Operation & Maintenance Manual

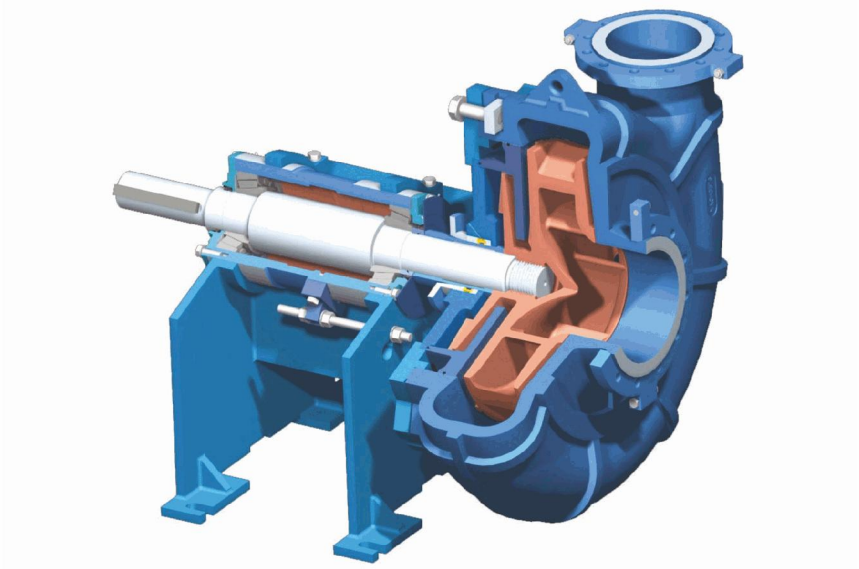
The Orion Series of Horizontal Slurry Pumps
MM200 EHC-S C5

Serial No

_____

Supplier
Metso Minerals Industries, Inc.

Customer Name / Reference no.
_____ / PO# _____



STOP!

DO NOT use this pump before first reading and understanding the special warnings on the next page.

Original language
2015-04-27

Special Warnings

This section provides information that is vital to safe use, long term reliability and performance of this product. Compliance with all the stated requirements is essential to the safety of the end user and the validity of any warranty claims. In addition to these special warnings the customer is advised to read, understand and apply all relevant precautions Metso Minerals has recommended in this manual for installation, operation and maintenance of the product.

	**Pumps subjected to excessive external vibration:** Full standard warranty shall not apply to pumps subjected to excessive resonant vibration caused by cross-talk, or other external sources. Metso shall not accept responsibility for bearing problems or damage resulting from such unforeseeable operating environments.
	**Pumps driven by internal combustion engines:** Impellers on pumps driven by internal combustion engines must be secured to the shaft using a special procedure detailed in section 9.5.2 (ii). Standard bare-shaft pumps supplied for electrical drive systems are not suitable for use with internal combustion engines. The wet-end must be disassembled and the impeller reinstalled in accordance with the procedure provided.
	**Health and safety:** Read and comply with health and safety instructions in section 3.

8. OPERATING INSTRUCTIONS

9. CARE AND MAINTENANCE

10. SPARE PARTS

11. APPENDICES

1 GENERAL

1.1 About this manual

This manual is a part of the equipment to which it relates. It is written for the use of installers, commissioning engineers, operators and maintenance personnel. It should be kept for the life of the equipment and, in case of re-sale, passed on to any subsequent purchaser.

Information contained in this manual is specific to the equipment and is accurate at the date of publication. As improvements are continually being made, **Metso Minerals** reserve the right to make alterations to the equipment design and specification without giving prior notice. Any amendments issued by **Metso Minerals** should be promptly inserted into this manual.

Read this manual before installing, commissioning, operating or maintaining the equipment to which it relates. General health and safety instructions are grouped together in section 3, Health and Safety, and at the beginning of each section, where they are applicable. Definitions for the health and safety symbol and signal words used are also provided in section 3. Specific health and safety instructions are embedded within the text where they are immediately applicable.

Ensure that all the personnel understand the health and safety instructions and, if required, are properly trained before becoming involved in any way with the equipment. Otherwise they are not qualified to do so.

The instructions provided in this manual are complementary to any relevant local and national health and safety regulations.

1.2 Transport and storage

1.2.1 Delivery

A pump is either dispatched as an individual unit (bare shaft pump) or mounted complete with drive unit on a bedplate (pump-set). In either case, any exposed machined parts are coated with a suitable rust inhibitor.

Each pump is supplied complete with inlet and outlet flanges and gaskets, drive key, and with the bearing cylinder charged with grease.
The packing or boxing will always be more than adequate for the method of shipment and subsequent storage.

On receipt of the pump, check that the items listed on the consignment list have been supplied and have not been damaged in transit. Ensure that the inlet and outlet apertures are clear and that the impeller runs freely when the shaft is turned by hand.

If the pump has been disassembled for shipment, a consignment list will contain complete information on the identification of parts. Where parts are boxed, each box is numbered and the corresponding number is noted on the consignment list.

If damage has occurred or any items are missing, immediately file a report with the carrier making the delivery. Also, submit a written report to **Metso Minerals** detailing the damage and/or missing items, as soon as possible.

1.2.2 Handling and lifting

⚠ WARNING

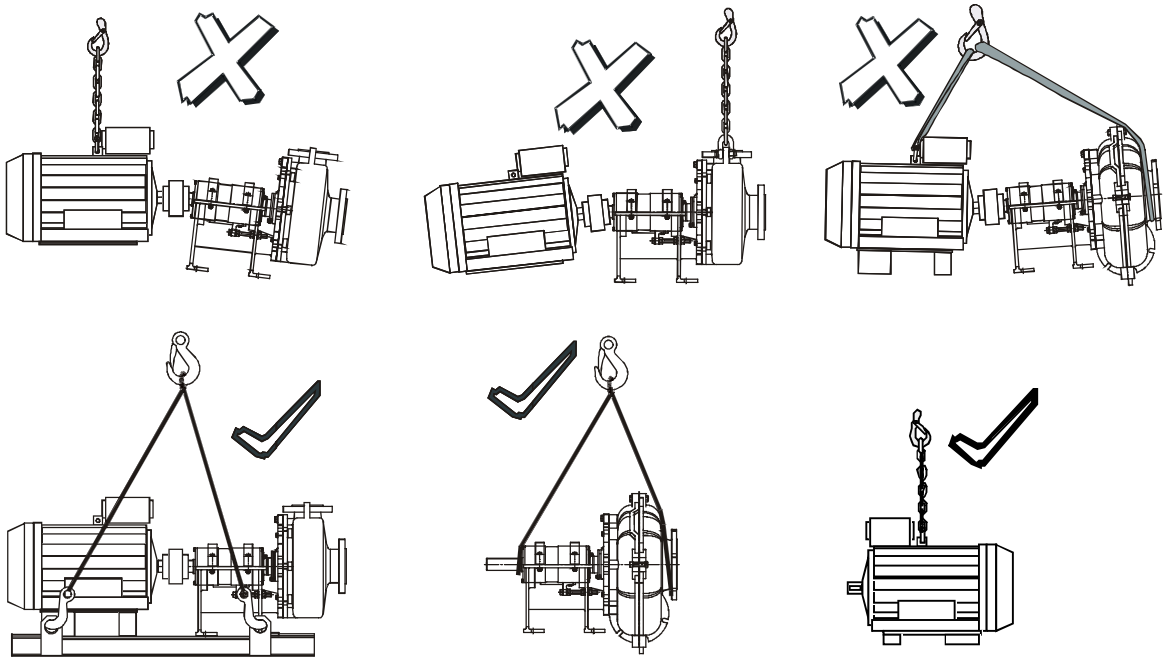
Ensure that all slings, shackles, etc., are of adequate load carrying capacity for the unit to be lifted. Check that all lifting equipment certificates are current.

Whether at the depot or on site, **ALWAYS** follow normal handling and lifting procedures and instructions contained or referred to in this manual.

Handling of centrifugal pumps requires great care to avoid personal injury and property damage. All slinging, lifting or conveying **MUST** be carried out by appropriately skilled personnel.

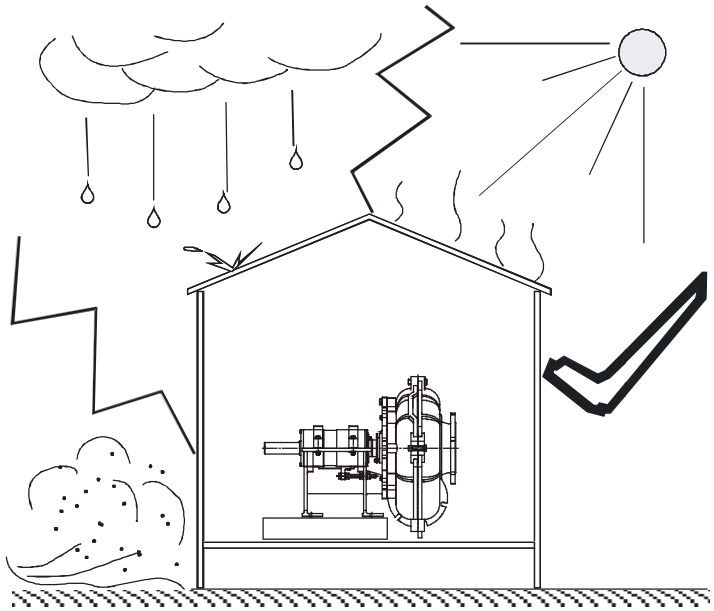
Always lift slowly and smoothly, maintaining the pump in a level attitude.

For your convenience and safety, approximate weight of the pump, or pump complete with drive unit and baseplate, is in the Appendices, Section 11.

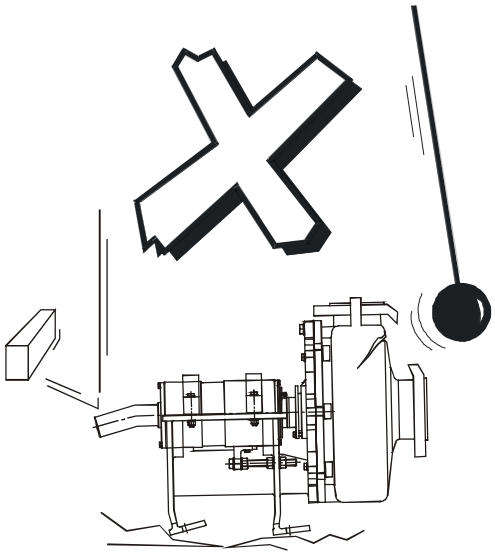


1.2.3 General storage instructions

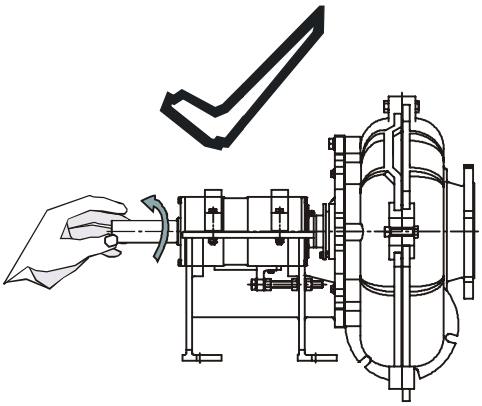
- Re-apply rust inhibitor to all moving parts, at least, every two months.



Protect pump against dust and weather by storage indoors or under weatherproof cover



Protect pump against impact



Turn shaft at least every month

1.2.4 Long-term field storage

Minimum requirement for storage and maintenance of centrifugal type pumps on site before their installation and start-up.

1. Medium term storage

Indoor storage of equipment is recommended in order to prevent the harmful effects of exposed conditions, particularly in dust laden atmospheres.

The standard anti-rust protection provided prior to dispatch remains adequate for periods not exceeding two months.

Whenever indoor storage is not possible, it is necessary to follow the guidelines given below:

a) Locate the pump set with its bedplate on a concrete floor and supported on wooden joists of approximately 100 mm x 100 mm (4" × 4") in section.

b) Cover the pump set, whether located indoors or outdoors, with a strong, waterproof cover extending down to the baseplate. The cover must be securely fixed to withstand ambient weather conditions.

c) Prior to securing the cover, ensure that:-

i) all openings, including inlet and outlet apertures, are properly sealed, and;

ii) the bearing cylinder and drive are properly protected against dust.

2. Prolonged storage -up to 2 years

The following steps are essential in all cases where prolonged storage is foreseen:

a) The pumps are to be adequately warehoused in a closed dry and, if possible, a temperature controlled building.

b) Every six months, the stuffing box/shaft seal sleeve area should be inspected, cleaned and re-coated with a suitable anti-rust compound, if required.

c) If disassembly of the pump is not practical then proceed as follows:-

i) Thoroughly dry the pump case with hot air at 35°C to 65°C (95 °F to 149 °F).

ii) Seal all pump openings and attach sachets of hygroscopic salts (silica gel).

iii) While drying with hot air, ensure that no other parts become overheated as this may be detrimental.

d) The pump rotor should be turned over several times by hand at intervals not exceeding one month.

e) The bearing grease should be checked at least once every twelve months.

f) The bearing cylinder must be disassembled, cleaned and regreased prior to reassembly at least once every 24 months.

During prolonged storage, it may prove difficult to rotate the pump rotor manually for normal maintenance. In such cases proceed as follows:-

a) Loosen the bearing end covers which limit the axial displacement of the bearings.

b) Move the pump rotor along its axis, thus freeing the assembly and allowing manual rotation.

3. Storage in excess of two years

For prolonged storage in excess of two years in adverse ambient conditions, special protection may be necessary. Any moisture absorbing devices used must be absolutely effective and regularly maintained. Whenever possible for storage periods in excess of two years, it is recommended that all pump components are disassembled, washed, dried, protected and reassembled afterwards. This work may be done by **Metso Minerals** and charged to the purchaser under normal rates in force at the time the service is carried out.

1.2.5 Storage of spares

In general, unless otherwise instructed, keep all spare parts in a cool, dry environment and protect rubberised/synthetic components from sunlight and high voltage electrical equipment.

Rubber is affected by ageing and its rate of deterioration is dependent on the type of rubber and the storage conditions. Rubber perishes most rapidly when exposed to heat, ultra violet light and oxidants, the more commonly overlooked sources of which are sunlight and electrical machinery. Rubber can become permanently deformed if compressed out of shape during storage. Mineral oils, solvents, dust, contact with metals and moisture can also damage rubbers depending on type.

To ensure rubber products maintain their original properties, storage conditions must be controlled. Where practicable, ensure rubber products are:

1. kept sealed in their original packing which should be opaque;
2. kept away from direct sunlight;
3. kept away from electrical machinery -e.g. motors and generators;
4. kept in a cool, dry environment between 15° C to 25° C (59 °F to 77 °F);
5. stored away from exhaust fumes;
6. stored separately from chemicals and fuels;
7. stored loosely packed;
8. rotated on a first in - first out basis.

Storage life for different types of rubber stored under recommended conditions is as indicated in Table 1.2.5-1.

NOTICE At 15°C (59 °F) the storage life will be about double and at 35 °C (95 °F) about half of that stated in the table.

Type of rubber	**Product ref.**	**Storage life @ 25°C (77 °F) (years)**
Natural	NR	5
Nitrile	NBR	7
Chlorobutyl	CIIR	7
Butyl	IIR	7
Ethylene-propylene	EPDM	10
Chlorosulphonated polyethylene (Hypalon)	CSM	10

Table 1.2.5-1 Types of rubber and their expected storage life.

1.3 Pump specification

Headline	Description	Qty
	Reference:	
Complete pump:	PDWE51414	1
Pump type:	MM200 EHC-S C5	
Serial no:		
Frame Size:	400	
Wear parts, quality:	High chrome	
Special design:	Motor base and guard – supplied and installed by others.	
Painting:	MP15	
Capacity USgpm:		
Total head ft lc:		
Pump speed rpm:		
Specific gravity kg/l:		
Motor:		
Special req.:		
Motor supplied by:	Customer	
Drive supplied by:	Customer	

	Part no.	**Description**
Motor sheave:		
Motor bushing:		
Pump sheave:		
Pump bushing:		
V-belts:		

1.4 Customer service

Thank you for purchasing a Metso Slurry pump. Please register your pump online at:

www.metso.com/pumpregistration

To register your pump you will require:

- pump model (pump type)
- serial number

This information is provided in section 1.3, Pump Specification.

For any inquiry regarding the servicing and repair of Metso Minerals Slurry pumps please contact the local Metso Minerals Branch. For information on the Metso Minerals Branch closest to you, contact one of the Metso Minerals Global Sites listed below:

Metso Minerals Industries, Inc.
1030 Metso Way
Columbia, SC 29229
USA

Tel: (+1)800643-4321
Email: metsopumpparts@metso.com

Metso Sweden AB
Norrängsgatan 2
Box 302
S-73325 SALA
Sweden

Tel: (+46) 224 374 00
Fax: (+46) 224 169 69

Please provide the following information:

1. model and size of equipment;
2. serial number;
3. approximate date of purchase;
4. details of enquiry, apparent fault etc..

2 DESCRIPTION

2.1 Product and warning signs

2.1.1 Product signs

All product signs attached to the pump are shown below.

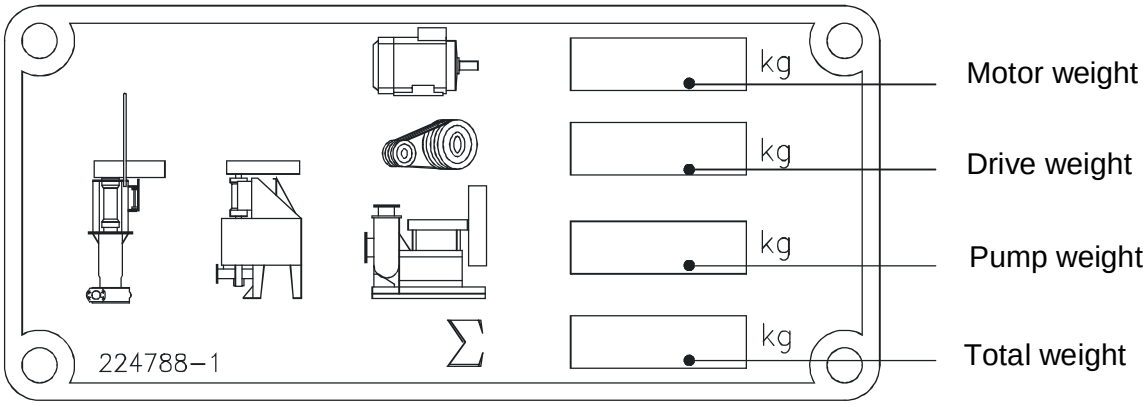


Figure 2.1.1-1 Weight plate

The weight sign is mounted next to the machine sign. When the pump is supplied without motor and drive, only the weight of the pump is stamped on the sign, in which case the total weight is stamped on the sign by the mechanic who fits the motor and drive on the pump.

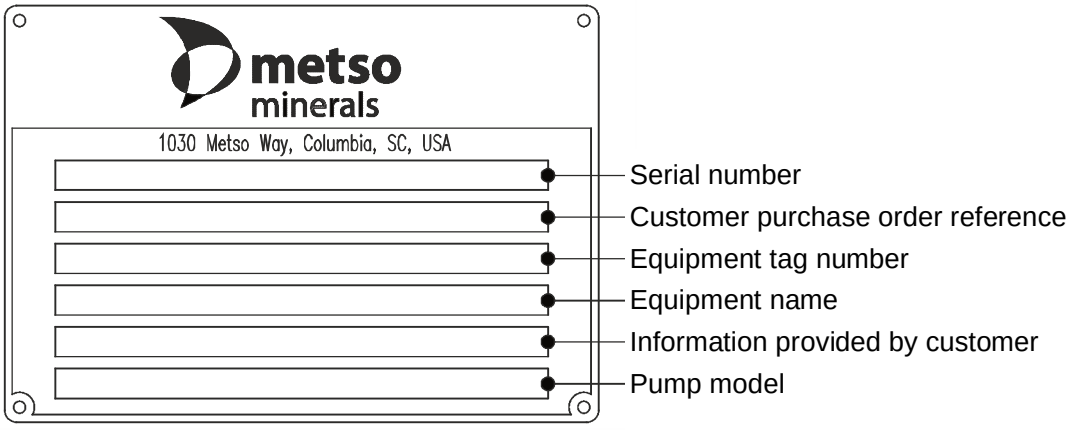
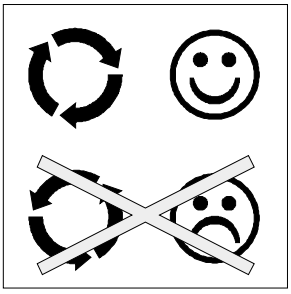


Figure 2.1.1-2 Name plate

A name plate containing information as above is affixed to the pump.

2.1.2 Warning and caution signs



This sign, attached to the drive cover, indicates the direction of rotation of the pump when viewed from the drive end.

THERE IS RISK OF SERIOUS DAMAGE TO THE PUMP IF IT IS ALLOWED TO ROTATE IN THE WRONG DIRECTION.

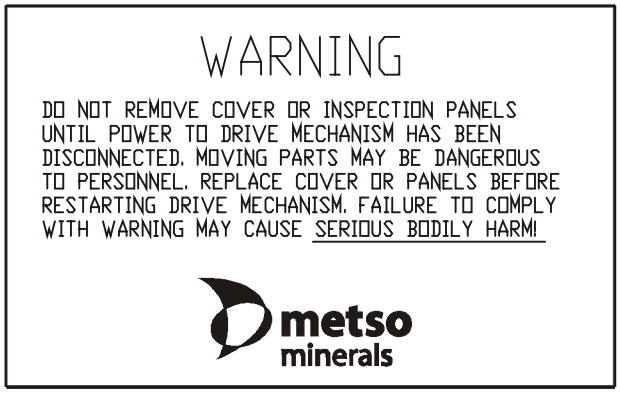
This sign is a hazard warning and is usually accompanied by text indicating the nature of the hazard.

THERE IS RISK OF SERIOUS INJURY IF THESE WARNING INSTRUCTIONS ARE NOT OBSERVED.

The guard should always be fitted when the pump is in operation.

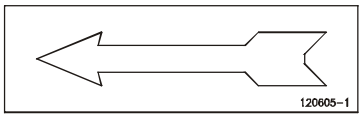
If the guard is to be removed, check that the motor is disconnected from the mains or that the main switch is turned off and locked so that the motor cannot be started inadvertently.

The guard must always be refitted before the pump is started.

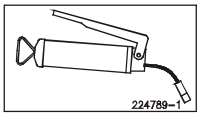


The sign is mounted on the V-belt guard.

This sign is attached to a direct-drive coupling guard.



Direction of rotation of the pump is indicated by this sign attached to the front of the case.



This sign, attached to the frame, indicates that the pump requires periodic greasing.

2.2 Applications

The Metso Minerals Slurry Pump has been designed for a wide variety of abrasive pumping duties. While the pumps may be used in many different industries, they are all designed for constant use in the most arduous conditions. These high-efficiency pumps are of a simple design, providing ease of maintenance and facilitating replacement of wearing parts.

2.3 Design

2.3.1 General

Slurry Pumps are made up of four basic modules, the frame (A), the bearing cylinder (B), the shaft seal (C) and the wet-end (D) assemblies – see Figure 2.3.1-1.

A comprehensive range of modules are available, to configure pumps to suit a wide range of applications.

Pumps are supplied bareshaft or as fixed-base pumpsets with various choices of motor mounting position. Manual or hydraulic slide-bases are optional.

Maximum efficiency is maintained by setting impeller running clearance(s). The adjustment is easily carried out during maintenance and shut-down periods.

Standard bearing cylinders are grease lubricated, but oil lubricated bearings are an option.

Pump designation is made up of letters which identify the range and numbers which indicate the inlet diameter in millimetres –e.g. HM150.

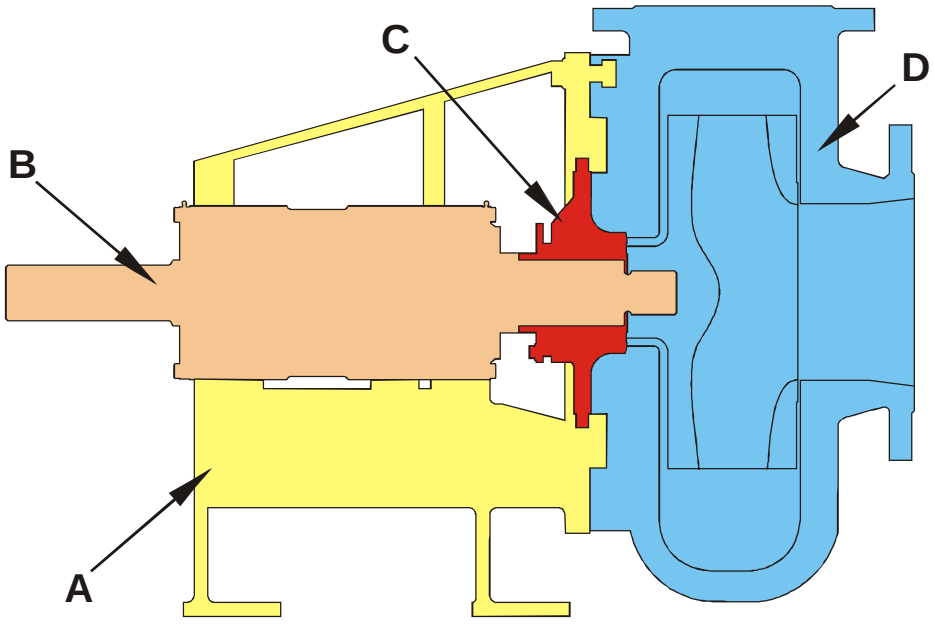


Figure 2.3.1-1 Typical outline design of Metso Minerals Slurry Pumps showing the basic pump modules: Frame (A), Bearing cylinder(B), Shaft seal(C), Wet-end (D)

2.3.2 Noise level

In certain installations and outside the optimum operating conditions, the noise level of 70 dB(A) may be exceeded. The motor generates most of the noise and, in general, the noise level for properly designed installations will be about 2dB(A) above that of the motor.

2.3.3 Vibration

The international standard ISO 10816-1 is valid for all slurry pumps.

When the pump is new, the vibration level at any bearing should not exceed 4.5 mm/s (0.17 in/sec), if the pump is fixed to foundation. If the pump is installed on slide base, the vibration should not exceed 7.1 mm/s (0.27 in/sec).

Vibration levels above 4.5 mm/s (0.17 in/sec) should always receive attention.

NOTICE Should vibration levels exceed 11 mm/s (0.43 in/sec), stop the pump immediately.

Common reasons for high vibrations are:

- ⇒ inadequately tightened fasteners;
- ⇒ slack V-belt;
- ⇒ misalignment of the drive;
- ⇒ the pump impeller is blocked by debris.

2.4 Materials and maximum working pressures

Metso Minerals Slurry Pumps are constructed from materials selected to give excellent wear characteristics over the full range of pumping duties. This section lists the materials of construction and working pressures for STANDARD duty applications. Other materials are also used for specialist applications or as specified by the customer – see section 1.3.

MATERIALS OF CONSTRUCTION			
Item	**Material Type**	**Material Code**	**Material Standard**
Case	White Cast Iron	JN3049	EN 12513
Impeller	White Cast Iron	JN3049	EN 12513
Back Liner	White Cast Iron	JN3049	EN 12513
Bearing Frame	Cast Iron	JS1030	EN 1563
Expeller	White Cast Iron	JN3049	EN 12513
Expeller Ring	White Cast Iron	JN3049	EN 12513
Stuffing Box	Cast Iron	JS1030	EN 1563
Shaft Sleeve	White Cast Iron	JN3049	EN 12513
Shaft Sleeve (option)	Stainless Steel	1.4401	EN 10088
Shaft Sleeve (option)	Stainless Steel	1.4021	EN 10088
Shaft Sleeve (option)	Stainless Steel	1.4462	EN 10088
Shaft	Steel	1.1191	EN 10083
Seals	Nitrile Rubber	NBR	-

PUMP SIZE	**WORKING PRESSURES**		
	bar	kPa	psi
MM100	16.0	1600	232
MM150	16.0	1600	232
MM200	16.0	1600	232
MM250	16.0	1600	232
MM300	20.0	2000	290
MM350	20.0	2000	290
MM400	16.0	1600	232

2.5 Surface treatment

2.5.1 Standard finish

The external surfaces of the pump are protected by the anti-corrosive system specified in Table 2.5.1-1, except exposed machined surfaces which are coated with an air drying rust inhibitor. Drive motors are supplied in the original manufacturer's standard finish. Stainless steel, plastic or elastomeric parts are not painted.

Table 2.5.1-1 Paint specification

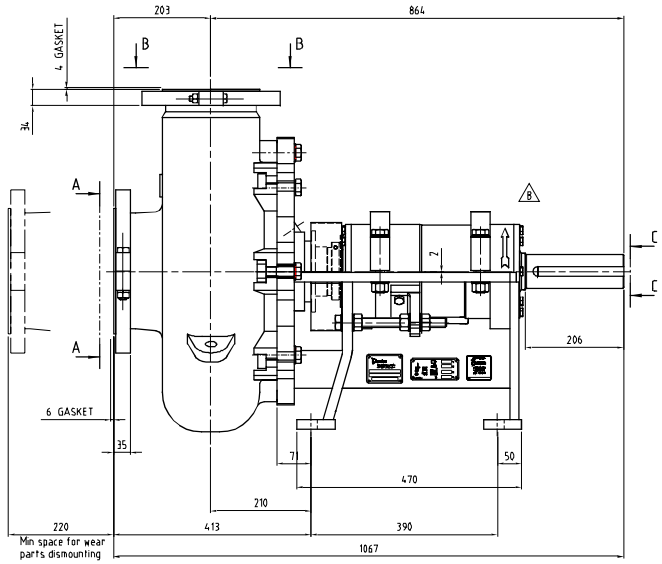
COATING	TYPE	COLOUR	Finish 70	DFT (µm) [mil]
Finish (all except guards)	Two-pack gloss oxiranester thick coat paint	Blue (RAL 5009)	Gloss	120 [5]
Finish (guards only)	Epoxy powder	Yellow (RAL 1032)	Gloss	100 [4]

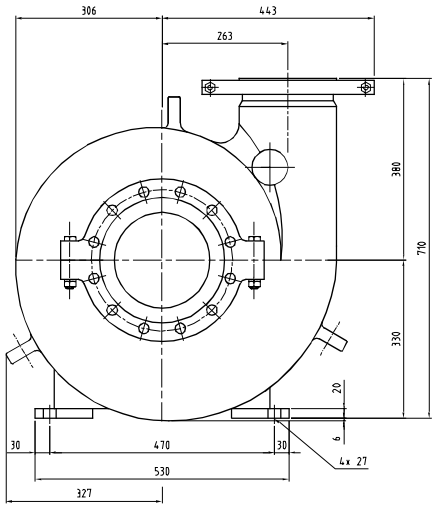
2.5.2 Paint repairs

To repair damage to a painted surface;

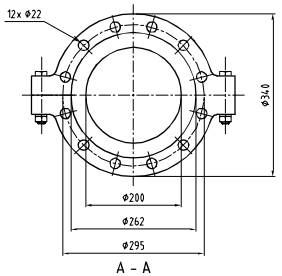
1. remove any trace of oil and dirt using solvent wash;
2. remove all loose paint by chipping or scraping back until only sound paintwork remains and clean the exposed surface by wire brushing or other mechanical means to grade St2 of Swedish Standard SS 055900 (ISO 8501-1:1988);
3. sand down and feather a 25mm (I inch) band of the sound bordering paintwork;
4. vacuum the surface to remove all dust and debris;
5. apply the paint system specified in Table 2.5.1-1.

Date	Sign	Rev	Changed from
04-08-12	AKM	B	ECN04-108



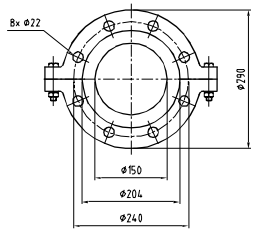


Suitable counter flange
DN 200 PN 16
Optional flange on request

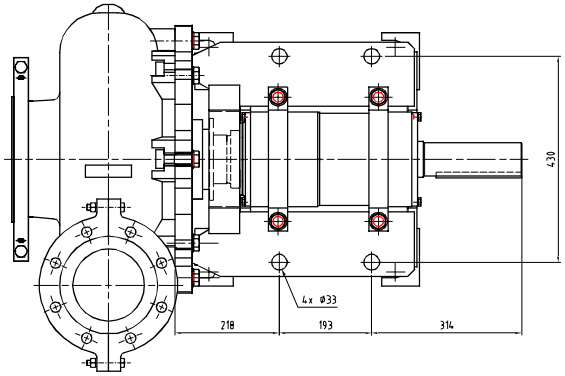


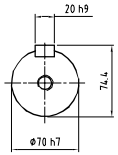
A - A

Suitable counter flange
DN 150 PN 16
Optional flange on request



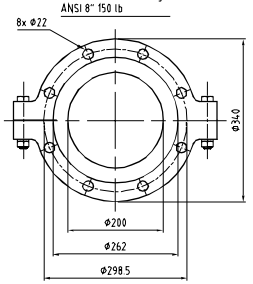
B - B



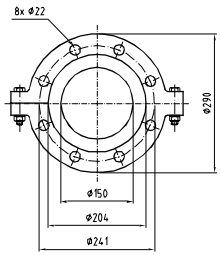


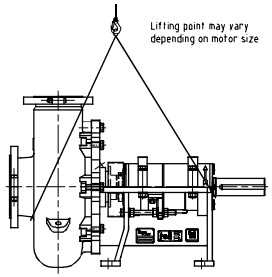
C - C Scale 1:2.5

OPTIONAL inlet flange
Suitable counter flange
ANSI 8" 150 lb

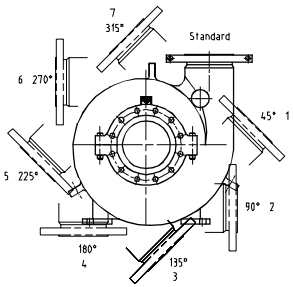


OPTIONAL outlet flange
Suitable counter flange
ANSI 6" 150 lb

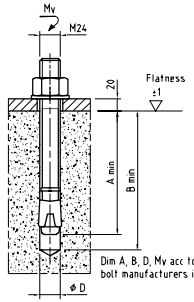




Lifting instruction



Outlet position



Dim A, B, D, My acc to bolt manufacturers instruction

Anchor bolts, proposal design

If water flushed stuffing box, connection is G1/2"

Mass bare shaft pump 525 kg

Measurements subject to change without notice

Description: PUMP MM200-S GENERAL ARRANGEMENT SINGLE ADJUSTMENT FRAME 400	Drawn: AKM 03-03-12 Checked: MHÖ 03-03-12 Approved: MHÖ 04-08-12 Reference Dwg:		
metso minerals	Projection: 1st angle	File Name: SA501246	Scale: 1:5
	Size: A1	Drawing Number: SA 501246	Revision: B
			Sheet: 1 Cont: -

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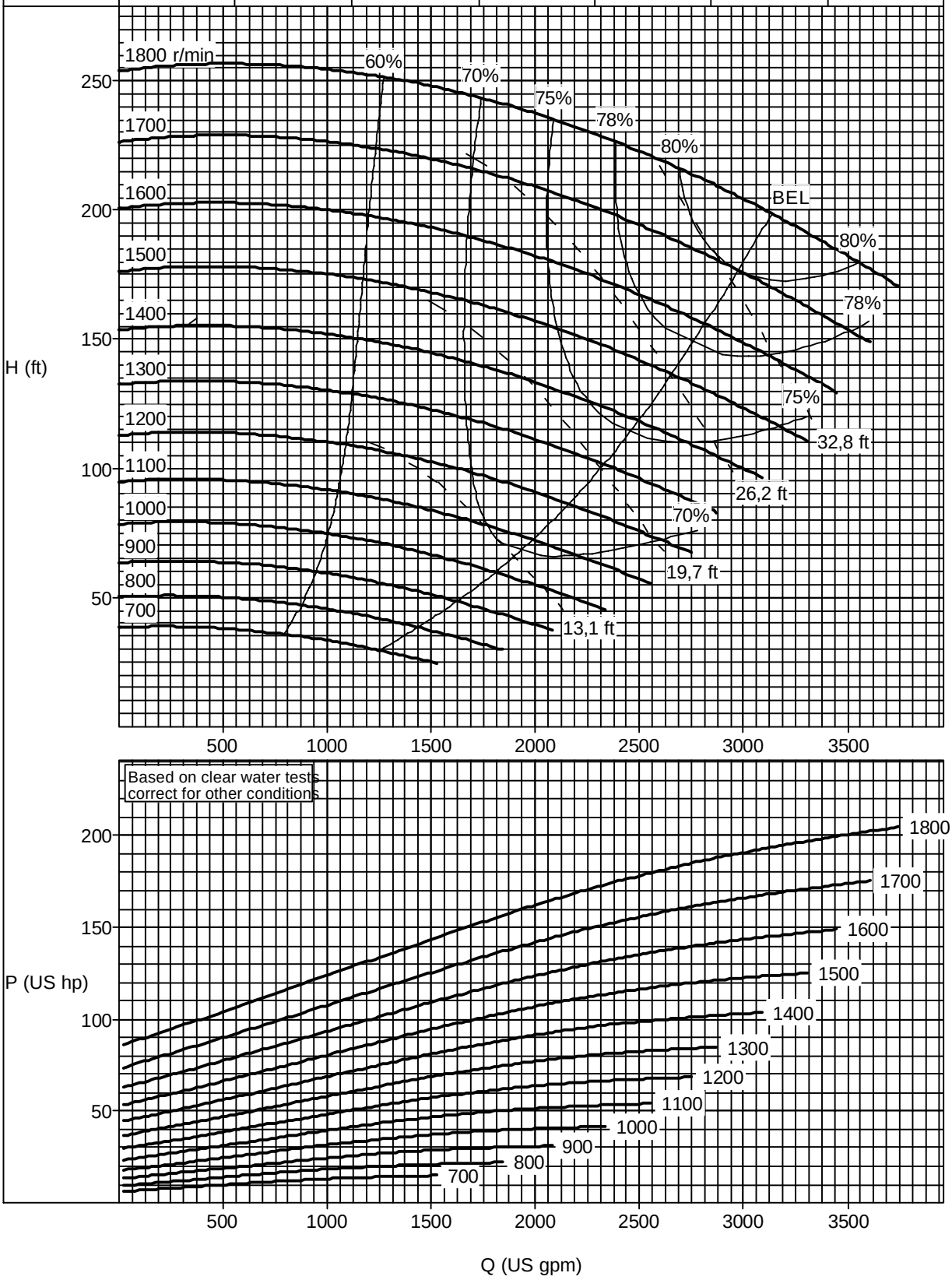
Pump MM200 C5
Performance curve

Full impeller dia	Vane diameter	Vane config	Impeller type	No. of vanes	Max sphere	Impeller material	Liner material
400 mm	**400** mm	**Full**	**Closed**	**5**	**35** mm	**Metal**	**Metal**



2.8 Certificates & test results

3 HEALTH AND SAFETY

3.1 General

HEALTH AND SAFETY STATEMENT

Take time to ensure that your safety and that of others is not put at risk. Failure to observe certain elementary safety precautions may result in death, personal injury or damage to this pump equipment. The safety information in this and other sections is intended to encourage a safety conscious approach to operating and carrying out maintenance.

3.1.1 Warnings and cautions

Safety alert symbols and words are used throughout this manual to inform the user of potential risks to health and safety. The definitions are provided below:

Indicates instructions which, if not acted upon, could result in death or serious injury.

⚠ WARNING — Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION — Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE — Indicates instructions which, if not acted upon, could result in property damage.

3.1.2 Training

It is strongly recommended that all production and maintenance personnel and site visitors are made fully aware of potential dangers of this equipment. If any doubt exists, please contact Metso Minerals for advice.

For your own personal safety , read and take note of the following:

HAZARDOUS AREAS

- These are in the areas of the impeller, shaft seal, impeller release mechanism, drive motor shaft, direct drive coupling or drive belts. Under normal operating conditions these areas **MUST** be enclosed by safety covers or guards. Do not remove safety covers, or guards. Pump intake and discharge ports, when open, are also hazardous areas. **NEVER** insert your hand into either of these ports without first ensuring that the pump drive has been isolated.

LIFTING THE PUMP

- Make sure that **ALL** slings, shackles, etc. are of adequate load carrying capacity. **ALL** lifting tools must be tested periodically in accordance with manufacturer's recommendations and local health and safety regulations. Metso Minerals Slurry pumps may be provided with lifting eyes designed for lifting individual components. These should NOT be used to lift the pump unit or the pump set. See sub-section 1.2.2, and the GA drawing in sub-section 2.6, for recommended lifting techniques.

OPERATING THE PUMP

- Ensure that **ALL** safety covers and guards are in position and securely fitted.

  DO NOT wear loose clothing when working in close proximity to rotating parts.

  NEVER allow water or slurry to rise above the top of the pump base. Water can short-circuit electrical equipment, posing a serious risk of electrocution to personnel, in addition to a risk of damage to the pump and drive components.

MAINTAINING THE PUMP

- **SWITCH OFF** and **ISOLATE** the electrical supply to the pump motor and allow rotating parts to come to rest before carrying out any maintenance or adjustments.

3.2 Warning and caution signs

See sub-section 2.1.

3.3 Disposal

Metso Minerals is committed to sustainable development and protection of the environment. This is reflected in the design of its slurry pumps. Components are carefully selected to ensure that their composition and manufacturing method complies with company policy on sustainable development.

Metso Minerals is nonetheless aware that environmental protection priorities and requirements vary over time and with geographical location. It, therefore, recommends that waste materials, wear components and the product itself, at the end of its useful life, are disposed of in accordance with local regulations in force at the time.

⚠ WARNING

When determining the correct method of disposal, e.g. establishing the european waste code, consider both the contaminants from actual use and the material of construction. materials of construction for the main components are listed in section 2.4.

4 DESCRIPTION OF OPERATION

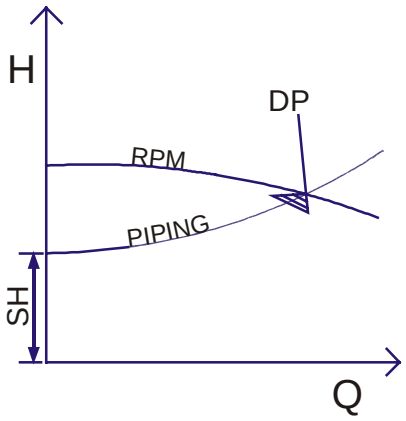
4.1 General

Centrifugal pumps work best with minimum wear and other mechanical stress if the operating point is close to the pump's best efficiency point (BEP). To choose a pump that works close to its best efficiency line (BEL), it is important to understand how the pump interacts with the piping system in which it is installed.

In simple terms, a pump and its piping system act as two communicating vessels. The piping sysem has a resistance curve that starts at the delivery static head (SH), at zero flow. As the flow increases, the resistance increases with pipe friction. A radial centrifugal pump has a descending discharge/flow curve for each rpm. The pump's operating point (DP) at a given pump speed is the point of intersection between the piping system's resistance curve and the pump's discharge/flow curve. See diagram below.

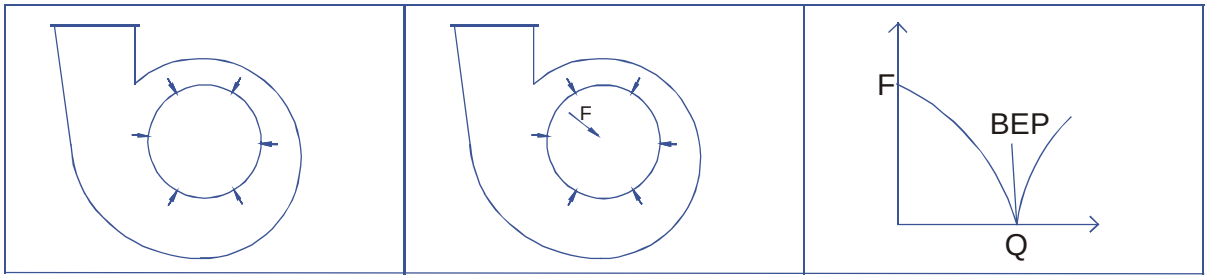
It is therefore important to calculate the piping system's resistance curve correctly and to take into account the manner in which the admixture of solid particles, for example, affects the curves of the piping system and pump. We recommend using **Pumpdim™ for Windows™** for our pump applications.

To obtain the best wear properties the pump can be provided with different materials in the parts exposed to the greatest wear.



4.2 Best efficiency point

Pressure conditions in the pump casing are shown in Figure 4.2-1. At the BEP there is even pressure round the impeller, resulting in small radial forces which in their turn exert little load on bearings and cause little shaft deflection. When the pump operates at low capacity and not at BEP, differential pressure builds up over the casing volute. This gives rise to a radial force F on the impeller which is a function of the differential pressure (Pa, psi) and the impeller's projected area (mm^2, in^2).



When the pump operates at best efficiency point, uniform pressure is obtained in the casing which in its turn eliminates radial forces on the impeller.

When the pump's flow capacity is not utilized, uniform pressure in the pump casing will not be obtained and this results in a radial force **F** on the impeller.

The magnitude of the radial force F is greatest when the pump runs against closed valve = 0 flow. The force subsequently diminishes up to **BEP** where it is close to zero. At flows above **BEP** the force changes direction.

Figure 4.2-1 Best efficiency point

When the pump is not operating at BEP the bearings will have a shorter service life because of higher radial bearing loads projected onto the bearings. In addition, the differential pressure over the impeller gives rise to the circulation of slurry between the impeller and the inlet liner, causing rapid wear of the liner.

4.3 Hydraulic effects of operation at, and outside, BEP

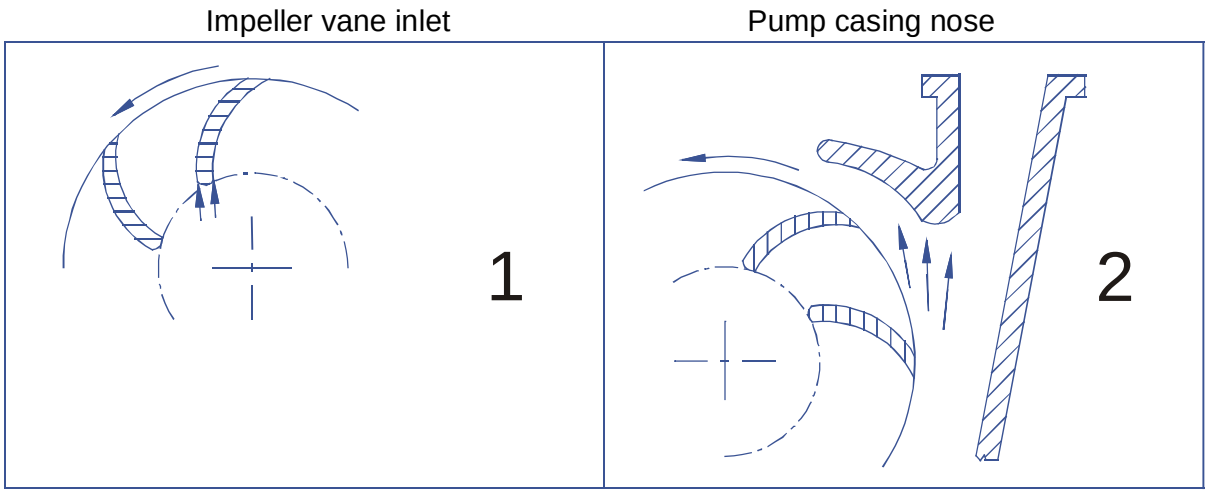


Figure 4.3-1 Operating at best efficiency point

1. The slurry's inflow angle coincides with the impeller's vane angle and no erosive vortices occur.
2. The slurry's flow angle harmonizes with the angle of the pump casing nose and no erosive vortices occur.

The way in which the hydraulic work is affected when the pump does not operate at BEP is shown in Figure 4.3-2 and Figure 4.3-3 This is of decisive importance in slurry pumping.

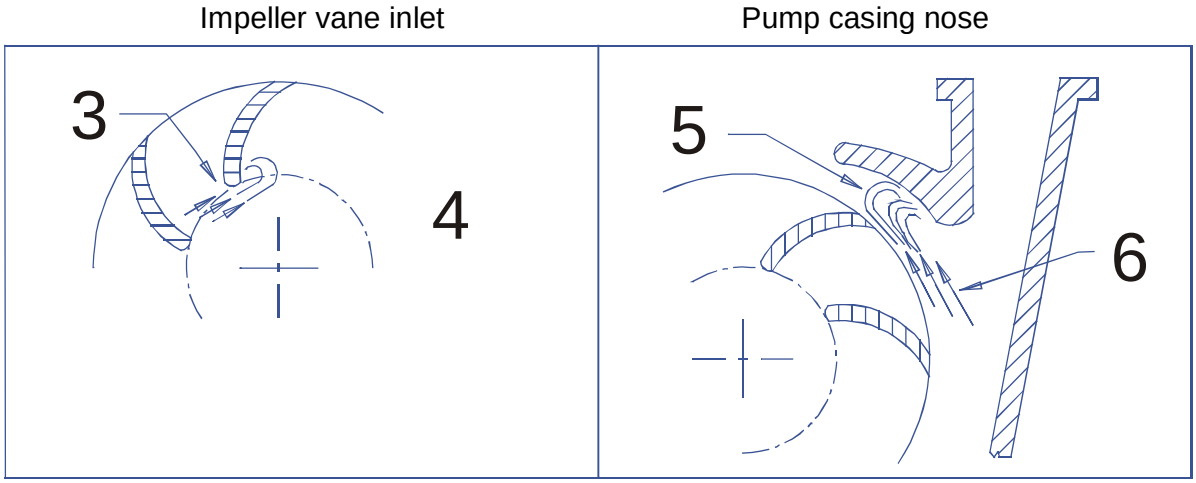


Figure 4.3-2 Operating outside BEP - At low load

3. Abrasion on the impeller vane's pressure side.
4. Vortices occur on the vane's vacuum side.
5. Vortices.
6. Abrasion caused by particles striking and bouncing against the surface.

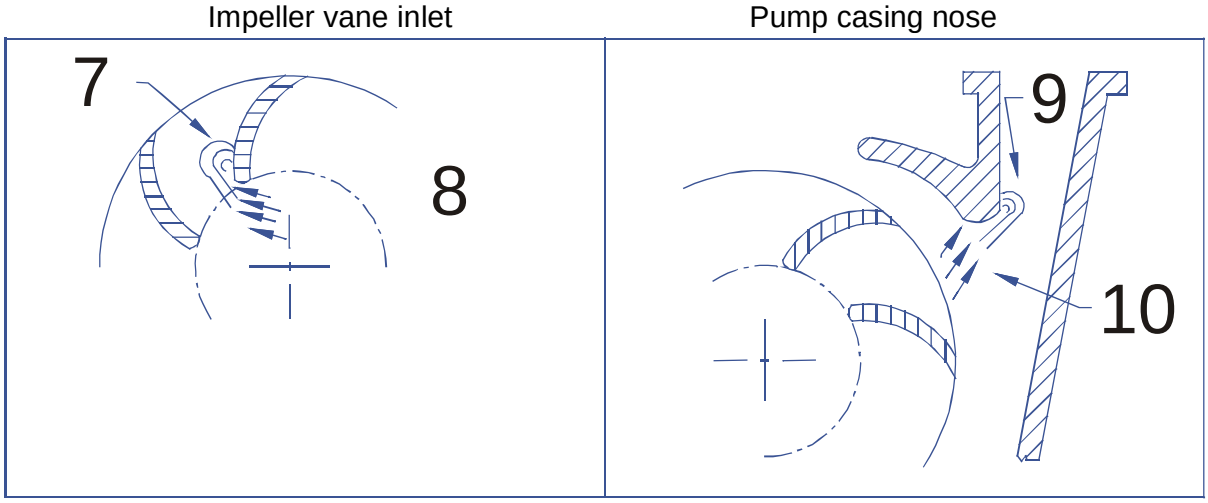


Figure 4.3-3 Operating outside BEP - On overloading

7. Vortices are formed on the pressure side of the impeller vane.
8. Abrasion occurs on the vacuum side of the vane tip.
9. Vortices.
10. Abrasion on the pump casing nose.

Hydraulic efficiency is a function of hydraulic turbulence - the more turbulence, the less efficiency. In slurry pumping, a high level of efficiency is therefore important.

Little hydraulic turbulence is formed at BEP and the abrasion is chiefly of a sliding nature, since the differential pressure is low when the slurry passes through the impeller and pump casing. The rate of abrasion is low and the wear is spread evenly over the surfaces. The rasping wear or high-pressure wear that occurs between the impeller and suction side liner is lower, since the evenly distributed hydraulic pressure reduces recirculation.

When the full capacity of the pump is not used and its efficiency is less than at BEP, hydraulic turbulence occurs and the solid particles in the slurry strike and rasp the impeller and pump casing. This causes local wear damage and the service life of these components is severely shortened. At the inlet to the impeller the slurry's flow angle is not the same as the pump vane angle, which gives rise to turbulence and results in recirculation of slurry in the channel. At the pump casing nose the flow from the impeller does not harmonize with the shape of the casing, causing turbulence to occur immediately after the pump casing nose.

In the worst case, oversized pumps which do not operate at BEP result in bearing breakdown, shaft fracture and unevenly worn inlet and pump casing liners with deep wear marks at the casing nose.

4.4 Choice of pump size

For preference, choose the pump size which operates as close as possible to the pump's best efficiency point (BEP).

5 CONTROL SYSTEM

(NOT APPLICABLE)

6 INSTALLATION

6.1 General

Refer to sub-section 1.2 for handling instructions.

6.2 Foundation requirements

Ideally, the pump and its drive should be mounted on a common bedplate which is fixed to a level foundation of adequate strength. All bedplates supplied by Metso Minerals incorporate holding-down bolt holes. It is recommended that the pump is installed in such a way that maintenance and adjustments can be carried out easily. It is essential that the pump is not subjected to flooding.

A foundation must provide a rigid and durable support, while absorbing shock loads and vibrations to and from the machine. Many criteria influence its design, its construction materials and its preparation: vibration and loading characteristics, operating environment and effect of nearby machinery are some. Each installation is, therefore, a special case needing careful examination of its particular requirements. The following are general guidelines for preparing a foundation for Metso Slurry Pumps –refer to Figure 6.2-1 for details.

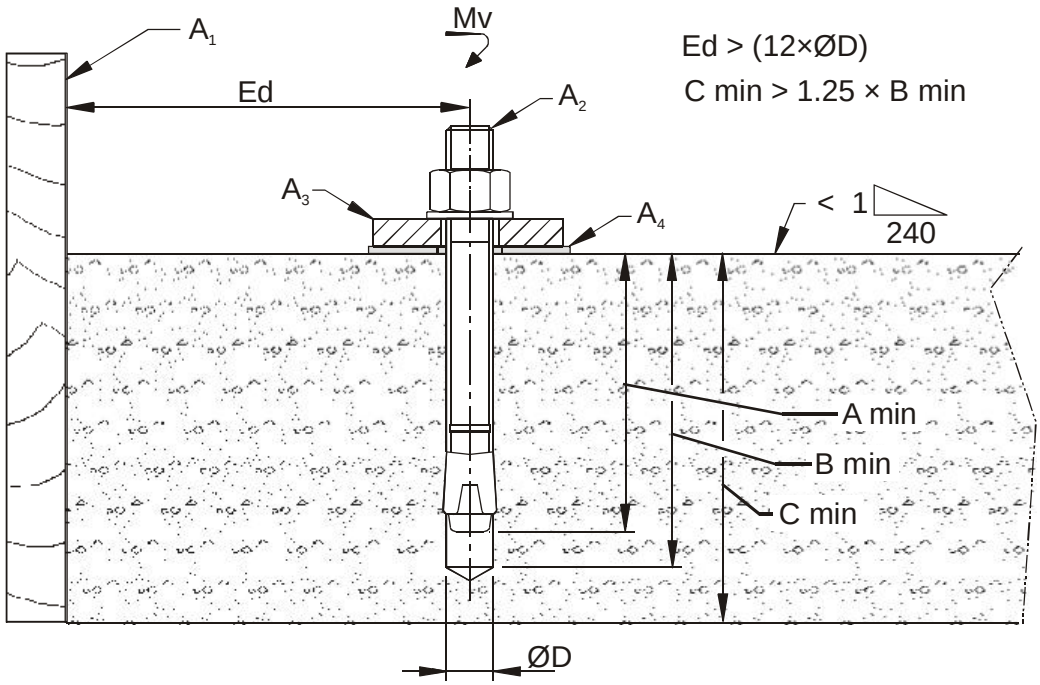


Figure 6.2-1 Foundation and fixings, general arrangement

1. The foundation must be poured on a well prepared solid ground.
2. A mixture of good quality cement and coarse aggregate is suitable in most cases, but, where applicable, the physics and chemistry of the soil, the operating environment and the local building regulations may impose additional requirements. Reinforcement bars may also be necessary depending on application.
3. The total foundation mass and its related support structures should be **at least** five times the total weight of the rotating assembly. The weight of the rotating assembly – excluding the rotating parts of the motor – is roughly ¼ of the weight of the bare shaft pump. See section 11.3 for the bareshaft assembly weight.
4. Foundation depth (C_{min}) should be at least 125% of the anchor hole depth (B_{min}).
5. For maximum strength, anchor fixings should be positioned more that 12 times the anchor hole diameter (ØD) from the edge of the concrete slab (Ed).
6. The concrete slab should be level to within 12.5 mm in 3000 mm (1" in 240").
7. If the installation is in close vicinity of other moving machinery, then necessary precautions should be taken to prevent cross-talk.

6.3 Installation tools and equipment

Apart from suitable lifting equipment, a standard fitter's tool kit together with suitably-sized hexagon key wrenches and torque wrenches are normally sufficient to install the pump. See Toolkit, sub-section 10.6.

Metso Minerals can supply all recommended fixtures and tools at additional cost.

6.4 Installation procedure

6.4.1 Pump

When the foundation has fully cured, the anchor bolts may be installed –refer to Figure 6.2-1 and Figure 6.4-1.

a) Spacing between anchor fixings should normally be more than 10 times their diameter, unless otherwise instructed. Refer to manufacturer's instructions for specific details.

b) Lift the pumpset into position over the foundation and align it as required in the plant layout drawing.

NOTICE If lifting the pumpset into position is not convenient, prepare a footprint pattern of the bedplate (A_3) using hardboard.

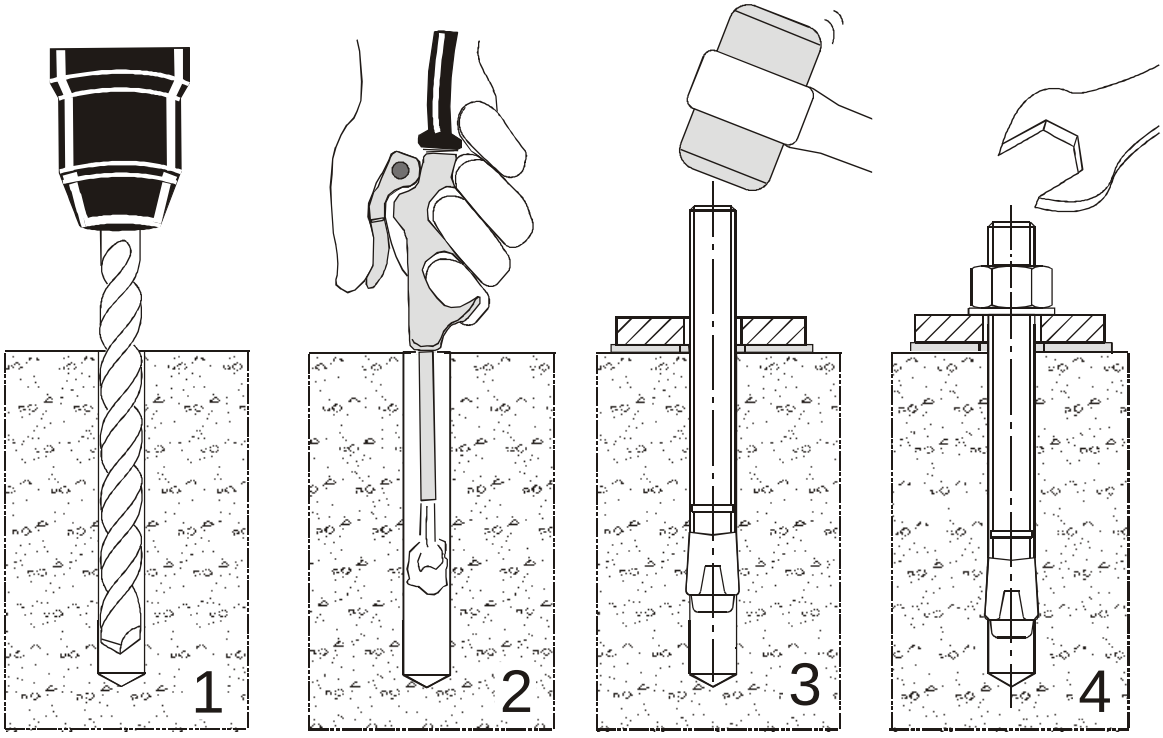


Figure 6.4-1 Installing the anchor fixings

1. With the pumpset (or the pattern) in position, drill the required number of holes in the foundation.

NOTICE Ensure that the hole depth (B_{min}) and diameter (ØD) conform to the bolt manufacturer's specification.

2. Blow out the dust and debris from the holes.

3. With the pumpset in position, level the bedplate using shims (A_4), if necessary, and tap in the anchor fixings to a depth (A_{min}), as specified by the bolt manufacturer.

4. Assemble the fixing nuts to the anchor fixings and tighten to the torque setting (Mv), as specified by the bolt manufacurer.

⚠ WARNING See sub-section 1.2.2, and the GA drawing in sub-section 2.6, for recommended lifting techniques.

6.4.2 Belt driven pumps

1. Make allowances for possible pump shaft forward adjustment when positioning the drive pulley on the shaft.
2. Align the pump and motor pulleys correctly. Misalignment between pulleys could cause excessive belt wear, heat generation and noise.

6.4.3 Direct driven pumps

NOTICE **ALWAYS** check drive alignment after installation.

Where practicable, fit a spacer coupling so that the pump "back pull-out" method can be used, thus avoiding the need to remove the drive or other equipment. Where applicable, the minimum distance between shaft ends needed to facilitate the "back pull-out" method is given in, 'General Arrangement', sub-section 2.6.

6.4.4 General installation procedure

1. Check that the inlet and outlet openings and the case are clear of any debris and that the respective joint seals are in position before connecting the pipework.
2. DO NOT force the pipes into alignment with the inlet and outlet joint flanges. Avoid unnecessary loads on the pump by ensuring that all pipework is adequately supported and is not resting on the pump. See Table 6.5-1.

NOTICE The joint flanges are split for ease of assembly. If found to be loose, tighten the respective screws to the torque loading noted in the torque table, sub-section 11.1.

3. Disconnect the drive belts or coupling before connecting the electrical supply to the drive motor.
4. Run the motor and check that it turns in the direction indicated by the arrow sign – see section 2.1.2.

NOTICE The pump must not be run in the opposite direction as this could result in the impeller unwinding from the shaft, causing extensive damage to the pump.

5. Reconnect the drive belts or couplings as necessary.
6. Re-check drive component alignments, and re-set if necessary –see section 9.5.6 .

NOTICE	**ALWAYS** check drive alignment after installation.

7. Connect the gland water supply pipe, in case of pumps with a water flush gland seal. Water must be clean, and at the correct pressure and flow rate. See section 9.5.3.
8. Check lubrication – see section 9.4. Where applicable, also top up the motor and gearbox lubrication in accordance with the manufacturer's instructions.

NOTICE	If the pump has been brought out of storage, lubricant renewal may be advisable. See Long Term Storage recommendations in section 1.2.4 .

9. Ensure that all safety covers are fixed securely in position.

6.4.5 Cold climates

Where there is the likelihood of pump being exposed to below freezing conditions the following precautions are strongly recommended.

1. If practical, on site all pumps should be installed with their outlets in position-3 as shown in 'General Arrangement', sub-section 2.6.
2. Immediately pump is stopped drain discharge pipework.
3. Where practicable, fix adequate drain plugs on discharge pipework local to pump.
4. Disconnect flange fixings to pump oulet and inlet. Siphon out as much of the slurry as possible.
5. In case of pumps equipped with an expeller seal, after draining/siphoning out the content of the pump case, run the pump for 10 seconds to expel any remaining fluid in the expeller chamber. Then drain/siphon out the pump case once again if needed.

A small amount of slurry can remain in bottom of pump case provided it does not come in contact with the impeller.

These precautions will make it possible to drain the pump and its pipework of all slurry during shut-downs.

6.4.6 Pump outlet positions

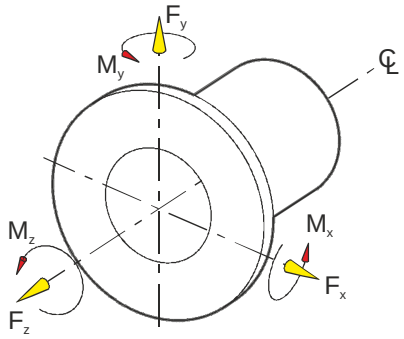
To reposition the pump case outlet to suit existing pipework, follow relevant instructions in Dismantling and Assembly, section 9.5. 'General Arrangement', sub-section 2.6 shows the possible outlet positions.

6.5 Pipe connections and pump sump

NOTICE

DO NOT install the pipework in such a way that it puts any excessive load onto the pump case. Table 6.5-1 indicates the standard allowable flange forces. Please consult Metso Minerals should the flange load requirement be greater.

Pumps equipped with an adjustable inlet door must have adequate flexibility, or provision for adjustment, built into their inlet pipes as a means of avoiding extra structural forces when the inlet door is re-adjusted.



FLANGE SIZE	F_X AND F_Y		F_Z		M_X AND M_Y		M_z	
	N	lb	N	lb	Nm	lb.ft	Nm	lb.ft
32	350	75	700	155	165	120	325	240
50	510	115	1000	225	240	175	475	350
80	800	180	1600	360	370	270	750	550
100	1100	245	2200	495	510	375	1000	735
150	2000	450	4000	900	895	660	1790	1320
200	2900	650	5800	1300	1325	975	2650	1955
250	4350	980	8700	1950	2000	1475	4000	2950
300	5800	1300	11600	2600	2650	1950	5300	3900
350	7600	1700	15200	3400	3500	2570	6900	5070
400	9700	2170	19400	4350	4500	3300	8900	6550
450	12200	2750	24500	5500	5700	4200	11200	8260
500	15200	3410	30300	6810	7000	5160	13900	10250
550	18500	4160	37000	8320	8500	6270	17000	12540
600	21800	4900	43700	9820	10000	7380	20000	14750
700	29700	6670	59500	13370	13600	10000	27200	20050
800	38800	8720	77600	17450	17800	13100	35500	26200

Table 6.5-1 Allowable flange forces

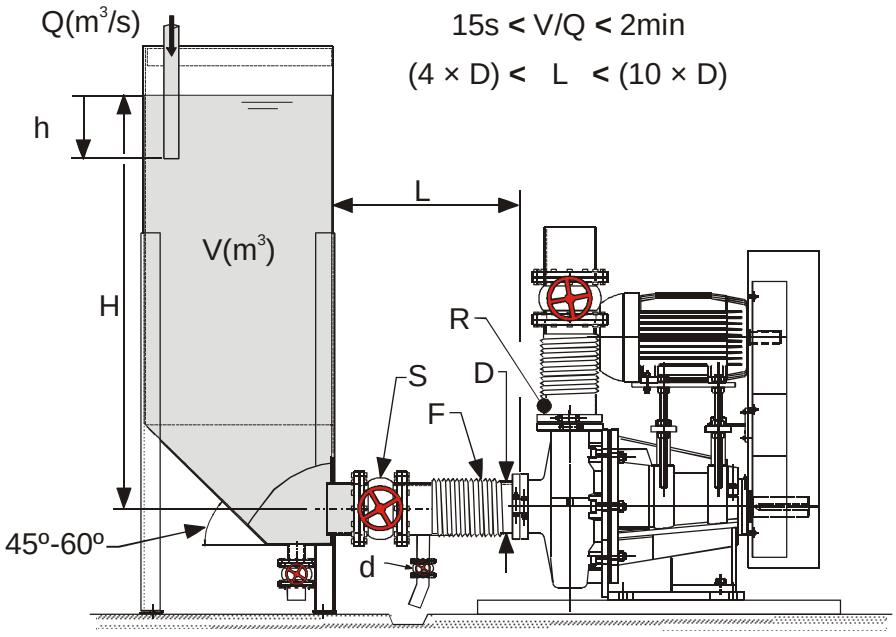


Figure 6.5-1 Recommendations for pipework layout

⚠ WARNING

Where the pipework is designed in such a way that the pump inlet and outlet lines can be shut off or blocked simultaneously, ensure that an appropriate pressure relief device (R) is installed and set to the pressure specified in 'Materials and Maximum Working Pressures', section 2.4. This is to eliminate the risk of the pump bursting, in such eventuality.

The choice of pressure relief device and its location in the pipework with respect to the pump is the responsibility of the pipework installation supplier.

The pump is **NOT** self-priming, which means that the pump case must be full of liquid before the pump is started. Additionally, take note of the following - see also Figure 6.5-1:

- Sump bottom should have an angle of 45º. Fast settling particles may require up to 60º.
- Sump feed (h) should be below the sump liquid surface to avoid air entrainment. Allowing the pump to draw air will drastically reduce the useful life of the hydraulic parts.
- Sump volume should be as small as possible. Slurry ***'Retention Time'*** is the relevant parameter for determining the size of the sump. It ranges between 15 seconds and 2 minutes for slurries containing coarse particles and fine particles, respectively.
- Separate sumps are preferred for standby pump installations. This will avoid settling out in the standby pump when not in use.
- For slurry applications, ensure a steady, uniform feed to the pump, where practicable.
- Install the pump as close as possible to the sump.
- Keep the length of suction pipe and the number of bends in the pipework to the minimum practicable. Use reinforced flexi-pipes (F) to connect to inlet and outlet.

NOTICE

Inlet pipe should, however, have a straight length (L), at least, 4 times its diameter to ensure favourable flow conditions into the pump. If a valve (S) is fitted on the inlet side, it must be fully open when the pump is running and should have a straight flow path of the same area as the connected pipe. Suction pipes which are longer than 10 times the diameter should be avoided.

- Sump level (H) should be 6 times pump inlet diameter (D) when measured from the centre line of pump.
- The diameter of the inlet pipe should be the same as, or larger than, the pump inlet diameter.
- A drain valve (d) should be incorporated in the inlet pipe. A floor channel should also be provided directly beneath it for recovering the waste slurry.
- Secure the pump inlet and outlet pipes separately to avoid unnecessary transmission of vibrations, forces or moments to the pump.
- Use expansion joints for high-pressure applications.

6.6 Shaft gland

See Care and Maintenance, Section 9, for specific installation instructions.

6.7 Motor and drive

See Care and Maintenance, Section 9, for specific installation instructions.

7 COMMISSIONING

⚠ WARNING | **BEFORE** carrying out the following checks, isolate the electrical supply to the motor. See also the warning in section 6.5 .

1. If the pipework has not been connected to the pump on installation, ensure that the pump case and associated pipework are clear of any construction debris, slurry etc. before connection.
2. Ensure that the foundation and the securing bolts are tight.
3. Check that the rotating assembly is free to turn manually.
4. Check that the direction of rotation is correct -see General installation procedure, section 6.4.4.

NOTICE | The pump must not be run in the opposite direction as this could result in the impeller unwinding from the shaft, causing extensive damage to the pump.

5. Check lubrication - see section 9.4 .

NOTICE | On grease lubricated units, the bearings and seal assemblies are grease packed on assembly. Oil lubricated units are *normally* supplied dry and will, therefore, require replenishment.

6. Ensure that the openings on each side of the bearing frame and the area around the gland are clear of debris, dried slurry, etc.
7. Check that all safety guards are secured in position.

8 OPERATING INSTRUCTIONS

8.1 Start-up

1. If the pump has just been maintained or has not been put into operation for some time, then carry out the pre-start checks as described in Commissioning, section 7.
2. Open the pump inlet and outlet valves.

⚠ WARNING **NEVER** run the pump with both inlet and outlet valves closed. See the warning notice in section 6.5 .

3. Check for leakage from the inlet and outlet connections.

NOTICE An inlet-side leak may cause the pump to draw air during operation, thus drastically reducing its pumping capacity.

4. If a water flushed gland is fitted, ensure that the water supply is turned on, and water is available at the correct pressure and flow rate.
5. If a mechanical seal is fitted, see section 9.5.3 before start up.
6. If auxiliary priming equipment is fitted, start the priming pump.
7. Start the pump drive motor.

8.2 Shutting down

The appropriate shutdown procedure for any installation depends on the slurry being pumped, and more generally on the process requirements upstream and downstream of the pump. What follows, therefore, may only be regarded as general guidelines for ensuring some degree of protection for the pump without reference to the particular application.

- Where practicable, switch the pump to clean water and allow the pipeline to be flushed through before shutting down.
- In case of systems with substantial discharge pipework and/or head of slurry, means of isolating the pump or draining the system should be provided –see section 6.5.

NOTICE Stopping the pump when there is a head of slurry in the discharge pipe should be avoided as this could result in damage to the gland and/or pump.

- Having shut down the pump on clean water, close its isolating valves and then drain the pump and its pipework, if required.

NOTICE

ALWAYS close the outlet valve first. **NEVER** close the inlet valve while the pump is running.

NOTICE

Reverse flow, in addition to posing a risk of damage to the shaft seal, can also cause the impeller to spin in the reverse direction. Starting the pump under these conditions might cause damage to a mechanical seal, if fitted, and/or can in extreme cases cause the shaft to shear. An override circuit is recommended to prevent the pump being started inadvertently while the impeller is rotating.

- For short stoppage periods **ONLY** and where there is **NO** risk of the slurry settling out, or solidifying in the system:

Pumps with expeller seal -	immediately after shutting down, close the isolation valves and then drain the pump and the sump, if necessary.
Pumps with water flushed gland or mechanical seal	leave the flush water '**ON**' when shutting down the pump, then close the isolation valves and finally drain the pump and the sump, if necessary.

Where there is a risk of slurry settling out, or solidifying, refer to the plant operation manual for the appropriate shutdown procedure.

NOTICE

Formation of ice can block or burst the pipework and the pump case. In below-freezing conditions, ensure that the pump case, and pump inlet and outlet pipework are drained of all slurry for any lengthy shut-down.

8.3 Running checks

During pump operation, the following checks should be made:

1. Check for leakage from the inlet and outlet connections, and from the gland seal.

NOTICE

An under tightened inlet flange may not be easily noticeable during operation, as the pump could be drawing air. Check for inlet-side leaks before start-up.

2. Check for excessive noise and vibration -see Description, section 2.
3. Check bearing temperature and lubrication –see Lubrication, sub-section 9.4.
4. Periodically verify that the shaft seal is correctly adjusted. If a water flush gland seal is fitted, ensure that the water supply is at the correct pressure and flow rate. (Refer to section 9.5.3 for shaft seal setting details.)

5. Check that the pump performance is satisfactory. (See Capacity Curves, section 2.7)

NOTICE If the running checks are unsatisfactory, pump adjustment or maintenance may be required.

NOTICE After the first 100 hours of operation, check and adjust the impeller axial clearance. see section 9.5.1.

9 CARE AND MAINTENANCE

9.1 Safety measures

⚠ WARNING

BEFORE carrying out any maintenance ensure that all electrical supplies to the pump, motor and associated equipment are switched off and isolated. Lock the relevant electrical supply switches in the off position, or attach suitable warning plates to them.

ALWAYS ascertain the nature of the process liquid before commencing work on a pump and comply with the health and safety procedures relevant to the process liquid. It may be **HARMFUL** to health.

Make sure that **ALL** slings, shackles, etc. are of adequate load carrying capacity. Approximate weights of major components are provided in sub-section 11.3.

Lifting points incorporated in individual components are intended solely for lifting that specific component. **NEVER** use these for lifting assemblies of components.

Should the process liquid be of a harmful or hazardous nature take, as a minimum, the precautions stated below;

1. always use protective goggles and rubber gloves;
2. flush the pump thoroughly with clean water, before opening the pump;
3. after removing the components, flush them thoroughly with clean water.
4. follow the health and safety instructions provided in section 3.

9.2 Preventive maintenance & service schedule

9.2.1 Routine maintenance

Use the maintenance schedule below as a basis from which to produce a schedule suitable to each pumping application after experience in operation has been gained.

ITEM	ACTION	RUNNING HOURS			
		10	100	250	1000
Pump Case, Bearing Cylinder Housing and Gland Area Pipework	Keep all areas clean and free from debris, slurry etc.	×			
Hydraulic cylinders (where applicable)	Check for oil leaks. Rectify, as required.				×

ITEM	ACTION	RUNNING HOURS			
		10	100	250	1000
Inlet/Outlet Connections	Check for security and leaks. Rectify as required.		×		
Gland Seal - General	Check for leaks. Tighten gland follower screws or renew seal as necessary.		×		
Water flushing gland seal.	Check stuffing box connection for leaks. Rectify as necessary.		×		
Centrifugal Gland Seal	Tighten gland follower screws or renew seal as necessary.		×		
Bearing Cylinder	Lubricate bearings. See section 9.4.			×	
	Check Bearings for overheating.			×	
All fixings	Ensure attachments are secure. Tighten to correct torque as necessary.				×
Adjusting Screw Locknut (P38)	See Torque Table, Section 11.1.			×	
Pump/Drive unit installation	Inspect Drive Belts, if fitted, for deterioration and damage. Replace as necessary. Check drive belt tension and adjust as necessary.				×
	Check drive couplings, if fitted, for security of connection.				×
	Check safety covers for security of attachment - **important**			×	
	Check drive motor holding down bolts for security of attachment.				×
	Keep drive motor clean and free from debris, slurry etc.	×			
	Service Drive Motor as necessary.	In accordance with manufacturer's instructions.			

ITEM	ACTION	RUNNING HOURS			
		10	100	250	1000
Pump impeller	Check axial clearance after run-in period. Adjust clearance by shimming. Refer to Setting Pump Clearances, sub-section 9.5.1.	After first 100 running hours and repeat at intervals equal to 25% of the anticipated life of the pump.			

9.2.2 Maintenance recommendations

Metso Minerals recommends that the following actions are carried out prior to any maintenance:

- clean down the pump, removing any accumulation of debris and/or slurry;
- ensure that inlet and outlet pipeline valves, if fitted, are closed;

⚠ WARNING **BEFORE** opening up the pump, make sure that any liquid pressure has been released.

- on breaking a joint face, keep the gasket and ensure it is replaced on assembly;
- if using lifting gear to remove components, ensure that it is of adequate capacity and that test certificates are valid;
- on larger size pumps it is recommended that special tools are used to help assembly or maintenance.

For information regarding special tools please refer to Special Tools, section 9.3.

9.3 Tools and special equipment for service and maintenance

NOTICE

The special tools described in this section are available for pumps with either single, or double, adjustment frames.

1. A special crank-handle to fit over the drive-shaft end diameter and locate the drive key is advantageous when fitting the impeller to the shaft. See Dismantling and Fitting the Hydraulic Parts, section 9.5.2.

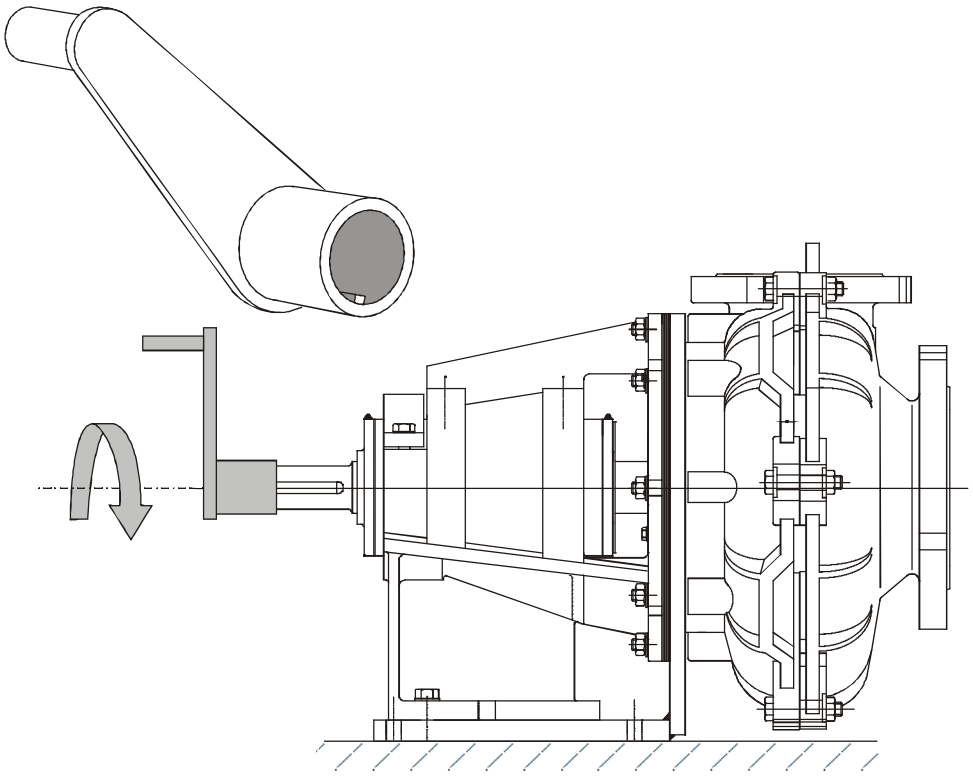


Figure 9.3-1 Special crank handle

2. Two proprietary packing extractors to facilitate the removal of the packing will also be advantageous.

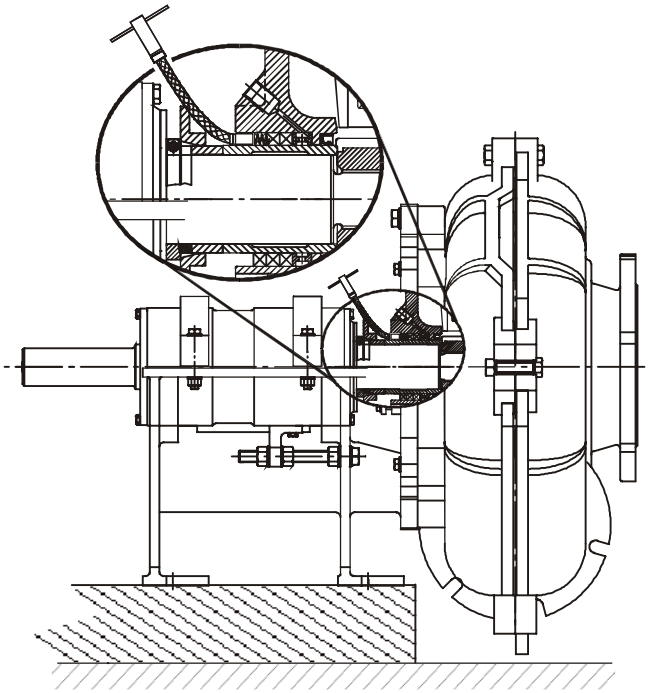


Figure 9.3-2 Packing extractor

3. Back-liners for large pumps are very heavy. Specially designed back-liner lifting tools allow safe handling of the components.

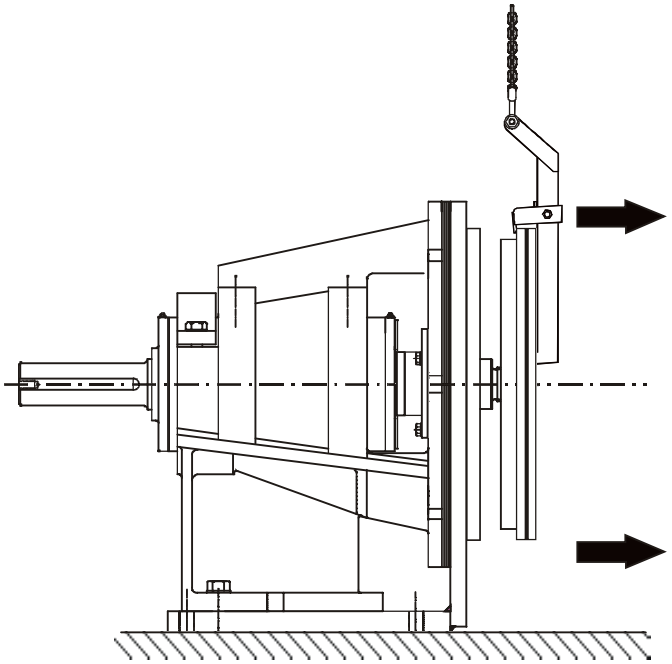


Figure 9.3-3 Back-liner lifting tool for metal pumps

4. Shaft seals for large pumps are also quite heavy. A special shaft extension (E) facilitates removal and refitting of the seal assembly. The tool is also useful for removing the bearing assembly.

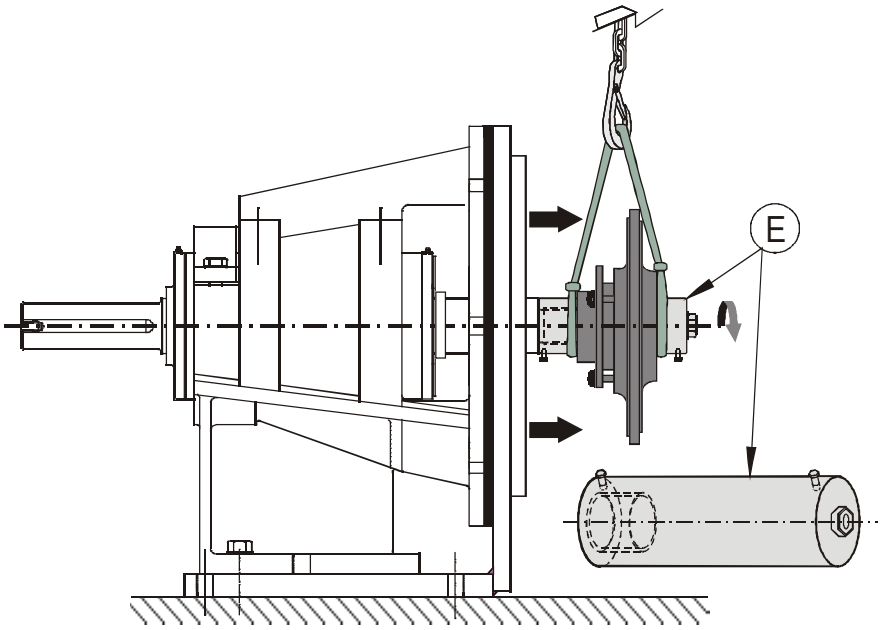


Figure 9.3-4 Shaft extension tool

5. A soft sling (strop) of appropriate lifting capacity (See Approximate Weights Table, section 11.3) to lift the case assembly is required.

NOTICE | To prevent damage, **ONLY** use a soft sling (strop) to lift the case.

All of the above special tools can be obtained from Metso Minerals. See section 10.6.

9.4 Lubrication

9.4.1 First-fill and re-packing after major servicing

Metso Minerals Slurry pumps are lubricated with SKF LGMT3 before dispatch. When renewing or re-fitting the bearings, they must again be re-packed with grease of the same specification as detailed in Table 9.4.1-1. The required quantity for each bearing is specified in Table 9.4.1-2.

Characteristic	Specification
Thickening agent :	Lithium soap
Base oil viscosity at 40 °C (104 °F):	120 cST
Base oil type :	Mineral oil
Consistency NLGI :	3

Table 9.4.1-1 Grease specification

Frame size	Grease quantity	
	(g)	(oz)
FR250	75	2.7
FR300	100	3.5
FR400	125	4.4
FR500	325	11.5
FR600	500	17.6
FR750	625	22.0

Table 9.4.1-2 Bearing lubrication - First fill & re-packing

9.4.2 Lubrication interval

The bearings may be re-greased with any lithium-based grease that conforms to the specification detailed in Table 9.4.1-1.

The lubrication interval depends upon the shaft speed and the bearing operating temperature, as shown in Table 9.4.2-1.

Frame Size	Grease		Pump speed (rpm)						
	(g)	(oz)	500	800	1000	1500	2000	2500	3000
FR250	20	0.7	2275	1500	1000	650	500	350	250
FR300	25	0.9	1600	1300	900	600	400	300	200
FR400	35	1.2	1250	1000	750	500	350	-	-
FR500	50	1.8	1250	900	550	350	-	-	-
FR600	70	2.5	1250	800	350	200	-	-	-
FR750	90	3.2	900	550	200				

Table 9.4.2-1 Recommended lubrication interval for bearings @ (158 °F) 70°C (hours)

The pump should initially be re-greased after 250 running hours or the recommended interval (whichever is less), unless stored for longer than 12 months before start-up, in which case the long-term storage instructions should be followed (See section 1.2).

Multiply the lubrication intervals by the factors given below if the normal bearing operating temperature (measured on the rim of the bearing end-cover) differs from 70 °C (158 °F).

Temperature (°C)	***50***	***60***	***70***	***80***	***90***	***100***	***110***	***120***
Temperature (°F)	*122*	*140*	*158*	*176*	*194*	*212*	*230*	*248*
Multiplier	*2.5*	*1.6*	*1.0*	*0.65*	*0.40*	*0.25*	*0.15*	*0.10*

While the bearings and specified grease have a maximum operating temperature of 120°C (248 °F), it is recommended that temperatures above 100 °C (212 °F) be avoided. However, transient temperatures between 100 °C (212 °F) and 120 °C (248 °F) are acceptable immediately following re-greasing.

NOTICE

DO NOT re-grease during the first 8 hours when running-in new bearings.

9.4.3 Lubrication points

The pumps have two bearing lubrication points. See Figure 9.4.3-1.

Part	Position	Qty.(cc)	Frequency	Lubricant
Bearing cylinder	A	See Table 9.4.2-1.	See Table 9.4.2-1.	SKF LGMT3 or equivalent - see Table 9.4.1-1.
Motor and/or gearbox (where applicable)	–	–	–	See manufacturer's instruction manual.

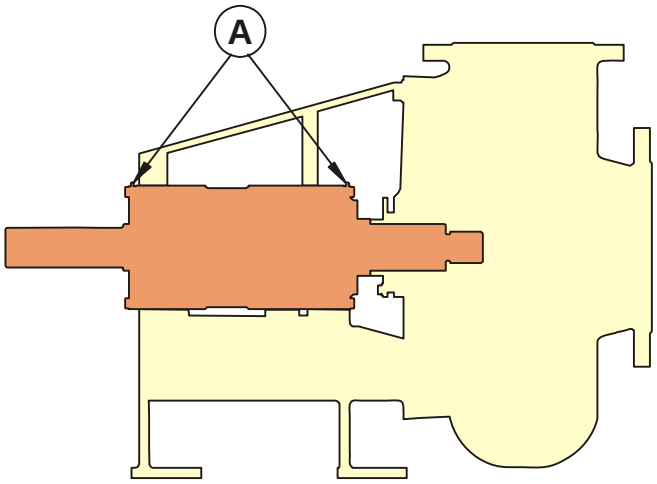


Figure 9.4.3-1 Lubrication point diagram- Bearing greasing points (A)

9.5 Dismantling and assembly

9.5.1 Setting pump clearances

- **Impeller clearance adjustment**

This adjustment enables the impeller inlet-side running clearance to be kept to a minimum so that maximum operating efficiency is maintained throughout the wear life of the pump. When no further adjustment is possible, the pump must be disassembled and inspected and worn parts renewed.

1. Isolate the drive motor and attach suitable warning plates to the relevant switches. It is advisable to remove the fuses and/or lock the isolator open to prevent accidental starting.
2. Remove the drive safety guard and disconnect the belt drive or direct coupling as applicable.
3. Where fitted, a mechanical seal requires ***setting*** for disassembly. Section 9.5.3 would provide the relevant instructions, where applicable.
4. Inlet-side clearance

   This clearance is set by moving the complete rotating assembly towards the inlet end:

   a) Loosen the two adjusting screw locknuts (P38 a & b) –see Figure 9.5.1-1.

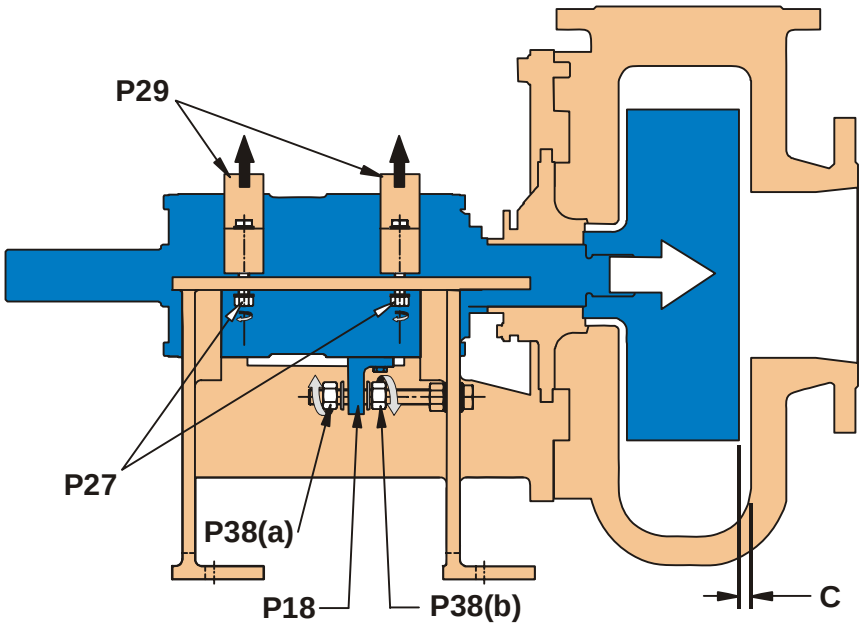


Figure 9.5.1-1 Adjusting the impeller inlet-side clearance

   b) Loosen housing clamp fixings (P16 & P27), and slacken bearing housing clamps (P29).

c) Ensure that the bearing cylinder assembly is free to move.

d) While rotating the shaft (B11) manually, take up the inlet-side clearance (C) by tightening adjustment screw locknut (P38 a) until impeller (W3) makes contact with the case assembly on the inlet-side.

e) Back off locknut (P38a) by one turn.

f) Tighten locknut (P38b) to pull back the rotating assembly until locknut (P38a) is tight against saddle (P18).

g) Check that impeller (W3) rotates freely.

h) Tighten locknuts (P38) and housing clamp screws (P16).

NOTICE

DO NOT over-tighten housing clamp screws (P16). over-tightening may distort bearing housing (B14). Refer to section 11.1 for the correct torque setting.

5. If fitted, reset the mechanical seal.
6. Re-connect the drive belt or half coupling as applicable making sure that the drive is aligned correctly. Adjust as necessary to obtain the correct alignment.
7. Fit all safety guards.

9.5.2 Hydraulic parts and frame - dismantling and fitting

(i) Opening and closing the pump – fixed base

⚠ WARNING

Make sure that **ALL** slings, shackles, etc. are of adequate load carrying capacity. approximate weights of major components are provided in sub-section 11.3.

Lifting points incorporated in individual components are intended solely for lifting that specific component. **NEVER** use these for lifting assemblies of components.

1. General

The base (L) supports the case, the bearing and the rotating assemblies. See Figure 9.5.2-1.

The bearing frame vertical plate incorporates a number of important features. Slots in its periphery provide locations for case bolts (B), and also facilitate the assembly of the case. Vertical plate's inner flange provides a spigot for an expeller ring or a stuffing box and threaded holes in its outer flange are intended for jacking screws.

The open construction of the bearing frame allows easy access to the shaft seal (F), and the impeller adjustment screw (G).

Fixing holes (D) are provided in the frame top plates to mount the drive motor overhead, if required.

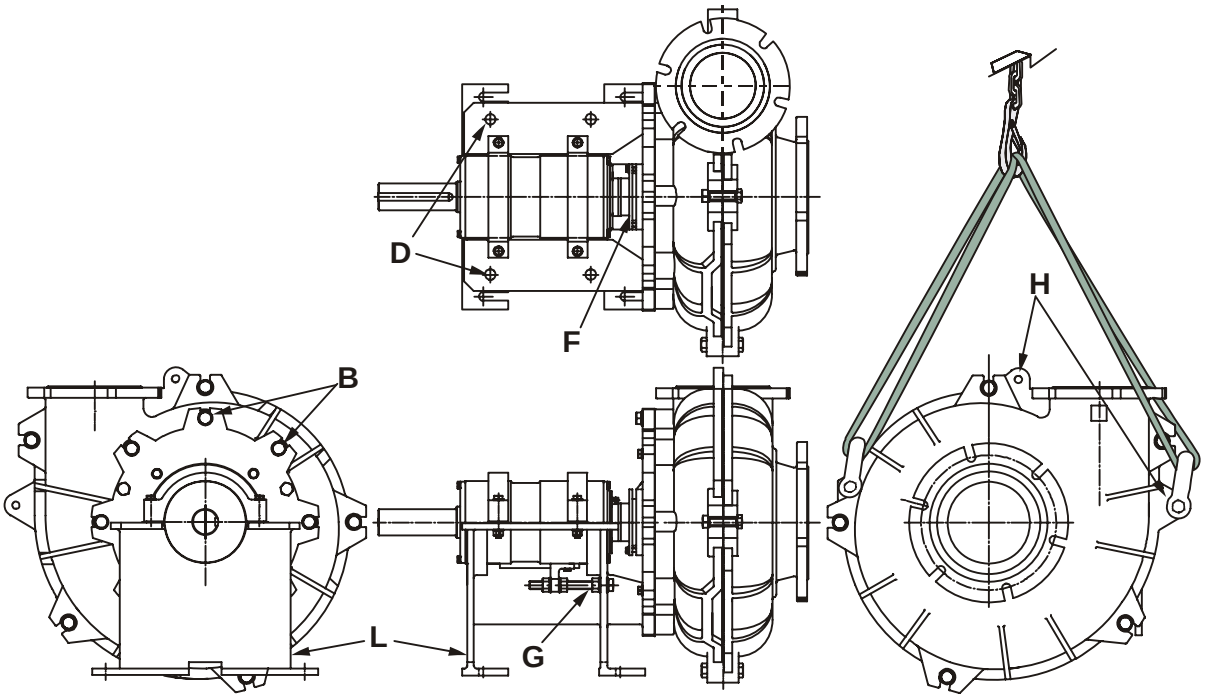


Figure 9.5.2-1 Bareshaft pump (typical)

2. Opening the pump

Figure 9.5.2-1 and parts list drawings in section 10.4 identify parts referenced in this section.

a) Run the pump on clean water or flush clean the inside of the case.

b) Isolate the pipework and drain the pump case.

c) Isolate the drive motor and attach suitable warning plates to the relevant switches. It is advisable to remove the fuses and/or lock the isolator open to prevent accidental starting.

d) Remove the drive safety guard and disconnect the belt drive or direct coupling as applicable.

e) Disconnect the inlet and outlet pipework from the pump.

NOTICE

Metal pumps are equipped with inlet and outlet flange gaskets (F2, F4). Ensure that these are saved for reassembly. Rubber pumps have integral gaskets.

f) Note the position of the outlet to ensure correct reassembly.

g) Where fitted, a mechanical seal requires setting for disassembly and section 9.5.3 would provide the relevant instructions.

h) Disconnect the flush water tapping, if fitted.

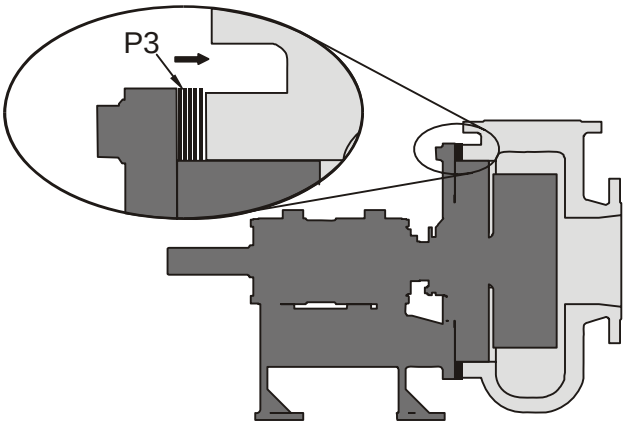
i) Support the case in slings –cases for large pumps incorporate lugs (H) for attaching lifting shackles.

j) Remove case fixings (B). Keep them safe for reassembly.

k) Use jacking screws (P10) to ease apart the case and the rotating assembly.

l) Withdraw the case over back-liner (W4) and impeller (W3) and lower it onto a suitable support.

m) Remove jacking screws (P10).



NOTICE

Casing shims (P3) are fitted on some pumps to achieve the required impeller clearances. Where applicable, ensure that they are removed as sets and refitted on assembly in the same position.

3. Closing the pump

   a) Lift and push the case assembly over impeller (W3) and back liner (W4) against the vertical plate.

NOTICE

Where applicable, ensure case shims (P3) are in position. Case shims (P3) may be necessary if the case has been renewed. Contact Metso Minerals spares department – see section 10.3 .

   b) Ensure that case fixings (B) enter their respective holes around the flange joint.

   c) Incrementally tighten opposite pairs of case fixings (B) to the torque values given in sub-section 11.1. until all fixings are tightened –ensure that impeller remains free to rotate manually.

   d) Set the impeller clearance –see sub-section 9.5.1.

   e) Check inlet and outlet gaskets and re-connect the respective pipework.

NOTICE

Refer to section 6.5 before renewing pipe flanges.

   f) If a mechanical seal is fitted, *reset* it for operation.

   g) Where applicable, reconnect the flush water tapping.

   h) Fit the drive belts or connect the drive coupling, ensuring that they are in correct alignment.

   i) Fit and secure the drive safety guard and the gland guard in position.

   j) Check that all fixings are secure.

   k) Remove warning plates and safety locks from power switches and restore power supply to the motor.

9.5.2 Hydraulic parts and frame - dismantling and fitting

(ii) Wet-end - disassembly and reassembly

1. General

Case (W1), impeller (W3) and back-liner (W4) are high quality, high-chrome iron castings. Larger size pump cases are ribbed and incorporate a number of lifting lugs. The inlet and outlet branches are fitted with joint seals (F2, F4) and split flanges (F1, F3) to provide a leak-proof and secure pipework connection.

The back-liner, which forms the rear face of the case, is attached to bearing frame (P14) by tee bolts (W19) and hexagon-headed nuts (W20). For ease of assembly, the bolts are retained in the slots by means of a rubber strap (W18). O-rings (W6) are used to seal the back liner and the case.

The wide choice of impellers available permits the most efficient case-impeller combination to be adopted for each application.

2. Removing impeller (W3) and back-liner (W4)

   a) If an impeller release mechanism is fitted refer to section 9.5.2 (iii); otherwise, insert a suitable bar between two impeller vanes and lock the bar against a suitable static object. Apply a shock load by turning shaft (B11) in a direction opposite to the pump rotation. Alternatively, lock the shaft and shock the impeller. Sub-section 2.1.2 identifies the direction of rotation of the pump during operation.

   b) Steady and suitably support impeller (W3) as it moves off shaft (B11).

⚠ WARNING | **DO NOT** apply heat in order to remove the impeller

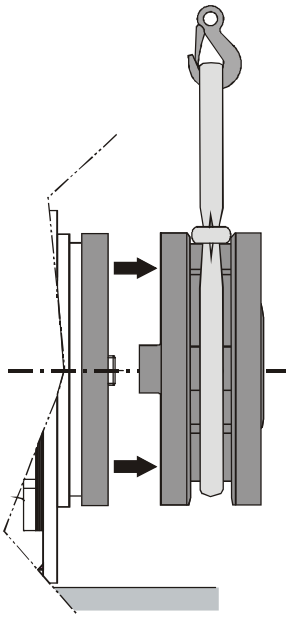


Figure 9.5.2-A Removing impeller (W3)

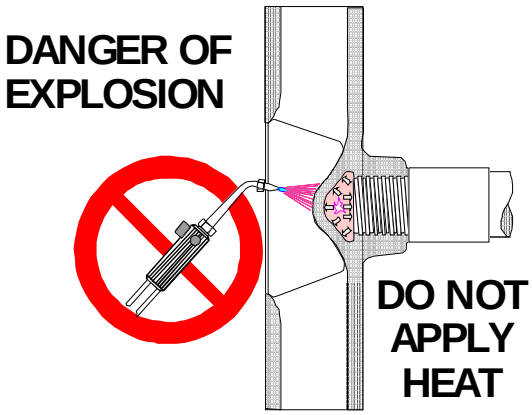


Figure 9.5.2-B Danger of explosion

   c) Remove nuts (W20) from the four back liner bolts (W19) and withdraw back liner (W4). The bolts are retained in position by a rubber strap.

⚠ WARNING | Back-liners on large pumps are extremely heavy. use the back-liner lifting tool recommended in section 9.3.

3. Inspection

   a) Clean and inspect case (W1), impeller (W3) and back-liner (W4) for severe scoring, extensive wear, pitting, corrosion and damage. Renew if necessary.

   b) Inspect back-liner seal (W6). Renew it , if it shows any signs of damage.

   c) Refer to sections 9.5.3 and 9.5.4 for Shaft Seal and Bearing Maintenance.

4. Assembly

a) Ensure that the impeller release mechanism, where applicable, and the shaft seal components are in position. See parts list drawings in section 10 for details.

b) Fit back-liner seal (W6) into the groove around back-liner (W4). Grease the seal to aid assembly.

c) Locate back-liner bolts (W19) into the lugs around back-liner (W4) and retain in position with back-liner bolt retaining strap (W18).

d) Offer back-liner (W4) to the frame, engaging back liner bolts (W19) in the frame holes.

⚠ WARNING Where applicable, use the back-liner lifting tool recommended in section 9.3.

e) Fit and tighten nuts (W20) to the correct torque (refer to sub-section 11.1).

NOTICE When fitting new parts to pumps fitted with expeller type shaft seals, it may be necessary to adjust the bearing assembly axially using the adjusting screw to prevent the expeller fouling the back liner.

f) Clean the thread on the shaft and grease with appropriate lubricant or anti-seize compound.

g) Renew impeller gasket (W17), or seal(W31), as appropriate.

h) Lift impeller as shown in Figure 9.5.2-A and mount it onto the shaft end. For internal combustion engine driven pumps, see special procedure in Figure 9.5.2-C.

i) Block impeller (W3) using a bar inserted in between two of its vanes, then turn the shaft with the special crank-handle until the impeller is locked tight –refer to sub-section 9.3.

j) Set the impeller back clearance, where applicable – see section 9.5.1.

k) Apply grease liberally around back-liner seal (W6) to assist entry into case (W1).

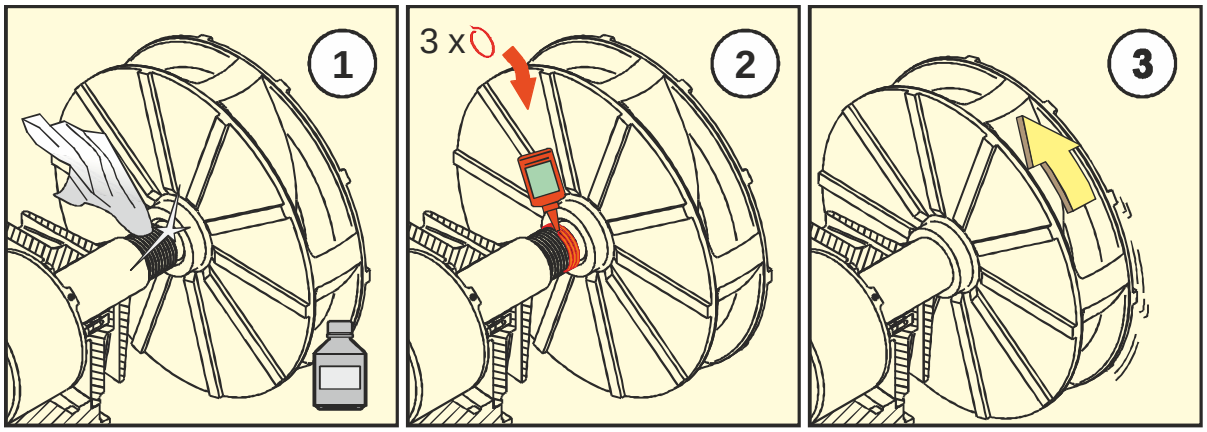


Figure 9.5.2-C Special procedure applicable **ONLY** to pumps driven by internal combustion engines

(1) Clean impeller (W3) and shaft (B11) threads using a cleaning agent recommended by the adhesive manufacturer.

(2) Apply a high strength retainer (e.g. Loctite® 638 or equivalent) to the first three threads at shaft end.

⚠ WARNING Always comply with adhesive manufacturer's user instructions and H&S advice.

(3) Mount and tighten impeller (W3) onto shaft (B11) as described above and continue with the rest of the assembly procedure.

9.5.2 Hydraulic parts and frame - dismantling and fitting

(iii) Impeller Release Mechanism (IRM), type-2

An IRM (a) is fitted behind the shaft sleeve (b) to ease removal of the impeller during maintenance and repair. Removing this mechanism releases the tightening torque on the impeller. See Figure 9.5.2-i.

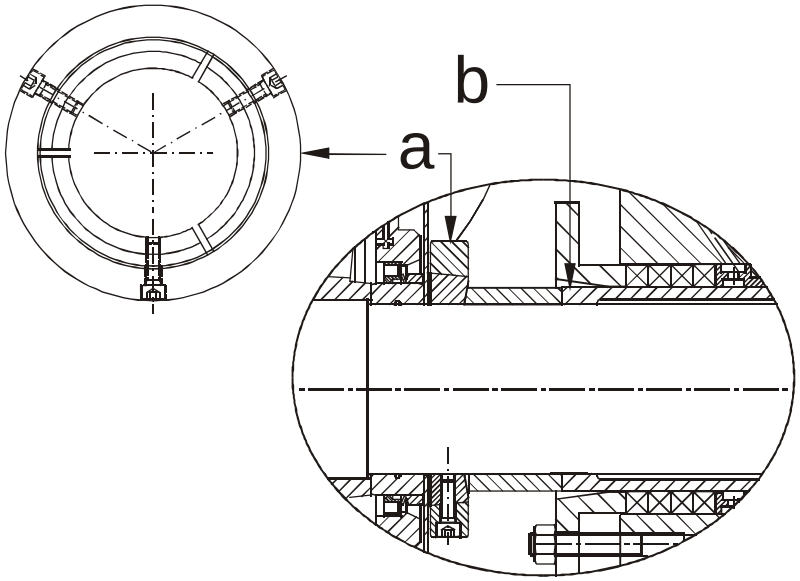


Figure 9.5.2-i Using impeller release mechanism (typical) eases impeller removal

Refer to Figure 9.5.2-ii:

To dismantle IRM (B25):

1. remove the assembly screws;
2. pull the outer ring away from the clamping segments;
3. if necessary, use one of the screws to lift the individual inner segments off the shaft.

To assemble IRM (B25):

1. apply an anti-seize compound to the IRM assembly screw threads;
2. secure the clamping segments to the outer ring using the assembly screws and tighten the screws to the recommended torque setting –see section 11.1;
3. slide IRM (B25) and impeller spacer (B54) into position in the correct sequence, make sure that they fit together correctly -i.e. as cone and cup.

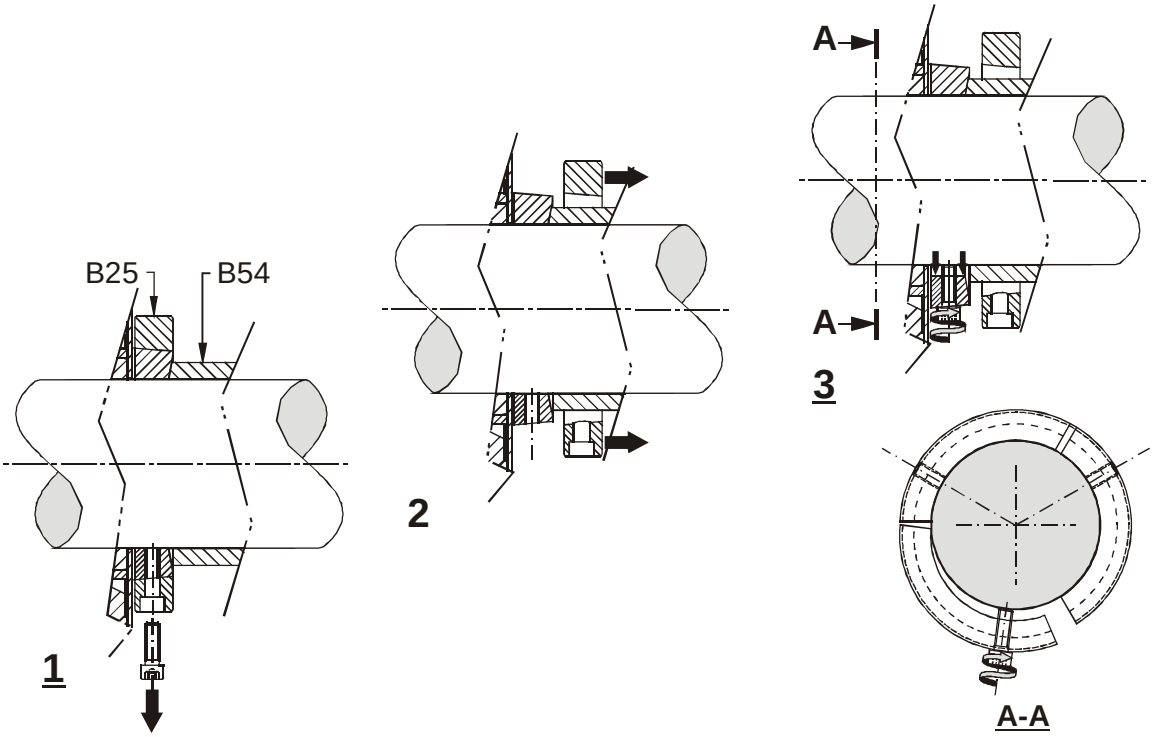


Figure 9.5.2-ii Impeller Release Mechanism, removal

9.5.2 Hydraulic parts and frame - dismantling and fitting

(iv) Hydraulic system

Not applicable

9.5.3 Shaft seal - dismantling and fitting

- **Centrifugal Seal (High-Chrome Expeller Ring)**

The centrifugal seal is used in pumping installations where water flushed glands are not acceptable.

A vaned expeller (G15) mounted on the shaft between the impeller and shaft sleeve (G2) generates a head that, working in conjunction with the back vanes of impeller (W3), keeps the liquid away from packing (G5). During normal operation there is no leakage at the gland. The packing is only used to retain the liquid when the pump is stationary.

This gland arrangement consists of three split packing rings (G5) and a lantern ring (G1) fitted into the annulus formed by shaft sleeve (G2) and expeller ring (G7). A gland follower (G10), with screws equally spaced around its flange and screwed into expeller ring (G7), retains the gland and allows for adjustment to the packing. A grease nipple (G21) is provided to lubricate the packing.

Expeller ring (G7) locates in bearing frame (P14) inner flange and is retained in position by back liner (W4). Differential impellers of reduced diameter may be used in some installations to give an improved gland seal where the expeller operation would otherwise be marginal.

1. Running Checks

During pump operation there should be no leakage from the gland. If leakage occurs this could indicate a number of problems:

Worn Pump Components	:	Strip and inspect the impeller, expeller and expeller ring. Renew as necessary.
Incorrect System Operation	:	Check for closed inlet or outlet valves or blocked pipelines.
Incorrect Pump Speed	:	Check for belt slip or for incorrect setting of a variable speed drive.

2. Stopping

NOTICE

Avoid stopping the pump when there is a head of slurry in the outlet pipe . This could result in damage to the gland or pump. Isolate the pump by a suitable valve arrangement or shut down the pump after pumping clean water.

a) Adjust the system so that the pump is pumping clean water, or isolate the pump.

b) Stop the pump.

c) Inspect the gland for excessive leakage.

d) If the centrifugal seal leaks when the pump is stationary, tighten gland follower (G10) by means of the gland follower screws (G18).

NOTICE

DO NOT over-tighten the screws as this will cause severe wear of the shaft sleeve.

3. Routine Adjustments

Apart from the running checks specified above the only routine adjustments required are:

a) To check the gland for leakage on stopping the pump and to adjust as necessary.

b) When full adjustment of the gland follower has been taken up, packing rings (G5) should be renewed.

c) Periodically lubricate the gland through grease nipple (G21).

NOTICE

The amount of grease injected should be a quarter of the quantity injected into the main bearings and at the same periodicity as the main bearings -see lubrication, section 9.4. The periodicity and quantity given here are a guide and should be modified in light of operational experience.

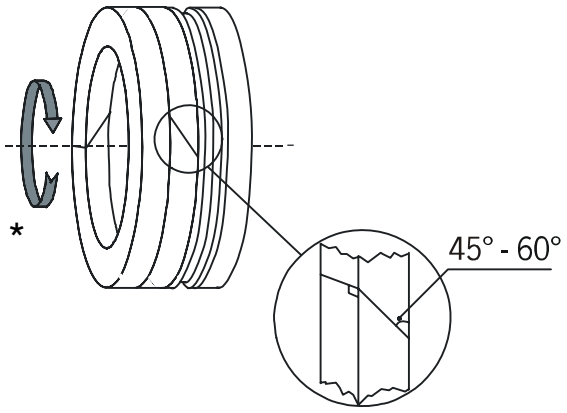


Figure 9.5.3-1 Arrangement of packing rings showing direction of rotation of the shaft (*)

4. Renewing Packing

a) Remove gland follower screws (G18).

b) Slide gland follower (G10) away from the gland and remove the first two packing rings (G5) with a packing extractor.

c) Charge the gland through grease nipple (G21).

d) Insert two packing extractors, one each into diametrically opposite holes in lantern ring (G1), and extract it.

e) Remove the last packing ring (G5).

f) Smear three new packing rings with grease and then insert into expeller ring (G7); one turn of packing (G5), lantern ring (G1), the last two packing rings, followed by gland follower (G10).

NOTICE

Make sure that the packing joints are staggered by approximately 180° to prevent a leakage path from occurring (see Figure 9.5.3-1). If necessary use the gland follower to press each turn of packing into position.

g) Grease the gland through grease nipple (G21).

h) After opening the inlet and outlet valves check the gland for leaks. If leakage is excessive tighten the gland follower evenly until leakage is acceptable.

NOTICE

DO NOT over-tighten the screws as this will cause severe wear of the shaft sleeve.

5. Maintenance of the Centrifugal Seal (Removal)

a) Gain access to expeller ring (G7) and gland by opening up the pump using the Front or Back Pull-Out Method.

b) Remove expeller (G15).

c) Slide expeller ring (G7) complete with the gland seal assembly from the shaft.

⚠ WARNING

Shaft seals for large pumps are quite heavy. Use the special shaft extension to facilitates their removal and refitting –see sub-section 9.3.

d) Remove shaft sleeve (G2) and gaskets (G58) if these items have not come away with the gland seal.

6. Maintenance of the Centrifugal Seal (Disassembly)

a) Remove gland follower screws (G18) and gland follower (G10).

b) Push out shaft sleeve (G2) if it is still in position.

c) Remove packing rings (G5) and lantern ring (G1).

7. Maintenance of the Centrifugal Seal (Inspection)

a) Inspect expeller ring (G7) and its seal (G17.1) for wear and/or damage.

b) Examine all gaskets for deterioration, wear and/or damage.

c) Check shaft sleeve (G2) for wear and/or damage.

d) Examine gland follower (G10) for distortion of the flange due to over-tightening of the screws.

e) Inspect the lantern ring for wear and/or damage.

8. Maintenance of the Centrifugal Seal (Assembly)

NOTICE | Renew all packing rings and any suspect components.

a) If expeller ring seal (G17.1) is to be renewed, remove the old seal and thoroughly degrease the groove in expeller ring (G7) using a suitable cleaning agent. Apply grease to the new seal and fit into the groove.

b) Assemble the gland with the expeller ring resting on a flat surface, rear face uppermost.

c) Position shaft sleeve (G2) vertically in the bore of expeller ring (G7).

d) Smear grease on packing rings (G5) and, in the order listed, fit the following parts over shaft sleeve (G2) into the bore of expeller ring (G7):

- One turn of packing (G5)
- Lantern ring (G1)
- Two rings of packing (G5)
- Gland follower (G10).

e) Fit gland follower screws (G18) and nip finger tight.

f) Using the wet-end sealing system drawing in section 10.4, identify and fit the appropriate gaskets and spacers onto the shaft in the order shown.

g) Offer up the expeller ring and gland assembly so that shaft sleeve (G2) abuts a gasket. Ensure that the expeller ring spigot locates in bearing frame (P14).

h) Fit the last shaft sleeve gasket (G58) followed by expeller (G15) onto shaft (B11).

9. Maintenance of the Centrifugal Seal (Re-fitting)

Re-fit the bearing frame and rotating assembly or the case as appropriate for the method of removal.

NOTICE | **BEFORE** operation, carry out the pre-start checks.

9.5.4 Shaft and bearing assembly - removal and fitting

⚠ WARNING

Make sure that **ALL** slings, shackles, etc. are of adequate load carrying capacity. Approximate weights of major components are provided in sub-section 11.3.

Lifting points incorporated in individual components are intended solely for lifting that specific component. **NEVER** use these for lifting assemblies of components.

The following instructions assume that the pump is installed complete with the drive unit and is connected to the suction and discharge pipework.

1. Removal

   a) Remove the wet end assembly (refer to sections 9.5.2 & 9.5.3).

   b) Remove the drive safety guard and disconnect the drive belts, or drive coupling, as applicable.

   c) If necessary, remove the drive motor to provide sufficient space to withdraw the bearing frame assembly from the case.

   d) Where applicable, remove impeller release mechanism from the shaft – see section 9.5.2 (iii).

   e) Slacken impeller adjusting fixings (P19, P38 & P42) and jiggle out the whole adjustment screw assembly.

   f) Unscrew saddle screws (P20) and remove saddle (P18).

   g) Unscrew housing clamp fixings (P15, P16, P27) and remove housing clamps (P29).

   h) Lift bearing cylinder assembly, as shown in Figure 9.5.4-1, out of the bearing frame.

   i) Place the assembly on suitable supports, ideally wooden vee blocks.

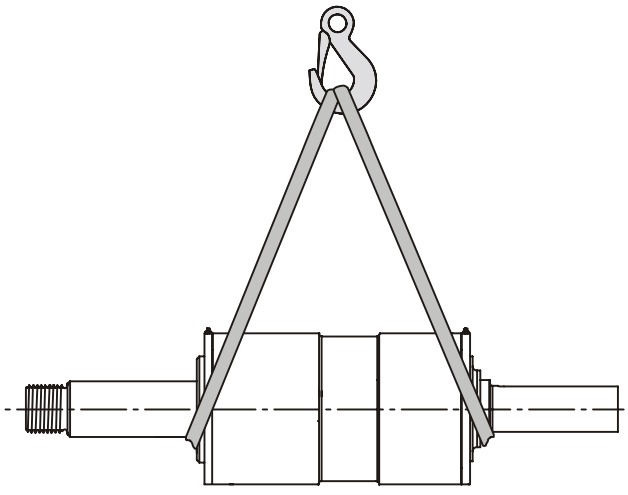


Figure 9.5.4-1 Lifting the bearing cylinder

2. Re-fitting

a) Clean and degrease the bearing frame contact surfaces. Coat the machined surfaces with anti-seize compound.

b) Lift the bearing cylinder assembly, as shown in Figure 9.5.4-1, and lower it onto bearing frame (P14).

c) Rotate (Ra or Rc as convenient) the bearing cylinder assembly in the bearing frame so that the tapped holes for the saddle screws are in-line with the slot in the frame for impeller adjusting screw (P19). As shown in Figure 9.5.4-2.

NOTICE In either position, grease nipples will be visible above the frame top plate.

d) Fix saddle (P18) to bearing housing (B14) using screws (P20), and tighten to the recommended torque setting.

e) Mount adjusting screw assembly (P19, P38 & P42) in position between frame (P14) & saddle (P18) – see Figure 9.5.4-2.

f) Tighten saddle-end locknut to the recommended torque setting. See section 11.1.

g) Where applicable, assemble impeller release mechanism to the shaft – see section 9.5.2 (iii).

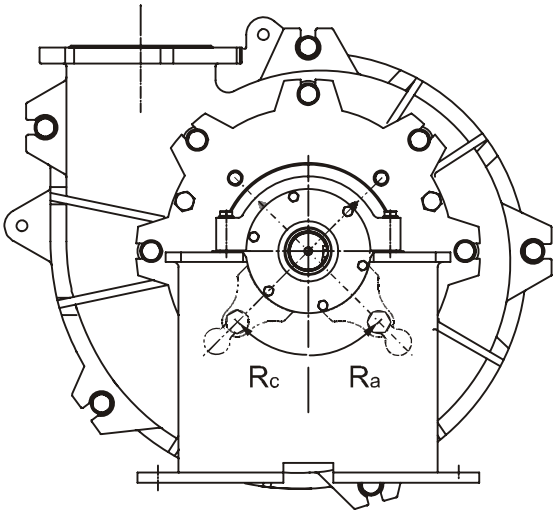


Figure 9.5.4-2 Bearing orientation

h) Reassemble the shaft seal and the wet-end as described in sub-sections 9.5.3 & 9.5.4.

i) Reassemble the drive, fit the guards and restore all the supplies to the pump.

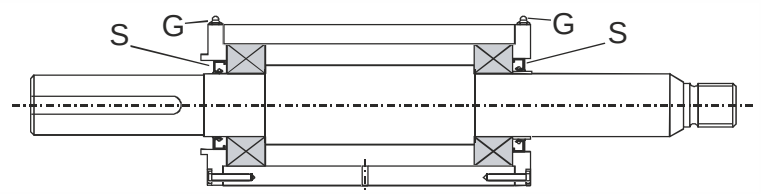
9.5.5 Shaft and bearings - disassembly and re-assembly

1. General

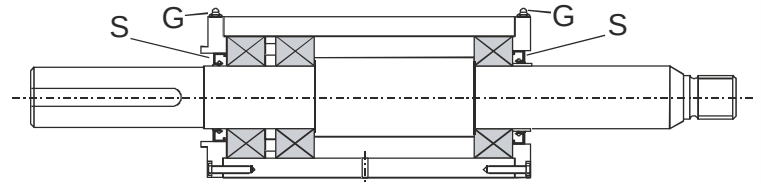
⚠ WARNING Make sure that **ALL** slings, shackles, etc. are of adequate load carrying capacity. Approximate weights of major components are provided in sub-section 11.3.

The bearing assembly consists of a steel shaft onto the end of which the impeller is screwed. The other end of the shaft is keyed to accept a coupling or belt drive arrangement.

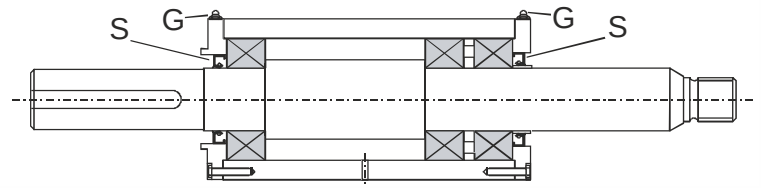
Heavy-duty, tapered roller bearings are used in various configurations as illustrated schematically below:



Standard bearing assembly



Double dry-end bearing assembly for high belt loads



Double wet-end bearing assembly for high impeller loads

A lipseal with an integral dust lip (S) at each end of bearing housing (B14), protects it against ingress of dirt and other foreign matter. Grease nipples (G) are fitted to allow periodic bearing lubrication. Grease is purged through the bearings to remove any contamination.

The central portion of the bearing housing is color coded to allow the assembly type to be ascertained from the exterior. The band is visible, when the cover plate (P24) is taken off the bearing frame (P14). Table 9.5.5-1 explains the coding.

Table 9.5.5-1 Bearing assembly type color coding

UNIT TYPE	STATUS	COLOR CODE
Standard	New build	Mid Blue-18.E.53
Double dry-end	New build	Green
Double wet-end	New build	Yellow
Standard	Reconditioned	Red
Double dry-end	Reconditioned	Red with green band
Double wet-end	Reconditioned	Red with yellow band

2. Disassembly

a) Remove flinger (B1) from the wet-end of the bearing cylinder.

b) Support the shaft and bearing assembly vertically in a secure stand – see Figure 9.5.5-1 on its wet-end end-cover with the impeller thread pointing down.

c) Remove the following parts from the dry-end of the bearing cylinder housing (B14):

- End –cover fasteners (B5, B26)
- End-cover (B2.2)
- End-cover seal (B19.2).

d) Lift out the shaft and bearings.

e) Tap or press off the bearings.

NOTICE Three-bearing assemblies have an inner and outer spacer fitted between the bearings at the two-bearing end.

f) Lay the bearing cylinder housing horizontally on vee blocks.

g) Remove end-cover (B2.1) and shims from the wet-end.

h) Remove end-cover seal (B19.1)

i) Wash all parts in a suitable cleaning solvent and dry carefully.

3. Inspection

a) Inspect bearing housing (B14) internally for excessive wear where the roller bearing outer races locate. Check that all threaded holes are clear and that the threads are undamaged.

b) Check for damaged seals (B16, B19.1, B19.2). Inspect end-covers (B2.1, B2.2) for damage and ensure that grease passages are clear.

c) Carefully inspect the roller bearings, cages and races for wear, damage and corrosion. After inspection, dip the bearings in gear oil and wrap them in a clean cloth or paper to protect them until installation.

d) Check the condition of the shims.

NOTICE

Metso Minerals shims are coded. Packs of shims in assorted sizes are available as spares. See section 10 for details. Table 9.5.5-2 identifies shim coding.

END COVER SHIM PACK		
Shim thickness		Color
(mm)	(in)	
0.050	0.002	Dark blue (translucent)
0.075	0.003	Green (translucent)
0.100	0.004	Orange (translucent)
0.200	0.008	Light blue (transparent)
0.250	0.010	White (opaque)
0.375	0.015	Red (opaque)
0.500	0.020	Cream (translucent)

Table 9.5.5-2 Shim color coding

e) Examine the shaft for damage and corrosion. Remove any nicks and burrs with a carborundum stone.

f) Inspect the shaft sleeve and gaskets for deterioration, damage and wear. Renew any gaskets which are suspect.

g) Renew any defective components.

4. Assembly

a) Slide the bearing inner races and bearing cages onto shaft (B11). Ensure that the large outer diameter of the inner races are facing inwards on the shaft.

NOTICE

On assemblies with two bearings at one end, the arrangement is as follows: inner race, inner spacer, outer race, outer spacer, inner race.

b) Press the bearing inner races onto the shaft so that they are tight against the inner shoulders of the shaft.

NOTICE

The bearings may be heated in oil or in a bearing heater to a maximum of 121 °C (250 °F) for ease of assembly.

c) Coat the shaft between the bearings with a suitable corrosion preventive solution.

NOTICE

DO NOT grease the bearing lands of the bearing housing. These lands should be cleaned with a proprietary degreasant and thoroughly dried. Ensure that the lands are free from all dirt, grit and contaminants before assembling.

d) Push or tap a bearing (B8) outer race into the bearing cylinder housing (B14) at the end nearest the tapped saddle screw (P20) location holes (wet-end) and position it just below the end face of the housing. The smaller inner diameter must be outermost. See the assembly diagram for correct orientation if in doubt. Stand the housing on one end to assist assembly.

e) Fit grease nipples (B13) to end-covers (B2.1, B2.2), if not already fitted. Purge greaseways with fresh grease using a grease gun and wipe excess grease away. Ensure that the end-covers are kept clean.

f) Press seal (B19.1) into end-cover (B2.1), with the spring-loaded lip facing the bearing housing (B14) side. Apply an adhesive such as LOCTITE® 480, or equivalent, to ease assembly and to bond seal (B19.1) in position.

⚠ WARNING

ALWAYS comply with adhesive manufacturer's user instructions and H&S advice.

g) Fill the void between the seal's lips with grease.

h) Place one thick end-cover shim (B3) over the spigot of end-cover (B2.1) and fit it to bearing cylinder housing (B14) using fasteners (B5, B26) so as to push the outer bearing race into the housing. Position the end-cover so that the bearing grease hole will be accessible when the bearing cylinder assembly is fitted to bearing frame (P14). Tighten fasteners (B5, B26) evenly and to the correct torque. See Torque Table, section 11.1.

i) Fit shaft (B11) into bearing cylinder housing (B14) with its threaded end protruding from the wet-end cover (B2.1). It is recommended that the housing is supported vertically in a secure stand to give sufficient clearance underneath the shaft –see Figure 9.5.5-1.

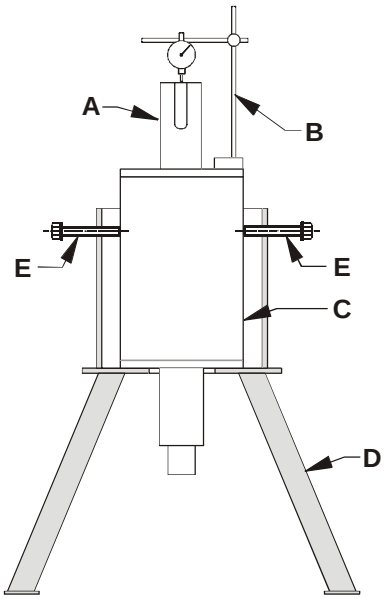


Figure 9.5.5-1 Bearing cylinder housing support & bearing clearance: Shaft(A), Dial test indicator (B), Bearing cylinder housing (C), Support stand (D), Securing screws (E).

j) Fit the bearing (B8) outer race into the bearing cylinder housing at the dry-end and press it into position using dry-end cover (B2.2) until the shaft becomes stiff to turn.

k) Assemble a new pack of shims (B3) or the pack removed during disassembly if in good condition.

l) Remove cover (B2.2), fit the shims over the cover's spigot, then re-fit the cover to the housing.

m) Tighten fasteners (B5, B26) evenly and to the correct torque.

NOTICE

Strike the individual ends of the shaft to ensure that the bearing races are hard up against the end cover before checking the bearing clearance.

Table 9.5.5-3 Bearing clearances

FRAME SIZE	CLEARANCE (END-FLOAT)	
	(mm)	(mil)
FR250	0.075 to 0.125	3 to 5
FR300	0.075 to 0.125	3 to 5
FR400	0.100 to 0.150	4 to 6
FR500	0.100 to 0.150	4 to 6
FR600	0.150 to 0.200	6 to 8
FR750	0.180 to 0.250	7 to 10

n) Check the bearing clearance for the size of pump (See Table 9.5.5-3) using a dial test indicator on the shaft end.

NOTICE

Ideally, the indicator should be fitted to a magnetic base located on the end-cover. By moving the shaft backwards and forwards the end clearance may be read on the indicator (see Figure 9.5.5-1).

o) Remove or add shims (B3) as necessary to obtain the correct clearance.

NOTICE

Rotate the shaft while checking the clearance to ensure correct seating of the bearing rollers.

p) Having set the clearance, remove dry-end cover (B2.2) and its shim set (B3).

q) Remove the dry-end bearing (B8) outer race and withdraw the shaft assembly.

r) Pack the required quantity of grease into both bearing cages -see Lubrication sub-section 9.4.

NOTICE

When hand packing, force grease through the bearing under the cage from the large to the small end to ensure thorough distribution. Always use the correct quantity of grease. Over or under greasing can be detrimental to the life of the bearing.

s) Re-fit shaft (B11) into bearing cylinder housing (B14).

t) Re-fit the dry-end bearing outer race into the housing.

u) Fit seal (B19.2) into end-cover (B2.2). Press seal (B19.2) into end-cover (B2.2). Apply an adhesive such as LOCTITE® 480, or equivalent, to ease assembly and to bond seal (B19.2) in position.

⚠ WARNING

ALWAYS comply with adhesive manufacturer's user instructions and H&S advice.

v) Fill the void between the seal's lips with grease.

w) Fit the shims and refit end-cover (B2.2) to the housing, positioning the grease hole such that it will be accessible when the bearing cylinder assembly is fitted to bearing frame (P14).

x) Tighten fasteners (B5, B26) evenly and to the correct torque.

y) With the bearing cylinder housing now supported horizontally, lubricate the parts with grease and slide the shaft spacer (B6) with the shaft spacer seal (B16) into position taking care not to damage the seal.

z) Fit the flinger (B1).

9.5.6 Pump drive - removal and re-fitting

(NOT APPLICABLE)

9.6 Fault finding

9.6.1 General

Use the checklist provided to quickly establish the cause of any running problems. The checklist assumes that the equipment normally operates satisfactorily.

⚠ WARNING

Where possible checks must be carried out with the power supply securely isolated. Where power is required for carrying out the checks, take every precaution prescribed in order to avoid injury to personnel. Electrical work must only be carried out by a fully qualified electrician.

A multimeter, a test lamp and appropriate circuit diagrams will be required to carry out checks on electrical equipment.

NOTICE

If all fails, contact metso minerals for further advice.

9.6.2 Pump fails to start

Is power supply live ?

Yes

⇓

⇓

⇓

⇓

⇓

⇓

No⇒ Check that:

- mains switch is closed;
- starter and its fuses are intact;
- control voltage is available for starting;
- overload protection has been reset;
- all phases are live;
- power cable to motor is not damaged.

Can pump be started manually ?

Yes

⇓

⇓

⇓

⇓

No⇒ Is there a fault with:

- level control equipment ?
- other monitoring or control equipment ?

Consult monitoring equipment documentation and change any faulty equipment.

Is the shaft jammed ?

No

⇓

⇓

⇓

⇓

⇓

⇓

Yes⇒ Securely isolate the power supply.

- Remove the belt guard and try to rotate the pump shaft by hand.
- Dismantle the pump and clean behind the impeller. See section 9.5.2. Flush out the pump and the pump sump.
- Dismantle the drive and check that both the motor and pump shaft can be rotated. Fit new bearings if necessary. See section 9.5 and the motor manufacturer's instructions.

9.6.3 The pump starts but the motor protection trips

Has flow path or pipe run been modified ?

No

⇓

⇓

Yes⇒

- Alter the flow path or pipe run, or adjust the rating of the drive motor and pump to suit new operating conditions.

Is motor protection setting too low ?

No

⇓

⇓

Yes⇒

- Check against the motor rating plate and adjust as necessary

Is shaft jammed or hard to turn?

No

⇓

⇓

⇓

⇓

⇓

⇓

⇓

⇓

Yes⇒

- Securely isolate the power supply.
- Remove the belt guard and try to rotate the pump shaft by hand.
- Dismantle the pump and clean behind the impeller. See section 9.5.2. Flush out the pump and the pump sump
- Dismantle the drive and check that both the motor and pump shaft can be rotated. Fit new bearings if necessary. See section 9.5 and the motor manufacturer's instructions.
- Check that pump clearances are correct. See section 9.5.1.

9.6.4 The pump is running but the flow rate is too low or nil

Has operating conditions or pipe run been modified ?

Yes⇒

- Alter the operating conditions, the pipe run, or adjust the rating of the drive, motor and pump to suit new operating conditions.

No
⇓
⇓

Has leakage been detected in plant ?

Yes⇒

- Renew or seal the leaking parts.

No
⇓
⇓

9.6.5 The pump runs unevenly or vibrates

Is the inlet flow uneven or is the pump drawing air ?

Yes⇒

- Either adjust the feed to the pump, or adjust the rating of the drive, motor and pump to suit the operating conditions.

No
⇓
⇓

Are all valves open and are the pipes clear ?

No⇒

- Remedy the fault.

Yes
⇓
⇓

Is the impeller clogged ?

Yes⇒

- Clean the impeller -see Dismantling and Assembly, section 9.5.

No
⇓
⇓

9.6.6 Abnormal leakage from the shaft gland

See Shaft Seal Removal and Fitting, section 9.5.3.

10 SPARE PARTS

10.1 Recommended stock of spares

To reduce the length of time a pump is out of service, it is advisable to always keep in stock a set of the recommended spare parts listed in this section. Please refer to the table below for part item number references.

Item	Part Reference
Case (complete volute)	W1
Impeller	W3
Back-liner	W4 (+ W6)
Wet-end seal kit (G17.1, G39, G58, W6, W17, W18)	W77
Shaft sleeve	G2
Gland packing	G5
Expeller ring	G7
Expeller	G15
Bearing cylinder assembly	B99
Set of seals – Bearing (B3, B16, B19.1, B19.2)*	B98

*** NOTE:** '**METRIC**' BEARING CYLINDER - (B16, B19, B22)

END COVER SHIM PACK **		
Shim thickness		**Colour**
(mm)	**(in)**	
0.050	0.002	Dark blue (translucent)
0.075	0.003	Green (translucent)
0.100	0.004	Orange (translucent)
0.200	0.008	Light blue (transparent)
0.250	0.010	White (opaque)
0.375	0.015	Red (opaque)
0.500	0.020	Cream (translucent)
Shim material: synthetic (various)		

**** NOTE:** NOT APPLICABLE TO PUMPS WITH '**METRIC**' BEARING CYLINDERS

10.2 Storage of spares

See section 1.2.5.

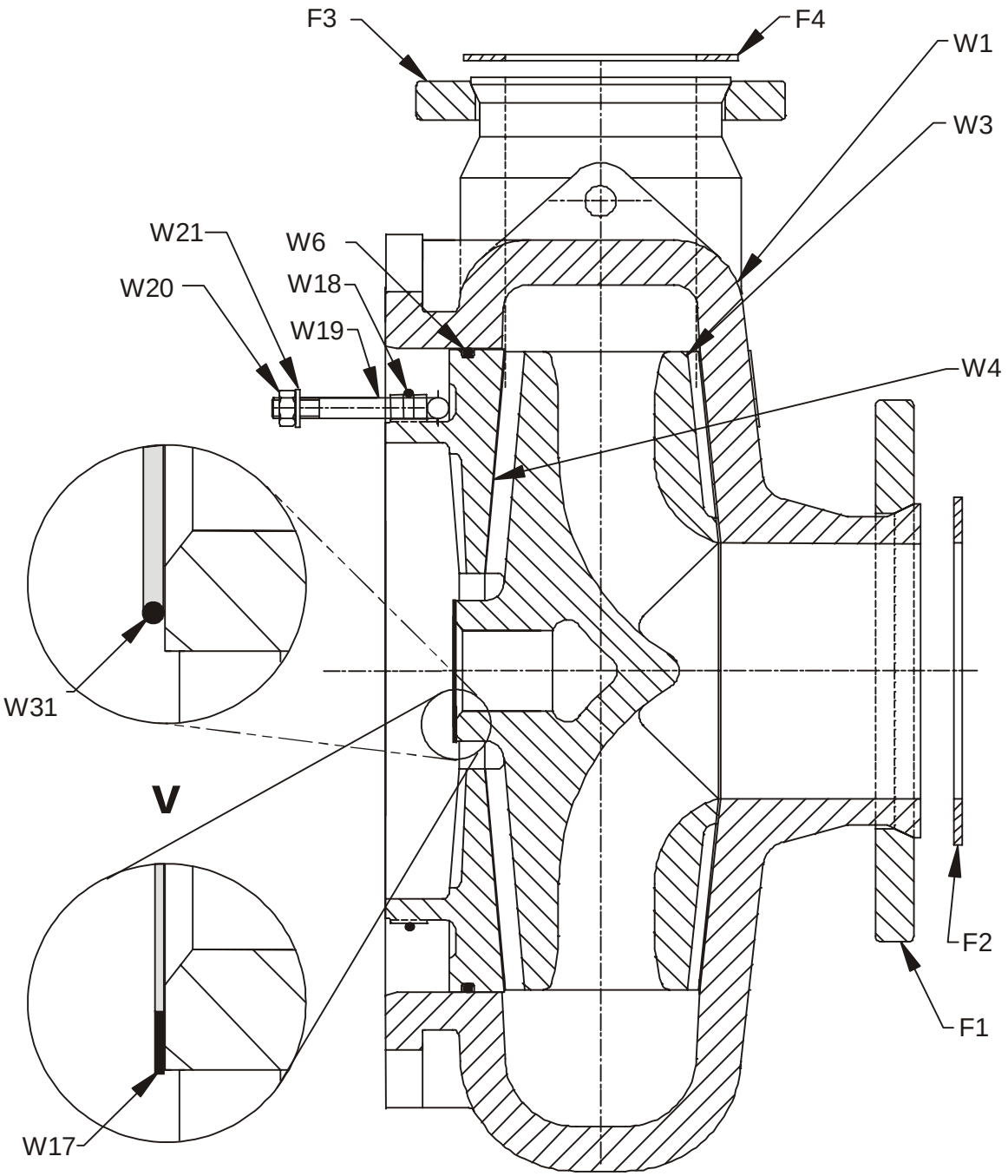
10.3 Spares ordering procedure

To assist our Spares Department process your order quickly, customers are requested to provide the following information when ordering spares:

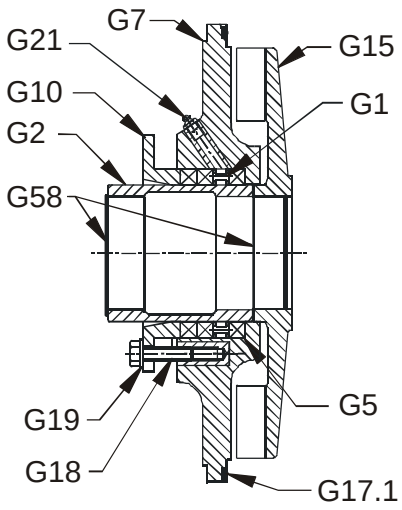
- Model and Size of pump
- Serial Number
- Build Number
- Approximate date of purchase
- Part Number and Description of Required Spare Parts

This information should then be forwarded to the local Metso Minerals branch for action - - see sub-section 1.4.

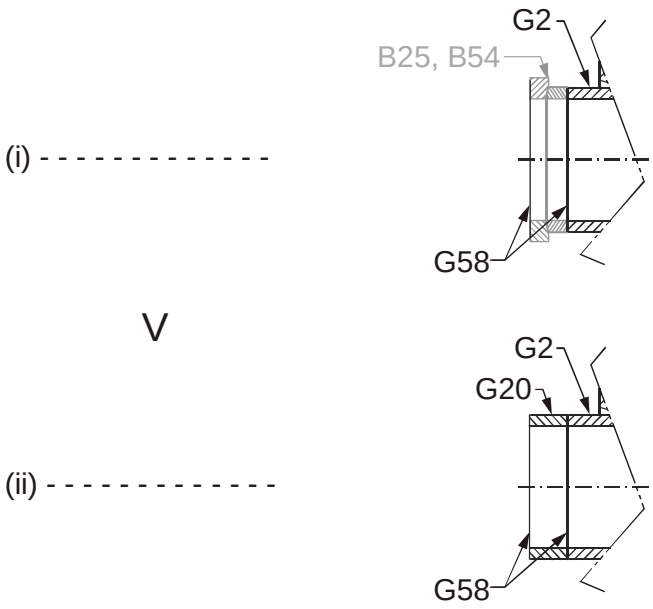
10.4 Spare part drawing

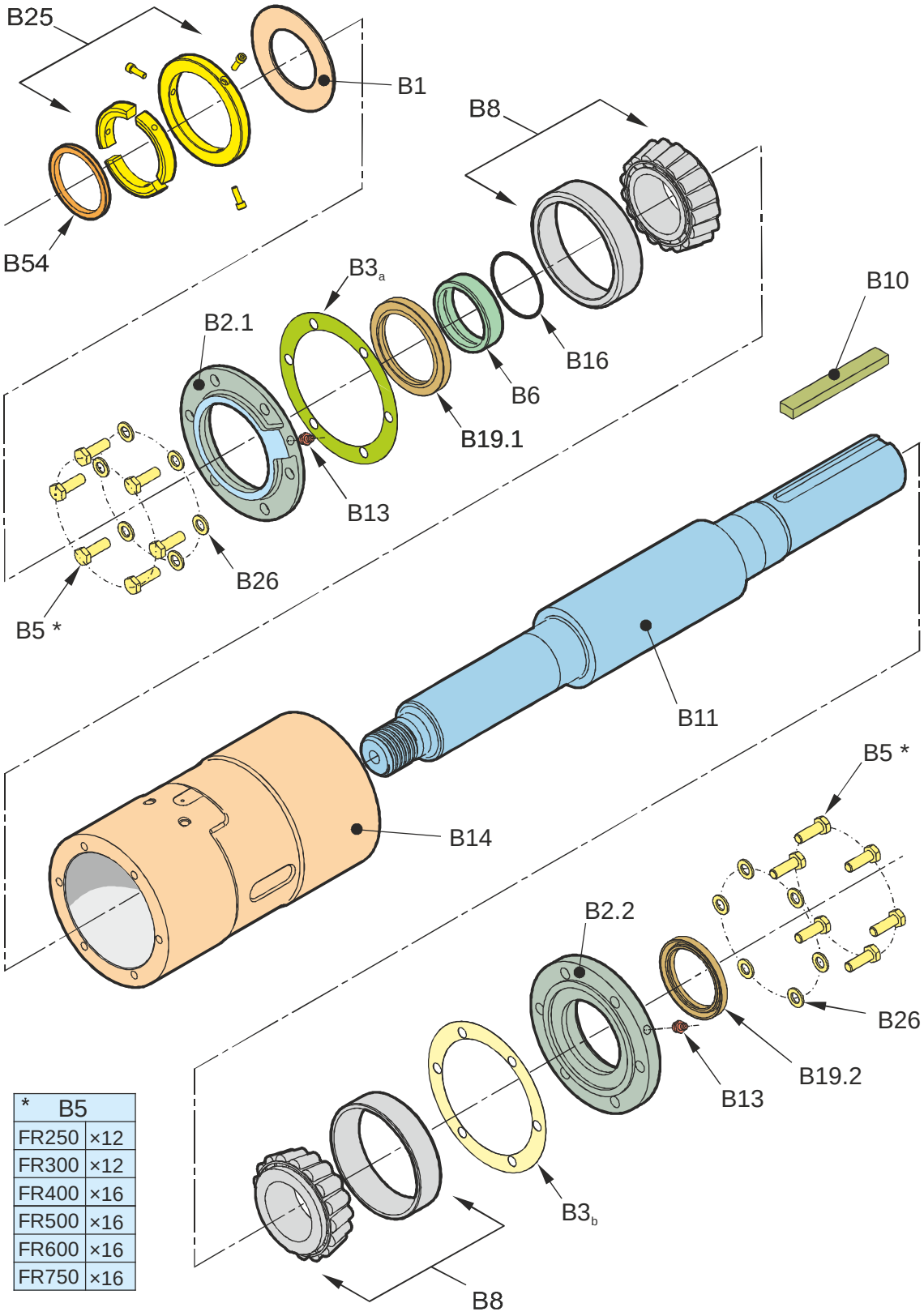

F3
F4
W1
W3
W21
W6
W20
W18
W19
W4
W31
V
F2
F1
W17

FR250, FR300

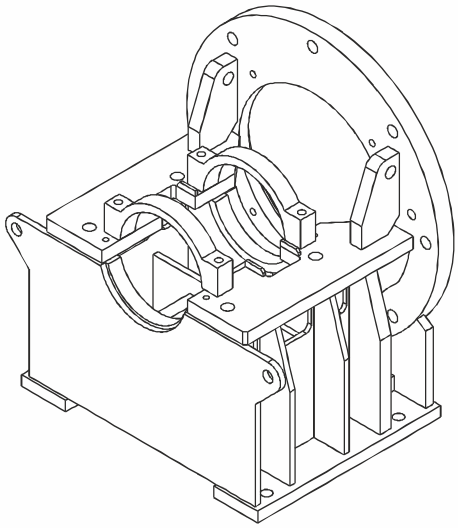


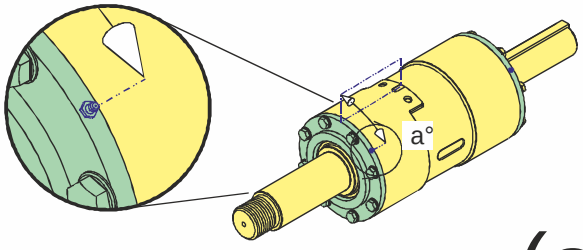
FR400, FR500, FR600, FR750



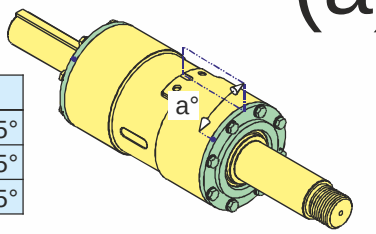


* B5	
FR250	×12
FR300	×12
FR400	×16
FR500	×16
FR600	×16
FR750	×16

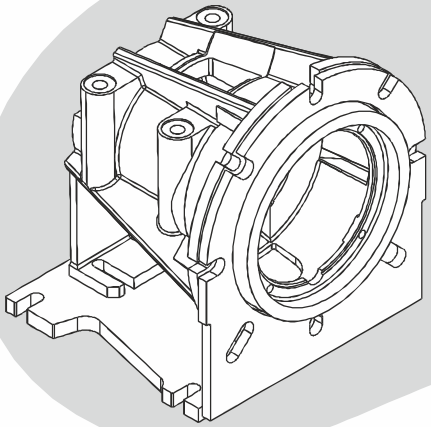




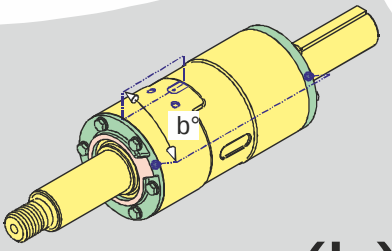
(a)



a°			
FR500	45°	90°	135°
FR600	45°	90°	135°
FR750	45°	90°	135°



b°	
FR250	60°
FR300	60°
FR400	45°
FR500	45°
FR600	45°
FR750	45°



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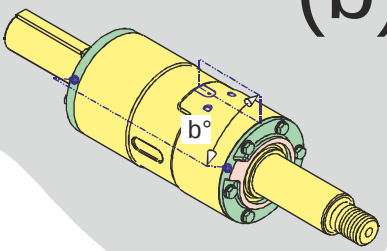
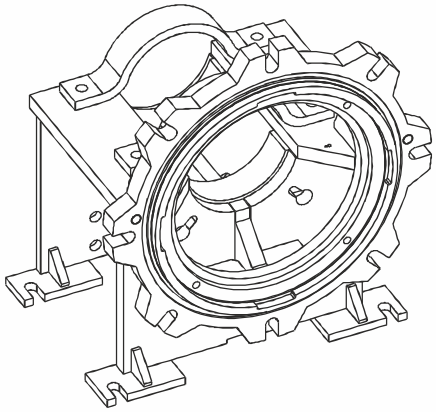
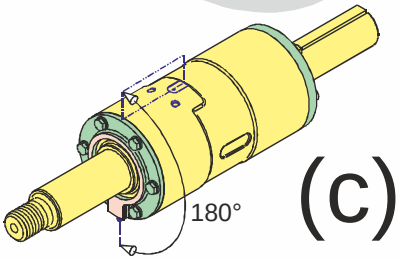
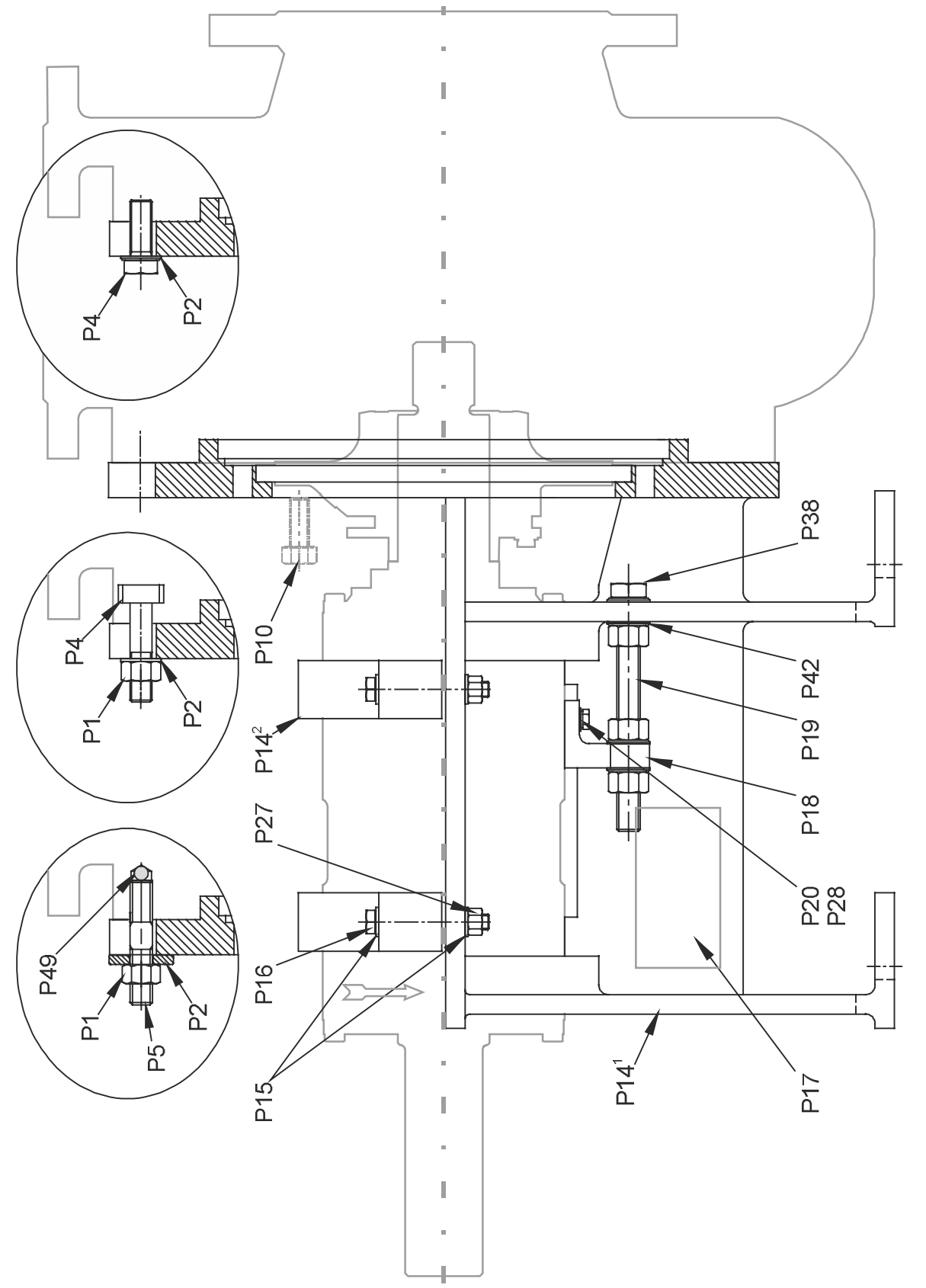






(c)


P4
P2
P4
P1
P2
P49
P1
P5
P2
P10
P14[2]
P27
P16
P15
P14[1]
P38
P42
P19
P18
P20
P28
P17

Item	Part No.	Description	Qty	Unit weight Kg
		Wear parts		
W01	PDCH2176	Case	1	0.00
W03	PDCH2178	Impeller	1	0.00
W04	PD721041	Back-liner	1	0.00
W06	SA983300	O-ring (incl. in w04)	1	0.00
		Shaft seal		
G01	SA500797-1	Lantern ring	1	0.00
G02	PDCF2539	Shaft sleeve	1	0.00
G05	PD730011	Packing	3	0.00
G07	PDCH7107	Expeller ring	1	0.00
G10	PD730044	Gland follower	1	0.00
G15	PDCH1877	Expeller	1	0.00
G17.1	SA00923201006S	O-ring (incl. in g07)	1	0.00
G58	PDCA565	Gasket	3	0.00
		Bearing assembly parts		
B01	SA507728-1	Flinger	1	0.00
B02.1	PDCH1875	End cover	1	0.00
B02.2	PDCH3075	End cover	1	0.00
B03	PD730025	Shim set	1	0.00
B06	PDCB821	Shaft spacer	1	0.00
B08	Z0370438	Bearing	2	0.00
B10	SA899020-180	Key	1	0.00
B11	PDCH1876	Shaft	1	0.00
B14	PD730004	Bearing cylinder housing	1	0.00
B25	SA500836-M1	Impeller release mechanism	1	0.00
B54	SA500836-6	Impeller spacer	1	0.00
B98	PDWB05-S1	Set of seals	1	0.00
B99	PDWB051-S	Bearing /shaft assembly	1	0.00
		Spare parts		
P04	SA507094-S5	Case bolt	8	0.00
P18	SA501039-1	Saddle	1	0.00
W17	PDCA564	Gasket	1	0.00
W18	SA873.0830-00	O-ring	1	0.00
W19	SA501476-1	Back liner bolt	4	0.00

10.6 Toolkit

10.6.1 Standard tools

In addition to the special tools detailed in sub-section 9.3 and Table 10.6-2, and installation tools and equipment detailed in sub-section 6.3, Table 10.6-1 lists a basic toolkit for performing normal maintenance operations on the pump. A dial test indicator may also be required to set bearing clearances – verify by reference to section 9.5.5. Additional tools may also be listed in the motor installation and maintenance documentation. Refer to Reference Publications, sub-section 11.2.

Table 10.6-1 Toolkit

Item	Qty.	Type	Sizes						
			MM100	MM150	MM200	MM250	MM300	MM350	MM 400
1	1	Spanner AF (mm)	17,24	17, 24	19, 30	19, 24, 36	24, 30, 46	24, 30, 46	30, 36, 55
2	1	Socket AF (mm)	17,24	17, 24	19, 30	19, 24, 36	24, 30, 46	24, 30, 46	30, 36, 55
3	1	Torque wrench (Nm range)	10 - 300		— 800		— 2500		
		Torque wrench (lb-ft range)	5 - 250		— 600		— 2000		
4	1	Adjustable spanner (mm)	25		40				

10.6.2 Special tools

Table 10.6-2 Special tools

Item	Size	Part No.			
		Crank	Packing extractor	Back-liner lifter	Shaft extension
1	**MM100**	SA500244-M1	981865	N/A	N/A
2	**MM150**	SA219594-M1			
3	**MM200**	SA219595-M1			
4	**MM250**	SA219596-M1	981607		SA501470-M1
5	**MM300/ MM350**	SA219598-M1			SA501471-M1
6	**MM400**	SA219598-M1			SA501472-M1

11 APPENDICES

11.1 Torque table

The following table gives the recommended torque values for tightening bolts and screws.

⚠ WARNING | All torque value tolerances are ±5%.

ITEM	TORQUE VALUES , Nm (lb-ft))						
	MM100	**MM150**	**MM200**	**MM250**	**MM300**	**MM350**	**MM400**
Case fixings (B)	M16 197 (145)	M16 197 (145)	M20 385 (285)	M24 665 (490)	M30 1310 (966)	M30 1310 (966)	M36 2280 (1678)
End-cover bolt (B5)	M8 24(18)	M8 24(18)	M12 81(60)	M12 81(60)	M16 197(145)	M16 197(145)	M20 385(283)
Outlet flange half-clamp bolts NP16 (F3)	M10 47(35)	M12 81(60)	M12 81(60)	M16 197(145)	M16 197(145)	M16 197(145)	M16 197(145)
Inlet flange half-clamp bolts NP16 (F1)	M12 81(60)	M12 81(60)	M16 197(145)	M16 197(145)	M16 197(145)	M16 197(145)	M20 385(283)
Housing clamp screws (P16)	**M16 115(85)**	**M16 115(85)**	M20 175(129)	**M16 115(85)**	M20 175(129)	M20 175(129)	M20 175(129)
Back-liner bolts (W19)	M10 47(35)	M10 47(35)	M12 81(60)	M16 197(145)	M20 385(285)	M20 385(285)	M20 385(285)

11.2 Reference publications

11.3 Weights table

Item	Description	Weight	
		(lb)	(kg)
-	Bare shaft pump	1150	522
W1	Case	449	204
W3	Impeller	121	55
W4	Backliner	59	27
P14	Frame	249	113
B99	Bearing cylinder assembly	169	77
-	Back pull-out assembly	650	295