



Pump Division



Byron Jackson Type M Double Mechanical Seal Submersible Pumping Unit

*USER INSTRUCTIONS:
INSTALLATION, OPERATION, MAINTENANCE*

PCN=85392711 1042.293/9 • Edition June 2004

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1 INTRODUCTION AND SAFETY

1.1 About the product and these user instructions

NOTE These user instructions must always be kept close to the product's operating location of operation or directly with the product so that they are available to the operating personnel at any time.

Flowserve's products are designed, developed and manufactured with state-of-the-art technologies in modern facilities. The pumping unit is produced with great care and commitment to continuous quality control, utilizing sophisticated quality techniques, and safety requirements.

Flowserve is committed to continuous quality improvement and being at service for any further information about the product in its installation and operation or about its support products, repair and diagnostic services.

These instructions are intended to facilitate familiarization with the product and its permitted use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. The instructions may not take into account local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws/regulations.

NOTE These instructions should be read prior to installing, operating, using and maintaining the equipment in any region worldwide.

The equipment must not be put into service until all the conditions relating to safety, noted in the instructions, have been met.

These user instructions outline the general procedures that must be observed to ensure long, trouble free performance of the pumping unit. However, it is assumed that plant personnel are familiar with the basic principles and tools involved in the installation, operation and maintenance of a pumping unit. Successful pumping unit operation is dependent on careful study of these user instructions

and a well planned and observed maintenance program.

In these user instructions, the numbers in brackets are item numbers, e.g.: shaft button screw (806-2). Refer to the drawings in Chapter 8 "Parts list and drawings", Page 59, for the position of the respective item.

1.2 CE marking and approvals

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform with the applicable CE Marking Directives covering Machinery and, where applicable, Low Voltage Equipment, Electromagnetic Compatibility (EMC) and Pressure Equipment Directive (PED).

Where applicable, the Directives and any additional Approvals cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where applicable, this document incorporates information relevant to these Directives and Approvals.

To check if the approvals apply and if the product itself is CE marked, check the serial number plate markings and the Certification, see Section 9 "Certification", Page 60.

1.3 Disclaimer

Information in these user instructions is believed to be reliable. In spite of all the efforts of Flowserve Pump Division to provide sound and all necessary information the content of these user instructions may appear insufficient and is not guaranteed by Flowserve as to its completeness or accuracy.

Flowserve manufactures products according to International Quality Management System Standards as certified and audited by external Quality Assurance organizations. Genuine parts and accessories have been designed, tested and incorporated into the products to help ensure continued product quality and performance in use.

As Flowserve cannot test parts and accessories sourced from other vendors the incorrect installation of such parts and accessories may adversely affect the performance and safety features of the products. The failure to properly select, install or use authorized Flowserve parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by Flowserve's warranty. In addition, any modification of

Flowserve products or removal of original components may impair the safety of these products in their use.

1.4 Copyright

All rights reserved. No part of these user instructions may be reproduced, stored in a retrieval system or transmitted in any form or by any means without prior permission of Flowserve Pump Division.

1.5 Duty conditions

This product has been selected to meet the specifications of your purchaser order. The acknowledgement of these conditions has been sent separately to the purchaser. A copy should be kept with these user instructions.

NOTE **The product must not be operated beyond the parameters specified for the application.**

If there is any doubt as to the suitability of the product for the application intended, contact Flowserve for advice, quoting the serial number.

If the conditions of service on your purchase order are changed (for example liquid pumped, temperature or duty) it is requested that the user seeks our written agreement before start up.

1.6 Safety

1.6.1 Safety symbols

These user instructions contain specific safety symbols where non-observance of an instruction would cause hazards.







Safety symbol and safety word	Meaning
 DANGER	This symbol indicates an imminent hazardous situation. The situation, if not avoided, will result in death or serious injury.
	This symbol indicates a potentially hazardous situation. The situation, if not avoided, could result in death or serious injury.
 CAUTION	This symbol indicates a potentially hazardous situation. The situation, if not avoided, could result in minor or moderate injury.
CAUTION	This word indicates a situation which, if not avoided, could damage the equipment.
NOTE	This sign is not a safety symbol but indicates an important instruction in the assembly process.
The following symbols may be added to the above symbols	
	This symbol indicates a potentially hazardous situation due to hazardous and toxic fluid. The situation, if not avoided, could result in death or serious injury.
	This symbol indicates a potentially hazardous situation due to strong magnetic field. The situation, if not avoided, could result in death or serious injury to persons with pacemaker implant. Further, the situation could damage instruments and stored data sensitive to magnetic fields.
	This symbol indicates a potentially hazardous situation in an explosive atmosphere according to ATEX. The situation, if not avoided in the hazardous area, could cause an explosion.

Table 1 Safety symbols in these user instructions

1.6.2 General safety instructions

- NOTE** Always follow
- legal regulations
 - plant regulations
 - these user instructions concerning safety.

Absolutely heed all information placed directly on the pumping unit and given in Chapter 12.2 "Data sheet", as for example

- rotation arrow
- labeling of connections
- rating plate.



Danger of injury by

- knocking against parts, tools or equipment
- jamming fingers or hands in or between parts, tools or equipment
- dropping parts, tools or equipment on parts of the body.

1.6.3 Personnel qualification, training and protective clothing

Personnel qualification and training

All personnel involved in the operation, installation, inspection and maintenance of the pumping unit must be qualified and authorized to carry out the work involved.

If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required, the operator may commission the manufacturer / supplier to provide applicable training.

Always co-ordinate repair activity with operations and health and safety personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.



DANGER

All work on the electrical system may only be performed by qualified electricians!

All work on the hydraulic connections may only be performed by qualified fitters.

Protective clothing

During transport, installation and removal of the pumping unit, all personnel must wear

- helmet
- safety boots
- protective gloves

During operation of the pumping unit at the control center, all personnel must wear

- protective gloves

NOTE Also follow

- legal regulations
 - plant regulations
- concerning protective clothing.

1.6.4 Authorized and prohibited use

The safe operation of the pumping unit can only be guaranteed if it is operated as authorized.

The only authorized utilization of the pumping unit is to pump water from a well. The pumping unit is to be operated submerged in water.

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

By not heeding this user instructions, product liability is rendered void.

Non-authorized utilization of the pumping unit includes:

- operating the pumping unit in a known malfunctioning state
- operating the pumping unit in conditions other than those given in Chapter 3.3.1 "Normal operating conditions", Page 15.
- making modifications of the pumping unit that are not authorized by Flowserve
- using spare parts that are not authorized by Flowserve.

CAUTION Alterations to the pumping unit are only permitted after written permission by Flowserve.

Only use spare parts that have been authorized by Flowserve.

Flowserve is not liable for any damage caused by the use of parts obtained from third parties.

2 TRANSPORT AND STORAGE

2.1 **Consignment receipt and unpacking**

A submersible pumping unit consists of

- Motor
- Pump bowl assembly
- Non-return valve
- Power cable
- Riser pipe (discharge column)
- Cable or bracket to fasten the motor power cable onto the riser pipe
- Wellhead (surface plate)
- Terminal box or junction box
- Tools for installation and maintenance.

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12 "Scope of delivery".

Flowserve generally ships the pumping unit in two packages:

- Main components described in Chapter 3.1.2 "Main Components", Page 14.
- Tools described in Chapter 4.4.4 "Arrange components for installation", Page 24.

All components and parts are suitably protective wrapped, crated or mounted on skids as appropriate.

The motor is shipped nearly completely filled with oil, with an oil expansion bag (shipping bladder) mounted outside of the motor to allow thermal expansion and contraction of the motor oil.

The power cable, if included in the delivery, is shipped on a reel with a shipping cap or other protective covering installed to protect the connectors.

Immediately after receipt of the equipment

1. Uncrate all parts.
Check all crates, boxes and wrappings for any accessories or spare parts which may be packed separately with the equipment or attached to side walls of the box or equipment.
2. Check the scope of delivery.
 - Check the delivery against the delivery and shipping documents for its completeness.

Each product has a unique serial number. Check that this number corresponds with that advised.

NOTE **Make sure you can always quote each part's serial number in correspondence and when ordering spare parts or further accessories.**

- Inspect the delivery for transportation damage.

Immediately report any shortage and or damage to Flowserve and the shipping company.

Claims must be reported in writing within one month of receipt of the equipment. Flowserve does not accept latter claims.

3. Check the available power against the requirements given on the motor data plate and in Chapter 12.2 "Data sheet".

If the equipment is to be stored

- continue with Chapter 2.3 "Storage and shipping", Page 12.

If the equipment is to be installed

- continue with Chapter 4.4 "Installation", Page 23.

2.2 Transport

2.2.1 Safety instructions

Transport is the process of moving the pumping unit or its components from the installation site to a storage site, maintenance site or repair site, or vice versa.

During transport, always

- Work carefully to avoid accidents.
- Handle equipment carefully.
- Be sure lifting devices are in good condition and are capable of safely handling the weights to be lifted.
- Mark and seal off the transport route so that unauthorized personnel do not enter the danger area.
- Take precautions to prevent foreign materials or dirt from entering the working parts of pump and motor.



Take care that the hoist has an adequate carrying force. For weight see Chapter 12.2 "Data sheet".

Never step under floating load.

Watch for and avoid overhead obstructions including power lines.

2.2.2 Equipment and personnel required

Provide the following equipment for the transport:

- Portable crane with adequate carrying force. For weight see Chapter 12.2 "Data sheet."
- Also see Chapter 4.2 "Equipment and personnel required", Page 19.

Flowserve recommends that 2 persons plus 1 crane operator perform the transport.

2.2.3 Transport of the motor



Do not raise or move the motor by the power cables!

CAUTION The motor is a dynamically balanced machine and should be handled accordingly.

Take precautions to prevent foreign materials or dirt from entering the working parts of the motor.

1. Refer to Figure 1.
Place hitching line under lifting lugs.

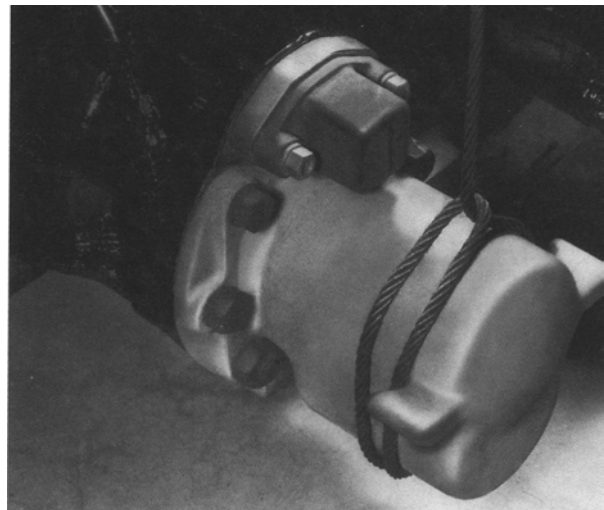


Figure 1 Hitching line under lifting lugs

2. Refer to Figure 2.

Place a wire around the motor. The wire is to be positioned between stator and lower casing, approx. 1/3 from bottom of motor.

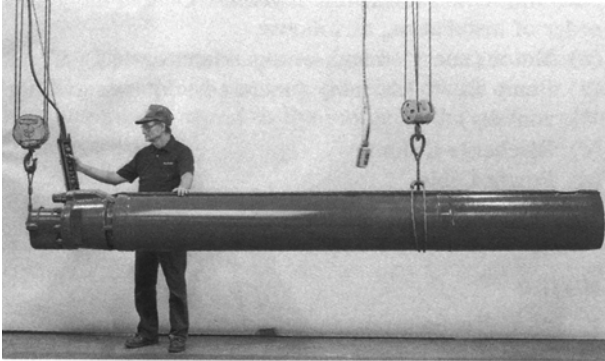


Figure 2 Lifting motor for installation

3. Lift the motor horizontally by 2 points.
4. Transport the motor horizontally to the installation or storage site.
5. Carefully lower the motor at the respective site and place it on the floor.

If the motor is to be stored:

- Continue with Chapter 2.3 "Storage and shipping", Page 12.

If the motor is to be installed in a well:

- Continue with Chapter 4 "Installation", Page 19.

If the motor is to be maintained:

- Continue with Chapter 6 "Maintenance", Page 50.

2.2.4 Transport of the pump bowl assembly

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

CAUTION Use care to prevent bumping, pushing, or scraping of pump bowl assembly parts, especially the shafts, or other machined surfaces.

Take precautions to prevent foreign materials or dirt from entering the working parts of the pump bowl assembly.

NOTE The following description refers to pumps without auxiliary carriers.

Should the pump be delivered on an auxiliary carrier, refer to the pump manual for transportation instructions.

1. Connect the pump
 - directly to the hoists, or
 - to the cross-beam of a portable crane.
2. By means of the crane, carefully lift the pump and move it to the desired site.

If the pump bowl assembly is to be stored:

- Continue with Chapter 2.3 "Storage and shipping", Page 12.

If the pump bowl assembly is to be installed in a well:

- Continue with Chapter 4 "Installation", Page 19.

If the pump bowl assembly is to be maintained:

- Continue with Chapter 6 "Maintenance", Page 50.

2.3 Storage and shipping

For the removal of the pump from the well see Chapter 4.5 "Uninstallation", Page 45, if necessary.

Requirements for the storage area

- Safe
- Clean
- Away from extended periods of direct sunlight
- Well ventilated
- Dry
Air humidity:40 % to 60 %
- Cool
Air temperature for motors
originally filled by Flowserve: ...+50 °C to -5 °C

CAUTION Always store motor and pump bowl assembly separately.

Prepare motor for storage or shipping after removing the motor from the well

1. Arrange the motor horizontally.
2. If pump and coupling are to be stored or shipped separately: Install coupling components on motor shaft.
3. Install power terminal shipping cap (112), power terminal gasket (744-6), and motor shipping caps (112-1).
4. If the motor is to be stored in a vertical position, proceed as follows:
 - a. Remove the adapter bracket (808).
 - b. Drill a vent hole in the motor shipping cap (112-1).

If the motor is returned to factory at a later time, seal the vent hole by a pipe plug.
5. If the motor is to be returned to the factory, proceed as follows:
 - a. Remove motor half-coupling (529) or motor one-piece coupling (531).
 - b. Lubricate shaft with some form of penetrating oil.
 - c. Place coupling and components in motor shipping cap (112-1) with its power terminal gasket (744-6) and bolt cap securely in place.

- d. Elevate motor over a sump or drum to drain oil and water from motor.
- e. Remove lower casing drain plug (806) from bottom of motor, then remove vent plugs (806-4 and 806-5) at top of motor and allow motor to fully drain.
- f. Replace drain and vent plugs.

Prepare pump bowl assembly for storage or shipping

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

NOTE The following description refers to pumps without auxiliary carriers.

Should the pump be delivered on an auxiliary carrier, refer to the pump manual for storage and shipping instructions.

1. Install blocks in the strainer to restrain the pump shaft.

This prevents shaft end float and possible internal damage during handling.
2. Make sure the bowl assembly is thoroughly dry.
3. Install suitable covers to seal off all openings.

Store pumping unit

NOTE The following description refers to pumps without auxiliary carriers.

Should the pump be delivered on an auxiliary carrier, refer to the pump manual for storage and shipping instructions.

Store the pumping unit as follows:

- Motor:
Preferably vertically
Filled with oil
- Pump bowl assembly with rubber bearing bushes:
Vertically
- Pump bowl assembly with other than rubber bearing bushes:
Preferably vertically



DANGER

Horizontally stored motors and pump bowl assemblies must be secured against rolling.

Vertically stored motors and pump bowl assemblies must be secured by appropriate means in this storage position to prevent tipping over.

- Power cable:
Leads protected from moisture

NOTE Do not bend power cable during storage.

Maintenance during storage

- Storage up to four weeks
At the beginning and end of the storage period: Carefully check the motor to be sure there are no signs of oil leakage.
- Storage between 1 and 24 months
Maintenance of the motor, every 6 to 8 weeks:
 1. Remove the motor shipping cap (112) at the motor.
 2. Turn the motor shaft several times by means of a wrench.

3. Mount the motor shipping cap (112) to the motor.

Maintenance of the pump, every 6 to 8 weeks:

1. Remove the discharge housing and the non-return valve for the pump shaft.
2. Turn the pump shaft several times by means of a wrench.
4. Mount the discharge housing and non-return-valve to the pump.

- Storage for over 24 months

After a storage of more than 24 months, we recommend a complete visual inspection at our main factory or at your nearest Flowserve representative.

Shipping

Ship motor and pump bowl assembly

- in non-airtight protection film
- in wooden box or similar transport packaging.

2.4 Recycling and end of product life

At the end of the service life of the pumping unit or its parts, the relevant materials and parts should be recycled or disposed of using an environmentally acceptable method and heeding local regulations.

If the product contains substances which are harmful to the environment, these should be removed and disposed of in accordance with local regulations. This also includes the liquids and or gases in the "seal system" or other utilities.



DANGER

Make sure that hazardous substances are disposed of safely and that the correct personal protective equipment is used.



The safety specifications must be in accordance with the local regulations at all times.

Hazardous substances in the pumping unit are

- Motor oil

3 DESCRIPTION

3.1 Configurations

3.1.1 General Description

The Flowserve submersible pumping unit is a combination of

- a vertical, oil filled motor with double mechanical seal
- a vertical pump bowl assembly

designed for sustained operation submerged in water. The motor is positioned directly below the pump bowl assembly.

The rotating element of the pump bowl assembly is driven from the bottom where its extended shaft is connected to the motor shaft by a coupling.

Power is supplied to the motor through a submarine power cable which is fastened to the riser pipe and extends to the starting equipment. Motor and pump bowl assembly are connected to the riser pipe. The riser pipe is threaded or flanged and coupled in random lengths and the entire unit is coupled to a wellhead assembly.

Each pumping unit has been individually manufactured according to the special requirements of the customer. The technical data is given in Chapter 12.2 "Data sheet".

3.1.2 Main Components

A pumping unit consists of

- Motor
- Pump bowl assembly
- Non-return valve
- Power cable
- Riser pipe (discharge column)
- Cable or bracket to fasten the motor power cable onto the riser pipe
- Wellhead (surface plate)
- Terminal box or junction box
- Tools for installation and maintenance.

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

3.1.3 Motor serial number

The motor serial number is on the name plate on the stator.

3.2 Design of major parts

The motor is filled with, lubricated and cooled by a special mineral oil of high dielectric strength.

This oil

- allows high efficiency rotor-stator design,
- provides excellent insulation and lubrication qualities, and
- protects the motor from internal corrosion.

CAUTION The oil used in this pumping unit is specified in Chapter 12.2 "Data sheet".

Use of other oil

- may cause damage to the pumping unit
- renders Flowserve's warranty void.

The motor does not require periodic oil changes.

The oil is circulated within the motor by pumping action of the thrust bearing disc. Separation between the motor oil and pump liquid at the shaft exit is maintained by two mechanical seals.

The motor is pressure compensated.

The double mechanical seal system uses a pressure balance process to equalize the pressure differential across the seals, minimizing leakage and providing years of maintenance free service. The inner seal diverts any pumped fluid leakage via a communication line to a storage reservoir at the bottom of the motor. The motor is vented to the well by the balance line. As the oil expands, some oil is pushed out of the motor through the balance tube. As the oil cools down, pumped fluid is drawn back into the lower casing at the bottom of the motor through the balance tube.

3.3 Performance and operating limits

3.3.1 Normal operating conditions

Operating purpose

Submersible pumps serve to transport water under the operating conditions described in the following.

CAUTION Other uses, operating purposes or operating conditions must be agreed upon by Flowserve.

Water characteristics

- Water temperature: See Chapter 12.2 "Data sheet"
- Sand content: Maximum 25 mg/l
Also see Chapter 3.4.3 "Development of the well", Page 16, and Chapter 3.4.5 "Effect of pumping sand", Page 16.
- No impurities which could lead to deposits and blockages within the pump or to deposits on the motor surface.
Also see Chapter 3.4.6 "Effect of air or gas", Page 16 and Chapter 3.4.7 "Oxidizing and corrosive effects of chemicals, air and gases", Page 16.
- No occurrence of water hammer

CAUTION At higher surrounding temperatures and/or lower flow velocities on the external motor surfaces, or if there is risk of clogging, special measures for heat dissipation are required.

Inform Flowserve of the surrounding conditions.

Flowserve will check the suitability of the pumping unit for its planned application and confirm its use, if applicable.

Pumping unit

- Correctly selected and adjusted motor protection

Operation

- Operation within prescribed voltage tolerance, see Chapter 12.2 "Data sheet"
- No operation against closed slide valve
- Permissible operational range: 50 % to 120 % of the optimal delivery rate
- Observation of the maximum permissible starting frequency

Installation position

Take the following criteria into account when determining the installation position and depth:

- Vertical installation in a well above the filter line, so that a perfect flow is guaranteed along the external motor wall.
- Sufficient water cover
- A static water level at least 2 m above the pump exit
- A dynamic water level above the suction housing, taking into account the required net positive suction head for the pump (see Chapter 12.2 "Data sheet")
- Flow rate (see Chapter 12.2 "Data sheet")
- Supply conditions of the pumping medium (dependent upon the installation conditions)

CAUTION The pumping unit should be installed above the well filter.

If this is not possible, prevent direct suction within the filter line by suitable measures (e.g. blind tube in the filter, outer pump mantle, pump with sand protection jacket).

3.3.2 Design changes

Alternation or addition of the pumping unit may only take place

- by Flowserve, or
- after written consent by Flowserve.

3.4 Preconditions at the installation site

3.4.1 Survey of well

Always sound the well to make sure it is deep enough to permit installation of the pumping unit consisting of pump bowl assembly and motor. If the exact diameter and depth of the well casing is not known, "cage" the well following the procedure outlined in Chapter 3.4.2 "Crooked well", Page 16.

Experience indicates that many wells have more than one string of casing installed and frequently the lower sections are smaller in diameter than the surface casing. Be certain the submersible pumping unit will pass into the well freely and hang well above of the well bottom.

3.4.2 Crooked well

A well that is known to be crooked and that has not previously accommodated a pumping unit of comparable size must be "caged" before the submersible pumping unit is installed.

1. Prepare a cage of the same length and diameter as the combined motor and pump bowl assembly, with 12 m to 15 m (40 feet to 50 feet) of the proper size of riser pipe.
2. Lower the cage into the well to the point at which the pumping unit is to be placed.
3. If the cage can be lowered to this point without touching the inner wall of the well, the submersible pumping unit can be installed.

3.4.3 Development of the well

Do not use a new pumping unit to develop the well.

Developing, surging and freeing the well of sand are considered a part of the well drillers contract and should be accomplished by the use of a test pumping unit.

3.4.4 Suction and submergence requirements

Pumping the well at a rate at which the pumping unit breaks suction will cause pump deterioration. It is suggested that a method be provided for keeping a record of the water level above the suction inlet.

The minimum submergence recommended is 3 m (10 feet) of riser pipe submergence below the

maximum well draw-down level, although some installations may require more submergence.

3.4.5 Effect of pumping sand

Flowserve does not guarantee the pumping unit to be resistant against the erosive action of sand, silt or other abrasive materials suspended in water.

Pumping sand will adversely affect the motor because the vibration produced in a worn pump bowl assembly will be transmitted to the motor and could result in a shortened motor life.

3.4.6 Effect of air or gas

The presence of gases in the water may reduce capacity and head of the pumping unit, thus decreasing the hydraulic performance. Further, air or gas in the water will cause deterioration of materials of the pumping unit sooner than under normal conditions.

3.4.7 Oxidizing and corrosive effects of chemicals, air and gases

Even if the composition of the pumped water is known due to chemical analysis, it is not always possible to predict the corrosive action of water on the metals of the pumping unit.

In addition to chemicals, water may also contain entrained air or gases that have a definite oxidizing or corrosive action of their own. This action is accentuated by high velocities within the pump. Such conditions are not recognizable in the chemical analysis of the water.

Conforming with the Standards of the Hydraulic Institute of the United States and the practice of all reliable pump manufacturers, Flowserve does not guarantee its pumps and motors to be resistant against corrosive or electrolytic action.

Should you require motors or pumps to perform under oxidizing or corrosive conditions, contact Flowserve for further information.

3.5 Electrical requirements

3.5.1 General electrical requirements

The Byron Jackson submersible motor is designed for across-line start, eliminating the need for reduced voltage starting equipment. Maximum current inrush when the motor is connected across the line at full voltage will be limited to about 700 % of the rated load current.

Because starting the motor at full voltage results in high starting torque, the motor accelerates to operating speed very rapidly (within 0.8 seconds, typically), and current consumption correspondingly drops to normal. The rated power requirements of the motor are stated on the pump nameplate located on the wellhead.

Allowed combinations of voltage and frequency variations during operation are classified according to IEC 60034 as being either Zone A or Zone B (Figure 3) or according to NEMA (see Figure 4).

Voltage and frequency limits

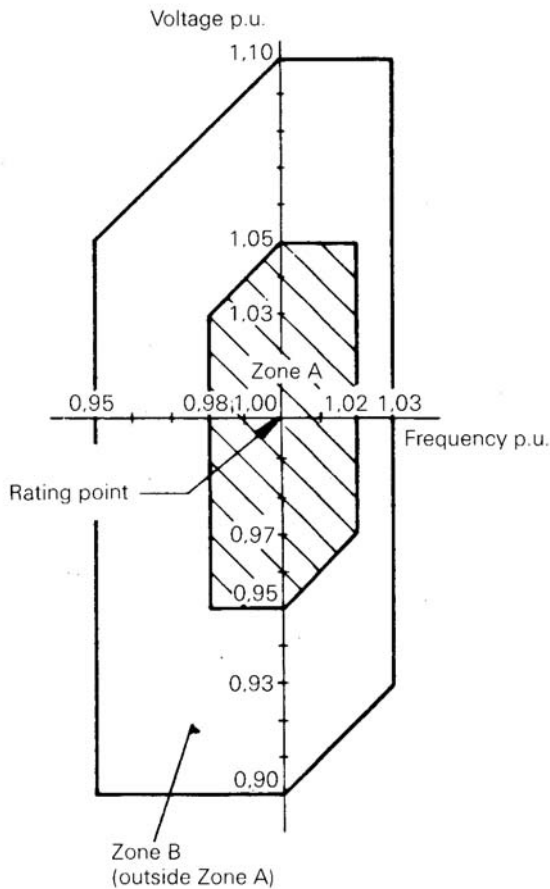


Figure 3 Voltage and frequency limits acc. IEC 60034

Voltage and frequency limits

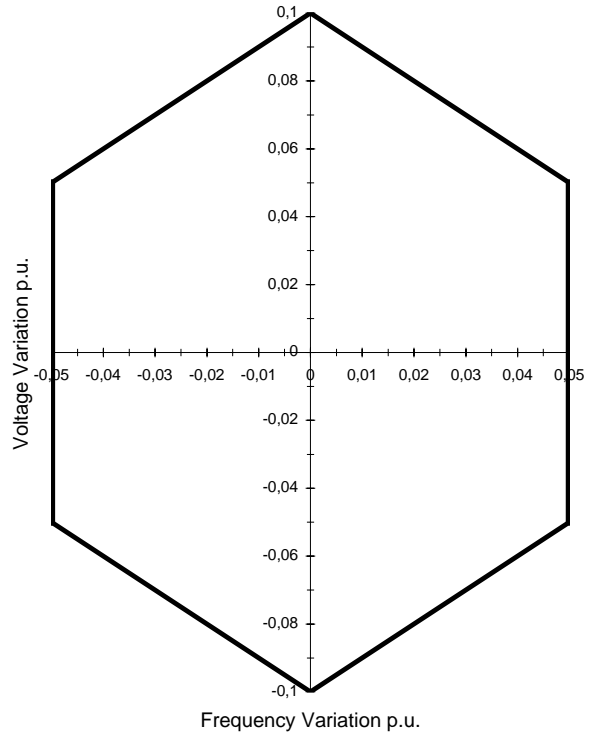


Figure 4 Voltage and frequency limits acc. NEMA

The motor is capable of performing its rated torque continuously within Zone A, but need not comply fully with its performance at rated voltage and frequency (see rated point in Figure 3), and may exhibit some deviations. Temperature rises may be higher than at rated voltage and frequency. For conditions at the extreme boundaries of Zone A, the temperature rises and temperatures may exceed the specified limits of temperature rise and temperature by approximately 10 K.

Operation outside Zone A (within Zone B) may exhibit greater deviations from its performance at rated voltage and frequency than in Zone A. Temperature rises may be higher than at rated voltage and frequency and most likely will be higher than those in Zone A. Extended operation at the perimeter of Zone B is not recommended.

Low voltage is a serious problem since the operating motor current is increased, resulting in additional motor heating. However, the motor is designed to operate continuously at 110 % of rated current, so that some reduction in voltage can be tolerated as long as it is not also accompanied by an overload of the motor.

With variations in voltage, the motor characteristics will, in general, vary as given in Table 2.

Voltage	110 %	90 %
Speed	Increase 1 %	Decrease 1.5 %
Efficiency (full load)	Increase 0.5 %	Decrease 1 %
Power factor (full load)	Decrease 3 %	No change
Current (starting)	Increase 11 %	Decrease 11 %
Current (full load)	Decrease 8 %	Increase 11 %
Temperature	Decrease 2 %	Increase 5 %

Table 2 Motor characteristics at varying voltage

Rated or full load current refers to the amperage drawn by the motor at nameplate output, frequency and voltage at the motor terminals. The maximum allowable current (except momentarily at start-up) is 110 % of the rated value.

The voltage on all three phases should be evenly balanced as closely as can be read on the usually available commercial voltmeter, because the current unbalance will be in the order of 6 to 10 times the voltage unbalance. Running the motor with the unbalanced voltage will lead to increased temperature and decreased motor life time, and therefore must be avoided.

Poor voltage regulations of an engine-driven generator, if the power is derived from such a source, can be very disadvantageous to the motor. Thus, Flowserve assumes no responsibility for pumping units operated on such equipment unless agreed on in writing.

Also, because of the unpredictable characteristics and past experiences associated with the use of phase converters, Flowserve must void all guarantees for applications that incorporate these devices as a means of obtaining three phase power.

3.5.2 Motor protection

To protect the motor against power overload, an inverse time-lag overload relay must be provided, sensitive to phase failure and which compensates for temperature.

The over current relay for the switchgear and the safety fuses can be adjusted or selected according to Chapter 12.2 "Data sheet".

The adjustment of the motor protection switch (thermally delayed over current relay) must be done according to the value given in Chapter 12.2 "Data sheet".

The value given in Chapter 12.2 "Data sheet", is a standard value for the operating point. If the actual operational current in the operating point of the pump bowl assembly lies under this given value, the switch must be adjusted lower so that there is effective protection and malfunctions can be indicated in time.



DANGER

Do not set the motor protection adjustment higher than the highest permissible value given in Chapter 12.2 "Data sheet".

Do not test the perfect functioning of a motor protection switch by intentional single-phasing.

3.5.3 Short circuit protection

To prevent short circuiting of the power cable and the motor, safety measures must be taken according to local ordinances.

Guide values for the safety fuse sizes can be taken from Chapter 12.2 "Data sheet".

4 INSTALLATION AND UNINSTALLATION

4.1 Fitter

It is recommended that the services of Flowserve be employed for the installation and initial starting of a Byron Jackson pump.

Such service will ensure the purchaser that the equipment is properly installed, and will provide an excellent opportunity for the plant operator to receive special instructions relative to the pumping unit.

4.2 Equipment and personnel required

4.2.1 Equipment and tools supplied with motor

Equipment and tools supplied with motor and half coupling

- Hex socket wrench for shaft button screw (806-2)
- Hex socket wrench for coupling set screw (806-1)
- Hex socket wrench for vent plug (806-4)
- Hex socket wrench for vent plug (806-5)
- Aligning jig assembly, including the following parts:
 - Shim, shaft adjusting (262-6)
 - Shim, shaft adjusting (262-7)
 - Button, thrust (130)
 - Screw, thrust Button (806-2)
 - Washer, coupling lock screw (690-4)
 - Screw, coupling lock (806-3)
 - Aligning jig (265)
 - Coupling, driver (529)
 - Key, coupling (676-1)
 - Screw, set, coupling (806-1)

4.2.2 Equipment and tools to be supplied by operator

Provide the following equipment and tools:

- Lifting Equipment.

Must be of sufficient strength and rigidity to lift the complete unit safely, see Table 3, Page 20, and of sufficient height to allow clearance between load hook and foundation. For weight see Chapter 12.2 "Data sheet".
- Two pairs of correctly sized pipe elevators
- One correctly sized column U-plate
- One correctly sized motor U-plate (see Figure 5, Page 21 and Table 4, Page 21)
- One 1.2 - 1.8 m (4 - 6 feet) section of column, threaded and coupled, to be attached to the top case and used for handling the pump bowl assembly.

Deduct this length from total column length specifications.
- Column

A supply of pipe, in random lengths, threaded and coupled, of correct size to handle the unit capacity and total weight and of adequate length to set the unit at the correct pumping level in the well. The threading is 8 threads per 25 mm (1 inch) and 19 mm (0.75 inch) taper per foot.
- One pair of cable reel stands, with axle
- One portable insulation resistance tester ("Megger"), 0 - 100 M Ω / 1000 Volts
- One clamp-on ammeter
- One volt/ohmmeter
- Components for water level indicating system
- Special banding tool ("Band-it") for cable bands
- A length of 1.27 cm (0.5 inch) hemp rope and a cable installation wheel. Diameter must be at least 14 times cable outer diameter.
- Ordinary hand tools (mechanical and electrical) used in this kind of work
- Two sets of chain tongs
- Rubber mat and insulated gloves for electrical work in damp conditions

- An adequate supply of approved thread compounds, as follows
 - For installation of the short section of column pipe, next to top case or top case flange, use only Loctite 277 (Red) & Primer T or equal.
 - For remaining column pipe threads, use a pipe thread compound that is capable of lubricating and sealing.

Column		
Size	Weight per foot in kg (pounds)	
	Empty	Full
2-1/2	2.6 (5.8)	3.6 (7.9)
3	3.4 (7.6)	4.9 (10.8)
4	4.9 (10.9)	7.4 (16.4)
5	6.7 (14.8)	10.7 (23.5)
6	8.7 (19.2)	14.4 (31.7)
8	11.3 (25.0)	21.4 (47.2)
10	14.5 (32.0)	30.2 (66.6)
12	20.4 (45.0)	42.6 (93.9)
Bowl Slumps		
Size	Weight in kg (pounds)	
	1 st Stage	Additional Stage
8MQ	36 (80)	7 (15)
10MQ	79 (175)	17 (37)
11MQ	132 (290)	32 (70)
12MQ	200 (440)	57 (125)
13MQ	284 (625)	79 (175)
15MQ	386 (850)	120 (265)
Cable		
Volts	Size	Weight per foot in kg (pounds)
600	8	0.14 (0.30)
	4	0.35 (0.77)
	2	0.50 (1.10)
	300MCM	2.00 (4.40)
	500MCM	3.08 (6.80)
5000	6	0.41 (0.90)
	2	0.54 (1.20)
	1/0	1.00 (2.20)
	4/0	1.54 (3.40)

Motors		
Nominal motor size	Horsepower	Weight in kg (pounds)
8"	7-1/2	211 (465)
	10	211 (465)
	20	227 (500)
	25	249 (550)
	30	249 (550)
10"	40	431 (950)
	50	431 (950)
	60	458 (1 010)
	75	458 (1 010)
	100	490 (1 080)
12"	125	553 (1 220)
	125	915 (2 018)
	150	953 (2 100)
	175	1 002 (2 210)
14"	200	1 027 (2 265)
	125	1 170 (2 580)
	150	1 288 (2 840)
	200	1 424 (3 140)
17"	250	1 485 (3 273)
	300	1 485 (3 273)
	300	1 690 (3 725)
	350	1 860 (4 100)
21"	400	1 928 (4 250)
	450	1 996 (4 400)
	500	1 996 (4 400)
	600	2 087 (4 600)
	600	1 950 (4 300)
	800	2 359 (5 200)
21"	1 000	2 767 (6 100)
	1 200	3 221 (7 100)
	1 500	3 720 (8 200)

Table 3 Component weight chart for calculating foundation, derrick and hoist loads

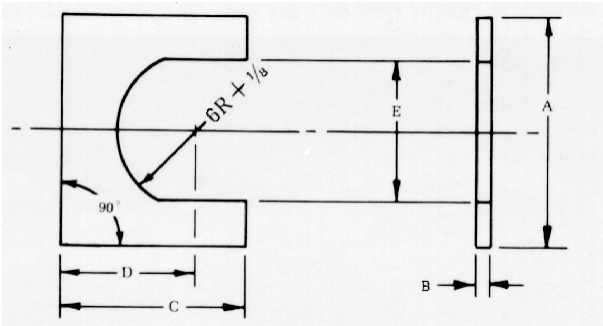


Figure 5 Motor U-plate

4.2.3 Personnel required

Flowserve recommends that 2 persons plus 1 crane operator perform the installation or uninstillation procedure.

4.3 Hydraulic connection

Exemplary construction of a water supply system is depicted in Figure 6, Page 22. As this shows a basic arrangement, the actual layout must be suited to local and technical conditions.

Nominal motor size	Dimensions in cm (inches)				
	A	B	C	D	E
8"	38.10 (15)	0.95 + 0.32 (0.375 + 0.125)	25.40 (10)	25.40 (10)	14.61 + 0.32 (5.750 + 0.125)
10"	40.64 (16)	0.95 + 0.32 (0.375 + 0.125)	30.48 (12)	25.40 (10)	18.10 + 0.32 (7.125 + 0.125)
12"	45.72 (18)	1.27 + 0.32 (0.500 + 0.125)	35.56 (14)	25.40 (10)	19.05 + 0.32 (7.500 + 0.125)
14"	50.80 (20)	1.27 + 0.32 (0.500 + 0.125)	35.56 (14)	25.40 (10)	24.77 + 0.32 (9.750 + 0.125)
21"	91.44 (36)	1.27 + 0.32 (0.500 + 0.125)	73.66 (29)	53.34 (21)	42.57 + 0.32 (16.760 + 0.125)

Table 4 Motor U-plate chart



DANGER

All work on the hydraulic connection may only be done by qualified fitters.

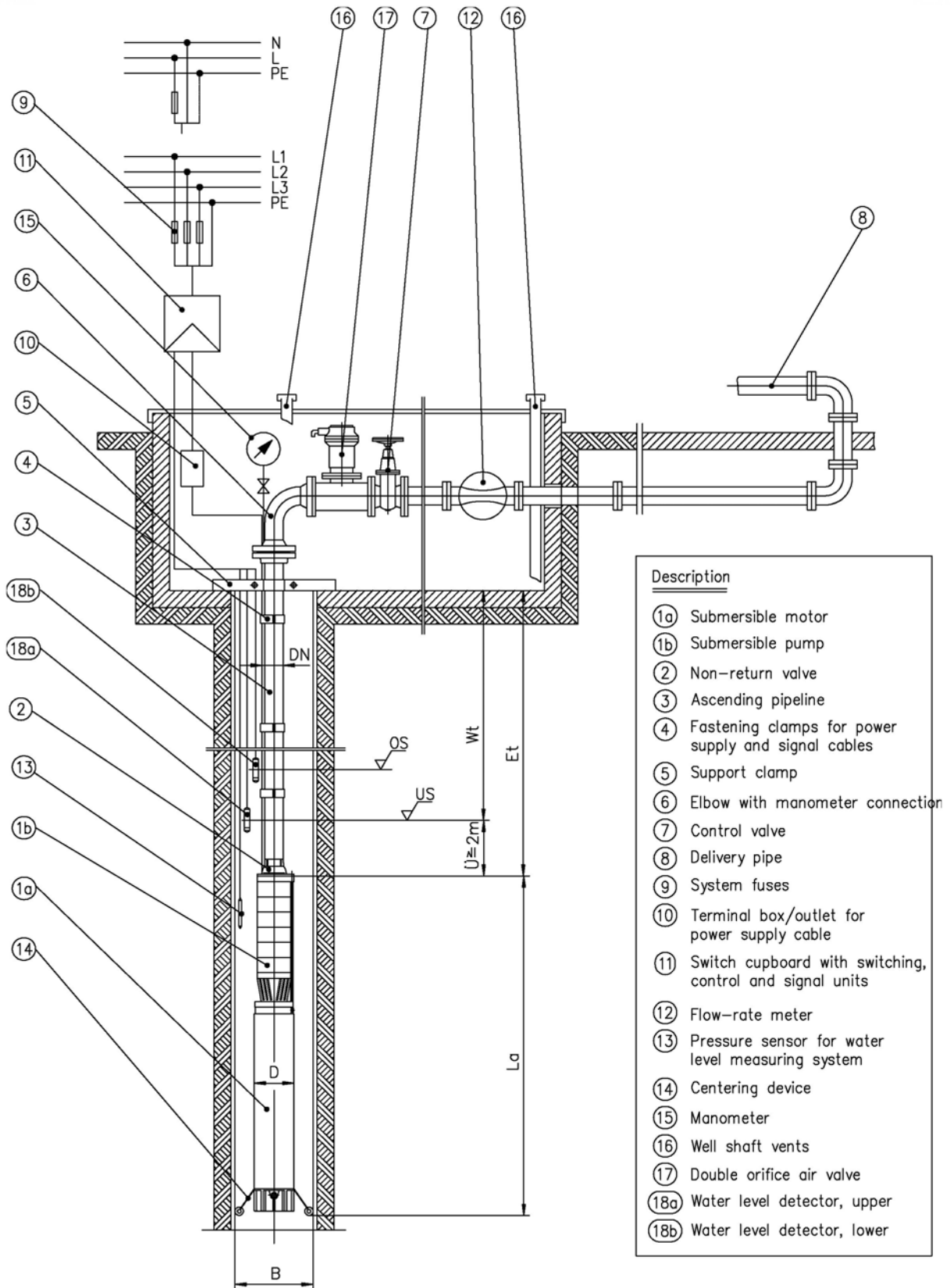


Figure 6 Scheme of water supply system

4.4 Installation

4.4.1 Safety instructions



DANGER

Before starting any installation work or removing any parts of the pumping unit, read Chapter 1.6 "Safety", Page 6.

Tighten all screws in accordance with Chapter 12.3 "Tightening torques".

4.4.2 Sequence of installation

Perform the installation in the following order:

1. Prepare installation site, see Chapter 4.4.3, Page 23.
2. Arrange components for installation, see Chapter 4.4.4, Page 24.
3. Inspect components, see Chapter 4.4.5, Page 25.
4. Install motor, see Chapter 4.4.6, Page 26.
5. Install coupling, see Chapter 4.4.7, Page 27.
6. Install pump bowl assembly, see Chapter 4.4.8, Page 30.
7. Install impeller, see Chapter 4.4.9, Page 32.
8. Vent motor, see Chapter 4.4.10, Page 33.
9. Install power cable, see Chapter 4.4.11, Page 35.
10. Fasten the power cable to the cable guard, see Chapter 4.4.12, Page 39.
11. Install riser pipe, fasten power cable to riser pipe, see Chapter 4.4.13, Page 40.
12. Connect power cable to terminal box, see Chapter 4.4.14, Page 43.
13. Connect terminal box to main power supply, see Chapter 4.4.15, Page 43.

4.4.3 Prepare installation site

1. Verify that the wellhead foundation is poured and cured, if made of concrete.

The total load on the wellhead foundation will consist of the motor, pump bowl assembly, riser pipe (full of water), wellhead assembly and power cable. See Chapter 12.2 "Data sheet", for weights.

2. Verify that open discharge run-off, ditch, etc. for flushing out well and testing unit is provided for.
3. Verify that a log of the well recording depth, straightness, casing variations, standing water level, rated capacity, pumping level, etc., is at the installation site.
4. Ensure that the well diameter is large enough down to the installation depth so that the pumping unit can be fitted without difficulties. See Chapter 3.4.1 "Survey of well", Page 16.
5. Check the dependability of auxiliary equipment, particularly of hoists.
6. Compare the information in Chapter 12.2 "Data sheet" with that on the rating plate on the motor.
7. Ensure that the line voltage (measured between two phases) is equal to the motor voltage according to the rating plate.

The maximum permissible voltage fluctuation is given in Chapter 12.2 "Data sheet".

Greater voltage and frequency fluctuations must be reported to Flowserve and be confirmed by Flowserve in written. In case of doubt, ask Flowserve before starting up the pumping unit.
8. Measure the insulating resistance of the motor according to Chapter 6.8.1 "Insulation test", Page 53.

CAUTION If the ascending riser pipe is made of flanged pipes, the flanges must have recesses for the power cable if the well diameter is narrowly proportioned.

4.4.4 Arrange components for installation

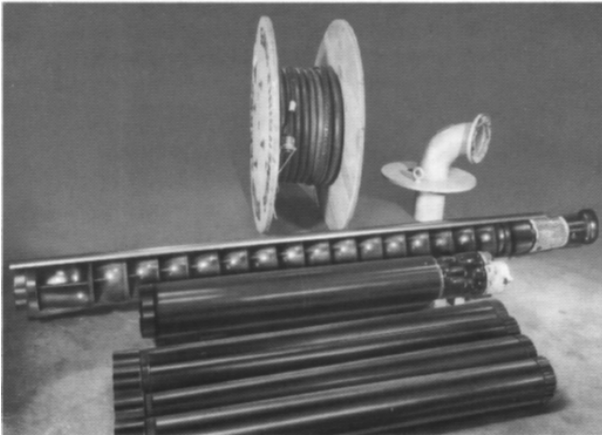


Figure 7 Components arranged for installation

Refer to Figure 7. An orderly arrangement of sub-assemblies will reduce the installation time.

1. Lay out the parts in order of installation, as follows:
 - Motor
Arranged horizontally.
 - Pump bowl assembly
Uncrated and arranged horizontally.
 - Riser pipes
Place all riser pipe sections with coupling end toward the well.
Check couplings with chain tongs to make sure they are screwed tight.
Place riser pipe check valve sections so that each will be installed in the proper sequence.
 - Power cable
 - Wellhead
 - Tools for installation, see Chapter 4.2 "Equipment and personnel required", Page 19.
 - U-plate
2. Record the complete motor serial number from the motor, see Chapter 3.1.3 "Motor serial number", Page 14.

NOTE Make sure you can always quote each part's serial number in correspondence and when ordering spare parts or further accessories.

3. Check motor rating, horsepower, poles, volts, and frequency against job requirements.

4.4.5 Inspect components

1. Remove the nuts (003-3) and lock washers (690-3) to remove the motor terminal shipping cap (112), and gasket (747-10).
2. Verify that motor terminal gland plate (111) and power terminals (019) are clean and free of dirt and foreign matter.
3. Megger the motor for ground and continuity (see Figure 8).

The reading should be 10 MΩ or more.

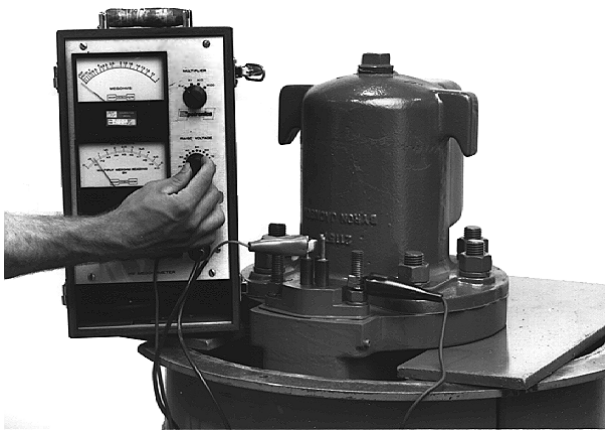


Figure 8 Megger test

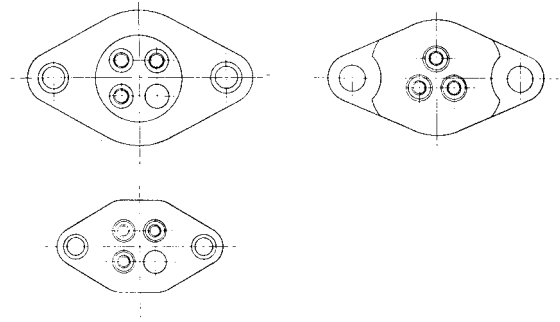


Figure 9 Arrangement of terminals

7. Mount motor power terminal shipping cap (112), gasket (747-10), lock washers (690-3) and nuts (003-3).
8. Reinstall power cable shipping cap.
9. Verify that all riser pipe threads are clean and free of dirt and foreign matter.

4. Remove the shipping cap from the power cable terminal box.
5. Verify that the terminal box and connectors are clean and free of dirt and foreign matter.
6. Verify that the power terminals (019) at the motor will fit the connectors of the terminal box:

- Refer to Figure 9.
Check position of power terminals (019) against that of connectors.
The terminals (019) and connectors may be arranged in either an equilateral triangle or a right triangle positioning.
- Check height of terminal against depth of connector to assure proper engagement.

4.4.6 Install motor

Transport the motor to the well site, see Chapter 2.2.3 "Transport of the motor", Page 10.



Never step under floating load.
Watch for and avoid overhead obstructions including power lines.

1. Install motor U-plate on foundation.



Use to 2 persons to install the U-plate.
Handle the U-plate carefully.
Danger of injury by dropping the U-plate onto parts of the body.

2. Cover the U-plate and foundation with a tarpaulin.
3. Orient the motor horizontally so that the terminal shipping cap is on top.

Remove motor shipping cap (112-1), power terminal gasket (744-6), nuts (003-8), and lock washers (690-5). Some oil may be present in the shipping cap.

Be certain to put the power terminal gasket (744-6) in a safe area until it can be stored in the motor shipping cap (112-1).

NOTE The power terminal gasket is not used in the unit assembly.

Then remove the tools and the power terminal gasket (744-10) from the power terminal shipping cap.

4. Reinstall motor shaft shipping cap (112-1), nuts (003-8), and lock washers (690-5).
5. Lift the motor as described in Chapter 2.2.3 "Transport of the motor", Page 10.
6. Slowly elevate the motor to vertical position.
7. Center the motor over the well casing opening.
8. Lower the motor to rest on the U-plate.

Refer to Figure 10.

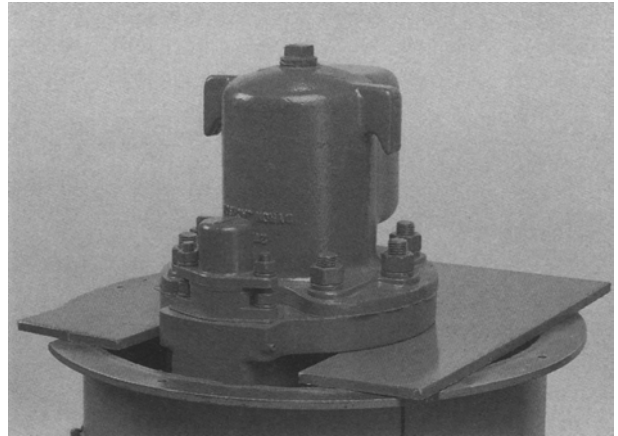


Figure 10 Motor in place on U-plate

9. Remove motor shipping cap (112-1), nuts (003-8), and lock washers (690-5).
10. Cover coupling (529 or 531) and shaft with a clean cloth.

The motor is now ready to receive the coupling.

4.4.7 Install coupling

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

The coupling between motor and pump bowl assembly depends on the type of pump bowl assembly delivered.

Flowserve manufactures two coupling variants for the Byron Jackson Double Mechanical Seal Motor:

- Variant A: Motor half coupling
- Variant B: One-piece coupling

Both are described in the following. See Chapter 12.1 "Scope of delivery" to determine the coupling delivered and follow the respective instructions.

Variant A: Motor half coupling

1. Motor half coupling is factory installed. Refer to Figure 11.
2. Clean coupling and shaft, and lightly oil both.
3. Slip coupling on shaft with keyways aligned.

NOTE Do not attempt to force the coupling.

If the coupling will not seat freely:

- remove the coupling
- verify that the shaft is free of dirt and foreign matter
- replace the coupling.

4. Insert key (676-1), round end down, in the keyway.
5. Install socket head set screw (806-1) through its hole in the coupling (529) to engage its hole in the shaft.

Use wrench provided to tighten set screw (806-1).

6. Identify the shaft adjusting button (130), alignment jig (265), screws (806-3) with

washers (690-4), shaft button screw (806-2) and shims (262-6 and 262-7).

7. Remove string from shaft button screw (806-2) which holds shim in place.

Verify that the shims (262-6 and 262-7) are attached to the screw (806-2).

8. Install alignment jig assembly in motor half coupling (265).

9. Install cap screw (806-2) and use wrench provided to tighten screw (806-2).

10. Remove the coupling lock screws (806-3) and washers (690-4).

Set these pieces aside for later use (see Chapter 4.4.8 "Install pump bowl assembly", Page 30).

11. Remove alignment jig (265) and hold for storage in motor shipping cap (112-1).

12. Clean the motor flange face of any dirt or foreign matter.

Verify that the balance line hole in the flange face is open and clear.

13. Cover the coupling (529) and shaft with a clean cloth.

The motor is now ready to receive the pump bowl assembly.

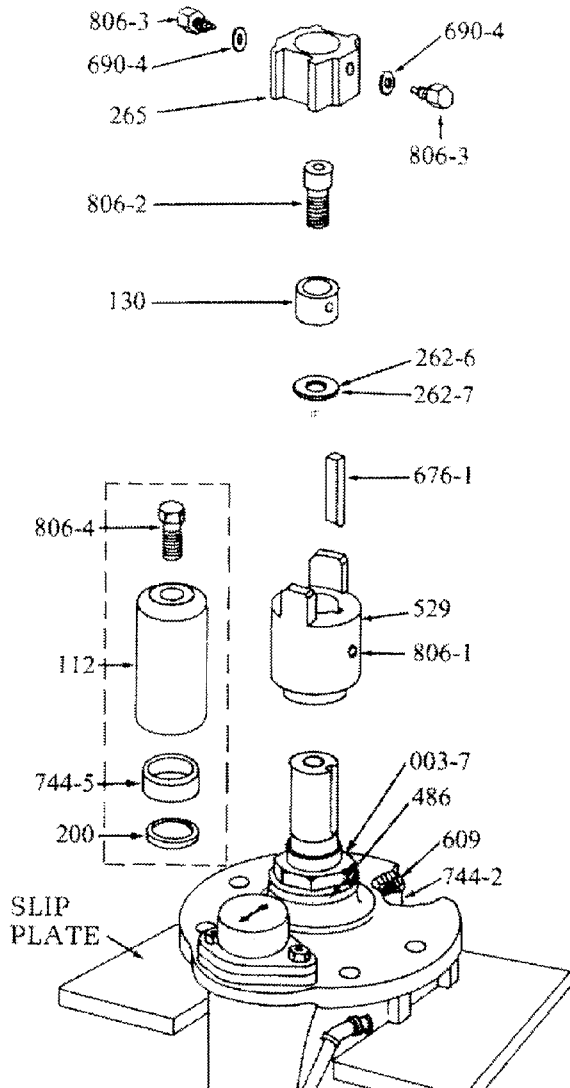


Figure 11 Motor half coupling components

Variant B: One-piece coupling

See Figure 12.

1. Clean the coupling (531) and shaft and lightly oil both.
2. Identify the thrust button (130), thrust button screw (806-2) and shaft adjusting shims (262-6 and 262-7) as required. These pieces are factory installed.
3. Insert key (676-1), round end down, in the keyway.
4. Slip coupling (531) on shaft with keyways aligned.

CAUTION Do not force the coupling.

If the coupling will not seat properly, again verify that shaft and coupling are clean.

5. Install the coupling pins (697) into the coupling holes and the thrust button.
The thrust button may need to be rotated to align holes.
Install the coupling lock screws (806-6), flat washers (004-1), and lock washers (690-6) to secure the pins in the coupling.
6. Tighten the thrust button socket head screw (806-2).
7. Rotate the motor shaft and coupling until the pin holes on the coupling are pointed 90° from the power terminal shipping cap.
This aligns pin holes in coupling with adapter bracket to allow pump coupling pin (697-1) to be installed later. Also see Figure 12.

8. Clean the motor flange face of any dirt or foreign matter. Verify that the balance line hole is open and clear.
9. Cover the coupling (531) and shaft with a clean cloth.

The coupling is now ready to receive the pump bowl assembly.

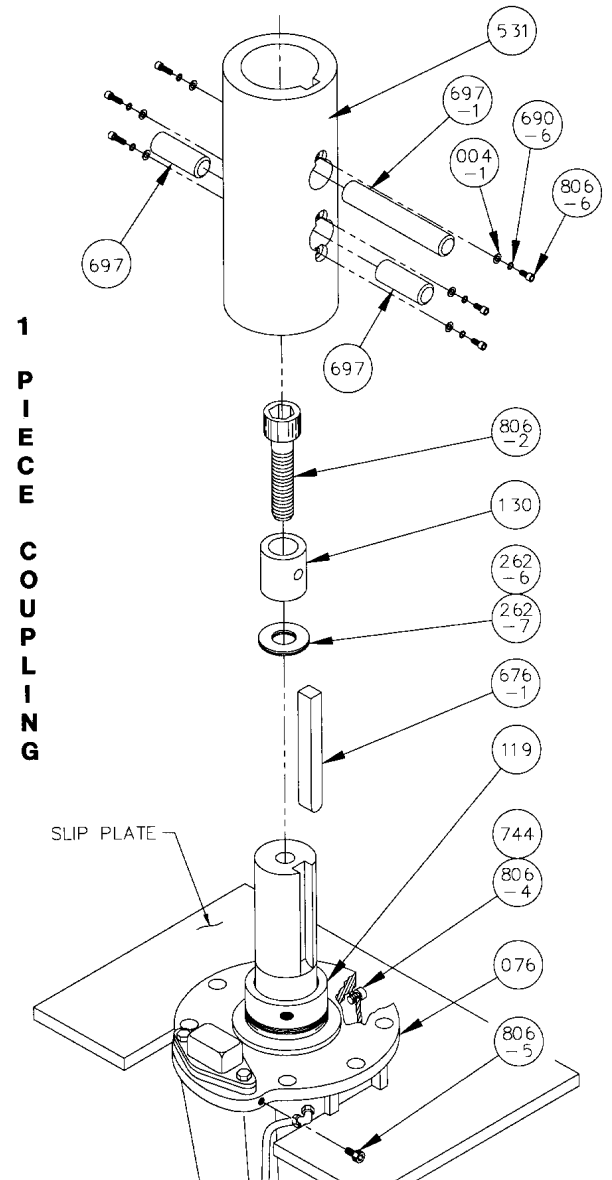


Figure 12 Components for one-piece coupling

4.4.8 Install pump bowl assembly

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

Lift pump bowl assembly



Never step under floating load.
Watch for and avoid overhead obstructions including power lines.

NOTE The following description refers to pumps without auxiliary carriers.

Should the pump be delivered on an auxiliary carrier, refer to the pump manual for lifting instructions.

To transport the pump bowl assembly to the well site see Chapter 2.2.4 "Transport of the pump bowl assembly", Page 11.

1. Connect the pump to two lifting lines of a portable crane.
The attachment points may vary according to pump type and local requirements.
2. Carefully lift the pump to a vertical position over the well head.

Install pump bowl assembly

The riser pipes are connected among each other by

- threads or
- flanges.

The motor hangs in the well on the U-plate.

1. Disassemble discharge housing or non-return valve from the pump bowl assembly.
2. Install the discharge housing or non-return valve in the short section of riser pipe.

Additional information for threaded riser pipes:

- a. Clean the mating pipe threads of the pipe and the case or flange as shown in Figure 13.

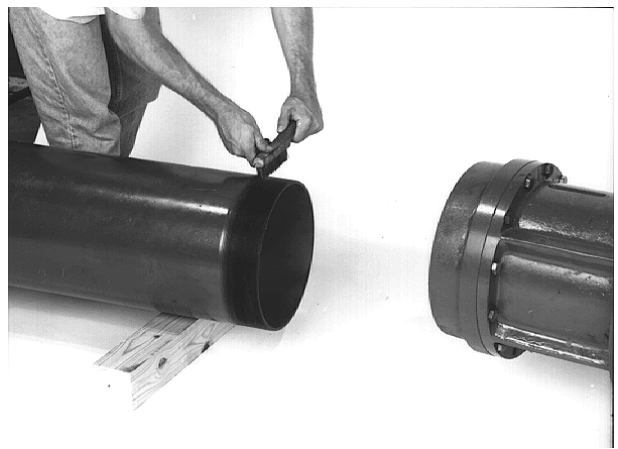


Figure 13 Cleaning riser pipe threads

- b. Apply thread locking fluid, e. g. Loctite 242 or DELO 5249/5349 or equivalent, to the threads as shown in Figure 14.



Figure 14 Applying thread locking fluid

- c. Install the pipe using chain tongs.

Figure 15 shows the proper method of applying chain tongs to the flange.

Thereby most of the force is exerted on the upper flange rather than the on the discharge housing or the non-return valve.

Apply torque approximating the values given in Table 5.

- 3. Mount the first length of the riser pipe, which should not be longer than 0.5 m, onto the assembled pump bowl assembly.
- 4. Remove the cable clamps or cable guard from the pump bowl assembly.
- 5. Remove the cloth from the coupling.
- 6. Lift the pump bowl assembly above the motor.
- 7. Check the end float settings that are pre-adjusted by Flowserve.

CAUTION The discharge section may require modification to provide protective clearance to the flat cable and splice which will be mounted later on the riser pipe just above the pump.



Figure 15 Proper method of applying chain tongs

Pipe Size	Torque [Nm]	Torque [ft-lbs]
2-1/2	620	500
3	950	700
4	1 220	900
5	1 425	1 050
6	1 625	1 200
8	2 170	1 600
10	2 710	2 000
12	4 070	3 000

Table 5 Torque for riser pipe assembly

4.4.9 Install impeller

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

Flowserve manufactures two impeller variants for the Byron Jackson Double Mechanical Seal Motor:

- Variant A: Closed impeller
- Variant B: Open impeller

Both are described in the following. See Chapter 12.1 "Scope of delivery" to determine the coupling delivered and follow the respective instructions.

Variant A: Closed impeller

1. Refer to Figure 16.
 - Scale from the face of the adapter bracket (808) to the end of the pump shaft (167) with the shaft down.
2. Remove adapter bracket (808) from bowl assembly.
3. Install adapter bracket (808) on motor top flange, using fasteners for motor shipping cap (112-1).
4. Scale from the face of the motor top case (076) to the face of the shaft adjusting button (130).
5. The distance recorded in step 1 should be 3.175 mm to 6.350 mm (1/8" to 1/4") less than that of step 4.



Figure 16 Verify end float

Variant B: Open impeller

1. Remove adapter bracket (808) from bowl assembly.
2. Install adapter bracket (808) on motor top flange, using fasteners from motor shipping cap (112-1).
3. Remove the pump half coupling (530) or one-piece coupling (531).
4. Provide four pieces of shim stock, each (50.8 mm x 50.8 mm x 0.508 mm (2" x 2" x 0.020") thick, and place each shim 90 degrees apart on the face of the adapter bracket.
5. Lower the pump bowl assembly into the adapter bracket (808) to rest on the shims.
6. Put a feeler gauge through the plug opening in the adapter bracket (808) and check the gap from shaft adjusting button (130) to pump shaft (167).
7. If gap, step 6, is less than 0.0381 mm (0.015") or more than 0.4572 mm (0.018"), the shims beneath the shaft button (130) must be changed.
8. Reinstall the pump half coupling (530) or one-piece coupling (531).

4.4.10 Vent motor

1. Remove the oil vent plugs (806-4) and (806-5) in the flange located at the power terminals and 90° or 180° from the power terminals.

Add oil into the adapter bracket as shown in Figure 17. See Chapter 12.2 "Data sheet", Page 65, for oil quality.

NOTE Do not add more than two full motor shipping caps' amount of oil during the venting process. The oil level in the motor will then rise and expel any air in the upper case cavity.



Figure 18 Removing vent plug



Figure 17 Adding oil



Figure 19 Reinstalling vent plug

2. Continue to add oil until bubble free oil flows from the vent located near the power terminals.

Reinstall vent plug (806-4). Refer to Figure 18.

Continue to add oil until bubble free oil flows from the vent located 90° or 180° from the power terminals.

Reinstall vent plug (806-5) and tighten to 27 Nm (20 foot pounds). Refer to Figure 18.

3. Remove oil vent plug next to power terminals (806-4) and again check for bubble free oil.

Reinstall vent plug (806-4) and tighten to 27 Nm (20 foot pounds).

4. Place power terminal shipping cap (112-2), power terminal gasket (744-7), jig (265), hex socket wrenches (806-1, 806-2, 806-4, and 806-5), and power terminal gasket (744-6) into the motor shipping cap (112-1).

Send to storage.

The motor is now ready to receive the pump bowl assembly.

6. Verify that the pump half coupling (530) or one-piece coupling (531) is securely locked in place

- by the coupling pin (697-1) and retainer ring (526) on pump half coupling or

- by the coupling pin (697-1) and the retainer screws (806-6), flat washers (004-1), and lock washers (690-5) on the one-piece coupling.

Also verify that the coupling bore and motor shaft are clean and free of dirt and foreign matter.

7. Refer to Figure 20.

Lower the bowl assembly to engage

- the jaws of the pump half coupling (530) and those of the motor half coupling (529) or
- the one-piece coupling bore (531) with the motor shaft and key (676-1).

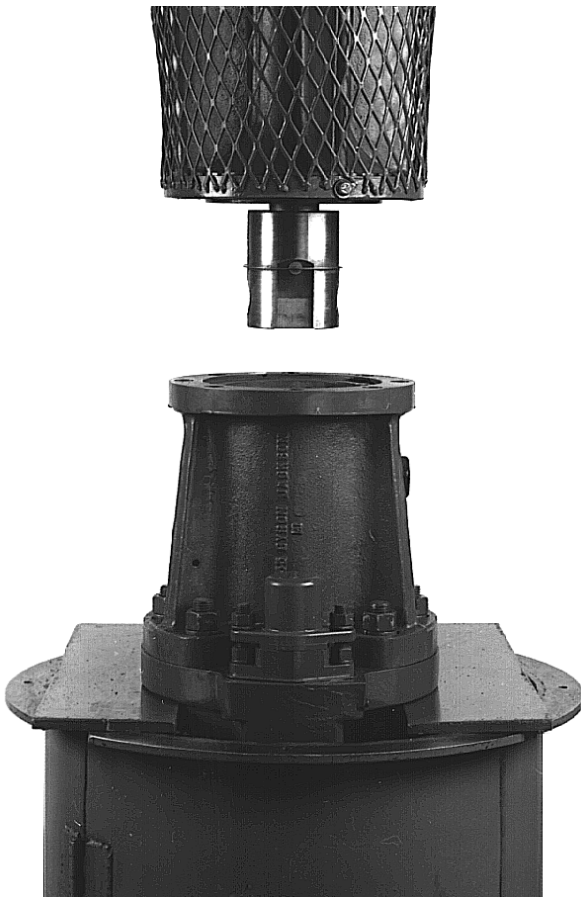


Figure 20 Aligning strainer and adapter

8. Rotate the bowl assembly to line up bolt holes of strainer with those of the adapter (808) and to line up bottom cable guard with power terminal shipping cap (112-2), then lower until flanges butt metal-to-metal.

Install and tighten fasteners (cap screws or stud nuts with washers).

9. Remove the adapter bracket pipe plugs (794) to observe, through the pipe plug holes, the alignment of the holes for the half coupling lock screws (806-3).

Install the half coupling lock screws (806-3) in the half-coupling, with their washers (690-4) and apply torque to the half coupling screws (806-3) according to Table 6.

Unit size [inches]	Torque [Nm]	Torque [Ft-lbs]
8	27	20
10	41	30
12	54	40
14	54	40
17	68	50
18	68	50
21	68	50

Table 6 Torque for half coupling screws

After tightening, check that lock washers (806-3) are seated firmly and lock washers (690-4) are compressed.

For one piece couplings, you will now install the coupling pin (697), coupling lock screws (806-6), lock washers (690-6), and flat washers (004-1) or the retaining rings (526) to retain the coupling pin in its proper position.

10. Reinstall the adapter bracket pipe plugs (609) and tighten firmly.
11. The strainer body has two holes, size 1/8" N.P.T. at 180°. Pour water into one of these holes to fill the adapter bracket (808) until water runs out the other hole. (A 90° street elbow is used for this purpose.)

The pumping unit is now ready for installation of the power cable.

4.4.11 Install power cable

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

- Use a rope to hold the cable and the power cable installation wheel to support the power cable.
- Bring the power cable looping up off the power cable reel stand so that the power cable terminal box is suspended over the power terminal shipping cap.

CAUTION Do not strain the power cable or bend it sharper than a diameter of 14 times the power cable outer diameter.

Avoid strain on terminal box.

Do not use cable installation wheel to suspend cable above the top of pump bowl assembly until the flat cable guards are securely banded.

In the following, two variants of the power cable are described:

- Power cable for voltages of 2 300 V and less (metal clamp power terminal connector)
- Power cable for voltages of 4 000 V and greater (metal housing power terminal connector)

Power cable for voltages of 2 300 V and less (metal clamp power terminal connector)

1. Use the power cable installation wheel to un-reel a sufficient length of power cable to pass the bowl assembly.

Elevate the power cable to the approximate height of the pump bowl assembly and fasten the cable plug to the motor.

CAUTION Do not kink or stretch the power cable.

2. Remove the power terminal shipping cap nuts (003-3), washers (690-3) and power terminal shipping cap (112) at the motor.
3. Depending on configuration supplied:
 - For flat faced (no rabbet fit) gland plate:
Install flat gasket (744-10) over power terminals (019).
See Figure 21.

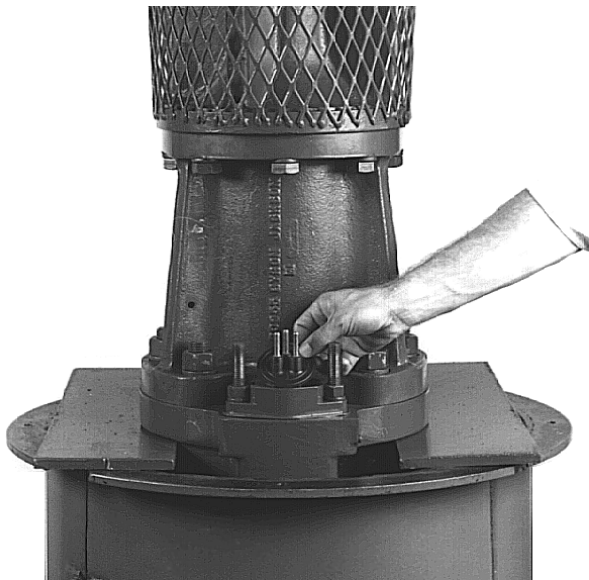


Figure 21 Installing power terminal gasket (flat-faced type shown)

- For gland plate with rabbet fit:
First install gasket (744-11) over rabbet fit on gland plate (111).
Then install gasket (744-10) over the motor terminals (019).

4. Remove the shipping cap (023) from the power cable plug (182).
5. Refer to Figure 22.

Slide the metal terminal box clamp (180) down over the terminal box (182) as far as possible.

Then check gap from bottom face of terminal box clamp (180) to bottom face of terminal box. This gap should be minimum 0.8 mm (1/32) and maximum 2.4 mm (3/32).

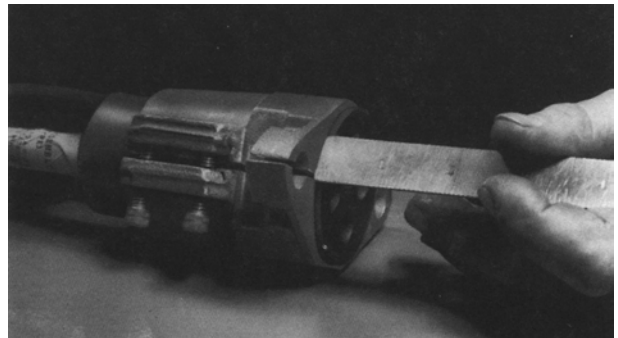


Figure 22 Checking gap, terminal box clamp to terminal box

6. See Figure 23.
Slide the metal clamp (180) up the flat cable and off the cable plug (182), loosening the clamping screws (806), if necessary.

CAUTION Do not distort the clamp.

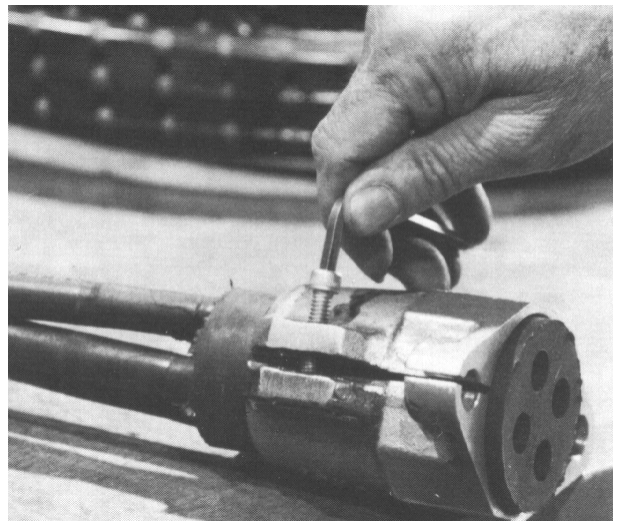


Figure 23 Preparing terminal box clamps

7. See Figure 24.

Align plug connectors with the motor power terminals and push the cable plug (182) down on the motor power terminals (019) to mate with the gland plate (111) and gasket(s) (744-10, 744-11).

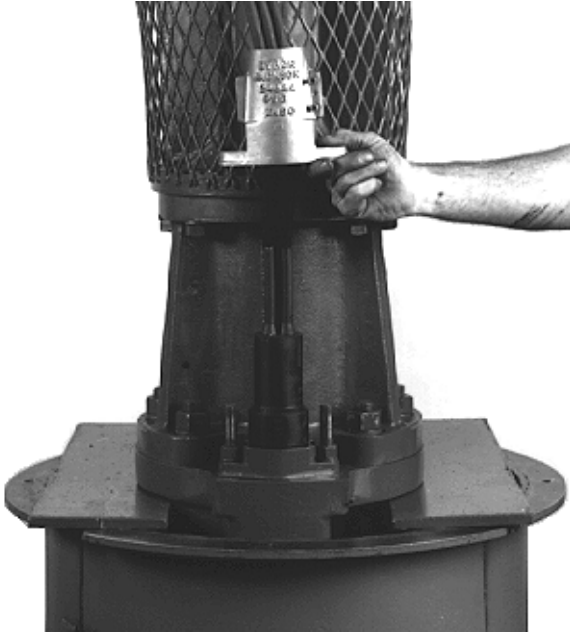


Figure 24 Terminal box installed

8. See Figure 25.

Slide metal clamp (180) down over terminal box (182) and gland plate studs (002-1)

9. Install washers (690-3) and nuts (003-3). Tighten the nuts (003-3) alternatively and evenly to bring the clamp (180) firmly metal to metal against the gland plate (111).

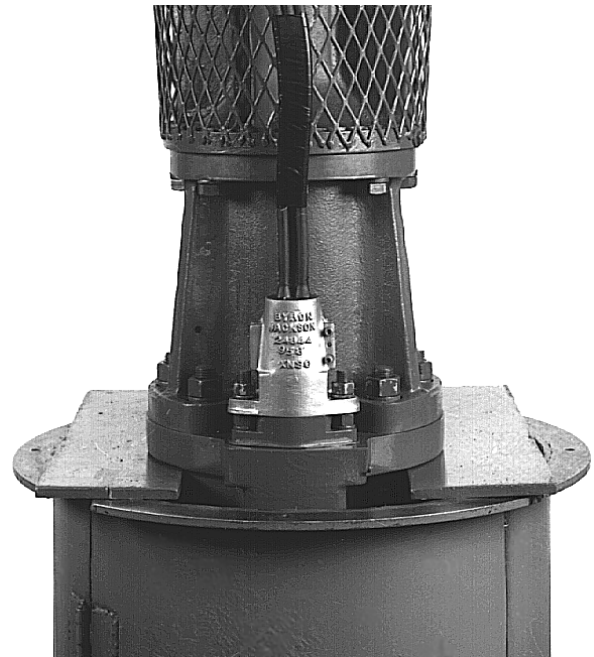


Figure 25 Power cable clamp installed

10. Back off the nuts (003-3) two or three turns each and tighten clamping screws (806).
11. Retighten the nuts (003-3) to achieve metal-to-metal fit of clamp (180) to gland plate (111).
12. Attach ground wire to rib of pump adapter using terminal, lock washer and cap screw.
13. Using surface end of the power cable, which should be accessible, megger the power cable and motor for ground and continuity. The megger reading should 10 MΩ or more.
14. When megger test is completed, install a plastic bag over the surface end of the power cable for protection from the weather.

Continue with "Fasten the power cable to the cable guard", Page 39.

NOTE Key and keyway must be engaged prior to terminal engagement to prevent damage.

The gland nut must be tightened by hand and repeated until seal is accomplished.

Failure to fully engage the plug and receptacle will result in electrical failure.

Power cable for voltages of 4 000 V and greater (metal housing power terminal connector)



Figure 26 Metal housing power terminal connector (4 000 V-cable)

1. Remove the power terminal shipping cap nuts (003-3), washers (690-3) and power terminal shipping cap (112) at the motor.
2. Remove the shipping cap (023) from the power cable connector (182).



Figure 27 O-ring for metal housing power terminal connector at motor gland plate (4 000 V-cable)

3. Refer to Figure 27.

Place new O-Ring (747-10) into groove of the terminal gland plate (111) at the motor top case (074).

4. Align the power cable connector (182) with the motor power terminals (019) and push down them down to mate with the gland plate (111) and O-Ring (747-10).

Slight side-to-side movement will aid this engagement.

3. Install the lock washers (690-3) and tighten nuts (003-3) at gland plate studs (002-1).
4. Tighten the nuts alternately and evenly to bring the power cable connector (182) firmly metal to metal against the gland plate (111) at the motor top case (074).
5. Attach ground wire to rib of pump adapter using terminal, lock washer and cap screw.
6. Using surface end of the power cable, which should be accessible, megger the power cable and motor for ground and continuity. The megger reading should 10 MΩ or more.
7. When megger test is completed, install a plastic bag over the surface end of the power cable for protection from the weather.

Continue with "Fasten the power cable to the cable guard", Page 39.

NOTE Key and keyway must be engaged prior to terminal engagement to prevent damage.

The gland nut must be tightened by hand and repeated until seal is accomplished.

Failure to fully engage the plug and receptacle will result in electrical failure.

4.4.12 Fasten the power cable to the cable guard



Figure 28 Outer guard and band in place - example

1. Inspect cable guards, particularly their inner surfaces, for sharp edges that could damage the cable jacket or insulation.
2. Support the cable alongside the pump bowl assembly with the cable installation wheel without stretching or straining the terminal box.

CAUTION The attachment of the power cable to the cable guard depends on the type of the pump bowl assembly.

3. Slightly lift the pumping unit.

4. Remove the U-plate.



Use to 2 persons to remove the U-plate.

Handle the U-plate carefully.

Danger of injury by dropping the U-plate onto parts of the body.

5. Install a clamp to hold the pumping unit.

The pumping unit is now ready for the attachment of riser pipe and lowering into the well.

4.4.13 Install riser pipe, fasten power cable to riser pipe

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

CAUTION Do not stretch the power cable and the splices.

During the installation, observe the following precautions:

- Support the pumping unit weight with riser pipe elevator.
- Keep the riser pipe centered in the well casing.
- While lowering the riser pipe, hold the power cable flat against the pipe and keep it from dragging across the sharp well casing or flange.
- Avoid loss of power cable length.
- Prevent rotation of the riser pipe so that the power cable does not spiral wrap around it.
- If used or out of round riser pipe is utilized it is recommended to weld a steel strap across each coupling to prevent unthreading during start up or running.

Install the riser pipe(s)

1. Raise power cable installation wheel to 1.5 times the riser pipe length to facilitate power cable alignment to riser pipe and well casing.
2. Arrange the random lengths of riser pipe with their coupling ends facing one direction.

At five feet in from each pipe end, draw a chalk mark to set the banding location.

3. Install the riser pipe.

Ensure that the flow direction is upward.

If the riser pipes are threaded:

- Clean the mating pipe threads of the riser pipe as shown in Figure 13, Page 30.

- Apply thread locking fluid, e. g. Loctite 242 or DELO 5249/5349 or equivalent, to the threads as shown in Figure 14, Page 30.
 - Install the pipe using chain tongs (see Figure 15, Page 31) and apply torque according to Table 5, Page 31.
6. When the motor first enters the water, use the surface end of the power cable to megger the power cable and motor for ground and continuity. The reading should be 10 M Ω or more.

If one or more vertical riser pipe check valves are to be used on an installation, each valve, which should have a bleed-back self draining feature, will take the place of a riser pipe coupling.

The recommended installation is as follows:

- One valve:
Locate the valve approximately 23 m (75 feet) above the pump bowl assembly.
- Two valves:
Locate the first valve 30 m (100 feet) above the pump bowl assembly.
Locate the second valve at 3/5 of the distance between first valve and the surface support plate.

Fasten the power cable to the riser pipe

Use "BAND-IT" or equal stainless steel bands and buckles to fasten the cable guard to the riser pipe.

Pull each steel band tight enough to fasten the cable guard onto the riser pipe, but do not over tension it.

Instructions for use of "BAND-IT" materials and tools are shown in Figure 29, Page 41, to Figure 36, Page 42.

Use of BAND-IT steel bands

1. Cut off about 12" of band from the bulk roll.

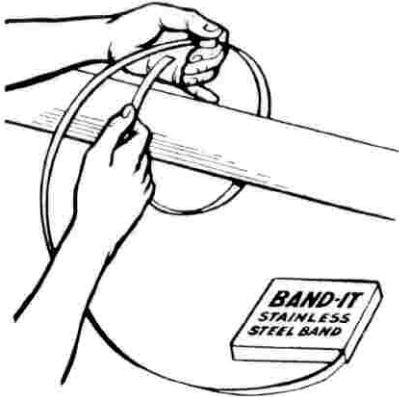


Figure 29 Use of "Band-It" steel band, step 1

2. Hook one end on the buckle and bring the other end around the object to be banded and through the buckle.

For best results, apply the band twice around. Double banding develops almost 4 times the grip of single banding.

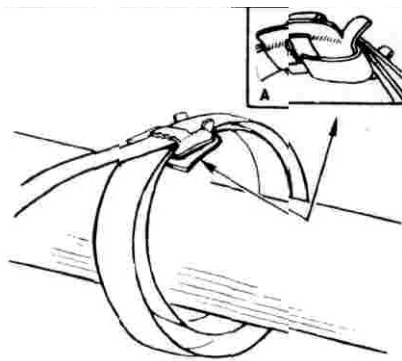


Figure 30 Use of "Band-It" steel band, step 2

3. Draw band tight.

With the thumb on the band gripper lever, apply tension with the tool.

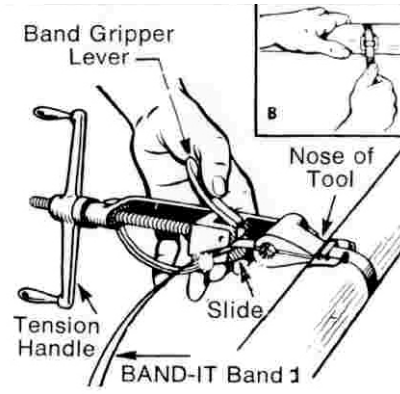


Figure 31 Use of "Band-It" steel band, step 3

4. Apply a proper amount of tension. The band gripper lever locks itself under tension.

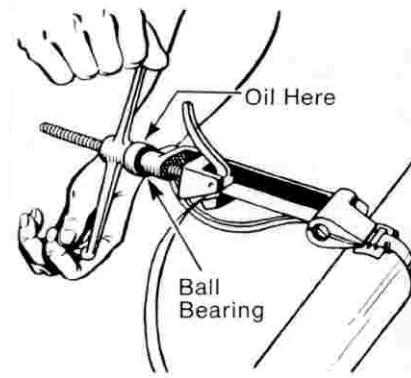


Figure 32 Use of "Band-It" steel band, step 4

5. Rotate the tool over the buckle, backing off with tension handle throughout the entire course of the bend.

Failure to back off with tension handle throughout the entire course of bend may result in breaking of band. There is no loss of tension, as the band released is used up in the bend.

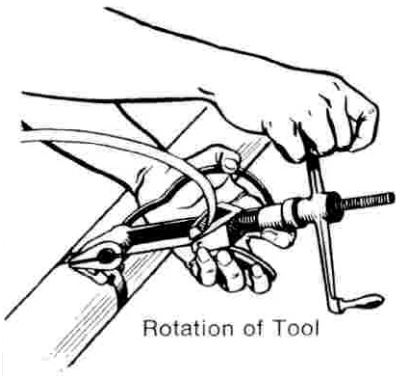


Figure 33 Use of "Band-It" steel band, step 5

6. Pull the cutter handle to cut the band.

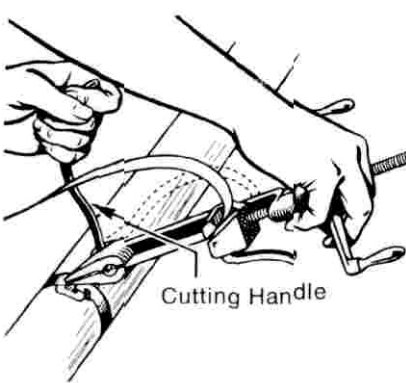


Figure 34 Use of "Band-It" steel band, step 6

7. Remove the tool holding the stub of the band down with your thumb.

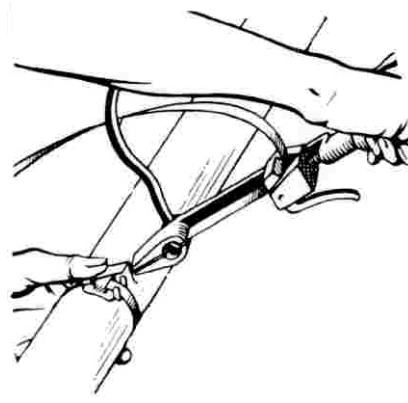


Figure 35 Use of "Band-It" steel band, step 7

8. Lock the stub by hammering down the buckle ears, thus completing the BAND-IT clamp.

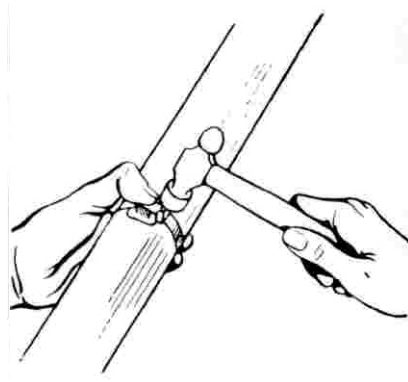


Figure 36 Use of "Band-It" steel band, step 8

4.4.14 Connect power cable to terminal box

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".



DANGER

Before completing the electrical connection, review Chapter 3.5 "Electrical requirements", Page 17.

The surface plate assembly is screwed in place and the pumping unit hangs well above the well base.

1. Measure and cut the cable to approximate length for surface make up.
2. Strip the power cable, if necessary.
3. Feed the cable through the packing gland (or glands) in wellhead and then into the terminal box.
4. Connect the terminal box leads to the power cable.
Each lead is to be waterproof.
5. Place the two final supporting cable clamp assemblies 0.9 m to 1.2 m (3 feet to 4 feet) below the wellhead.
6. If the power cable is a 4-conductor cable and the grounding is in the scope of delivery: make the ground wire connection to wellhead with lug, lock washer and cap screw.
7. Lower the wellhead into its correct position and secure it in place.
8. At the terminal box, megger the power cable and motor for ground and continuity.

The reading should be 10 MΩ or more.

The pumping unit is now ready for connection to the power supply.

4.4.15 Connect terminal box to main power supply

NOTE Starting equipment for the pump bowl assembly is furnished by the customer.

1. Ensure that the rating of the equipment is used conform to the National Electric Code requirements for high reactance squirrel cage motors.

Make certain that the starter main contacts are in good condition and are working properly.

Also see that the overload relays are for the correct full load current.

To ensure that the starter is operated safely, verify that the panel housing is properly grounded to a ground rod and to the surface plate assembly.

2. Check the no-load voltage at the starter between all three phases. The voltage values must be equal and must be approximately the same as the voltage rating.
3. Strip back the outer sheath on the cable between 152 mm and 457 mm (6 " to 18") depending on cable size and panel terminal requirements.

Strip by scoring the sheath, lengthwise with a knife or tool to the length needed, in several places around the outside.

Do not cut all the way through and damage the individual conductor insulation.

Grasp a scored segment of the sheath at the end and peel like a banana.

Repeat this all the way around and cut off the stripped segments.

4. Strip a short segment of insulation off the end of each conductor for connection into the starter load terminals.
5. Remove a conduit knock-out in the bottom of the panel. Install the cable with its gasketed grip in this hole, and connect to the starter load terminals.
6. Ensure that the starter cannot be activated accidentally.
7. Perform insulation test as described in Chapter 6.8.1 "Insulation test", Page 53.

Insulation resistance must be at least 10 MΩ.

8. Perform continuity test as described in Chapter 6.8.2 "Continuity testing, Page 53.
9. Connect the terminal box to the power source cable.

The pumping unit is now ready to be started.

4.5 Uninstallation

4.5.1 Safety instructions



DANGER

Before starting any installation work or removing any parts of the pumping unit, read Chapter 1.6 "Safety", Page 6.

Tighten all screws in accordance with Chapter 12.3 "Tightening torques".



DANGER

If the area was designated a hazardous location, refer to applicable safety procedures for safe handling of tools, equipment, and test instruments.

CAUTION If the pumping unit is equipped with a non-return valve without load relieving holes, the pumping unit weight with ascending pipeline and the water column contained within it must be lifted during removal!

If the non-return valve is provided with load relieving holes, the weight of the water column does not apply.

4.5.2 Uninstallation

1. Stop the pumping unit operation at the control panel.
2. Measure the power cable leads to check insulation resistance (leads-to-ground) and conductance (lead-to-lead) as directed in Chapter 6.8 "Electrical tests of the motor", Page 53.
3. Disconnect the cable at the starter panel. Megger the leads for ground and continuity. Reading should be 10 MΩ.
4. Remove the pumping unit in the reverse order of the installation procedure (see Chapter 4.4 "Installation", Page 23) and place all parts on the floor.

Also consider Chapter 2.2 "Transport", Page 10.

- a. Disconnect terminal box from main power supply, see Page 43.

- b. Disconnect power cable from terminal box, see Page 43.

- c. Uninstall riser pipe and detach power cable from riser pipe, see Page 40.

If the bands are double wrapped, cut them properly so that they can be saved for use as a single band for reinstallation.

- d. Uninstall power cable, see Page 35.

Separate cable from motor and seal the cable with the original terminal box shipping cover (023).

- e. Uninstall pump bowl assembly, see Page 30.

- f. Uninstall coupling, see Page 27.

- g. Uninstall motor, see Page 26.

5. Check the riser pipes for need of replacement, particularly the sections between high and low well fluid levels.
6. Inspect any column check valves for wear and proper functioning.
7. Remove the coupling retainer rings, retainer screws, lock washers, and coupling pins. Separate the pump element from the motor between the adapter bracket (808) and the strainer body (564).
8. Megger the motor for ground and continuity. Reading should be 10 MΩ or more.
9. Seal the motor terminals with original power terminal gasket (744-7) and power terminal shipping cap (112-2).
10. If there is water in the motor, elevate motor over a sump or drum. Remove lower casing drain plug (806) from bottom of motor, then remove vent plugs (806-4 and 806-5) at top of motor to drain the water from the motor. Replace drain and vent plugs.

Continue with Chapter 2.3 "Storage and shipping", Page 12.

5 COMMISSIONING STARTUP, OPERATION AND SHUTDOWN

5.1 Safety instructions

NOTE Before commissioning, operation or shutdown of the pumping unit, read Chapter 1.6 "Safety", Page 6.

The pumping unit may only be operated

- by trained personnel,
- in a completely assembled condition, and
- completely filled and immersed.

5.2 Direction of rotation

The direction of rotation of motor and pump is given in Chapter 12.2 "Data sheet".

5.3 Starting the pump

5.3.1 First-time start-up of the pump

1. Measure insulation resistance (leads-to-ground) with power turned off and motor turned off to ascertain that not short circuits are present.

CAUTION Do not attempt to start the pumping unit with an insulation resistance reading of less than 5 MΩ.

2. Verify that balanced three-phase voltage is supplied by taking readings with the line voltmeter and using the voltmeter selector switch.

CAUTION Never attempt to run the pumping unit with an unbalanced voltage between two leads.

An imbalance between two leads can cause 6 - 10 times that amount of imbalance in an amperage and the resultant temperature increase means a decrease in motor life.

Poor voltage regulation of an engine driven generator, if the power is obtained from such a source, can be very detrimental.

3. Close the pump discharge valve.
4. Start the motor.

The contractor closes and the pump motor starts.

CAUTION Do not run the pump for more than 2 minutes with discharge valve closed.

5. Immediately take current reading using line ammeter.

If the current is in the range of amps at shut-off (see Chapter 12.2 "Data sheet"), rotation is correct.

If current is about 80 % of shut-off amps, rotation is not correct. In this case,

- a. press STOP
- b. turn off all power
- c. move isolator handle to OFF
- d. reconnect motor leads for proper rotation.

Mark the leads so that they can always be placed correctly any time they are removed.

6. After verifying proper rotation,
 - stop the pumping unit.
 - open the discharge valve
 - start the pumping unit again.
7. Recheck the current, which should be the full load current as shown in Chapter 12.2 "Data sheet".

Current could also be the same as full load amps with reversed rotation but head and flow would be greatly reduced.

CAUTION If a circuit breaker trips, always wait at least 10 minutes before resetting.

During first-time start-up, take notice of the following:

- When motor is started, it should attain full speed within 3 seconds.

If after this period the line current is still high (over twice normal value), the pumping unit is not attaining the full speed.

CAUTION In the event the pumping unit does not attain the full speed, stop the pumping unit and do not attempt to restart it until the trouble is found and corrected.

During normal operation, the current must not exceed the motor data plate value.

- Measure the line voltage between phases while the pumping unit is pumping.

The readings obtained should not be more than 10 % above or below the rated motor voltage.

- In case of malfunction, stop the pumping unit and refer to Chapter 7 "Faults, causes and remedies", Page 56.

5.3.2 Normal start-up of the pump

CAUTION If maintenance has been performed, follow Chapter 5.3.1 "First-time start-up of the pump", Page 46.

1. Verify that the control panel door is closed.
2. Verify that balanced three-phase voltage is supplied by taking readings with the line voltmeter and using the voltmeter selector switch.

CAUTION Never attempt to run the pumping unit with an unbalanced voltage between two leads.

3. Start the pumping unit.
The contractor completes the pump circuit, and the pump motor starts.
4. Verify that the pump motor comes up to speed within 3 seconds as indicated by normal readings of current, voltage, head and flow.

If

- current exceeds the rated value of the amperage shown in Chapter 12.2 "Data sheet", or
- voltage varies + 10 % or - 10 % from the rated value shown in Chapter 12.2 "Data sheet", or
- head and flow are abnormal

then stop the pumping unit and refer to Chapter 7 "Faults, causes and remedies", Page 56.

5.4 Running or operation

5.4.1 Performance and operating limits

Usually, a pumping unit has been selected and built to perform a maximum efficiency under defined conditions, see Chapter 3.3 "Performance and operating limits", Page 15.

Changes of these conditions, e. g. increase or decrease in head, will not cause a noticeable difference in the efficiency.

However, a large variation in head will not only show up as efficiency loss, but as a output, or thrust bearing overload.

Water level

- A well should always be provided with a means for determining the static water level, and pumping level. A good air line, with depth gage, is generally the most simple and practical.
- For monitoring the water level in the well, we recommend water level detectors or water level measuring units.

Sand

- When a pumping unit is first started, a new well may produce considerable amounts of sand, despite the fact it had been sand pumped after drilling.

The discharge should be throttled back to where this is cut down to a minimum, then gradually opened up to full discharge as the sand disappears.

This operation may last from a matter of minutes to several days or longer.

If the sand flow shows no signs of stopping

- rework the well to screen out the sand, or
- install a pumping unit with a capacity smaller than that of the currently installed unit.

Continued sand pumping will result in increased pump wear which in turn will show up as increased efficiency loss. Too great a wear will run the pump beyond the repair stage and possibly have serious effects on the motor.

- Some wells will always produce a small amount of sand at start-up. Therefore, it may be necessary to bypass or trap out this first flow at each start-up, particularly if a closed piping system is used.
- When a pumping unit is known installed near to the bottom of a well, a close check should be kept to make sure that the well does not sand-up (fill in) around the motor.

This may take place without any noticeable effect in pumping or motor operation. However, the motor is dependent on adequate cooling from water, and any sand around it would eventually create overheating, resulting in at least shortened life, if not a burnout.

If this problem cannot be cured by well work, contact Flowserve for devices that can be added to the pumping unit to prevent its sanding up.

Hydro-pneumatic pressure system

If the pumping unit is coupled into a hydro-pneumatic pressure system, the set-up must be designed so that the pumping unit

- does not get "water-logged" (loss of air through water absorption without replacement) and
- and does not receive too much air at each start-up.

5.4.2 Motor operation

- Always "meg" the motor before setting a tripped circuit breaker.
- Wait 10 minutes before restarting the motor.
- Breaking suction and/or inadequate power supply renders warranty void.
- A time delay must be installed when any type of automatic system is used in order to prevent starting of the motor while it is spinning backwards due to riser pipe drainback through the pump.

A 3 minute time delay is usually adequate. This provides a safety measure in the event a failure in the automatic control system creates a rapid recycle series. It also provides a time period for the rotating element of pump and motor to stop, after reverse rotation due to vertical riser pipe drain-back.

- A pumping unit should not be run at closed valve for more than 2 minutes as virtually all

the energy created is then dissipated as heat. This condition has been known to have practically "boiled" the water in the well and created an overheating problem for the motor.

- After the pumping unit has operated for a longer period of time, a minimal readjustment of the motor circuit breaker may be required due to changed operating conditions, e. g. sinking of the water level.

CAUTION In no case select a motor protection adjustment setting that is greater than the highest permissible value given in Chapter 12.2 "Data sheet".

If the pumping unit has shut-off hand the reason cannot be traced to a positive external source:

1. Switch off the motor.
2. Disconnect the motor from the main power supply.
3. Disconnect the power cable leads from the starter
4. Measure the insulation resistance of the power cable leads to the ground (the well casing).

CAUTION Never re-set or re-fuse and start a motor without first measuring the insulation resistance the unit.

5.4.3 Starting frequency

The amount of regularly-distributed starts per hour must be taken from Chapter 12.2 "Data sheet".

Higher starting frequencies are only permissible upon written agreement by Flowserve.

Amount of maximum permissible starts in sequence:

- Cold motor2 starts
- Warm motor 1 starts
- Rest interval after each cycle 10 minutes

It is suggested to protect the motor against non-permitted reconnection by a time relay.

5.5 Stopping and shutdown

To stop the pump, follow the user instructions of the control panel.

NOTE An automatic 10-minute delay before restart is suggested as a feature in the control panel.

6 MAINTENANCE

6.1 Safety instructions

Before maintenance or repair work



DANGER

Before commissioning, operation or shutdown of the pumping unit, read Chapter 1.6 "Safety", Page 6.



Before starting any maintenance or repair work or removing any parts of the pumping unit:

1. Switch off the motor, see Chapter 5.5 "Stopping and shutdown", Page 49.
2. Completely separate the pumping unit from the power supply.

During maintenance or repair work

During maintenance or repair work, avoid polluting water or soil with hazardous substances such as lubricants or cleaning agents. Collect these substances in suitable containers and dispose of the in accordance with the local regulations.

After maintenance or repair work

Immediately after finishing maintenance or repair work and before restarting the pumping unit, ensure that

- all tools and equipment required for maintenance or repair work have been removed from the pumping unit

- all screws and connections that were previously undone are retightened
- all safety devices are replaced and/or operate correctly
- the motor is filled.

6.2 Maintenance schedule

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

Flowserve submersible pumps are custom designed to operate for extended periods with a minimum of regular maintenance, the frequency and scope of maintenance depending primarily on the conditions of service to which the pump is subject. Periodic dismantling for inspection is not necessary unless excessive wear is indicated or a pump malfunction is suspected.

To determine when major maintenance is required, periodic testing of the pumping unit (as described in Chapter 6.7 "Periodic testing", Page 52) is strongly recommended. This will establish a baseline of performance data indicative on pump condition that will permit scheduling of major maintenance tasks well ahead of the time they become necessary and will prove very beneficial to the prolonged lift and satisfactory operation of the pumping unit.

Interval	Part	Maintenance
Before each installation and after each uninstallation	All parts	Inspect all piping connections for evidence of leakage, loosening or other damage and repair if necessary.
	Pump bowl assembly	Inspect the integrity of the pump mounting fasteners which may loosen due to vibration, and tighten if necessary.
Every 2 - 3 months	Motor	Periodic testing, see Chapter 6.7, Page 52.
	Power cable, motor	Electrical tests of the motor, see Chapter 6.8, Page 53.
Every 2 to 3 months if pump stands idle for longer period of time	Pump bowl assembly	Pump test run, see Chapter 6.6, Page 51.

Table 7 Maintenance schedule

6.3 Working substances and auxiliary agents

Motor lubricants

The specific type of oil used in the motor is given in Chapter 12.2 "Data sheet". Do not use other oils.

The motor does not require periodic changing of oil. However, it may be necessary to fill up oil in larger intervals.

Pump bowl assembly lubricants

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

The pump bowl assembly does not contain lubricants.

The bearings of the pump bowl assembly are self-lubricated by the liquid being pumped.

6.4 Motor maintenance

Motor maintenance can consist of anything from disassembly and inspection to complete rewinding and overhaul. In normal service, motor maintenance should be required infrequently.

To determine when motor maintenance is needed, periodic testing should be faithfully performed as described in Chapter 6.7 "Periodic testing", Page 52. If periodic testing is performed satisfactorily, the need for motor maintenance can usually be anticipated and maintenance scheduled accordingly.

When periodic testing indicates a motor problem, remove the pump and inspect the motor while still vertical in the top of the well to check its electrical condition (see Chapter 6.8 "Electrical tests", Page 53). Also rotate the shaft manually to check for possible binding. Spare motors should be maintained in field stock to permit rapid re-installation when a pump is pulled.

No attempt should be made to repair a motor in the field. If a motor problem is suspected, contact a Flowserve service representative for further in-

structions. When repair of a motor is required, install a spare motor in its place and arrange to have the pumping unit returned to the factory.

6.5 Pump maintenance

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

The pumping unit can be operated without maintenance measures, insofar as no irregularities in operation or pumping, caused by sand or a corrosive pumping medium, make premature removal necessary.

Fluctuating and/or rapidly increasing current consumption points to mechanical problems in the pump bowl assembly or motor.

Strong oscillation of the pressure and at the same time of the ammeter can be caused by irregular water inflow.

6.6 Pump test run

NOTE Not all components or sub-assemblies of a pumping unit are necessarily supplied by Flowserve or part of this delivery.

These user instructions apply only to the components or sub-assemblies supplied by Flowserve in this delivery, see Chapter 12.1 "Scope of delivery".

If the pump bowl assembly should stand idle for a longer period of time, perform a 10-minute test run every 2 to 3 months, in order to recognize malfunctions.

CAUTION The pumping unit must be completely submersed in pumping medium for this test run.

6.7 Periodic testing of motor and pump

Motivation

As the pump wears, the internal sealing clearances increase, which results in increased recirculation flow (or leakage) from the impeller discharge back to its suction side.

At a fixed differential head, the total flow through each impeller in a worn pump is the same as in a new pump, but more of the flow is recirculated flow that the net flow out of the pump discharge is reduced.

To produce the same net flow output as a new pump, a worn pump must operate at a lower differential head so that the impellers can operate at a higher flow rate to make up for the higher recirculation flow. This reduced performance in a worn pump is the basis for the periodic testing procedure outlined below.

Scope

Periodic testing or mounting of critical pump bowl assembly and motor performance parameters such as head, flow, line voltage, driver current, starting time, etc., is recommended to establish a reliable performance record for use in evaluating and projecting the pumping unit's condition and in establishing the maintenance requirements for its particular application. Periodic testing is an important part of a well-planned maintenance program.

The scope and frequency of periodic testing is primarily a matter of customer decision based on the severity of pump operating conditions.

A "Periodic Test Record" is provided with each submersible pump to record the results of periodic tests.

Operating conditions during test

Periodic test measurements should be taken under one of the following conditions:

- Pumping unit operating at a predetermined test flow.
The test flow used should be the same in each test and should be greater than 75 % of the design flow.
- Pumping unit operating at zero flow (discharge valve closed).
- Shut-off head reduced by 5 % - 10 %.

CAUTION To prevent possible overheating, do not run the pump more than 2 minutes against closed valve.

Evaluation

Periodic test data can be used in the following ways to plan preventative maintenance:

- Method 1
Plot total differential head measurements at zero flow and, if practicable, at a fixed test flow.
Extend (extrapolate) the curve to a future time when the differential head will be reduced to an unacceptable value. Plan to pull the pump before this future time.
- Method 2
Sometimes, customer flow requirements will not permit throttling pump flow.
If total differential head and flow can be measured during normal operation, this data can be used to plan preventative maintenance. To do so, plot the measured head and capacity point on the factory pump performance curve and record the test head as a percentage of the performance curve head at the test capacity. Plot this head versus time, extrapolate and use as in method 1.
- Method 3
An alternate method would be to plot capacity (flow rate) as a percentage of performance curve capacity at test head. Plot this capacity data versus time, extrapolate and use as head data used in method 1. Note that in any case, absolute accuracy of test equipment is not too important, but repeatability is important to permit comparison of worn pump performance with pump performance when new.

Adaptation of maintenance intervals

If direct or projected periodic testing readings show reduced shut-off head, change maintenance intervals as follows.

- Shut-off head reduced by < 5 %
No preventative maintenance is indicated.
- Shut-off head reduced by 5 % - 10 %
Consider and project maintenance to take place at a time most convenient to the user providing the fall off in shut-off head would not exceed 15 % by such time.

- Shut-off head reduced by 10 % - 15 %
Undertake maintenance before the next check period.
- Shut-off head reduced by > 15 %
The pump requires immediate attention and should not be run further.

The limits for minimum insulation resistance and critical insulation resistance for measurements at 20 °C winding temperature are as follows:

- Critical insulation value after longer operational time10 MΩ

6.8 Electrical tests of the motor



DANGER

Do not conduct this test in an area that has been designated a hazardous location.

CAUTION A relatively low insulation resistance does not definitely show that the pumping unit will break down due to insulation problems.

If however after measurements over a longer period of time, an extreme drop in the insulation resistance occurs within a short time, these must then be inspected.

6.8.1 Insulation test

Before initial starting, as well as after longer storage or idle time, the insulation resistance of the drive must be measured.

If the insulation resistance falls below minimum value, the cause or the malfunctioning part (power cable, line connection or windings) must be determined and the insulation weakness removed.



DANGER

During and after the measurement, the connector ends of the motor line and/or the connection terminals partly carry dangerous voltage and may not be touched.

Before the measurement, ensure that there is no line voltage.

6.8.2 Continuity testing

1. For continuity testing of the motor stator windings, use low resistance Ohm-Meter (4-pole Kelvin Bridge)
2. Perform continuity test with motor. The terminal resistance must first be measured in the three possible combinations (1-2, 1-3, 2-3). These three values must not vary by more than ± 2% from their average. The terminals must be grounded before the low resistance Ohm-Meter leads are connected. The temperature of the winding in °C must also be measured and recorded.

To measure the insulation, disconnect all leads of the power cable of the motor.

All leads must carefully be cleaned of all dirt. Heed the operating instructions of the insulation measuring device.

Insulation measurement is always performed with a measuring-circuit voltage of 1000 V. The measured value must be read after a minute of measurement duration.



DANGER

The motor windings or power cable, charged up to the measuring-circuit voltage, must be discharged after measurement by means of the insulation measuring device.

6.9 Spare parts

6.9.1 Recommended spares and consumable items

Flowserve generally provides spare parts listings as part of the original order specifications.

Flowserve recommends that the customer holds the following spares at the installation site.

General spares:

- One full spare pump, assembled, but not installed, and available to replace any unit, or one full spare pump installed in system with valve.

Spares for the pump bowl assembly:

- One full set of bowl assembly bearings
- One pump shaft key.
- Two full sets of case gaskets.

Spares for the motor:

- Case vent plug with gasket.
- Case shipping plugs.
- Shaft shipping cap nuts and lock washers.
- Driver shaft key.
- Coupling lock pin with retaining ring, if required (depends on pump type).
- Motor oil (Flowserve part no. and quantity see Chapter 12.2 "Data sheet").

6.9.2 Ordering spare parts

Ordering identical duplicate spare parts

When ordering identical duplicate replacement parts for this pumping unit, be certain to state

- pump serial number,
- size,
- type,
- service (or application)
- part name, and
- part reference number

as indicated on the applicable sectional drawing in Chapter 8 "Parts list and drawings".

Ordering spare parts for pumps with modified operating conditions

If the operating conditions have changed since pump was purchased, add full particulars of new operating conditions. This is especially important when selecting new impellers.

CAUTION Should a change in operating conditions be considered, consult your nearest Flowserve representative or factory to determine if such a change is feasible with the existing pumping unit.

Ordering oversized or undersized parts

If oversized or undersized parts are required add:

- Required dimensions (with sketch of part, if possible).
- Finishing by Flowserve or by customer ("leave rough")

NOTE If the customer finishes parts the customer assumes the sole responsibility.

Determine whether such a change is feasible.

Replacement of parts alternated during operation

Flowserve accepts no responsibility for incorrect replacement of original parts which have been altered in the field.

6.9.3 Storage of spare parts

Storage of spare metal parts

Shelf life:

- Indefinitely

Storage conditions:

- Adequately protected from moisture and physical damage.

Storage of rubber parts, e. g. spare O-rings

Shelf life:

- Maximum three years

Storage conditions:

- Stored in original heat sealed packaging
- Adequately protected from air, light, ozone, radiation, excessive temperature > 49 °C (> 120°F), contamination, and physical damage.

6.10 Tools for repair and maintenance

Refer to Chapter 4.2 "Equipment and personnel required", Page 19.

7 FAULTS, CAUSES AND REMEDIES



DANGER

Before repairing the pumping unit, read Chapter 1.6 "Safety", Page 6.



Before starting any maintenance or repair work or removing any parts of the pumping unit:

1. Switch off the motor, see Chapter 5.5 "Stopping and shutdown", Page 49.
2. Completely separate the pumping unit from the power supply.

FAULT SYMPTOM

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FAULT SYMPTOM

Motor protection triggered										
↓	Pump does not start									
↓	Flow inadequate									
↓	Pumping unit runs, but does not pump									
↓	Shut-off head current (amps) is higher than originally recorded but shut-off head is not diminished									
↓	Shut-off head is diminished but shut-off current (amps) is unchanged									
↓	Shut-off head is diminished and shut-off current (amps) is much higher									
↓	Duty capacity and head are low but running current (amps) and shut-off valves are normal									
↓	Pump starts bus trips circuit breaker									
↓	Pump does not start									
↓	PROBABLE CAUSES					POSSIBLE REMEDIES				
						●	Blockage in discharge or intake	Disassemble and clean discharge and intake.		
						●	Valve in system is not fully open	Fully open valve		
							C. ELECTRICAL TROUBLES			
●							Motor circuit breaker adjusted too low.	Readjust motor circuit breaker according to rating plate or Chapter 12.2 "Data sheet".		
●							Current consumption of motor too high due to under voltage or wrong frequency.	Check system voltage and frequency. Check if the information on the type plate corresponds with the system voltage and frequency.		
●							Phase failure.	Check fuses. Examine power cables for damage.		
●							Voltage failure due to blown fuse(s).	Replace fuse(s).		
●							Defective power cable.	Replace power cable.		
	●						Incorrect rotating direction.	Change rotating direction.		
		●					Rotating speed too low because of under voltage or wrong frequency.	Check system voltage and frequency.		
			●				Rotating speed too low because motor runs with one phase.	Check fuses.		
				●			Rotating speed too low due to bearing damage.	Remove pumping unit and repair.		
		●	●				Drop in line voltage	If amperage remains within 110 % of the rated value: No remedy necessary. If amperage does not remain within 110 % of the rate value: Check line voltage		
						●	Insulation failure	Measure insulation resistance.		
						●	Insulation failure	Measure insulation resistance. Check voltage.		
						●	Pumping unit is stuck	Try momentarily reversing rotation by interchanging any two leads		

8 PARTS LIST AND DRAWINGS

9 CERTIFICATION

Certificates determined from the Contract requirements are provided with these user instructions where applicable. Examples are certificates for CE marking, etc.

If required, copies of other certificates sent separately to the purchaser should be obtained from the purchaser for retention with these user instructions.

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Change notes

If any changes, agreed with Flowserve Pump Division, are made to the product after its supply, a record of the details should be maintained with these user instructions.

10.2 Abbreviations

ATEX	Equipment for Potentially Explosive Atmospheres
NPSH	Net positive suction head
OD	Outer diameter
rpm	revolutions per minute
VDE	German Association for electrical, electronic and information technologies ("Verband der Elektrotechnik, Elektronik und Informationstechnik e.V.")

11 GLOBAL CONTACT POINTS, EU CE
MARKER AND SERVICE CON-
TACTS

12 APPENDIX

12.1 Scope of delivery

12.2 Data sheet

12.3 Tightening torques

12.4 Safety data sheet for motor oil



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