG CONT BALL BEARINGS		6300 SERIES DP GRV BALL BEARINGS		6200 SERIES DP GRV BALL BEARINGS	
	Maximum Allowable Tightening Torque		Maximum Allowable Tightening Torque		Maximum Allowable Tightening Torque	
	Lb-ft	N-m	Lb-ft	N-m	Lb-ft	N-m
N-06	20	28	15	20	11	15
N-07	26	34	20	28	17	23
N-08	36	48	30	40	26	34
N-09	50	68	46	62	30	40
N-10	70	94	60	82	36	48
N-11	90	120	80	110	50	68
N-12	115	155	100	135	66	88
N-13	145	195	125	170	86	115
N-14	175	235	150	205	100	135
AN-15	220	300	185	250	115	155
AN-16	260	355	220	300	140	190
AN-17	310	420	260	355	175	235
AN-18	360	490	310	420	210	285
AN-19	425	580	360	490	250	340
AN-20	530	710	450	610	300	405
AN-21	600	810	520	700	350	475
AN-22	680	920	640	860	415	560

## ADDENDUM 2

**TABLE 5M: Bearing Nut**

Coefficient of Friction  $\mu$  (threads) = 0.10,  $\mu$  (nut face) = 0.20

Coatings: Un-plated

Lubricant: Lightly oiled

LOCKNUT DESIGNATION	7300 SERIES ANG CONT BALL BEARINGS		6300 SERIES DP GRV BALL BEARINGS		6200 SERIES DP GRV BALL BEARINGS	
	Maximum Allowable Tightening Torque		Maximum Allowable Tightening Torque		Maximum Allowable Tightening Torque	
	Lb-ft	N-m	Lb-ft	N-m	Lb-ft	N-m
KM 6	21	28	16	21	11	15
KM 7	28	38	22	30	17	24
KM 8	44	58	32	42	25	34
KM 9	60	82	46	62	32	42
KM 10	82	110	62	82	38	50
KM 11	105	145	80	110	52	70
KM 12	135	180	100	135	62	86
KM 13	165	225	125	170	84	115
KM 14	205	275	155	210	100	135
KM 15	255	345	185	250	120	160
KM 16	300	410	220	300	140	190
KM 17	360	485	265	355	175	235
KM 18	420	570	310	420	210	285
KM 19	495	670	360	485	245	335
KM 20	610	820	445	610	295	405
KM 21	700	950	510	700	350	475
KM 22	790	1060	630	860	415	560
KM 24	950	1280	710	960	450	610
KM 26	1120	1500	890	1200	540	740
KM 28	1380	1860	1080	1460	660	900
KM 30	1720	2340	1340	1840	790	1060
KM 32			1440	1960	940	1280
KM 34	2440	3320	1820	2480	1200	1640
KM 36	2780	3780	2300	3120	1360	1840
KM 38	3360	4560	2580	3500	1680	2280

## ADDENDUM 2

**TABLE 6: Pivot Shoe Bearing Nut**  
Coatings: Un-plated  
Lubricant: Lightly oiled

Thrust Bearing Size	Torque Value	
	Lb-ft	N-m
JHJ-4	100	135
JHJ-5	100	135
JHJ-6	100	135
JHJ-7	150	205
JHJ-8	150	205
JHJ-9	150	205

## ADDENDUM 2

**TABLE 7: Rigid Coupling Values for Vertical Pumps – US Customary**

COLUMN NO.	1		2	
MATERIAL & GRADE	SAE Gr 8 A&SA354 Gr BD		A&SA193 Gr B7 A&SA320 Gr L7 A&SA574	
FASTENER SIZE	lb*ft	N*m	lb*ft	N*m
0.375 - 16 UNC	36	48	28	38
0.4375 - 14 UNC	54	74	44	60
0.500 - 13 UNC	84	115	68	92
0.625 - 11 UNC	165	220	130	180
0.750 - 10 UNC	285	390	230	315
0.875 - 9 UNC	455	620	370	500
1.000 - 8 UNC	680	920	550	750
1.125 - 8 UN	990	1340	800	1080
1.250 - 8 UN	1360	1860	1100	1500
1.375 - 8 UN	1840	2500	1480	2020
1.500 - 8 UN	2400	3260	1940	2640

## ADDENDUM 2

**TABLE 7M: Rigid Coupling Values for Vertical Pumps – Metric**

COLUMN NO.	1		2	
MATERIAL & GRADE	SAE Gr 8 A&SA354 Gr BD		A&SA193 Gr B7 A&SA320 Gr L7 A&SA574	
FASTENER SIZE	lb*ft	N*m	lb*ft	N*m
M10	42	56	34	46
M12	72	98	58	78
M14	115	155	92	125
M16	170	235	140	185
M18	240	325	195	260
M20	335	455	270	365
M22	445	610	360	485
M24	580	780	465	630
M27	840	1140	680	920
M30	1140	1560	920	1260
M33	1440	1960	1160	1560
M36	1980	2700	1600	2160

# ADDENDUM 4 - TROUBLESHOOTING

## 1.0 SAFETY INSTRUCTIONS FOR CORRECTING PROBLEMS



### **WARNING!**

#### **Explosive atmospheres!**

**Exposure to ignition sources, such as sparks, naked flames and hot surfaces, can cause an explosion in areas with a potentially explosive atmosphere. This may result in death, serious injury or significant material damage.**

- Obtain a written work permit before commencing work in an area with a potentially explosive atmosphere.
- Only perform work if a potentially explosive atmosphere can be excluded.
- Only use tools permitted for use in areas with a potentially explosive atmosphere.



### **WARNING!**

#### **Measurement and control equipment is energized!**

**Pump operation is monitored electrically. Danger of death from electric shock.**

- Work on measurement and control equipment should only be performed by qualified electricians with an additional qualification in explosion protection.
- If there is damage to the insulation, switch off the power supply immediately and have it repaired.
- Never bypass or disable fuses. When replacing fuses, make sure that the correct amperage is used.
- Keep moisture out of electrically charged components. This can cause a short circuit.



### **WARNING!**

#### **Unauthorized or uncontrolled switching on again!**

**If the pump is switched back on by an unauthorized person or in an uncontrolled manner it may result in serious injury or even death.**

- Before switching back on, make sure that all safety devices are installed and in full working order and that there is no danger to persons.
- Always comply with the process to secure against switching on again.

## ADDENDUM 4



### **CAUTION!**

#### **Hazardous Nitrogen Gases**

**Avoid contact with or inhaling hazardous gases.**

**The shaft seal system is braded packing which will allow some leakage.**

**Small quantities of the nitrogen gas purge will escape this area and displace CO<sub>2</sub> and O<sub>2</sub>.**

- Use this purge system in an open air environment, avoid use in a confined space.



### **WARNING!**

#### **Hot Work Environment!**

**Long-term close proximity to the pump should be avoided.**

**High product temperature and therefore high pump discharge head temperature is harmful to health due to the hot work environment.**

**Contact with hot surfaces will cause serious burns or scalds to the skin!**

- Always wear heat-resistant protective clothing and protective gloves when working in the vicinity of hot surfaces or fluids.
- Refer to pump specifications/data sheets for pumpage temperature.
- Indicate hot environment with warning signs and labels.



### **WARNING!**

#### **Hot surfaces, pumpage and operating fluids!**

**Component surfaces, pumped fluids and operating fluids, such as hydraulic or lubricating oils can become very hot during operation.**

**Contact with hot surfaces will cause serious burns or scalds to the skin!**

- Avoid Contact with the Pump parts during operation.
- Use a thermometer to verify surface temperature of pump parts and piping prior to servicing.
- Always wear heat-resistant protective clothing and protective gloves when working in the vicinity of hot surfaces or fluids.



### **WARNING!**

#### **Solidification of Pumped Liquid**

**Restoration of energy supply following interruption (Restarting conditions – Conditions for restarting pump after sudden stop.**

- Pump and pumped media must be adequately heated in order that the pump does not become blocked by solidification of the pumped liquid.
- Molten Salts solidifies when it is cooled to below 240 Deg C.

## ADDENDUM 4



### **WARNING!**

#### **Danger of being pulled in by moving components!**

**Being pulled in by moving components can cause serious injury.**

- Do not handle moving components during operation.
- Do not grasp moving components during operation.
- Never open covers during operation.
- Observe the stopping time: ensure that the components are no longer moving before opening the covers.
- Wear closely fitting protective clothing with a low tear resistance in the hazardous area.



### **WARNING!**

#### **Hot pump medium!**

**Direct contact with the pump medium through physical contact, inhalation or skin puncture can lead to serious burns and even death.**

- Avoid contact with the pump medium.
- Allow pump medium leakages to cool.
- When handling the pump medium, wear the personal protective equipment provided in addition to that mentioned here.



### **WARNING!**

#### **Heated component!**

**Certain components are heated for shrinking. Contact with hot surfaces or flames can cause severe burns.**

- Always wear heat-resistant protective clothing and protective gloves when working in the vicinity of hot surfaces.
- Carefully read the operating instructions for the equipment that you will be using for heating.



### **WARNING!**

#### **External Influences – Lightning Strike!**

**Possibility of lightning strike when machines are operated outdoors.**

- Before operation check the machine for damages ensuring that all safety devices are installed and in full working order and that there is no danger to persons.
- If necessary, repair all damages before switching on again.

## ADDENDUM 4



### **WARNING!**

#### **Improper operation!**

Improper operation can lead to serious injury and considerable property damage.

- Be careful when handling open, sharp-edged components.
- Ensure that the assembly area is tidy and clean! Components and tools that are loosely stacked on each other or lying around can cause accidents.
- Assemble the components correctly. Observe the prescribed screw tightening torques.
- Secure components so they will not fall or tip over.
- Before commissioning, observe the following:
  - Ensure that all work is carried out and completed according to the data and notices in these instructions.
  - Ensure that no one is in the danger area.



### **ENVIRONMENT!**

#### **Incorrect handling of ecologically hazardous substances**

Incorrect handling of ecologically hazardous substances can cause significant damage to the environment.

- Always follow the information provided by the manufacturer when handling and disposing of ecologically hazardous substances.
- Implement suitable measures immediately if ecologically hazardous substances are accidentally released into the environment. In case of doubt, inform the responsible local authority about the damage and ask what action needs to be taken.
- Wear appropriate protective gloves and face shield when handling lubricating fluids.

- 1.1 The following table identifies problems that may occur during startup or normal operation. It also suggests a course of action based on the initial diagnosis of the problem.
- 1.2 If there is an increased occurrence of problems, shorten the maintenance intervals according to the actual load.
- 1.3 Further assistance is available by contacting a Sulzer representative.

## **2.0 WHAT TO DO IF THERE ARE PROBLEMS**

- 2.1 Activate the emergency stop button immediately for faults that pose a direct danger to persons or property.
- 2.2 Determine the cause of the fault.
- 2.3 If correcting problem requires working in the hazardous area, switch off the pump and secure it against being switched on again.
- 2.4 Inform the site manager immediately about the problem.

## ADDENDUM 4

- 2.5 Depending on the type of problem, have it corrected by authorized specialists, or correct the fault yourself.

## ADDENDUM 4

	Symptoms	Possible Causes of faults	Remedies
1	Insufficient Pressure	A. Speed too Slow	Check if driver is across the line and receiving full voltage
		B. Improper impeller adjustment	Check the accuracy of the impeller adjustment. Follow manufacturers recommended clearances.
		C. Loose Impeller (rarely occurs)	Refit Impeller.
		D. Plugged impeller	Pull the pump. Inspect impeller and bowl pasageways.
		E. Wear rings worn	Inspect and replace.
		F. Entrained air in pump	Clean screen and trach racks. Check return line size and location in sump or tank. Increase suction bell diameter so the pumps required submergence is less than the actual submergence available.
		G. Leaking column joints of bowl castings	Pull pump and inspect.
		H. Wrong direction of rotation	Check - Refer to pump rotation arrow.
		I. Suction valve/line blocked	Inspect and correct.
		J. Foot valve blocked or damaged	Inspect foot valve
2	Insufficient Capacity	A. Speed too Slow	Check if driver is across the line and receiving full voltage
		B. Improper impeller adjustment	Check the accuracy of the impeller adjustment. Follow manufacturers recommended clearances.
		C. Loose Impeller (rarely occurs)	Refit Impeller.
		D. Impeller or bowl partially plugged	Pump pump and inspect for obstruction.
		E. Leaking joints	Pull pump and inspect.
		F. Strainer partially clogged	Backflush. Install finer mesh strainer or larger strainer. Pull pump and remove obstruction.
		G. Suction or discharge valve not fully open	Check valve position and correct as required.
		H. Minimum flow line open, minimum flow valve damaged or bypass orifice worn	Chcek minimum flow line, minumnm flow valve or bypass orifice.
		I. Wrong direction of rotation	Check - Refer to pump rotation arrow.
3	No Liquid Delivered	A. Pump suction broken (water level below bell inlet)	Check for adequate submergence.
		B. Suction valve closed	Open valve.
		C. Impeller plugged	Pump pump and inspect for obstruction.
		D. Strainer clogged	Backflush. Install finer mesh strainer or larger strainer. Pull pump and remove obstruction.
		E. Wrong direction of rotation	Check - Refer to pump rotation arrow.
		F. Shaft broken	Pull pump and replace shaft.
		G. Loose Impeller (rarely occurs)	Refit Impeller.
4	Using too Much Power	A. Speed too high	Check voltage on motor.
		B. Improper impeller adjustment	Check the accuracy of the impeller adjustment. Follow manufacturers recommended clearances.
		C. Improper impeller trim	Pull pump and inspect. Modify existing impeller to provide system requirements.
		D. Pump out of alignment or shaft bent	Check alignment of pump and driver, also foundations.
		E. Lubricating oil tool heavy	Check quantity and quality of lubricants. Refer to manufacturers recommendations.
		F. Pumping sand, silt, or foreign material	Test pumpage for suspended particals viscosity and specific gravity.

## ADDENDUM 4

	Symptoms	Possible Causes of faults	Remedies
5	Vibration	A. Motor imbalance (electrical)	Consult motor and pump manufacturer.
		B. Coupling alignment faults	Check coupling alignment.
		C. Worn shaft coupling	Check coupling condition and replace.
		D. Misalignment of pump castings, discharge head, column or bowls.	Determine cause utilizing vibration frequency analyzer and/or pump disassembly.
		E. Bent shaft	Check, straighten or replace.
		F. Worn pump bearings	Check and replace.
		G. Clogged impeller of foreign material in pump.	Backflush. Pull, check for damage and replace.
		H. Improper impeller adjustment	Check the accuracy of the impeller adjustment. Follow manufacturers recommended clearances.
		I. Vortex problems in sump.	Increase pump submergence. Apply sump modifications such as; install vertical splitter, install suction umbrella, relocate pump in sump or lower the inlet velocity in the sump.
		J. Piping strain, excessive high nozzle forces and moments	Piping should be properly supported to prevent strains from being imposed on the pump.
6	Abnormal Noise	K. Foundation too weak, base not correctly grouted	Inspect foundation bolt tightening and baseplate grouting.
		L. Resonance	System frequency at or near pump speed. Loosen anchor bolts. Change pipe strain.
		A. Motor Noise	Check for bearing failure. Monitor bearing oil temperature and oil level. Consult motor and pump manufacturer.
		B. Broken bearing spiders	Check and replace.
		C. Broken shaft or shaft enclosing tube	Check and replace.
		D. Impeller dragging on bowl case	Re-adjust impeller per manufactureres recommendations.
7	High shaft seal temperature. High leakage of mechanical seal. Short shaft seal life.	E. Cavitation	Check submergence. Check for sufficient NPSH available. Elevate system head conditions and reduce pump capacity, if possible. Change pump impeller to lower NPSH design.
		F. Foreign material in pump	Backflush or pull and inspect.
		A. Seal flush insufficient (flow rate) or missing	Check flow requirements. Enlarge flush line and/or orifices.
		B. Wrong orifice size or worn orifice	Check size, flow requirements.
		C. Solids block seal rings/springs	Disassemble and remove solids, review application.
		D. Vaporisation in the seal ring area	Check circulation flow or cooling requirements.
		E. Seal fluid not suitable (abrasive)	Review application, install filter or separator.
		F. Seal rings, auxiliary gaskets (O-rings) or springs damaged	Disassemble and replace damaged seal parts.
		G. Dry operation of seal. Seal system not correctly filled or vented.	Fill and vent shaft seal housing/system.
		H. Seal face material inadequate	Review application with seal manufacturer.
I. Pump shaft bent	Check shaft runout at seal area.		
J. Faces not flat	Check for installation dimensions.		

## ADDENDUM 4

	Symptoms	Possible Causes of faults	Remedies
8	High Bearing Temperature. Short Bearing Life.	A. Pump not running at operating point	Review operating parameters
		B. Coupling alignment faults	Check coupling alignment
		C. Too much grease or oil in the bearing	Check and correct
		D. Oil level too low or high	Check and correct oil level
		E. Wrong lube oil quality	Verify that recommended lubricant is used. Change lube oil.
		F. Bearings loaded during assembly	Examine assembly and condition of bearing and associated parts
		G. Insufficient bearing cooling (air / water)	Check air intake (environmental temperatures under noise hoods). Check cooling water requirement.
		H. Bearings damaged	Disassemble and replace bearings
		I. Excessive pump thrust	Check hydraulic balance device, balance pipe. Disassemble and inspect pump internal clearances.
		J. Shaft bent	Disassemble pump and check shaft runout.
9	Lube Oil Leakage	A. Oil level too high	Check and correct oil level
		B. Labrynth seal or shaft seal ring improperly installed	Examine assembly (labrynth leakage bore downwards)
		C. Bearing cover gasket or seal damaged	Disassemble and replace gaskets/seals
		D. Vent blocked	Check and clean vent connection
10	Excessive Wear of Pump Internals -Corrosion -Erosion -Loss of Material	A. Pump not running at operating point	Review pump operating parameters with a Sulzer representative, make necessary correction to unit design. Refurbish pump with correct parts, clean system. Assemble filter or separator.
		B. Insufficient suction pressure	
		C. Operating fluid differs from specified value (temperature, specific gravity)	
		D. Materials of construction not compatible with medium delivered	
11	Pump Overheating/Seizure.	A. Operating below minimum flow (pump running dry)	Review hints for minimum flow. In case of seizure, disassemble and repair unit.

### 3.0 BEARING HOUSING VIBRATION LIMITS:

ALL TYPES	Applicable for	(in/sec RMS)			ALL TYPES	Applicable for	(mm/sec RMS)		
		Good Performance	Alarm	Shut Down			Good Performance	Alarm	Shut Down
	All Vertical Pumps	0.28	0.43	0.71		All Vertical Pumps	7	11	18

3.1 Depending on the instrumentation purchased, Addendum 12 and/or the order-specific Process Instrumentation drawing will contain the other instrumentation alarm and shut down points.

### 4.0 Restart after problem is corrected

Perform the following steps for restarting after fault has been corrected:

- 4.1 Reset the Emergency-Off equipment.
- 4.2 Acknowledge the problem on the control.
- 4.3 Ensure that no one is in the hazardous area.
- 4.4 Start the pump per the instructions in the OPERATION Section, 6.3 and 6.4, of this manual.

# ADDENDUM 11 - LONG-TERM STORAGE PROCEDURES

## 1.0 STORAGE SAFETY INSTRUCTIONS



### **WARNING!** **Suspended loads!**

Loads can swivel out and fall during lifting operations. This can cause serious injury or even death.

- Never stand under or in the swivel range of suspended loads.
- Only move loads under supervision.
- Only use approved lifting tools and anchorage means with sufficient load carrying capacity.
- Do not use torn or abraded lifting tools (ropes and belts).
- Do not lay lifting tools such as ropes and belts on sharp edges and corners and do not tie or twist them.
- Set the load down on a sufficiently stable and flat surface after leaving the workplace.



### **WARNING!** **Falling or tipping packages!**

Packages can have an eccentric center of gravity. If anchored incorrectly, the package can tip and fall. Falling or tipping packages can cause a serious injury.

- Note the markings and specifications about the center of gravity on the packages.
- When transporting by crane, position the crane hooks above the center of gravity of the package.
- Carefully raise the package and observe if it tips. If necessary, change the anchorage.



### **WARNING!** **Improper transportation!**

Improper transportation can endanger personnel as well as cause damage to the goods being transported.

- Proceed carefully when unloading transportation items and transporting goods internally, and observe the symbols and instructions on the packaging.
- Only use the anchorage points provided.
- Only remove packaging shortly before assembly.
- If any transportation damage is detected, contact Sulzer Pumps and do not commission the pump.

# ADDENDUM 11



## NOTICE!

### Incorrect disposal of packaging materials

Packaging materials are valuable raw materials and can be further used in many cases, or reasonably processed and recycled. Incorrect disposal of packaging materials poses a hazard to the environment.

- Dispose of packaging materials in an environmentally friendly way.
- Observe locally applicable disposal provisions. If necessary, authorize a specialist operation for the disposal.
- Always follow the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

## 2.0 PURPOSE

- 2.1 This procedure is for pump storage greater than 2 years not to exceed 4 years.
- 2.2 The overall goal is corrosion prevention and protection from moisture.

## 3.0 APPLICABLE PRELIMINARY PROCEDURES AND OTHER NOTES

- 3.1 IOM document RCVG\_HORIZ for horizontal pumps or RCVG\_VERT for vertical pumps, storage section instructions and requirements still apply.
- 3.2 The pump is initially packaged using Sulzer internal Standard Operating Procedure D50.78 or MPI PI08-003.
- 3.3 This addendum takes precedence over API 686 storage procedures.
- 3.4 Auxiliary equipment (Driver, Lubrication System, etc.) is excluded. Refer to their OEM storage procedures.



## CAUTION!

### Storage instructions apply only to the pump!





The following storage instructions apply only to the pump and may not be appropriate to furnished auxiliary equipment.

For replacement parts storage, see REPLACEMENT PARTS section.


- Follow vendor instructions for all other components of the pump system.
- Contact Sulzer when a conflict in storage procedures occurs.

- 3.5 Store in a location that is safe from possible physical damage from equipment traffic.
- 3.6 The packaging features the following symbols. Always observe these symbols when transporting.

# ADDENDUM 11

	This way up	The arrows point to the top of the package. These must always point upward; otherwise the contents can be damaged.
	Centre of gravity	Designates the center of gravity of packages. Observe the center of gravity position when lifting and transporting.
	Protecting from moisture	Protect packages from moisture and keep them dry.
	Anchor here	Only attach lifting accessories (sling chain, lifting strap) at the points marked with this symbol.

## 4.0 APPROVED PROTECTIVE STORAGE MATERIALS – PLEASE REFER TO “RCVG\_VERT”

 **ENVIRONMENT!**  
**Incorrect handling of ecologically hazardous substances!**  
 Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Always wear protective clothing and protective gloves when working with potentially ecologically hazardous substances.

4.1 “Cortec” products are manufactured by the Cortec Corporation. It is recommended to also work with CorTec, or an equivalent company, to determine which of these protective products are best for each of your needs.

## 5.0 INSPECTION AND MAINTENANCE

### 5.1 Initial Requirements

- 5.1.1 All details in the “Storage” section of the IOM document RCVG\_VERT is expected to have been carefully followed.
- 5.1.2 New vertical pumps that have been disassembled into packaging sizes appropriate for shipping at the Sulzer factory or Sulzer shop, or new spare parts that will be stored at customer facility long-term, are recommended to be stored as received in most situations. The pump parts shall be protected from the elements and stored in a clean dry indoor area, away from forklifts, trucks, or any other method of damage to the parts packaging.
- 5.1.3 Shafting shall be supported to prevent any possible deviations from the critical straightness, so the lineshaft can be laid flat (as it was shipped and thereby properly supported) as it is also protected from the elements in that original (as shipped) packaging.

## ADDENDUM 11

5.1.4 O-rings, rubber bearings, and other components of a short shelf-life should be replaced when reassembled. Pumps with a grease-packed tail bearing located in the suction bell shall be inspected and re-packed with grease.

### 5.2 Inspection Interval

5.2.1 Indoor Storage: every 8 weeks.

5.2.2 Outdoor Storage: every 2 weeks, minimum. If conditions warrant, a shorter interval should be used.

### 5.3 Inspection Action

5.3.1 Check the condition and position of tarpaulin. Check for moisture penetration or damage.

5.3.2 Check for ingress of sand, dirt, insects, birds, or vermin.

5.3.3 A record of inspection is to be kept.

5.3.4 If conditions warrant, perform maintenance immediately, without waiting for scheduled maintenance interval.

### 5.4 Maintenance Interval

5.4.1 Indoor Storage Maintenance: Once per year.

5.4.2 Outdoor Storage Maintenance: At least every 6 months.

5.4.3 If conditions warrant, or depending on inspection, a shorter interval must be used. The overall goal of preventing corrosion takes precedence over specific interval timing guidelines.

### 5.5 Maintenance Action

#### 5.5.1 Pump Internal

5.5.1.1 Drain pump of any accumulated condensation.

5.5.1.2 Remove nozzle cover in order to replenish the Emitter (VpCI-10, or -111 or equivalent vapor corrosion inhibitor emitter). The nozzle covers should be equipped with rubber gaskets; ensure an airtight seal. Re-tag the exterior of the nozzle cover indicating replenishment date.

5.5.1.3 An alternative for maintaining pump internals is to completely fill the pump with a non-corrosive and pumpage compatible liquid.

#### 5.5.2 Pump and Bearing Housing External

5.5.2.1 Re-apply corrosion protection coatings. (e.g. VpCI-369 or equivalent, vapor inhibitor coating and rust preventive)

5.5.2.2 If any corrosion has developed, remove with rust remover product, re-coat surfaces with corrosion protection coating, and increase maintenance (rust should not develop).



#### **ENVIRONMENT!**

##### **Incorrect handling of ecologically hazardous substances!**

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- Always wear protective clothing and protective gloves when working with potentially ecologically hazardous substances.

## ADDENDUM 11

5.5.2.3 Unthread air release filter (breather) from bearing housing and replace with a threaded plug. Ensure all connections to the bearing housing and pump are sealed. Wrap the OD of visible portion of bearing isolators (labyrinth seals) with sealing tape. The goal is to seal the bearing housing.

5.5.2.4 Any exposed shaft should also be re-coated with corrosion protection coatings. (e.g. VpCI-369)

### 5.5.3 **Bearing Housing Internal**

5.5.3.1 Drain condensation and any old VpCI oil concentrate from bearing housing. Replenish with fresh VpCI-322 oil per product guidelines. Re-seal the bearing housing.



#### **ENVIRONMENT!**

##### **Incorrect handling of ecologically hazardous substances!**

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- Always wear protective clothing and protective gloves when working with potentially ecologically hazardous substances.

5.5.3.2 If the top half of bearing housing has been removed, for inspection or etc, any exposed shaft and interior should be coated with corrosion protection coating (e.g. VpCI-369). This would be in addition to above paragraph.

### 5.6 **Mechanical Seals**

5.6.1 The mechanical seals may be left installed. The use of any preservative on them is not recommended. Elastomeric seals, O-rings within the mechanical seal are subject to material specific and time-based alteration (aging) which might reduce the efficiency of the seal. Therefore prior to start-up, specific mechanical seal maintenance will need to be performed.

5.6.2 Mechanical seals may be removed from pump. This is a suitable method for long term storage. A stuffing box storage plug to seal pump must then be installed. Mechanical seal re-installation should take place shortly before start-up.

### 5.7 **Spare Rotor**

5.7.1 The spare rotor can be stored horizontally in the original wood box packing. The rotating element must be kept resting on the impellers and not suspended from the shaft journals.

5.7.2 For vertical storage hang from a fixture that picks up the coupling nut threads.

5.7.3 Dry heated Indoor storage is required. Outdoor storage allowed only if the rotor is stored in a sealed container with nitrogen purge.

5.7.4 For rotors in wood crates, inspect at a 30-day interval for moisture or deterioration of wrapping film or protective coating. Correct discrepancies, if necessary, by removing wrapping film, re-apply protective coatings and re-wrap with VpCI film. Coupling fit and bearing areas are particularly critical, as well as non-stainless shafts.

5.7.5 For rotors stored in nitrogen purge sealed containers, inspect at 6-month intervals.

## 6.0 **PRE-COMMISSIONING PROCEDURE**

6.1 The notes below are to be included with pre-commissioning procedures.

6.2 For pumps that have been in long-term storage, it is highly recommended that 30 days prior to commissioning, a Sulzer field service representative be called to site to help ensure an operable pump.

## ADDENDUM 11



### **NOTICE!**

#### **Commissioning after long term storage**

**A Sulzer field service representative must be called to site to help ensure an operable pump. This is mandatory for validation of extended warranty!**

- 6.3 Inspection records should be reviewed.
- 6.4 Bearings should be inspected and replaced if needed.
- 6.5 Mechanical seals should be inspected, rebuilt, replaced or (re-)installed, as per seal manufacturer guidelines.
- 6.6 Remove preservative.



### **ENVIRONMENT!**


#### **Incorrect handling of ecologically hazardous substances!**


Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Always wear protective clothing and protective gloves when working with potentially ecologically hazardous substances.


# ADDENDUM 13 - BEARING ISOLATOR INSTALLATION

## 1.0 SAFETY INSTRUCTIONS FOR ISOLATOR INSTALLATION


 **WARNING!**  
**Explosive atmosphere!**  
 Prior to and during maintenance, ensure that the atmosphere is not potentially explosive.  
 Stop all work immediately if any danger arises.


 **WARNING!**  
**Unauthorized or uncontrolled switching on again!**  
 If the pump is switched back on by an unauthorized person or in an uncontrolled manner it may result in serious injury or even death.

- Before switching back on, make sure that all safety devices are installed and in full working order and that there is no danger to persons.
- Always comply with the process to secure against switching on again.

 **WARNING!**  
**Danger of being pulled in by moving components!**  
 Being pulled in by moving components can cause serious injury.

- Do not handle moving components during operation.
- Do not grasp moving components during operation.
- Never open covers during operation.
- Observe the stopping time: ensure that the components are no longer moving before opening the covers.
- Wear closely fitting protective clothing with a low tear resistance in the hazardous area.

 **CAUTION!**  
**Sharp or rough edges!**  
 Wear appropriate protective equipment to protect hands and fingers from serious injury.

 **WARNING!**  
**Part handling!**  
 Care in handling of components must be exercised to prevent damage or distortion of those components.

- |                       |  |
|-----------------------|--|
| Personnel:            | <ul style="list-style-type: none"> <li>• Pump specialist</li> </ul>  |
| Protective equipment: | <ul style="list-style-type: none"> <li>• Protective clothing</li> <li>• Protective gloves</li> <li>• Industrial safety helmet</li> <li>• Safety shoes</li> </ul> |

This document contains bearing isolator installation instructions for various bearing isolator manufacturers. Refer to the bearing isolator instructions that correspond with the appropriate manufacturer using the table below.

Manufacturer	Page(s)
INPRO/SEAL, LCC	2

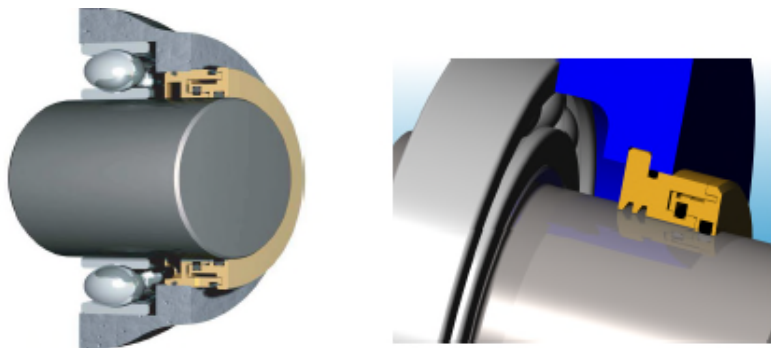
# ADDENDUM 13

ISOMAG	3 - 5
JM Clipper ProTech™	6 - 7

## 2.0 INPRO/SEAL, LLC BEARING ISOLATOR INSTALLATION



### Design Code 559, 561, and 660 Ball/Ball, Sleeve/Ball, Sleeve/Pivot Shoe Bearing Arrangement VBXX-D Seal Design with .025 inch (0.64mm) Axial Float



- 2.1 Remove rotating assembly from housing as outlined in the Case/Element Assembly module. Perform normal service as required.



#### CAUTION!

**Do not attempt to separate the rotor component from the stator component!  
The isolator is a unitized design and is intended to be installed as a single unit!**

- 2.2 Remove the Inpro/Seal Isolator from the packaging.
- 2.3 Inspect the pump shaft for sharp shoulders or other obstructions that may damage shaft O-rings.
- 2.4 With the supplied lubricant (or equal), lubricate the isolator O-rings and shaft.



#### ENVIRONMENT!

##### **Incorrect handling of ecologically hazardous substances!**

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective gloves when handling lubricating materials.

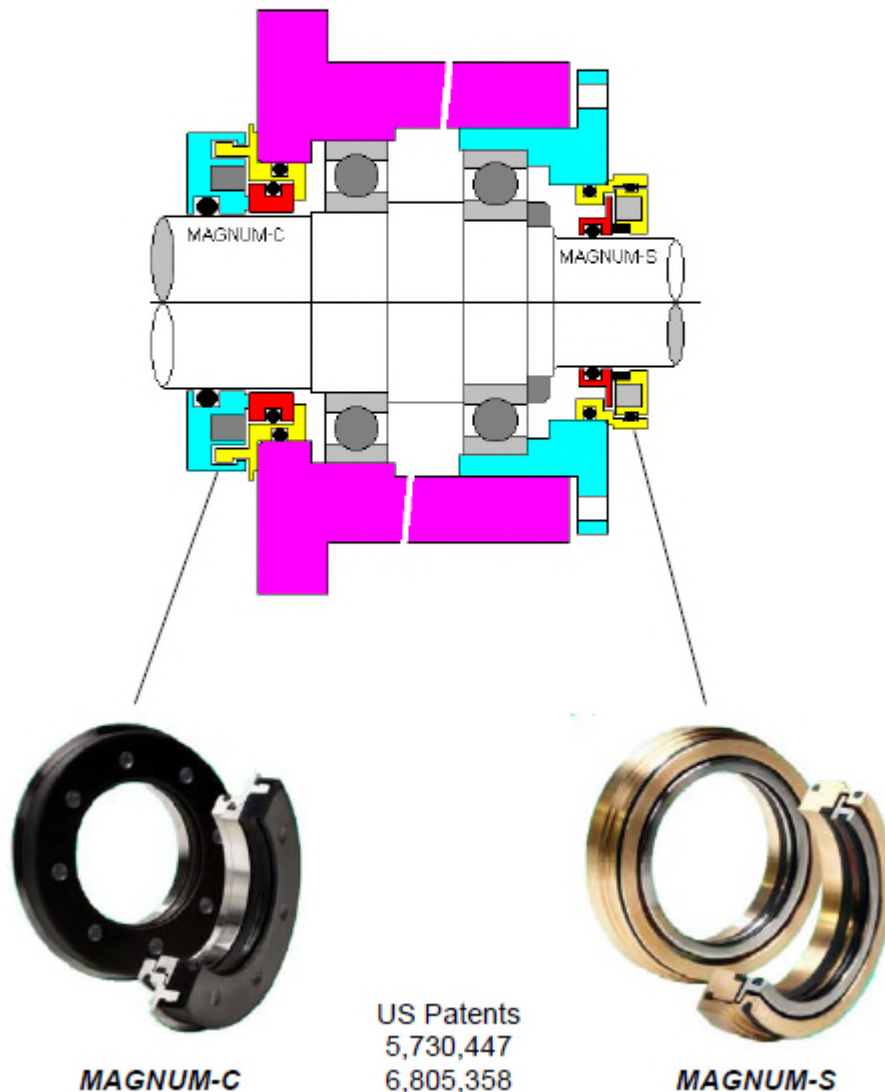
- 2.5 Use a hand arbor press to install press fit isolator in bearing cap. This step is not required for split case turbine fit design. Check for proper orientation. Be sure the isolator stationary face is facing the bearing and the oil return port is located in the 6 o'clock position. The expulsion port will align with the oil return drain.
- 2.6 Slide the bearing cover with isolator onto the shaft and into position. Always push on the outboard face of the isolator rotor.
- 2.7 Split case designs include optional RTV sealant.
- 2.8 Split case assembly – lower the complete rotating assembly, complete with Bearing Isolators.
- 2.9 Assemble and secure the upper half of the housing as outlined in the Case/Element Assembly module. Installation is complete.

## ADDENDUM 13

### 3.0 ISOMAG BEARING ISOLATOR INSTALLATION INSTRUCTIONS

# ISOMAG

## MAGNUM SEAL INSTALLATION GUIDE



### 3.1 CHECK EQUIPMENT CONDITIONS

- 3.1.1 Shaft diameter +/- .002" (0.05mm)
- 3.1.2 Shaft runout (.002" per inch of diameter. Maximum .008" @ 1800rpm)
- 3.1.3 Shaft surface condition (smooth, defect free, 32 RMS)

## ADDENDUM 13

- 3.1.4 Housing bore diameter (+.002", -.000") +0.05mm, -0.00mm
- 3.1.5 Housing bore roundness (.002") 0.05mm
- 3.1.6 Housing bore concentric with shaft ([.020"] 0.50mm minus rubout)
- 3.1.7 Housing square to shaft [(.001") 0.025mm per inch (25.4mm) of diameter. Maximum .010" (0.25mm) @ 1800 rpm)
- 3.1.8 Housing bore surface condition (smooth and defect free)

### 3.2 PREPARE EQUIPMENT

- 3.2.1 Clean shaft and housing bore.



#### ENVIRONMENT!

##### **Incorrect handling of ecologically hazardous substances!**

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective gloves when handling lubricating materials.

- 3.2.2 Break all sharp edges, key ways, shaft steps, and bore edges to prevent cutting O-rings during assembly.
- 3.2.3 Adding a 30° x .030/.045" (0.76/1.14mm) beveled entry to the housing bore will prevent cutting the outside O-ring during installation.

### 3.3 ROTOR O-RING LUBRICATION

Apply a thin coating of clean oil or assembly lubricant directly to both O-rings. The lubricant being used in the host equipment is always compatible.



#### CAUTION!

##### **DO NOT USE ANTI-SEIZE or SILICONE SPRAY!**

### 3.4 ASSEMBLY

- 3.4.1 Press seal into housing (this may require a fair amount of force). A hydraulic or bench press may be helpful. Seal should fit snug in bore. If the fit is slightly loose, apply a small amount of RTV or sealant to the outside of the seal then press into housing and allow sealant to dry.



#### CAUTION!

##### **DO NOT HIT THE SEAL!**

- 3.4.2 **MAGNUM – C**, it is best to push against the metal lip that extends around the outside of the seal using two metal blocks and a cross bar (Figure #1). If it is necessary to push against the composite rotor, place a block or spacer (Figure #2) over the back of the seal rotor to push against. The block should be large enough to spread the pushing force over the back of the seal. This will prevent damage to the seal.
- 3.4.3 **MAGNUM Models D, G & S**, place a block or spacer over the back of the seal rotor to push against (Figure #3). The block should be large enough to spread the pushing force over the back of the seal. This will prevent damage to the seal.



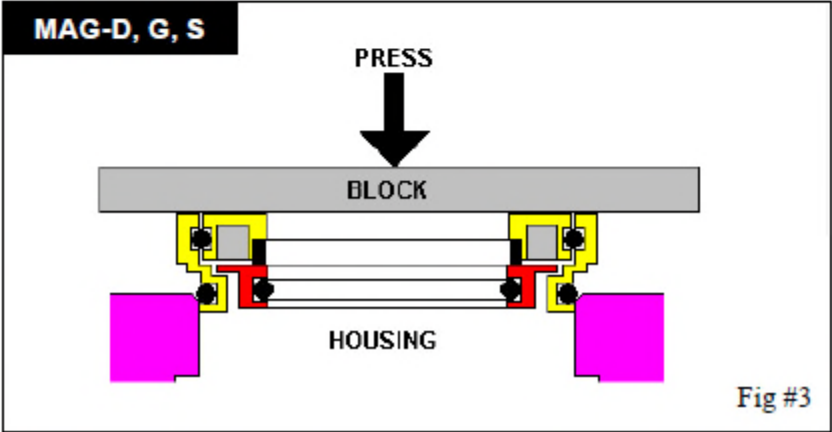
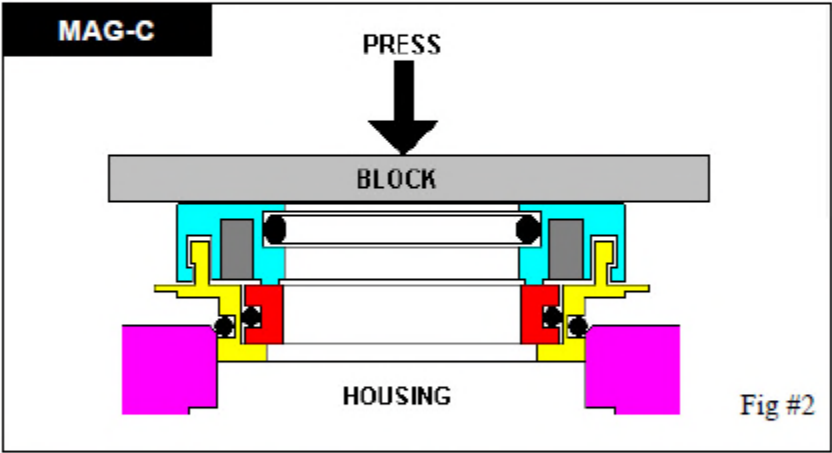
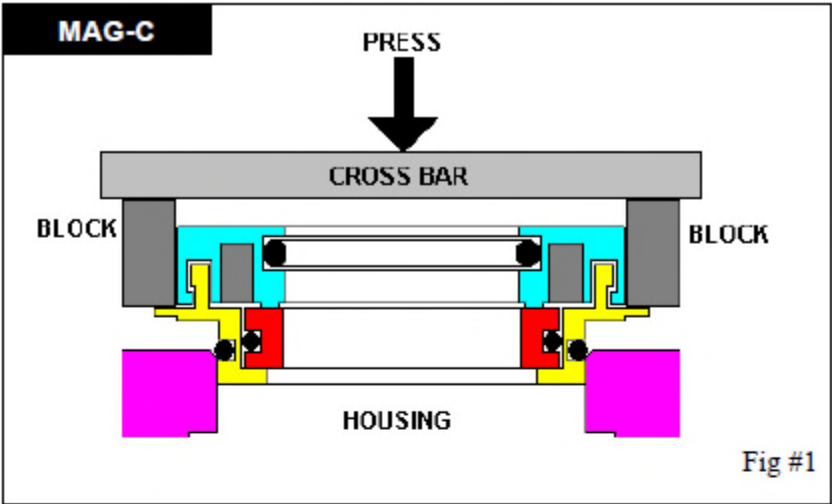
#### CAUTION!

##### **Do not attempt to disassemble seal!**

**Magnum seals are one piece cartridge assemblies.**

##### **DO NOT HIT THE SEAL!**

# ADDENDUM 13



# ADDENDUM 13

## 4.0 JM CLIPPER PROTECH BEARING ISOLATOR INSTALLATION



### 4.1 LABYRINTH SEAL INSTALLATION INSTRUCTIONS (STANDARD DESIGN)

The JM Clipper ProTech™ seal is unitized; any attempt to disassemble the seal will damage it. After making any adjustments to the equipment, confirm that the seal is still properly installed.



**CAUTION!**

**Do not attempt to separate the rotor component from the stator component!**  
The isolator is a unitized design and is intended to be installed as a single unit!

### 4.2 PRIOR TO INSTALLATION



**WARNING!**

**Unauthorized or uncontrolled switching on again!**

**Lock power breakers to the off position prior to performing work on the driver!**

If the driver is switched back on by an unauthorized person or in an uncontrolled manner it may result in serious injury or even death.

- Before switching back on, make sure that all safety devices are installed and in full working order and that there is no danger to persons.
- Always comply with the process to secure against switching on again.

4.2.1 Disconnect all system power, and follow all standard safety procedures.

4.2.2 Remove all sharp edges from the following:

- a. Lead in chamfers
- b. Key ways
- c. Splines
- d. Snap ring grooves

4.2.3 Clean all foreign debris from bore and shaft areas.

### 4.3 INSTALLATION

4.3.1 Lubricate bore and shaft O-ring's with system compatible grease.



**ENVIRONMENT!**

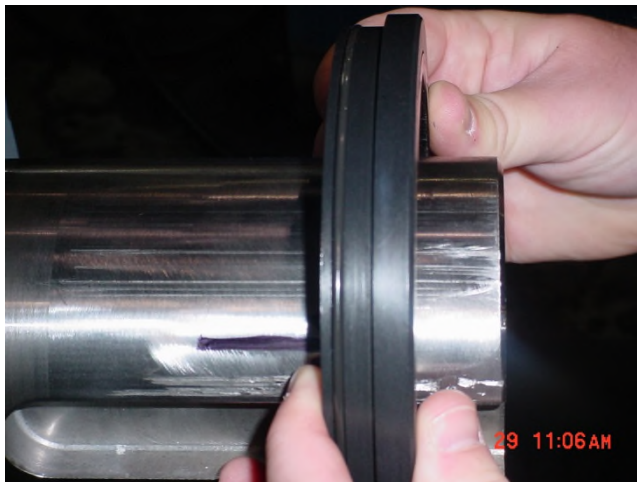
**Incorrect handling of ecologically hazardous substances!**

Always follow local regulations or the information provided by the manufacturer's Safety Data Sheets (SDS) when handling and disposing of ecologically hazardous substances.

- Wear appropriate protective gloves when handling lubricating materials.

## ADDENDUM 13

**4.3.2** Position the seal over the shaft by hand. Seal position is correct if the stator O-ring is towards the seal housing.



**4.3.3** Slide seal down the shaft stopping just before the seal housing of the equipment. Use hand pressure only.

**4.3.4** Rotate the seal so that the drain port is centered at the 6 O'clock position.

**4.3.5** Press seal into bore using hand pressure only. If necessary, gently tap seal into bore using a soft-faced tool.



**CAUTION!**

**DO NOT USE A METALLIC HAMMER OR PUNCH as this may damage the seal!  
DO NOT STRIKE STAINLESS STEEL SEAL ROTOR as this may damage the seal!**