



STANDARD OPERATING PROCEDURE

SOP 3.1 Booster Pump Stations

Abstract: Booster pump stations are installed to boost the system pressure and fill ground storage tanks located at higher elevations.



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Revision Tracking Sheet

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7. Peerless-Grundfos Installation and Operating Instructions
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1. DEFINITIONS/ACRONYMS

1.1. Definitions

- **Booster pump:** A device that delivers water to a desired point of height and distance in the water supply network by providing extra pressure to the water under all operating conditions. The water pressure generated by a booster pump is a force, exerted over a specific area, that moves water in the water line from the booster pump discharge point into the desired water supply location.
- **Cavitation:** Cavitation is one of the most serious operational problems with centrifugal pumps. Cavitation occurs when cavities or bubbles of vapor form in the liquid. The bubbles collapse against the impeller, making a sound as though there were rocks in the pump. If left uncorrected, cavitation will seriously damage the pump.
- **Centrifugal pump:** A pump that utilizes an impeller spinning at a high velocity to induce flow in a liquid.
- **Commutator:** Electrical device that converts alternating current to direct current.
- **Hydraulic grade line:** A measurement that incorporates both pressure and elevation into a single parameter that is useful for evaluating distribution systems, especially with changes in elevation.
- **Safety Data Sheet (SDS):** An Occupational Safety and Health Administration (OSHA) standardized hazard communication document detailing a chemical's properties and hazards (physical, health, and environmental); protective measures; and safety precautions for handling, storing, and transporting the chemical.
- **Water hammer:** Water hammer may occur when flowing water within a water system is abruptly stopped or changes direction, creating a pressure surge.

1.2. Acronyms and Abbreviations

- **DSO** Water Distribution System Operator
- **JBPHH** Joint Base Pearl Harbor Hickam
- **NAVFAC** Naval Facilities Engineering Systems Command
- **OIT** Operator(s)-in-Training
- **OSHA** Occupational Safety and Health Administration
- **PPE** personal protective equipment
- **PRP32A** Potable Water Branch
- **SDS** Safety Data Sheet
- **SOP** Standard Operating Procedure

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2. OVERVIEW

2.1. Scope and Purpose

This Standard Operating Procedure (SOP) covers the booster pump stations including pumps, station control, and general maintenance.

2.2. Operating Summary

2.2.1. Pumps

Booster pumps are utilized to raise the hydraulic grade line to fill ground storage tanks in elevated locations or provide adequate pressure to regions of higher elevation (see *Figure 2-1*). The booster pump operation falls into two categories: continuous operation or cycled operation.

The Manana Booster Pump Station is operated (b) (3) (B). Moanalua Terrace Booster Pump Station is operated (b) (3) (B). Aiea-Halawa and Red Hill Booster Pump Stations are all operated (b) (3) (B) through Supervisory Control and Data Acquisition based upon tank level set points (see *SOP 6.1 Water Storage* for target tank levels).

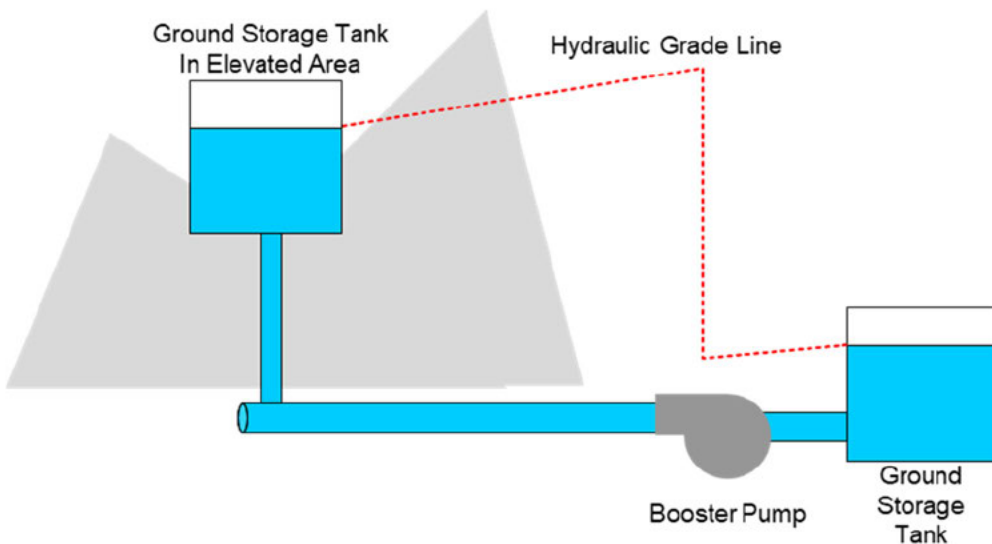


Figure 2-1 Distribution System Hydraulic Grade Line

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2.2.2. Pump Control Valves

The Manana and Moanalua Terrace Booster Pump Stations are both equipped with pump control valves. Moanalua Terrace is currently bypassing the pump control valves. Both stations utilize a (b) (3) (B) pump control valve, which maintains a backpressure on the pumps to prevent excessive speed during low head conditions. *SOP 5.2 Valves* provides detail on operation and maintenance of the pump control valves.

2.3. Equipment List at Each Shaft

Booster pump station equipment is listed in *Table 2-1*.

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Table 2-1 Booster Pump Station Equipment Specifications

Pump Station	Booster Pumps	Valves (See <i>SOP 5.2 Valves</i> for details)
Red Hill	- Pump 1: Goulds (b) (3) (B) (Attachment 5) - Pump 2: Goulds (b) (3) (B)	- Discharge check valve - Suction and discharge isolation gate valves - Pump air release valve
Aiea-Halawa	- Pump 1: Goulds (b) (3) (B) - Pump 2: Goulds (b) (3) (B)	- Discharge check valve - Suction and discharge isolation gate valves - Pump air release valve
Manana	- Pump 1: Peerless Pump (b) (3) (B) - Pump 2: Peerless Pump (b) (3) (B) - Fire Pump: Allis Chalmers (b) (3) (B)	(b) (3) (B) pump control valve - Discharge check valve - Suction and discharge isolation gate valves - Pump air release valve
Moanalua Terrace	- Pump 1: Grundfos Model (b) (3) (B) - Pump 2: Unknown (Assumed to be similar model to Pump 1) - Jockey Pump: (b) (3) (B)	(b) (3) (B) pump control valve - Discharge check valve - Suction, discharge, and various isolation butterfly valves
Camp Smith Emergency Booster	Peerless Pump (b) (3) (B)	- Air release valve - Suction and discharge isolation gate valves - Discharge check valve

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3. RESPONSIBILITIES AND QUALIFICATIONS

3.1. Responsibilities

The JBPHH Public Works Department owns and operates the JBPHH drinking water system. Operation and maintenance of the system is the responsibility of the Utility Division Potable Water Branch (PRP32A). The booster pump station operation and maintenance within JBPHH is performed by Production Work Center WHHP6A. Refer to *Figure 3-1* for details.

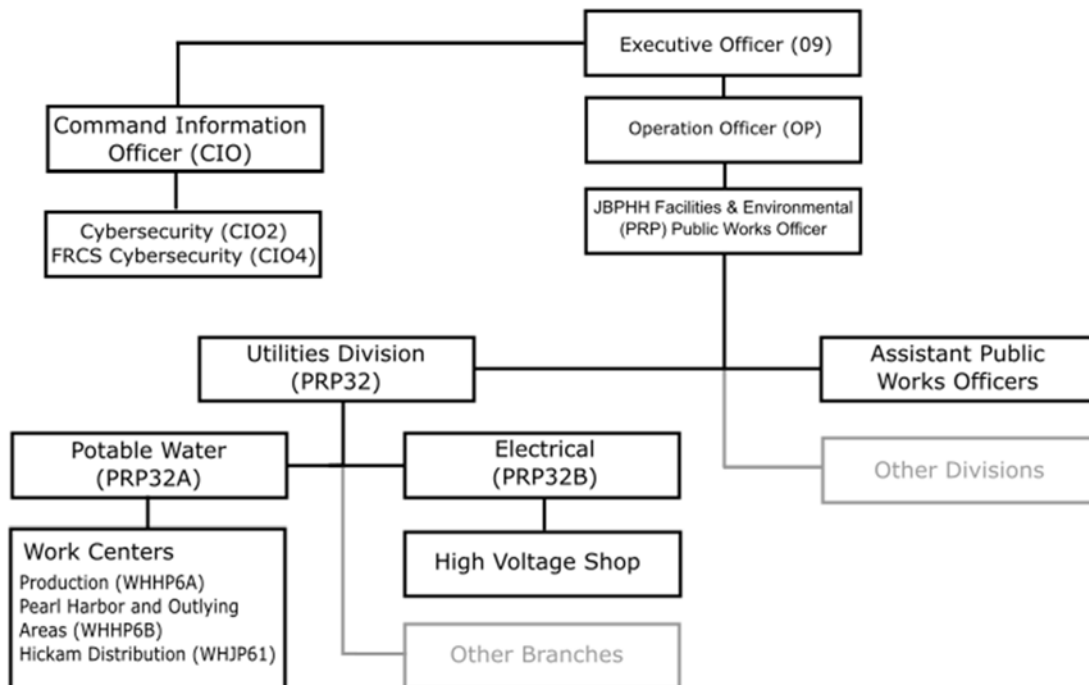


Figure 3-1 Public Works Department Organization

Lead operators and supervisors in PRP32A must ensure that the operators are trained and qualified prior to using this SOP. To support this process, a copy of this SOP should be made readily available to all users. Senior operators are required to update the SOP to reflect any changes in equipment, procedures, or regulations, and train the subordinate operators and maintenance crew(s) accordingly. It is important for senior operators to approve, coordinate, and maintain records of any major repairs on the equipment highlighted in this SOP. Training shall consist of in-depth, hands-on training for all new employees or employees new to this SOP and annual refresher meetings facilitated by the lead operator. All training should be documented using *Attachment 1 SOP Acknowledgement and Training Form*.

3.2. Qualifications

All personnel involved in operations and maintenance activities for the booster pump station must be trained and qualified to perform their assigned tasks:

- If required, personnel are responsible for obtaining and maintaining a Water Distribution System Operator (DSO) certification, Grade 1 or higher, from the State of Hawaii, Department of Health, Safe Drinking Water Branch.

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- Unlicensed or uncertified operators or Operators-in-Training (OIT) shall not make process control or system integrity decisions about water quality or quantity that affect public health.
- Follow Navy and base-specific safety regulations and directives and obtain appropriate safety training (see *Section 4.2*).
- Be familiar with the following:
 - Emergency protocols and communications
 - Operation of tools and equipment
 - Procedures outlined in this SOP

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4. HEALTH AND SAFETY

4.1. General Guidelines

With respect to health and safety, operators shall implement the following:

- Comply with the JBPHH Safety Manual.
- Use engineering, operational, or administrative controls or other means of performing work to eliminate or minimize health and safety hazard risk. Eliminating or minimizing health and safety hazard risk is preferred over the use of personal protective equipment (PPE). Use PPE to reduce hazard exposure when the hazard cannot be eliminated.
- Follow all OSHA requirements for works in confined spaces, trenching, roadways, etc.
- Pay specific attention to the hazards outlined in *Section 4.2*.
- Be familiar with all applicable SDSs. Ensure SDSs are up to date. Ensure the SDSs displayed / available match the chemical being used (i.e., do not use an SDS for the same chemical from another manufacturer).

4.2. Anticipated Hazards

- Injury due to moving parts and equipment (e.g., forklift, pump, motor)
- Confined space
- Electricity
- Work environment (hot weather, excessive heat, sun exposure, wet or humid environment, wet slippery grounds, elevated platform, uneven/unstable ground, noise, etc.)

4.3. Personal Protective Equipment

Utilize the following PPE based on anticipated activities:

- Safety steel toe shoes with anti-slip soles
- Work gloves
- Eye protection
- Hearing protection
- Hardhat/helmet
- Class 2 safety vest (class 3 vest is required when visibility conditions are limited)

4.4. First Aid

Stocked first aid kits shall be kept in two primary locations: service trucks and water supply pump stations. Promptly remove any expired stock from first aid kits and replace. Operators shall follow detailed instructions in the JBPHH Safety Manual and EM-385-1-1, *Section 3* regarding first aid kit requirements, documentation, and follow up procedures.

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5. EQUIPMENT AND MATERIALS

The section lists the equipment and materials that are relevant to perform this SOP. For detailed information regarding location and quantity of each item, please refer to the JBPHH inventory provided as an attachment to *SOP 1.1 Introduction and Overview*.

Parts:

- Seals
- Bearings
- Motor couplings
- Pressure Gauges

Equipment:

- General hand tools
- Grease gun
- Flashlight
- Straight edge
- Dial indicator
- Infrared thermometer
- Pressure gauges and various adaptors

Consumables:

- Grease
- Oil
- Packing material

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6. SCHEDULE AND PROCEDURES

6.1. Schedule

Refer to *Table 6-1* for a routine booster pump station operation and maintenance schedule. Detailed procedures are discussed in subsequent sections.

Table 6-1 Booster Pump Station Schedule

Frequency	Task	Section
Daily	Observations, inspections, and record keeping	6.2
Weekly	Pump packing inspection; oil and grease inspection; miscellaneous inspection and housekeeping	6.3
Monthly	Coupling alignment inspection; sump pump field test; monthly compressor maintenance; housekeeping	6.4
Quarterly	Inspections	6.5
Annual	Replace oil and grease; full pump operating check	6.6
	Perform refresher training on this SOP	6.7

6.2. Daily Observation, Inspection, and Record Keeping

- Observe pumps specifically for abnormal noise, vibration, leaks, or visible malfunctions.
- Observe motors specifically for abnormal noise, excessive temperature, excessive sparking at commutator, hot commutator, blackened commutator, sparking brushes, fine dust under couplings with rubber buffs or pins, smoke, charred insulation, solder whiskers extending from armature, excessive hum, regular clicking, rapid knocking, chattering brush, or vibration.
- If available, use the pump run-hour meters and cycle counters on control panel to record the running times and number of cycle starts.
- Record the pump discharge pressure and flow rate from available pressure gauges and flow meters.
- To the greatest degree practical, take these readings at the same time every day.
- Record values in the daily log and compare them to historical values to provide insight into potential pump problems.
- Compare individual pump run-time hours to ensure that the lead/lag controls are operating properly.
- Inspect cycle starts for an excessive number of starts per hour (greater than 6 starts per hour for a single pump).
- Notify lead operator of any potential issues regarding variations from historical records, uneven run time, or excessive starts per hour. Investigate root cause and adjust controls as required.
- Note any faults or warnings in the control system.
- Inspect piping for any leaks.
- Record all values and notes in *Attachment 2* and *Attachment 3*.

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6.3. Weekly Tasks

6.3.1. Pump Packing Inspection

- Inspect the packing for proper leakage rate, consult equipment operation manual for recommended rate.
 - If the leakage rate is too low, loosen the gland.
 - If the leakage rate is too high, tighten the gland.
- Inspect the packing gland temperature with an infrared thermometer; if the temperature is excessive (confirm acceptable temperature range with installed packing material) or appears to be rising during operation, loosen the gland.
- All adjustments to packing glands must be small adjustments. After any adjustments, recheck both leakage rate and temperature.
- If the leakage rate or temperature exceeds acceptable limits and cannot be adjusted, replace all packing as per manufacturer's recommendations.
- Record all values and notes in *Attachment 2* and *Attachment 3*.

6.3.2. Oil and Grease Inspection

- Check Oil and Grease
 - Excess oil can create oil splashes that require cleaning to prevent contamination of water supply; avoid overfilling oil.
 - Insufficient oil can result in increased wear and temperature of moving components. Check temperature utilizing infrared thermometer to ensure sufficient oil level.
- Adding Oil
 - Confirm oil fill point, acceptable levels, and type with manufacturer's literature.
 - Add oil to proper level.
- Adding Grease
 - Confirm grease injection point, acceptable levels, and type with manufacturer's literature.
 - Add grease to proper level.
- Inspect oil for excessive temperature (less than 120° F) with an infrared thermometer.
- Record all values and notes in *Attachment 2* and *Attachment 3*.

6.3.3. Miscellaneous Weekly Inspections and Housekeeping

- Inspect operation of miscellaneous equipment including HVAC systems, lighting systems, etc.
- Inspect bearing (less than 200° F) for excessive heat with an infrared thermometer.
- Measure vibration with handheld vibration meter; vibration should be less than 0.2 inches per second, see *SOP 8.2 Spot Monitoring* for details.
- Inspect the sump pump system for signs of improper operation, broken components, etc.
- Wipe equipment clean. Keep motors free from dirt or moisture.
- Perform general housekeeping including dusting, sweeping, and trash disposal.
- Check structure inside and outside for any openings, holes, gaps, or missing/broken screens whereby animals, including insects, can gain access and report findings to work leader or supervisor for creation of separate work order.
- Check remaining run time versus run time-based maintenance including:
 - Bearing grease/oil life
 - Bearing life

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6.4. Monthly Tasks

6.4.1. Coupling Alignment Inspection

- Coupling alignment should be checked as applicable and per the manufacturer's recommendations.
- Motor and pump shaft should be parallel and in line with manufacturer's recommendations.
- Adjust alignment as per manufacturer's recommendations, as required.
- If significant effort or specialized tools are required, contact the manufacturer or manufacturer's representative for assistance.
- Record all values and notes in *Attachment 2* and *Attachment 3*.

6.4.2. Housekeeping

- If applicable, read and record the electric meter at the pump house to track usage.
- Clean all windows.
- Clean all walls.
- Clean all ceilings.
- Remove all cobwebs.
- Hose down floor.
- Inspect and clean all name plates. Open work order to replace or provide protective coating as required.

6.5. Quarterly Tasks

- Inspect pump base and anchor bolts.
- Check spare part inventory versus manufacturer's recommendations, scheduled maintenance, and potential failure items.
- Inspect, clean, and repair (as needed) control panels in the pump house.

6.6. Annual Task

6.6.1. Replace Oil and Grease

- Replace grease/oil regardless of pump run time at least annually. Check clearances while replacing grease/oil.
- Replacement of Oil
 - Remove old oil as per manufacturer's recommendations.
 - Confirm oil fill point, acceptable levels, and type with manufacturer's literature.
 - Add oil to proper level.
 - Allow pumps to operate and reinspect oil levels until levels are consistent.
- Replacement of Grease
 - Remove old grease as per manufacturer's recommendations.
 - Confirm grease injection point, acceptable levels, and type with manufacturer's literature.
 - Add grease to proper level.
 - Allow the pump to operate and reinspect grease levels until levels are consistent.

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6.6.2. Full Pump Operating Check

- The pumps should be operated at as many operational points regarding speed and additional pump status (on/off) as practical. If the pump station has multiple pumps, the pumps should be operated in an isolated condition as well as any anticipated concurrent operating states (i.e., two pumps on or three pumps on).
- Full pump operating check consists of operating the pump at the conditions described above until the hydraulics (flow rate and pressure) reach a steady state (i.e., fluctuations are minimal; note that in some cases the system will not achieve a perfect steady state, and the operator must utilize their best judgement to determine if the system is adequately steady).
- During the full pump operating check, observe and note the following:
 - Number, tag, and description of pumps operating and target conditions
 - Flow rate
 - Discharge pressure
 - Suction pressure
 - Each pump operating speed
 - Each pump running amps (checking amps on pumps can be complicated and dangerous and should only be performed by a qualified and licensed electrician.)
 - Any excessive noise or vibration
 - Bearing temperature
- After completing the series of full pump operating checks, it is imperative to graph the observed design points on the pump curves.
 - Adjust flow rates based upon the number of pumps operating.
 - Mark the head and flow conditions of each operating point on the pump curve.
 - Note and retest any operating points that do not appear to fall on the pump curve.
 - If retested operating points do not fall on the pump curve, consult with manufacturer, manufacturer's representative, or engineering consultant to investigate the cause of the discrepancy.

6.7. Annual SOP Refresher Training

- Schedule training
 - Review operator schedules to identify a convenient time and date for most or all operators to attend the training session.
 - Provide refresher training.
- Review key aspects of this SOP:
 - General pump station operation observances
 - Maintenance takeaways
 - Visual instructions regarding all maintenance, specifically showing where maintenance items are located and how to safely access them
 - Operators' questions or concerns
 - Identified areas for improving the SOP
- Documentation
 - Record the date, time, and attendees of the training sessions in *Attachment 1*.
 - Note any updates or revisions made to the SOP.

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7. TROUBLESHOOTING

This section offers an approach to troubleshooting common issues encountered while following this SOP. *Table 7-1* provides general troubleshooting guidelines.

Table 7-1 General Troubleshooting Guide

Issue	Potential Related Issue or Cause	Remedy
No discharge with pump running	Pump not primed; lack of prime; incompatible priming.	Fill the pump and suction pipe completely with liquid.
	Loss of prime	Check for leaks in suction pipe joints and fittings; vent the casing to remove accumulated air.
	Suction lift too high	Check for obstruction at inlet.
	Wrong direction or rotation	Check motor rotation with directional arrow on pump casing.
Low rate of discharge	Discharge head too high	Check that valves are fully open.
	Speed too low	- Check whether the motor is receiving full voltage. - Frequency may be too low. - Motor may have an open phase.
	Impeller plugged or partially plugged	Dismantle pump and clean impeller.
	Obstruction of liquid passages	Dismantle pump, inspect impeller and its casing passages, then remove obstruction.
Pump cavitates	Air leak in suction	Test flanges for leakage with flame.
	Air leak in stuffing box	Increase seal lubricant pressure to above atmosphere.
Pump vibration with lowered discharge rate	Damaged impeller	Inspect impeller. Replace if damaged or vane sections badly eroded.
Excessive leakage around pump shaft	Defective packing	Replace packing and sleeves if badly worn.
Excessive vibration	Shaft bent	Check deflection of the rotor. Compare to manufacturer's tolerances.
	Misalignment of pump and driver	Realign pump and driver.
	Speed too high	Check voltage and frequency of motor.
	Foundation not rigid	Check if foundation bolt nuts are drawn tight against base. Check the foundation against the recommendations in manufacturer's instructions.

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Table 7-1 General Troubleshooting Guide (Continued)

Issue	Potential Related Issue or Cause	Remedy
Pump squealing or vibrating	Bearing worn	Check bearings for damage or excessive wear. Any irregularities will cause a drag on the shaft.
	Lubricating oil/grease dirty, contaminated	Clean bearings and bearing housing as per instructions and relubricate.
Motor overheating	Defects in motor	Check any motor defects.
	Voltage and/or frequency lower than rating	Check voltage and frequency.
	Rotor binding	Check deflection of rotor. Check bearings for damage or excessive wear.

Notes: _____

8. REFERENCES

- Unified Facility Criteria 3-230-02 - Operation and Maintenance: Water Supply Systems. 1 November 2023.
- EM-385-1-1 Safety and Occupational Health (SOH) Requirements Manual. 15 March 2024.
- OPNAV M-5100.23 - Navy Safety and Occupational Health Manual. 5 June 2020.
- JBPHH Safety Manual

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9. ATTACHMENTS

- Attachment 1: SOP Acknowledgement and Training Form
- Attachment 2: Pump Inspection Log Sheet
- Attachment 3: Full Pump Operating Check Record Sheet
- Attachment 4: Process Flow Diagrams
- Attachment 5: Goulds Pumps Model 3316 Information
- Attachment 6: Peerless Horizontal Centrifugal Pumps Information
- Attachment 7: Peerless-Grundfos Installation and Operating Instructions
- Attachment 8: Moanalua Terrace Booster Pump System Information

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Attachment 1:
SOP Acknowledgement and Training Form

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SOP ACKNOWLEDGEMENT AND TRAINING FORM

This SOP must be read and signed each time training is provided, or modifications are made to the SOP. This form should accompany the current SOP version.

Document Title:	Booster Pump Station
Document Revision Number:	
Document Revision Date:	

Please sign below in accordance with the following statement: "I have read and understood the above referenced document. I agree to perform the procedures described in this SOP in accordance with the document until such time that it is superseded by a more recent, approved revision."

Print Name	Signature	Date

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SOP Acknowledgement and Training Form (continued)

Trainee:

Sign below to acknowledge that training on this SOP was received, understood, and all questions/concerns were addressed by the trainer.

Trainer:

Sign below to acknowledge that training on this SOP was completed for the individual listed and that the trainee is competent to perform the procedures described within.

Date of Training [mm/dd/yyyy]	Trainee Print Name	Trainee Signature	Trainer Print Name	Trainer Signature

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Attachment 2:
Pump Inspection Log Sheet

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Date	Operator(s)	Pump Tag	Pump Flow Rate	Pump Discharge Pressure	Pump Run Time	Cycle Starts	Vibration Reading	Noise Observation	Bearing Temperature						Seal				Operator Notes
									Bearing Location	Bearing Temp	Bearing Location	Bearing Temp	Bearing Location	Bearing Temp	Location	Temperature	Location	Temperature	

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Attachment 3:
Full Pump Operating Check Record Sheet

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Full Pump Operating Check Record Sheet

Station:															
Date:															
Time:															
Operator 1:															
Operator 2:															
Additional Staff:															
Test Information					Pump Readings										
Test No.	Operating Point Description	No. of Pumps Online	Test Start Time	Total Flow Rate	Flow Rate Per Pump	Discharge Pressure	Well Level	Pump Tag	Pump Speeds	Pump Running Amps			Vibration Reading	Noise Observation	
										Phase 1 Amps	Phase 2 Amps	Phase 3 Amps			
1															
2															
3															
See Page 2															

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Pump Readings Continued						Is Pump Operating Point on Pump Curve?	Is Pump Operating Similar to Previous Years?	Pump Tag	Test No.
Bearing Temperature									
Bearing Location	Bearing Temp	Bearing Location	Bearing Temp	Bearing Location	Bearing Temp				
									1
									2
									3
See Page 2									

Test Information					Pump Readings										Pump Readings Continued						Is Pump Operating Point on Pump Curve?	Is Pump Operating Similar to Previous Years?	Pump Tag	Test No.
Test No.	Operating Point Description	No. of Pumps Online	Test Start Time	Total Flow Rate	Flow Rate Per Pump	Discharge Pressure	Well Level	Pump Tag	Pump Speeds	Pump Running Amps			Vibration Reading	Noise Observation	Bearing Temperature									
										Phase 1 Amps	Phase 2 Amps	Phase 3 Amps			Bearing Location	Bearing Temp	Bearing Location	Bearing Temp	Bearing Location	Bearing Temp				
4																					4			
5																					5			
6																					6			
7																					7			

Attachment 4: Process Flow Diagrams

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LEGEND	
	BALL VALVE
	GATE VALVE
	CHECK VALVE
	MOTORIZED BUTTERFLY VALVE
	DIAPHRAGM VALVE
	PRESSURE TRANSDUCER
	BOOSTER PUMP
	METER
	PRESSURE GUAGE
	POTABLE WATER LINE

(b) (3) (B)

LEGEND	
	GATE VALVE
	GATE VALVE (NORMALLY CLOSED)
	BALL VALVE
	BALL VALVE (NORMALLY CLOSED)
	CHECK VALVE
	BUTTERFLY VALVE
	DIAPHRAGM VALVE
	BOOSTER PUMP
	FLOW METER
	PRESSURE GUAGE
	POTABLE WATER LINE

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Attachment 5:
Goulds Pumps Model (b) (3) (B) Information

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 GOULDS PUMPS, INC.
ENGINEERED PRODUCTS DIVISION
SENECA FALLS NEW YORK 13148

Refer Correspondence To The
Goulds Branch Office or Agent
Where your order was placed,
and refer to Goulds
Factory Order No.

TO: COPENHAGEN INC
PO BOX 636
TUALATIN, OR 97062

SUBJECT: YOUR P.O. NO. 182-J-303

9/3/87

OUR BRANCH ORDER VPA70387

THE FOLLOWING TECHNICAL DATA IS SUBMITTED FOR YOUR REVIEW (SEE BELOW).

<u>QTY.</u>	<u>DESCRIPTION</u>	<u>DWG. NO.</u>	<u>ITEM NO.</u>	<u>GOULDS F.O. NO.</u>
3	DIMENSION PRINT	(b) (3) (B) #A1 REV 0		(b) (3) (B) -10
	" "	(b) (3) (B) #A1A REV 0		(b) (3) (B) -11

- ___ PUMP INSTALLATION, OPERATING AND MAINTENANCE MANUALS ATTACHED.
- ___ YOUR COMPLETE APPROVAL REQUIRED BEFORE ORDER IS SCHEDULED AND RELEASED TO MANUFACTURING. UNLESS A LONGER PERIOD IS STATED IN YOUR PURCHASE ORDER, APPROVAL PRINTS MUST BE RECEIVED IN THIS OFFICE BY _____; DELAY BEYOND THIS DATE WILL RESULT IN EXTENDED DELIVERY.
- X THE ABOVE LITERATURE IS FOR YOUR INFORMATION AND RECORDS, AND DOES NOT REQUIRE YOUR APPROVAL. RETAIN LITERATURE AS YOUR FINAL DISTRIBUTION.

NOTE: ANY CHANGES MAY AFFECT QUOTED PRICES AND SHIPPING SCHEDULES.

TRULY YOURS,

CC:

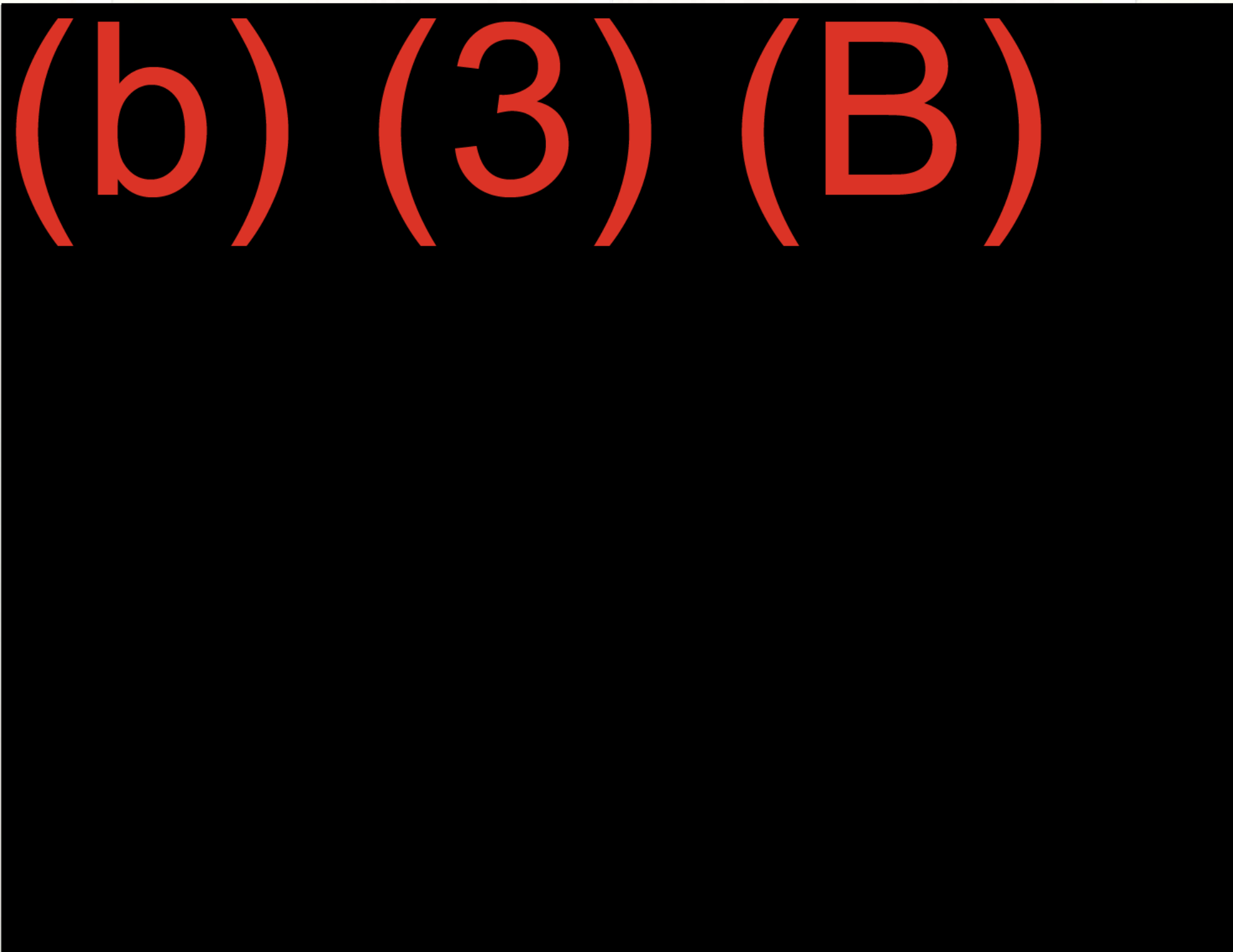
PORTLAND

PS

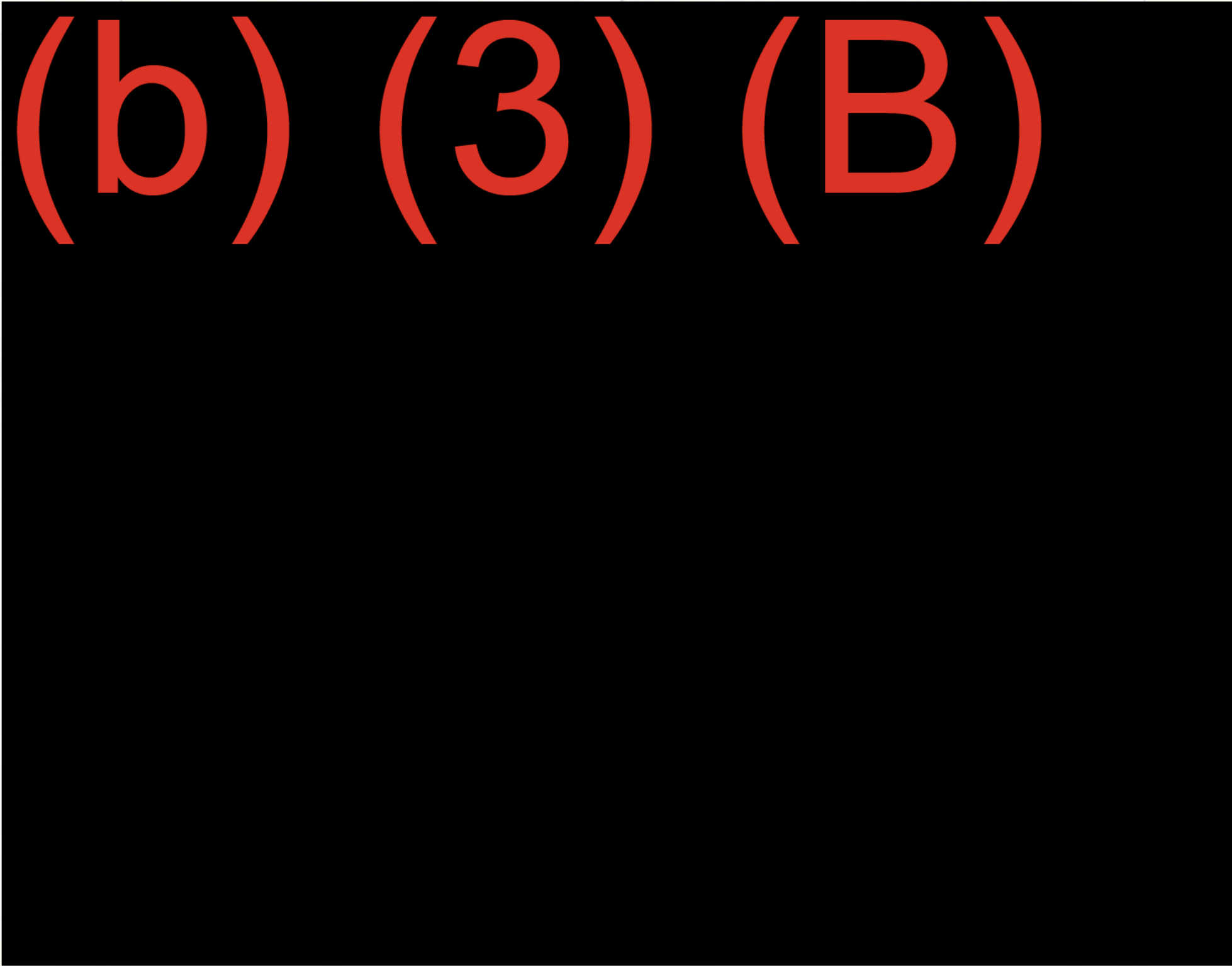
(b) (6)

(b) (6)

(b) (3) (B)



(b) (3) (B)





GOULDS PUMPS

Installation, Operation and Maintenance Instructions

MODEL

(b) (3) (B)

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Foreword

The design, material and workmanship incorporated in the construction of Goulds Model (b) (3) (B) make them capable of giving long, trouble-free service. The life and satisfactory service of any mechanical unit, however, is enhanced and extended by correct application, proper installation, periodic inspection and maintenance. This instruction book was prepared so operators will understand the construction and correct methods for installing, operating and maintaining these pumps.

Read thoroughly Section I, II, III, and IV and be sure to follow the instructions for installation and operation. Sections V and VI are answers to trouble and maintenance questions. Keep this instruction book handy for reference. Kindly direct any questions or suggestions to the attention of the Application Engineering Division, Goulds Pumps, Inc., Seneca Falls, New York.

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Contract (b) (4)
Renew (b) (3) (B) Booster Pumps
Halawa Freshwater Pump Station, S-5
Public Works Center Utilities
Pearl Harbor, Hawaii

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Section V Trouble Check List

V—A. NO WATER DELIVERED.

1. Priming — casing and suction pipe not completely filled with liquid.
- *2. Speed too low.
3. Discharge head too high. Check total head (particularly friction loss).
4. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss). Check with gauge.
5. Impellers or suction pipe or opening completely plugged.
6. Wrong direction of rotation.
7. Air pocket in suction line.
8. Stuffing box packing worn — allowing leakage of air into pump casing.
9. Air leak in suction line.
10. Not enough suction head for hot water or volatile liquids. Check carefully as this is a frequent cause of trouble on such service.

V—B. NOT ENOUGH WATER DELIVERED.

1. Priming — casing and suction pipe not completely filled with liquid.
- *2. Speed too low.
3. Discharge head higher than anticipated. Check total head (particularly friction loss).
4. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss). Check with gauge.
5. Impellers or suction pipe or opening partially plugged.
6. Wrong direction of rotation.
7. Air pocket in suction line.
8. Stuffing box packing worn — allowing leakage of air into pump casing.
9. Air leak in suction line.
10. Not enough suction head for hot water or volatile liquids. Check carefully as this is a frequent cause of trouble on such service.
11. Foot valve too small.
12. Foot valve not immersed deeply enough.
13. Mechanical defects:
 - Wearing rings worn.
 - Impellers damaged.
 - Casing gasket defective.

* When connected to electric motors, check whether motor wiring is correct and receives full voltage. When connected to steam turbines, make sure that turbine receives full steam pressure.

V—C. NOT ENOUGH PRESSURE.

- *1. Speed too low.
2. Air in water.
3. Impeller diameters may be too small.

4. Mechanical defects:
 - Wearing rings worn.
 - Impellers damaged.
 - Casing gasket defective.
5. Wrong direction of rotation.
6. Be sure pressure gauge is in correct place on discharge nozzle of pump and not on top of casing.

V—D. PUMP WORKS AWHILE AND THEN QUILTS.

1. Leaky suction line.
2. Stuffing box packing worn — allowing leakage of air into pump casing.
3. Air pocket in suction line.
4. Not enough suction head for hot water or volatile liquids. Check carefully as this is a frequent cause of trouble on such service.
5. Air or gases in liquid.
6. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss). Check with gauge.
7. Impellers plugged.

V—E. PUMP TAKES TOO MUCH POWER.

- *1. Speed too high.
2. Head lower than rating, pumps too much water.
3. Liquid heavier than water. Check viscosity and specific gravity.
4. Mechanical defects:
 - Shaft bent.
 - Rotating element binds.
 - Stuffing box too tight.
 - Pump and driving unit misaligned.
- *5. Wrong direction of rotation.

V—F. PUMP LEAKS EXCESSIVELY AT STUFFING BOX.

1. Packing is worn or not properly lubricated.
2. Packing is incorrectly inserted or not properly run in.
3. Packing is not right kind for liquid handled.
4. Sleeves scored.

V—G. PUMP IS NOISY.

1. Hydraulic noise — cavitation, suction lift too high. Check with gauge.
2. Mechanical defects:
 - Shaft bent.
 - Rotating parts bind, are loose or broken.
 - Bearings worn out.
 - Pump and driving unit misaligned.

Section VI Care and Maintenance

VI—A. LUBRICATION — BEARINGS.

1. Keep oiler bottle filled with correct grade of oil. (See Section II—A). Oiler will maintain constant oil level in bearing housing.
2. Under normal operating conditions, a good grade of oil will be suitable for 6 months to one year between changes, as long as it is free from contaminants. A small sample of oil should be drained from the bearing housing periodically. Any cloudiness, turbidity, discoloration or presence of solids is evidence of contamination, and the oil should be changed immediately.
3. If oiler adjustment is lost or disturbed, reset as directed in Section II—A.
4. Bearing Temperatures — All bearings operate at some temperature above that of the surrounding atmosphere, unless cooled. Heat is generated within the bearing due to rolling friction, and the drag of the race. Do not use the human hand as a thermometer. A temperature which feels "hot" varies from 120° to 130° F. depending on the individual. Above this temperature the human hand is worthless in estimating temperature. Oil lubricated ball bearings can be operated safely at temperatures up to at least 180° F. Bearing temperatures up to 160° F. are normal. Determine the temperature accurately by placing a contact type thermometer against the bearing housing. This temperature should be recorded in a convenient location. A stable temperature is an indication of normal operation. A sudden increase in temperature is an indication of danger and a signal to investigate. Check to see that oil is of proper viscosity and that oil level is neither too high nor too low. The unit should also be checked for unstable hydraulic operation and unnecessary loads, such as coupling misalignment. Occasionally, when the pumps are first started, the bearings seem to run extremely hot. This high temperature is frequently caused by oil seals, not the bearings. As soon as the seals are seated, the temperature will drop to a normal level.

VI—B. LUBRICATION — DRIVER AND COUPLING.

Follow manufacturer's recommendations.

VI—C. SECTIONAL VIEW (See p. 14, 15)

VI—D. REPACKING STUFFING BOXES.

1. To remove stuffing box gland assembly: Back off nuts (355). Slip the cupped washers (354) from bosses on gland, lift the upper gland half out of stuffing box and remove the gland bolts and lower gland half. This now affords unobstructed access to the stuffing box for repacking.
2. Remove the rings of packing with the aid of a packing hook.
3. Remove split lantern ring by inserting a wire hook in the slots in the outer edge of the ring and pulling ring from box.
4. Remove all foreign matter from stuffing box.
5. An alternate method of removing the packing and lantern ring is as follows: Remove the upper half casing. See VI—D 1, 2, 4, 5. Remove the packing and lantern ring from the stuffing box. This method permits the inspection of the shaft sleeve and the stuffing box bushing. If the shaft sleeves are found to be deeply grooved in the packing area, they should be replaced as it is only possible for the packing to do an efficient job when the sleeve surface is relatively smooth.
6. Install stuffing box packing as described in II—C.

VI—E. DISMANTLING OF PUMP.

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1. Drain liquid from pump.
2. Shut off and disconnect any auxiliary piping.
3. Disconnect coupling.
4. Remove gland assembly from stuffing boxes.
5. Jack and remove dowel pins from upper half casing by use of hex nut provided on

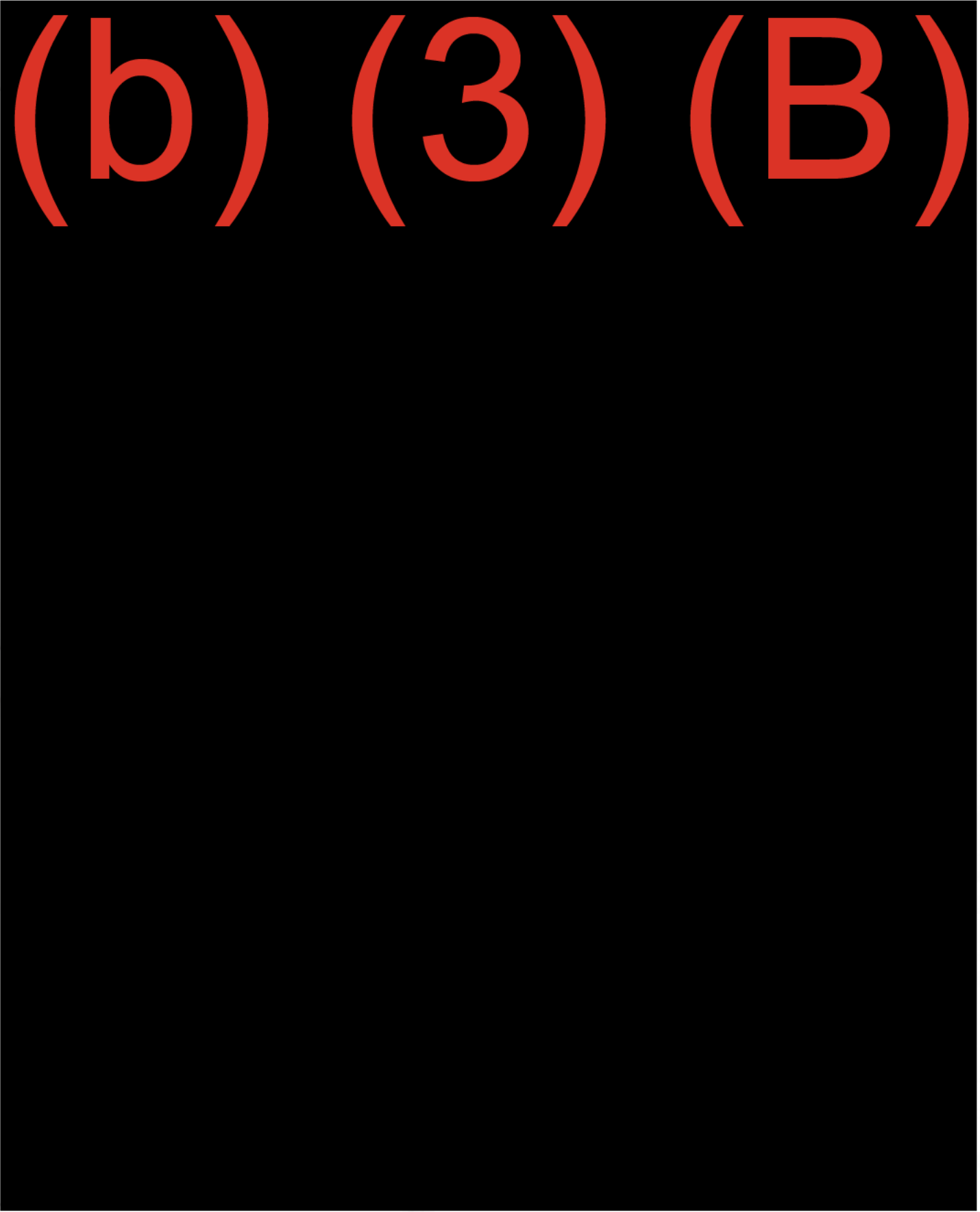
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Parts List and Interchangeability Chart

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VI—F. OVERHAUL OF PUMP.

The following items should be checked:

1. Wearing Ring Clearance:

The original diametral clearance between the impellers and case wearing rings for different materials is shown on Fig. 18 (dwg. 108-47). Clearance between casing wearing rings and optional impeller wearing rings is also shown. When hydraulic performance is reduced substantially, the casing rings and/or impeller rings should be replaced.

The diametral clearance on one impeller should not exceed the clearance on the other impeller in the same pump by more than .003".

2. Impeller Wearing Rings:

If the unit has impeller wearing rings and it is necessary to replace the rings:

a) Remove old rings by removing the three

set screws and pulling ring off hub.

b) Clean hub and press on new ring.

c) Drill and tap three holes 120° apart in each ring. Use "F" drill $\frac{3}{16}$ " deep with $\frac{5}{16}$ " — 18 NC taps $\frac{3}{16}$ " deep. Use $\frac{5}{16}$ " x $\frac{5}{16}$ " cup point safety set screws. Tighten screws and lightly "upset" threads. See Fig. 18.

d) Replacement impeller rings are supplied .021" to .039" oversize and must be turned to size after mounting on impeller. See Fig. 18 for dimensions.

3. Fit of Impeller on Shaft:

The impellers should tap easily on the shaft. If the impellers do not tap on readily, the bore and shaft should be inspected to see that they are free from foreign matter or burrs. The fit of the key in the keyways should also be checked to see that it is not causing binding. See Fig. 18.

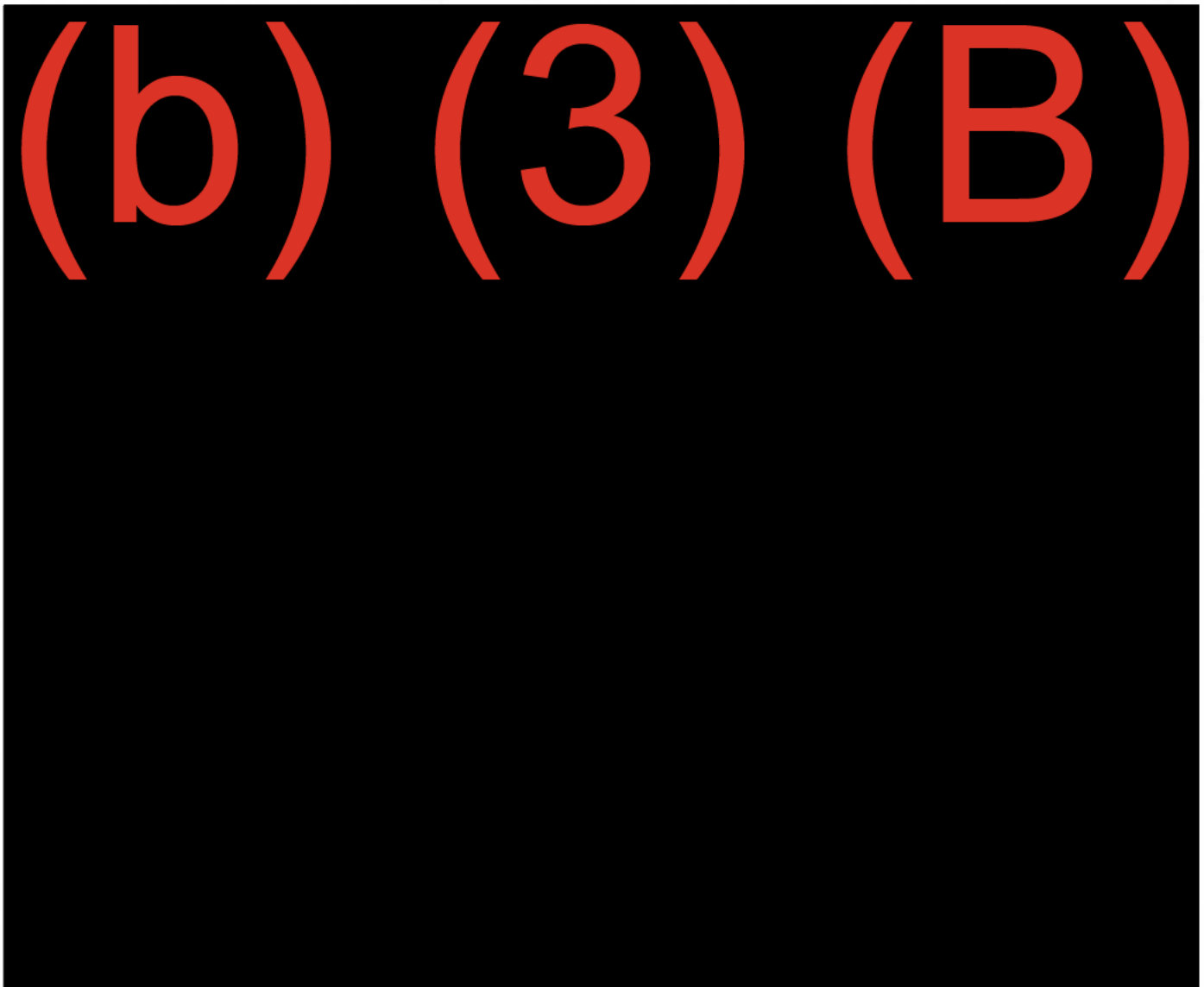


Figure 18

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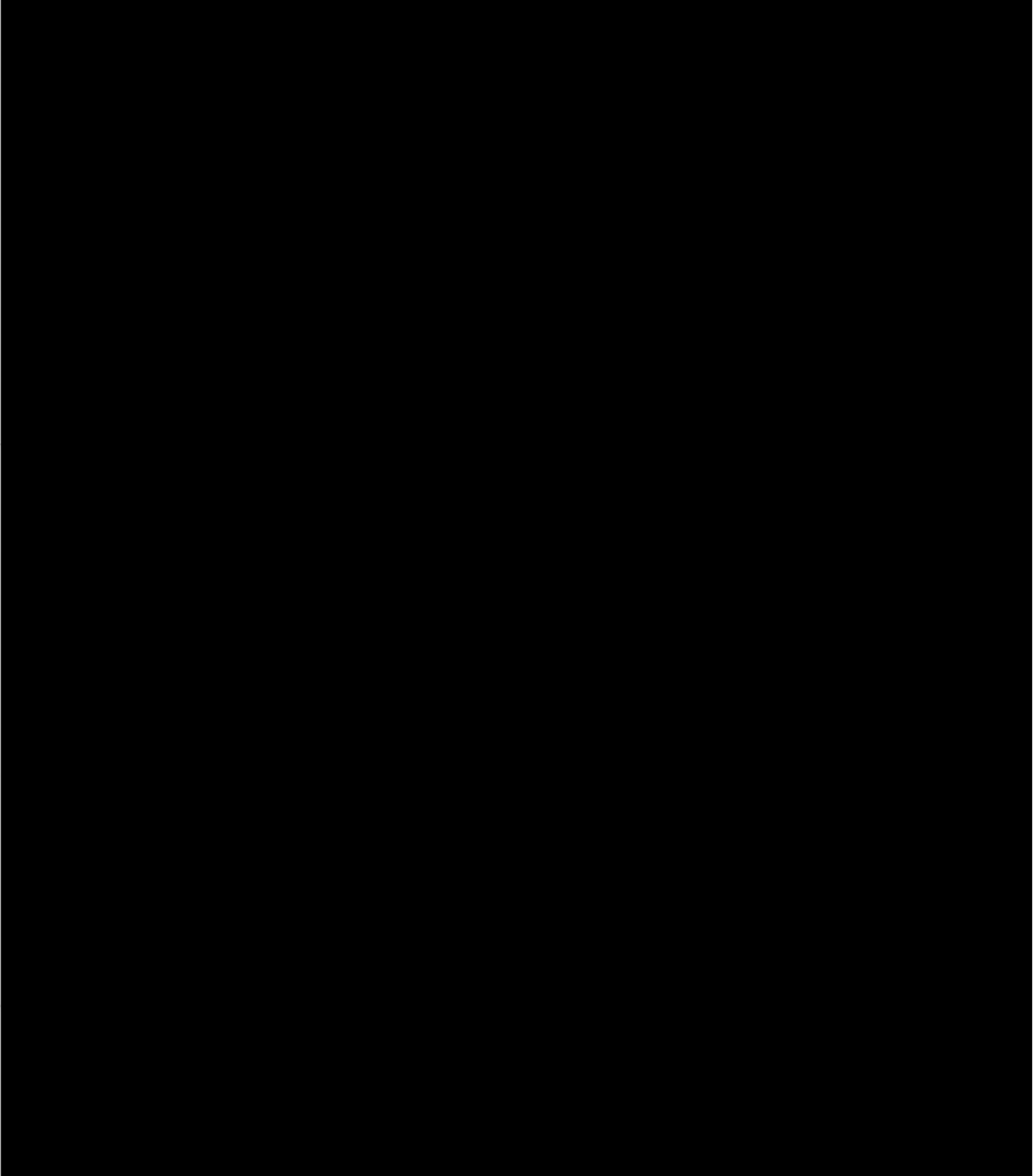
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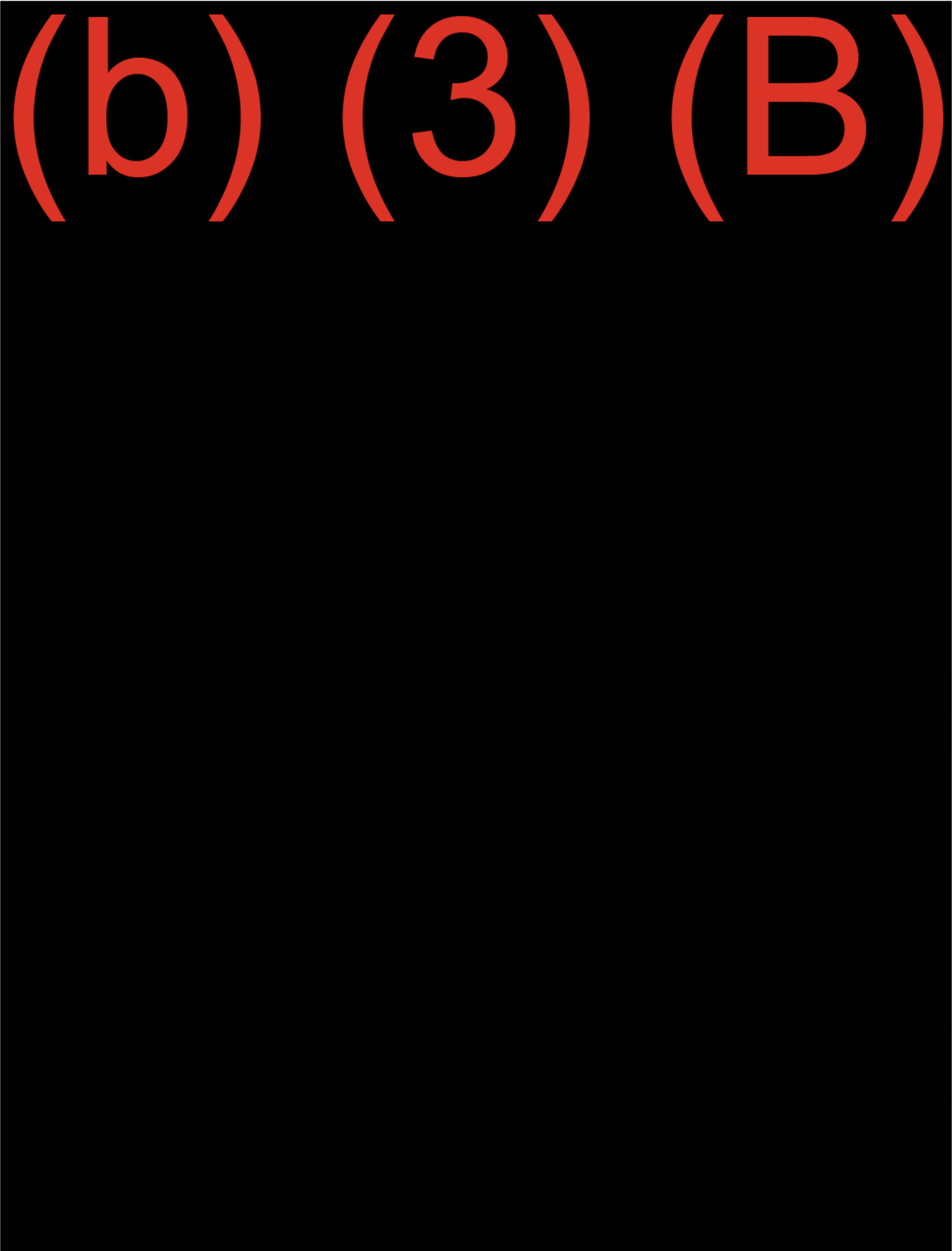
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Attachment 6:
Peerless (b) (3) (B) Pumps
Information

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Instructions

- Installation
- Operation



Peerless Pump
A Sterling Company

(b) (3) (B)
Rev. 9/88

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Read this entire bulletin

before attempting to install, operate or repair this pump. Properly installed, your Peerless pump will give you satisfactory, dependable service. We urge that you read carefully these step-by-step instructions, to simplify any problems of installation, operation or repair.

NOTE:

The bearing structure in all Peerless horizontal products is not designed to accept external loads from belt drive arrangements. When it is necessary to belt drive the pump, the customer must provide a separate jack-shaft with a bearing structure suitable for the intended belt loading.

Failure to read and comply with installation and operating instructions will void the responsibility of the manufacturer and may also result in bodily injury as well as property damage.

This bulletin is intended to be a permanent part of your pump installation and should be preserved in a convenient location for ready reference. If these instructions should become soiled, obtain a new copy from Peerless Pump. Include pump model and/or serial number with your request. Repair instructions for the pump are covered in a separate bulletin.

WARRANTY

New equipment manufactured by Seller is warranted to be free from defects in material and workmanship under normal use and service for a period of one year from date of shipment; Seller's obligation under this warranty being limited to repairing or replacing at its option any part found to its satisfaction to be so defective provided that such part is, upon request, returned to Seller's factory from which it was shipped, transportation prepaid. This warranty does not cover parts damaged by decomposition from chemical action or wear caused by abrasive materials, nor does it cover damage resulting from misuse, accident, neglect, or from improper operation, maintenance, installation, modification or adjustment. This warranty does not cover parts repaired outside Seller's factory without prior written approval. Seller makes no warranty as to starting equipment, electrical apparatus or other material not of its manufacture, since the same are usually covered by warranties of the respective manufacturers thereof.

In the event, notwithstanding the terms of this agreement, it is determined by a court of competent jurisdiction that an express warranty has been given by Seller to Purchaser with respect to the head, capacity or other like performance characteristics of said equipment. Seller's liability for breach of the same shall be limited to accepting return of such equipment F.O.B. plant of manufacture, refunding any amount paid thereon by Purchaser (less depreciation at the rate of 15% per year if Purchaser has used equipment for more than thirty (30) days) and cancelling any balance still owing on the equipment.

This warranty is expressly in lieu of any other warranties, expressed or implied, and Seller specifically disclaims any implied warranty of merchantability or fitness for a particular purpose.

See grouting requirement on page 5.

SECTION I INTRODUCTION

1-1. This bulletin provides general instructions for the installation and operation of horizontal, centrifugal pumps manufactured by Peerless Pump, Indianapolis, Indiana.

1-2. After carefully uncrating or unpacking, check the equipment against the shipping papers and inspect for damage incurred during shipment. Immediately notify the carrier of any damage or shortage found.

1-3. The type and size of pump was selected to meet requirements specified by purchaser. Among the more important are these:

- Type of Liquid Pumped
- Temperature, Viscosity, Specific Gravity
- Flow Rate
- Suction Pressure or Lift
- Total Head
- Type Driver
- Motor and its electric power supply characteristics
- Engine
- Steam turbine and its steam supply and exhaust conditions
- Other (as described)

1-4. If any one of these requirements has changed since the order was placed, particularly the suction condition, we

strongly recommend that such change be reviewed with the Peerless representative. If the performance curve previously furnished has been lost, the representative will furnish another copy.

WARNING

Do not operate this pump at any pressure, flow rate, or liquid temperature other than those for which the pump was originally purchased. Do not pump any other liquid than the one for which the pump was originally purchased without the consent of Peerless Pump or its authorized representatives. Disregard of this warning can result in pump failure and serious personal injury or death.

CAUTION

Operation of the pump under conditions differing widely from those for which the pump selection was based may result in reduced parts life.

1. Inadequate NPSH at any capacity will result in cavitation damage to the impeller and casing.
2. Operation at a reduced capacity for prolonged

periods may shorten the useful life of the seals or packing, shaft sleeves, bearings, and the shaft. Fire

pumps are applied with full knowledge that operation at reduced capacity will occur.

SECTION II INSTALLATION

2-1. LOCATION. Select a location for the pumping unit (pump, baseplate, coupling and driver) which will:

- (A) Be clean, well ventilated, properly drained and provide accessibility for inspection and maintenance (see outline drawing for dimension). Out door installations may require protection from the elements, particularly freezing.
- (B) The suction supply system must provide the pump with Net Positive Suction Head (NPSH) equal to or greater than that required by the pump at any capacity on its operating curve. Ask your Peerless representative for assistance if you do not understand how to calculate or measure suction supply system NPSH.

2-2. FOUNDATION. Concrete (reinforced as necessary or required) is most widely used for the foundation. In sufficient mass, it provides rigid support, which minimizes deflection and vibration. It may be located on soil, structural steel or building floors, provided the combined weight of the pumping unit and foundation does not exceed the allowable bearing load of the support. Allowable bearing loads of structural steel and floors can be obtained from Engineering handbooks; building codes of local communities give the recommended allowable bearing loads for different types of soil.

2-3. Before pouring the foundation, locate the foundation bolts by the use of a template frame and provide anchorage as shown in Figure 1. See the outline drawings furnished with each pump for the exact location of the foundation bolts. When pouring, allow for a grout thickness of $\frac{3}{4}$ to 1 $\frac{1}{2}$ inches. Roughen top surface to provide a good bond of the grout. Ordinarily, the proportions used as 1 part cement to 3 parts sand and 4 parts medium aggregate.

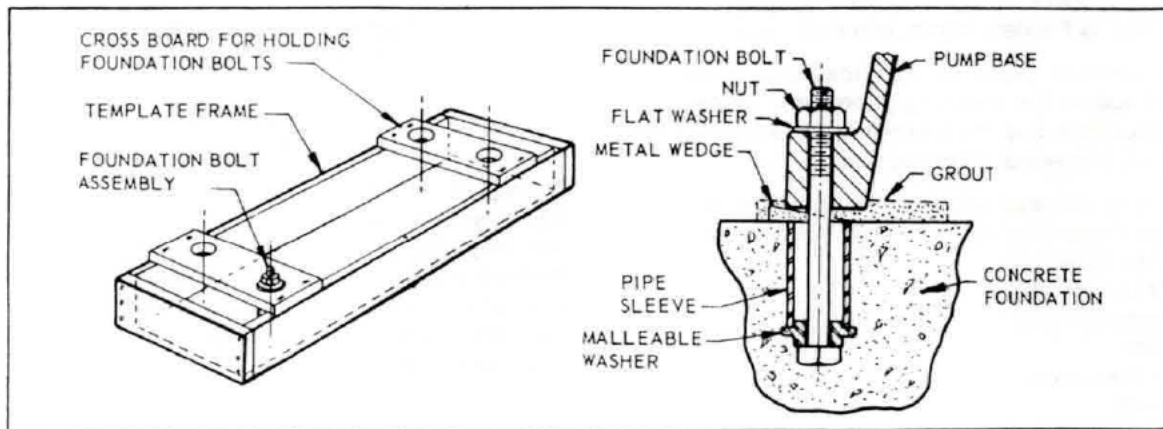


FIGURE 1. FOUNDATION BOLT LOCATION AND ANCHORAGE

Realignment is necessary after the complete unit has been leveled on the foundation and again after the grout has set and foundation bolts have been tightened. The alignment must be checked after the unit is piped and rechecked periodically as outlined in the following paragraphs. To facilitate accurate field alignment, we do not dowel the

2-4. MOUNTING AND LEVELING THE UNIT

CAUTION

Use qualified personnel (riggers) to lift or move unit at any time. Never lift unit using hooks or slings on shafts. Never place eyebolts in tapped holes except for removal of a part to perform service work.

When the unit is received with the pump and the driver mounted on the base plate, it should be placed on the foundation and the coupling halves disconnected. The coupling should not be reconnected until the alignment operations have been completed. The base plate should be supported on rectangular metal blocks and shims or on metal wedges having a small taper. The support pieces should be placed close to the foundation bolts (Figure 2). On large units, small jacks made of cap screws and nuts are very convenient. In each case the supports should be directly under the part of the baseplate carrying the greatest weight and spaced closely enough to give uniform support. A spacing of 24 inches is suggested on medium size units. A gap of about $\frac{3}{4}$ inches to 1 $\frac{1}{2}$ inches should be allowed between the baseplate and the foundation for grouting.

Adjust the metal supports or wedges until the shafts of the pump and driver are level. Check the coupling faces as well as the suction and discharge flanges of the pump for horizontal or vertical position by means of a level. Correct the positions, if necessary, by adjusting the supports or wedges under the baseplate as required.

Pumps and drivers mounted on a common baseplate were accurately aligned before shipment. **All baseplates are flexible to some extent and, therefore, must not be relied upon to maintain the factory alignment.**

pumps or drivers on the baseplates before shipment.

2-5. ALIGNMENT. Reliable, trouble-free and efficient operation of a pumping unit requires correct alignment of pump and driver shafts. Misalignment may be the cause of:

- (A) Noisy pump operation

- (B) Vibration
- (C) Premature bearing failure
- (D) Excessive coupling wear

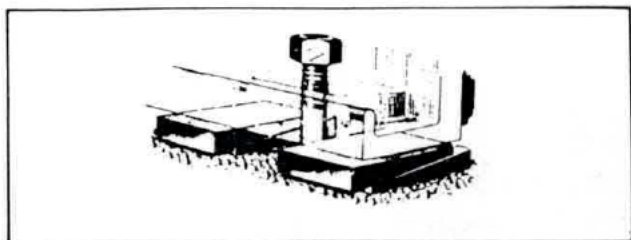


FIGURE 2. ADJUSTING WEDGES FOR MOUNTING

Factors that may change the alignment of the pumping unit are:

- (A) Setting of the foundation
- (B) Springing of the baseplate
- (C) Piping strains
- (D) Settling of the building
- (E) Shift of pump or driver on the foundation

2-6. The following checking procedure applies to a pumping unit consisting of a pump, flexible coupling and driver mounted on a common baseplate. Check alignment as follows:

- a. Disconnect the coupling halves.
- b. Set the coupling gap to the dimension shown in Table 1 or Table 3.
- c. Test for parallel and angular alignment with a straight edge and feeler gauge as shown in manufacturer's instructions at end of this section. With coupling halves stationary, make trials at four places 90° apart. Perfect alignment occurs when a straight edge is level across the coupling halves and the same gauge just enters between the halves, both conditions at all points.
- d. An alternate test for parallel and angular alignment may be made with a dial indicator mounted as shown in Figure 3. Proceed as follows:
 - (1) Scribe the index lines on the coupling halves (as shown) or mark where the indicator point rests.
 - (2) Set indicator dial to zero.
 - (3) Slowly turn BOTH coupling halves so that index lines match, or indicator point is always on the mark.
 - (4) Observe dial reading to determine whether pump or driver needs adjustment.
 - (5) Acceptable parallel and angular alignment occurs when total indicator reading (complete turn) does not exceed limits shown on either a tag or decal on the unit or on the unit outline drawing.

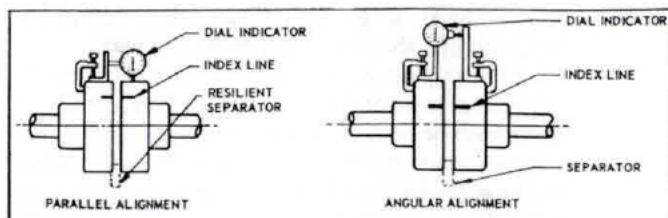


FIGURE 3. TESTING ALIGNMENT, DIAL INDICATOR

When significant operating temperature differential will exist between the pump and driver (i.e. steam turbine drive

with pump handling cold liquid), thermal growth will cause the hotter unit to rise. Compensate for this growth by initially setting the hotter unit 0.003 inch to 0.005 inch low. When both units are at normal operating temperature, a final check of coupling alignment must be made. Correct the alignment if necessary.

NOTE

Check for correct electric motor rotation as described in paragraphs a and b under paragraph 2-15 while coupling halves are disconnected.

2-7. Correct excessive parallel and angular misalignment by slightly shifting the leveling wedges under the baseplate. Tap lightly (in or out) with a hammer. Retest alignment after each shifting of a wedge.

- a. In some instances, for factory-aligned pumping units, it may be necessary to change the shims under the pump or driver, or even relocate these factory-positioned units on the baseplate. Make such changes only after it is certain alignment cannot be obtained by shifting of the wedges.
- b. If wedges are shifted or shims changed a substantial amount to obtain proper alignment, recheck the piping alignment and level of the shafts.

NOTE

Pumping unit shafts must be level, have proper alignment and the piping must mate with the pump flanges without strain. All three conditions must be correct to provide proper performance and long life of the pumping unit.

2-8. Recheck alignment, and correct as required, after:

- (A) Mounting,
- (B) The grout has hardened,
- (C) Foundation bolts are tightened,
- (D) Piping is connected,
- (E) Pump, driver, or baseplate is moved for any reason.

2-9. GROUTING

Unless otherwise specified on the unit outline drawing, the baseplate must be completely filled with grout and the leveling wedges grouted in place. The product warranty is void if this instruction is not followed.

When the alignment is correct, the foundation bolts should be tightened evenly but not too firmly. The unit can then be grouted to the foundation. Foundation bolts should not be fully tightened until the grout is hardened, usually about 48 hours after pouring. Installation without grout completely filling the baseplate is acceptable only when recommended by specific notation on the unit outline drawing.

Grouting that completely fills a baseplate is also necessary for minimum vibration levels, since a very stiff base is uneconomical and unnecessary except for portable units. Grout compensates for unevenness in the foundation and baseplate and distributes the weight of the unit uniformly over the foundation. It also prevents the unit from shifting after mounting and alignment. It is essential that the pumping unit be expertly grouted by use of non-shrinking grout. The mix required varies with the type of unit to be grouted, location and amount of grout. The instructions included with the non-shrinking grout package will provide the required information for the proper mix for individual applications. Grout the unit as follows:

(b) (3) (B)

a. Build a form of plywood or think planking around the foundation to contain the grout. Support adequately to prevent deformation.

b. Soak the top of the concrete pad thoroughly with water before grouting. Remove all surface water before pouring.

c. A recommended mix of grout that is satisfactory for most applications is as follows:

(1) One part of normal Portland cement (94 lbs.)

(2) One part of Embeco cement (100 lbs.)

(3) One part coarse clean sand (100 lbs.)

(4) Approximately 5 gallons of water

(5) If the thickness of the grout has to be above approximately 2 inches, add 1½ parts of ¼ inch pea gravel (1½ cubic feet) and an additional ½ gallon of water to the mixture.

d. Pour the grout through the holes provided in the baseplate or through open ends of steel channel baseplates. While pouring, tamp liberally in order to fill all cavities and prevent air pockets.

NOTE

If pouring and tamping the group will trap air in some places, temporarily place small diameter tubes (thick-walled rubber hose) to provide venting. Remove the tubes after grout has filled the cavity, before pouring the remainder.

e. After the grout has thoroughly hardened, tighten the foundation bolts and connect the piping. **BE CERTAIN PIPING DOES NOT STRAIN PUMP.**

f. Check the alignment after the piping is connected and the foundation bolts are tightened.

g. Connect the coupling halves.

h. Approximately fourteen days after the grout has been poured or when the grout has thoroughly dried, apply an oil base paint to the exposed edges of the grout to prevent air and moisture from coming in contact with the grout.

2-10. PIPING. The suction and discharge piping should be arranged for the simplest, most direct layout, to be of sufficient size and be internally free of foreign material. The piping must never be pulled into position by the flange bolts. It must be independently supported and arranged so that expansion and contraction, due to temperature changes, will not cause misalignment. If the installation requires a low noise level of operation, the suction and discharge piping of the system should be connected to the pump suction and discharge flanges with rubber flexible connectors.

2-11. The suction piping, if not installed properly, is a potential source of faulty operation. To achieve best performance, provide for the following:

(A) Suction lines, when operating under suction lift, must be kept absolutely free from air leaks.

(B) The suction pipe, when operating under suction lift, must be at least one pipe diameter larger than the pump suction nozzle. In order to prevent eddies and vortices, the end of the suction pipe must be at least two pipe diameters below the free liquid surface. If a foot valve is used to facilitate priming, the foot valve must have a minimum flow area 1½ times the area of the suction pipe. The suction at all points and should not contain loops or high spots in which air can be trapped.

- (C) A strainer should be installed in the suction line. The screen must be checked and cleaned periodically. The openings in the screen must be smaller than the sphere size allotted for the impeller.
- (D) A pump operating under suction lift should never use a gate or globe valve in the suction line.
- (E) The suction piping size, when operating under suction pressure, may be equal to, but never less than the suction nozzle size.
- (F) Available NPSH must be greater than the NPSH requirement of the pump.
- (G) Piping should be cleaned mechanically and chemically, and flushed prior to installing the pump. A large number of pump packing, mechanical seal and seizure troubles are due to improperly cleaned systems.
- (H) The pump should also be inspected internally for foreign matter that may have entered the pump.

2-12. DRIVER. When the driver of the pumping unit is to be mounted in the field on a baseplate furnished by Peerless, the driver bolt holes for some models must be added as follows: Set the baseplate with the pump on the foundation and level the unit as in paragraph 2-5. Set the driver on the baseplate, and align the coupling halves as described in paragraph 2-7 for parallel alignment. Mark the driver bolt holes. Remove the driver and drill and tap the baseplate for the driver bolts. Set the driver on the baseplate and align completely.

2-13. Safe and efficient operation of a pumping unit driven by an engine, whether gas, diesel, or gasoline, requires the installation to satisfy the following requirements:

- (A) Be well ventilated in order to keep the ambient temperature as low as possible. Taking 60°F as a datum point, every 10°F rise in temperature reduces the horsepower of the engine by approximately 1%.
- (B) Provide ample air for proper combustion.
- (C) Provide the engine with an efficient exhaust system so that the combustion gases discharge with a minimum of back pressure.
- (D) Provide for a fuel system of adequate capacity which meets the local codes.
- (E) Provide ample accessibility to service engine.
- (F) Provide correct rotation of the pump. Engine rotation is determined at the factory. No change of engine rotation can be made in the field.

It is recommended that the operator become familiar with the installation and service manual supplied by the engine manufacturer.

2-14. For electric motor drives, connect power supply to conform with national and local codes. Line voltage and wire capacity must match the ratings stamped on the motor nameplate.

- a. Only when the coupling halves are disconnected, momentarily energize the motor to check that rotation is in the same direction as the arrow on the pump.
- b. If motor is three-phase type, reverse rotation (if required) by inter-changing any two of the three power leads. The rotation of most single phase motors is fixed by internal wiring and cannot be easily changed.

2-15. DOWELING. To comply with Hydraulic Institute recommendations, all pumps should be dowelled. Pump feet can be drilled for dowels at the factory or in the field. Bases or risers are not drilled at the factory.

- a. Doweling the pump accomplishes the following:
 - (A) Prevents lateral movement.
 - (B) Eases realignment if the pump is removed from the base.
 - (C) Temporarily holds the pump should the holddown bolts loosen.

2-16. We recommend installation of straight dowel pins as shown in Figure 5 as follows:

- a. Check the coupling alignment after the unit has been in operation approximately one week. Correct if necessary (refer to paragraphs 2-7 and 2-8).
- b. Through opposite pump feet, drill through the riser (if used) and into the base (when necessary), holes of the same diameter (1/64 inch less than dowel pin) as in the feet to the proper depth for the pins (see Figure 5). Clean out the chips.
- c. Ream the holes in the pump feet and base to the proper diameter for the pins (light push fit). Clean out the chips.
- d. Install a spare nut (or cap) on the pins to prevent damaging the threads. Insert pins to a depth which leaves sufficient thread to attach nut.
- e. Attach nuts and tighten — do not pull dowel.
- f. If the pump was not drilled at the factory for dowels, use the following to determine dowel pin diameter. Measure the mounting bolt hole diameter in the pump foot.

$$\text{Dowel Diameter} = \text{Foot bolt hole diameter} - \frac{3}{16}''$$

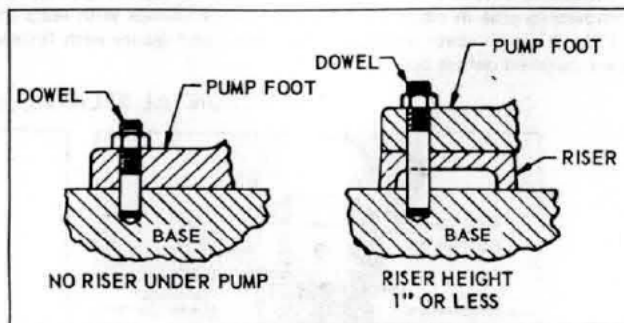


FIGURE 5. DOWELING METHODS

INSTRUCTIONS
PEERLESS PUMPS WITH FALK STEELFLEX COUPLINGS

(b) (3) (B)

PACK WITH GREASE AND ASSEMBLE COVERS

Pack the spaces between and around the grid with as much lubricant as possible and wipe off excess flush with top of grid. Position seals on hubs to line up with grooves in cover. Position gaskets on flange of lower cover half and assemble covers so that the match marks are on the same side (see above). If shafts are not level (horizontal) or coupling is to be used vertically, assemble cover halves with the lug and match mark UP, or on the high side. Secure cover halves with fasteners and tighten to torque specified in Table 1. (Note that Sizes 20 thru 70 have a self-locking feature for the stop nuts.) CAUTION: Make certain lube plugs are installed before operating.

(Continued next page)

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FALK STEELFLEX COUPLINGS, continued

(b) (3) (B)

PERIODIC LUBRICATION — Remove both lube plugs and insert lube fitting. Fill with recommended lubricant until an excess appears at the opposite hole. **CAUTION:** Make certain all plugs have been inserted after lubricating.

COUPLING DISASSEMBLY AND GRID REMOVAL

Whenever it is necessary to disconnect the coupling, remove the cover halves and grid. A round rod or screw driver that will conveniently fit into the open loop ends of the grid is required. Begin at the open end of the grid section and insert the rod or screw driver into the loop ends. Use the teeth adjacent to each loop as a fulcrum and pry the grid out radially in even, gradual stages, proceeding alternately from side to side.

(b) (3) (B)

WOOD'S SURE-FLEX COUPLINGS INSTALLATION INSTRUCTIONS

TYPES J, S

Sure-Flex flanges (outer metallic parts) and sleeves (inner elastomeric members) come in many sizes and types. All rubber sleeves (EPDM and Neoprene) have the same ratings for a given size and may be used interchangeably. Hytrel sleeves, however, has completely different ratings. **Rubber sleeves must not be substituted for Hytrel, or Hytrel for rubber.** First, determine the size and type of components being used. Remove all components from their boxes, and loosely assemble the coupling on any convenient surface. (Do not attempt to install the wire ring on the two-piece E or N sleeve at this time.)



1. Inspect all coupling components and remove any protective coatings or lubricants from bores, mating surfaces and fasteners. Remove any existing burrs, etc. from the shaft.
2. Slide one coupling flange onto each shaft, using snug-fitting keys.
3. Position the flanges on the shafts so that each shaft extends into each flange a minimum length equal to the shaft diameter. Tighten one flange in its final position. Slide the other far enough away to install the sleeve. With a two-piece sleeve, do not move the wire ring to its final position; allow it to hang loosely in the groove adjacent to the teeth, as shown.

(b) (3) (B)

4. Slide the loose flange on the shaft until the sleeve is completely seated in the teeth of each flange. Tighten all fasteners to the values given in Table 2.

TABLE 2 — FASTENER TORQUE VALUES (ft.-lbs.)

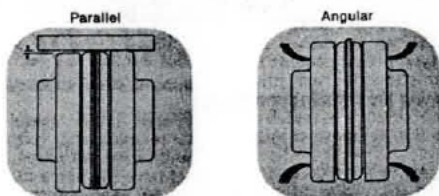
(b) (3) (B)

Different coupling sleeves require different degrees of alignment precision. Locate the earing failure
(D) Excessive coupling wear

(Continued next page)

SURE-FLEX COUPLINGS, continued

5. Check parallel alignment by placing a straightedge across the two coupling flanges and measuring the maximum off-set at various points around the periphery of the coupling. **DO NOT** rotate the coupling. If the maximum off-set exceeds the figure shown under "Parallel" in Table 3, realign the coupling.
6. Check angular alignment with a micrometer or caliper. Measure from the outside of one flange to the outside of the other at intervals around the periphery of the coupling. Determine the maximum and minimum dimensions. **DO NOT** rotate the coupling. The difference between the maximum and minimum must not exceed the figure given under "Angular" in Table 3. If a correction is necessary, be sure to recheck the parallel alignment. (Note: For maximum life, keep misalignment values as near to zero as possible.)



NOTE: Periodically check elastomeric coupling sleeves for any visible evidence of deterioration. If deterioration is apparent, the coupling sleeve must be replaced.

TABLE 3 — MAXIMUM ALLOWABLE MISALIGNMENT

(Dimensions in inches)

SLEEVE SIZE	G DIMENSION	TYPES JES, JNS, E & N		TYPE H & HS*	
		PARALLEL	ANGULAR	PARALLEL	ANGULAR
3	3/8	.010	.035	—	—
4	5/8	.010	.043	—	—
5	3/4	.015	.056	—	—
6	7/8	.015	.070	.010	.016
7	1	.020	.081	.012	.020
8	1-1/8	.020	.094	.015	.025
9	1-7/16	.025	.109	.017	.028
10	1-5/8	.025	.128	.020	.032
11	1-7/8	.032	.151	.022	.037
12	2-5/16	.032	.175	.025	.042
13	2-11/16	.040	.195	.030	.050
14	3-1/4	.045	.242	.035	.060
16	4-3/4	.062	.330	—	—

NOTE: Values shown above apply if the actual torque transmitted is more than 1/4 the coupling rating. For lesser torque, reduce the above values by 1/2. *Type H sleeves (orange) should not be used as direct replacements for EPDM or Neoprene sleeves (black) or with J or B flanges.

7. If the coupling employs the two-piece sleeve with the wire ring, force the ring into its groove in the center of the sleeve. It may be necessary to pry the ring into position with a blunt screwdriver.
8. Check safety codes and install protective guards or shields as required.

Caution: Coupling sleeves may be thrown from the assembly when subjected to a severe shock load.

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SECTION III LUBRICATION

3-01. COUPLINGS. Couplings with elastomeric drive parts do not require lubrication. Most other couplings require some form of lubrication. After completion of installation and alignment, and before operating the unit, lubricate coupling in accordance with manufacturer's specific instructions contained in the pump installation packet or on an instruction tag.

3-1. BEARINGS. Reasonable care and proper lubrication of Peerless Pump bearings will result in many years of service. Lubricant is normally grease; oil is optional on some pump types. The lubricant provides a film between the rolling elements and races, giving low friction and preventing excessive temperature rise and corrosion.

3-2. The normal life of bearings is terminated only by fatigue. Improper lubrication practices are the primary cause of failure. Good practice includes the following:

- (A) Keep lubricant clean. Provide, and use, a dust-tight cover on the storage container.
- (B) Use the oldest lubricant first.
- (C) Clean pump lubricant fittings before relubricating with grease.
- (D) Use clean dispensing equipment.
- (E) Use the proper amount of lubricant —
 1. Too much results in churning, unnecessary power consumption, rapid heating to a high temperature and inadequate lubrication.
- (F) Use the correct lubricant —
 1. Grease, Lithium soap base, meeting National Lubricating Grease Institute Grade 2 specifications. This has a safe operating temperature up to 250°F.
 2. Oil, see Maintenance and Repair instructions.
 3. Some pumps are built with "Lifetime" sealed bearings, requiring no relubrication or maintenance.

Such pumps are not provided with external lubrication fittings.

3-3. OPERATING TEMPERATURE. Use of the lubricants and procedures given in this bulletin will allow safe operation at bearing temperatures up to 250°F.

3-4. A high normal operating temperature is not a sign of bearing failure. Normal temperatures vary with the seasons and environment and may range from 0 to approximately 200°F. A continuous rise (determine as shown in Figure 6) from the **established, normal** operating temperature indicates trouble and probable failure of the bearing. Shut down the pump immediately. Disassemble, clean and inspect the bearing; replace if required. Refer to Maintenance and Repair instructions.

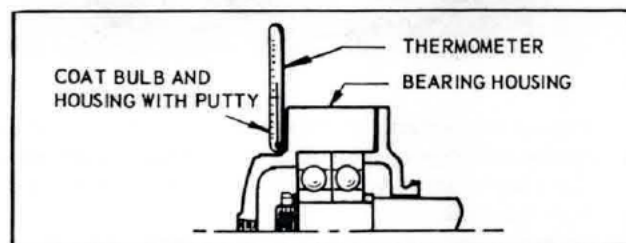


FIGURE 6. MEASURING BEARING TEMPERATURE

3-5. RELUBRICATION

- (A) Grease — Grease that has been in service does not "wear away." It needs replacing only because of contamination by dust, metal particles, moisture or high temperature breakdown. Relubricate bearings as follows (with the pump shutdown): Pumps have been provided with the initial supply of grease in the bearings.

1. Thoroughly clean grease fittings and outside of bearing housing.
2. Inject clean, new grease, forcing out the old through the small opening between the shaft and the bearing housing.
3. Start and run the pump for a short time to eject any excess grease.
4. Wipe off all ejected grease.

(B) Oil — see Maintenance and Repair instructions.

3-6. STUFFING BOX. The function of a stuffing box is to limit or eliminate leakage of the pumped fluid and to prevent air from entering along the shaft. Pumps are equipped with packing or mechanical shaft seals. These instructions are intended for pumping units handling water.

3-7. Packed type seal. A packed type stuffing box must correspond to the suction conditions of the installation. The pump is shipped with the packing installed unless otherwise specified by the customer. Check the packing carefully, allowing a slight leakage for lubrication. Never force the packing into a leak-proof position since this will create excessive friction and cause damage to the packing or shaft sleeve. Maximum packing life can be expected when the leakage approximates a minimum of 40-60 drops per minute. A reduction of leakage considerably reduces the life of both the packing and shaft sleeve. If leakage is excessive, tighten the gland bolts evenly, about 1/6 of a turn at a time. Do not be confused if the leakage seems to increase after an adjustment of the packing has been made. The leakage will normally reduce after a period of time as the packing adjusts itself to its new position. It should be kept in mind that it takes time for newly installed packing to "run-in" and that during this initial period, frequent attention and adjustments are necessary. It sometimes takes several days to achieve the desired results. Peerless Pump recommends the use of lantern rings and water seal lines only when suction pressure is less than 30 psig.

Replacement packing can be obtained from Peerless Pump or from your local packing supplier.

3-8. Mechanical Shaft Seal. The mechanical shaft seal is adjusted at the factory and no further adjustment is required except for a short run-in period. Follow the recommendations made by the shaft seal manufacturer to obtain good performance and life.

3-9 Special Shaft Seal. A separate special instruction is included for any pumps completely describing any special shaft seals. This same instruction will specify any required system piping that is required by the shaft seal arrangement. The pump sectional drawing will completely describe the construction of any special shaft seal.

NOTE

The types of packing listed in Table 4 are for use with water pumps. Pumps handling other liquids may require special types other than those listed.

TABLE 4
RECOMMENDED STUFFING BOX PACKING ARRANGEMENTS

SUCTION PRESSURE RANGE	PACKING	SHAFT SLEEVE	LEAKAGE RATE
6.0 PSIA — 60 PSIG	1) Square Braid Non-Asbestos 2) Lattice Braid Non-Asbestos 3) Plastic with end rings of Non-Asbestos	SAE 40 Bronze or stainless steel	50 drops/min.
60 — 100 PSIG	Plastic with metallic or Non-Asbestos end rings	Hardened stainless steel*	1/3 pint/min.
100 — 250 PSIG	Combination plastic and metallic packing or Teflon impregnated packing	Hardened stainless steel*	1 pint/min.

*Metallic packing has an affinity for bronze, therefore, do not use brass or bronze shaft sleeves.

NOTE

All UL/ULC listed fire pumps will have water seal piping only when suction pressure is less than 30 psig. All FM approved fire pumps will have water seal piping regardless of the suction pressure.

NOTE

See supplemental instruction 4850332 for high pressure fire pump applications.

SECTION IV OPERATION

(b) (3) (B)



Peerless Pump

A Sterling Company

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Attachment 7:
Peerless-Grundfos Installation and
Operating Instructions

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(b) (3) (B)

Installation and operating instructions

(b) (3) (B)

English (US) Installation and operating instructions

Original installation and operating instructions.

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**Warning**

Prior to installation, read these installation and operating instructions. Installation and operation must comply with local regulations and accepted codes of good practice.

1. Symbols used in this document

**Warning**

If these safety instructions are not observed, it may result in personal injury.

**Warning**

If these instructions are not observed, it may lead to electric shock with consequent risk of serious personal injury or death.

**Warning**

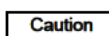
When pumping hazardous liquids, special attention must be paid to the risk of personal injury.

**Warning**

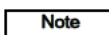
The surface of the product may be so hot that it may cause burns or personal injury.

**Warning**

The sound pressure level is so high that hearing protection must be used.

**Caution**

If these safety instructions are not observed, it may result in malfunction or damage to the equipment.

**Note**

Notes or instructions that make the job easier and ensure safe operation.

2. General information

These instructions should be retained for reference regarding maintenance and operation near the pump.

These are general instructions and may not take into account local regulations. The user should ensure such regulations are observed by all parties.

Information in this manual is believed to be reliable. In spite of all the efforts to provide sound and all necessary information, the content of this manual may appear insufficient and is not guaranteed to be complete or accurate in all instances.

2.1 Warranty

This unit is manufactured under a quality management system standard 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 their continued product quality and performance in use.

Damage or failure caused by misuse, abuse or failure to follow these instructions are not covered by our warranty.

Any modification of our products or removal of original components may impair the safety of these products in their use.

2.2 Personnel qualification

All operations must be carried out by qualified personnel.

2.3 Warnings



Warning

If the site is left unattended before the installation is complete, all openings must be covered to prevent entry of children, animals, stones or any other foreign objects. Use unbreakable covers that cannot be removed without tools.



Warning

When a pump has experienced temperatures over 400 °F [205 °C], skin contact must be avoided with components. Additionally, partial decomposition of fluoro-elastomers (when fitted) will occur.



Warning

Many precision parts have sharp corners and the wearing of appropriate safety gloves and equipment is required when handling these components.



Warning

Hot or freezing components or auxiliary heating supplies can present a danger to operators and persons entering the immediate area. Action must be taken to avoid accidental contact. If complete protection is not possible, the machine access must be limited to maintenance staff only, with clear visual Warnings and indicators to those entering the immediate area.



Warning

Rapid changes in the liquid temperature can cause thermal shock that can result in damage of pump components and should be avoided.



Warning

When the pump is handling hazardous liquids, care must be taken to avoid exposure to the liquid by appropriate setting of the pump, limiting personnel access and by operator training. If the liquid is flammable and/or explosive, strict safety procedures must be applied. Gland packing must not be used when pumping hazardous liquids.

Do not use pump as a support for piping.

Caution

Do not mount expansion joints, unless allowed by Peerless Pump in writing, so that their force, due to internal pressure, acts on the pump flange.

Caution

Products used in potentially explosive atmospheres. Special consideration must be taken when pumps are installed in these applications. Contact Peerless Pump for more information.

Warning



Parts which are provided with lifting lugs, lifting ears or eyebolts should be lifted by these points only. They may not be used for lifting the entire pump. When lifting the entire pump, use appropriate slings.



Warning

Do not attempt to lift the entire pump by the lifting lugs (eyes) of the driver or pump. Never lift unit using hooks or slings on shafts. Use proper lifting techniques when manually lifting components -keep component close to body, back straight, lift with legs, DO NOT BEND AT WAIST.



Warning

Do not work under suspended object unless you have taken precautions to stop its fall in the event of sling failure. Do not place hands under component in such a way that the component would fall on the hands if dropped.



Warning

Pumps are not designed to accept external loads from belt driven arrangements. A separate jack-shaft with a bearing structure suitable for belt loading is required.



Warning

Do not remove or paint over any safety labels. If labels are lost or damaged, contact your Peerless Pump representative for replacement.



Warning

Never do maintenance work when the unit is connected to power.



Warning

All guards must be in place on the pump prior to startup. Read and follow all recommended guarding and safety instructions for accessories, if any.



Warning

Do NOT place fingers, hands, arms, etc. into any opening (such as the air relief valve hole). Do NOT wear loose or frayed clothing or jewelry that could catch on equipment or become trapped in the equipment. Do NOT touch the impeller or other rotating elements, if rotated, this can cause severe injury. The area between the stuffing box and bearing bracket is left open to allow for inspection and adjustment of packing. Do NOT place hands or fingers into this area while equipment is in operation. Do NOT wear loose clothing, long hair, or jewelry around this area.



Warning

Use only qualified electricians for electrical installation and maintenance. Refer to manuals provided with electrical accessory components and disconnect power supply as recommended for servicing.

**Warning**

Most surfaces on the driver (engine or motor) can become hot during normal operation.

If packing is too tight, the drain water from the stuffing box can become hot enough to scald. Ensure that drain water is not excessively hot before contact.

The stuffing box and bearing bracket areas on the pump can become hot in the event of a malfunction or maladjustment. These surfaces may remain hot for some time after the unit has been shut down.

Use care when touching these surfaces and wear protective gloves if necessary to touch these surfaces when hot.

Warning

Noise levels, especially for diesel engine driven units, can exceed safe levels. Refer to the noise level published in the accompanying documentation, and, if this noise level exceeds local code or safe levels, place the unit in a controlled access area and provide ear protection to personnel authorized to be in this area.

Fire pump units can start unexpectedly at any time. Ear protection should be carried by, or readily available to, all personnel authorized to be in the pump room with these units.

Warning

Isolate engine before any maintenance work is done. Switch off the main supply, remove fuses, secure fuel lines, apply lock-outs where applicable, and affix suitable isolation warning signs to prevent inadvertent re-connection.



ISOLATE the fuel supply to the engine BEFORE working on any part of the fuel supply or control system

DISCONNECT the batteries by removal of the NEGATIVE terminal connector. Do NOT place tools on or near the batteries. This could result in a short circuit. INSPECT all cables for damage or signs of failure and replace immediately if damaged.

Warning

Engine fuel fumes are highly flammable! Do NOT refuel the engine when it is running or is still hot from recent running.



When refueling, avoid breathing the fuel fumes, particularly if the pump is installed in an enclosed pump room. Maintain maximum ventilation to clear the fumes quickly.

Do NOT start the engine while fuel fumes remain evident or may be present.

**Warning**

Exhaust gases are hazardous; the exhaust system **MUST** be maintained free from leaks and directed to discharge in a safe area.

**Warning**

Battery gasses are hazardous and flammable. The battery area **MUST** be well ventilated to clear these gases quickly.

**Warning**

Do NOT store lubricants or other volatile substances near the engine. These should be placed in a designated area having a suitable storage enclosure.

2.4 Material Safety Data Sheet

As a general practice, material safety data sheets (MSDS) are not supplied with pumps unless required. They may be requested from Peerless Pump.

2.4.1 Noise level**Warning**

Whenever pump noise level exceeds 85 dBA, attention must be given to the prevailing health and safety legislation to limit the exposure of plant operating personnel to the noise. The usual approach is to control exposure time to the noise or to enclose the machine to reduce emitted sound.

3. Transport and storage**3.1 Transport and handling requirements**

The pump has been prepared for shipment at the factory in such a way as to minimize potential damage due to handling and transport.

Caution

The equipment should not be subjected to excessive g-forces during the handling or transport.

3.2 Receipt and inspection

Receiver should report any shortage or damage to the transport company handling the shipment and to Peerless Pump.

Prior to installation, take inventory of the shipment to ensure that the parts received match the list of parts on your order.

Note the extent of damage or shortage on the freight bill and bill of lading. Failure to note damage or missing parts may result in declined warranty or replacement of parts.

It is important that all the components for a pump unit be identified and properly stored until installation is to be done.

There may be many small parts (such as line shaft couplings or hardware) that are best left in their shipping container until installation.

Do not unpack any more than required to verify that the equipment is complete and undamaged unless installation is to be done immediately. Check all packaging material that is to be discarded to verify that no parts or instructions are being accidentally discarded. In some shipments, small boxes containing additional parts are bound to pump skids. Leave small parts in their shipping container until installation so they don't get lost. Upon unpacking make certain that accessories with a pump unit are clearly marked showing which pump unit they are to be used with.

3.3 Rigging and lifting

When pumps are received unassembled, all the parts should be located close to the location where the pump will be installed.

Caution

Pump parts that are too heavy to be lifted by hand must be lifted from the transporting vehicle with a suitable hoist. Lifting chains or cables must not contact machined surfaces.



Warning

Parts which are provided with lifting lugs, lifting ears or eyebolts should be lifted by these points only. They may not be used for lifting the entire pump.

When lifting the entire pump, use appropriate slings.



Warning

Do not attempt to lift the entire pump by the lifting lugs (eyes) of the driver or pump.

Never lift unit using hooks or slings on shafts.

Use proper lifting techniques when manually lifting components -keep component close to body, back straight, lift with legs, DO NOT BEND AT WAIST.



Warning

Do not work under a suspended object unless you have taken precautions to stop its fall in event of sling or hoist failure.

3.4 Storage

Standard factory packaging is suitable for protection during shipment and during covered storage at jobsite for a short period between installation and startup. The preservatives applied at the factory have an effective life of two to three months from date of shipment from factory, depending on the severity of the environment in which the equipment is exposed. For international destination this will vary depending on the sea worthiness of export boxing.

3.4.1 Controlled storage

Storage facilities should be maintained at an even temperature of at least 10 °F [5.5 °C] above the dew point with relative humidity lower than 50 % and little or no dust. The equipment is to be inspected weekly to ensure that all preservatives are intact and internals are protected.

Inspect and recoat periodically the equipment with water displacement rust inhibitors (VPCI-368-021, Rust-Ban 392 or equal), crusting grease (Rust-Ban 326 or equal), vapor phase inhibitor (Shell VPI-260 or equal) or rust preventative coating (Rust-Ban 373 or equal).

Protect the equipment from flooding or from harmful chemical vapors.

Caution

Storage should be free from ambient vibration. Excessive vibration can cause bearing damage. Precautions should be taken to prevent rodents, snakes, birds or insect from nesting inside the equipment.

3.4.2 Uncontrolled storage

For uncontrolled storage periods of three months or less, the equipment is to be inspected weekly to ensure that all preservatives are intact and internals are protected.

Inspect and recoat periodically the equipment with water displacement rust inhibitors (Rust-Ban 392 or equal), crusting grease (Rust-Ban 326 or equal), vapor phase inhibitor (Shell VPI-260 or equal) and/or rust preventative coating (Rust-Ban 343 or equal).

All pipe threads and flanged pipe covers are to be sealed with tape. Furthermore you should place 10 lbs. [4.5 kg] of moisture-absorbing desiccant or 5 lbs. [2.3 kg] of vapor phase inhibitor crystals near the centre of pump.

If the pump is assembled, place an additional one pound in the discharge of the pump securely fastened.

Install a moisture indicator near the perimeter of the pump.

Cover the equipment with black polyethylene or equal with a minimum thickness of 0.006" [0.15 mm]. Provide a small ventilation hole approximately the size of a small coin.

Provide a roof or shed shelter to protect from direct exposure to the elements.

If equipped, connect space heaters on equipment such as motors, engines or controls.

3.4.3 Standard short-term storage

The pump and equipment, as shipped, have adequate protection for short-term (two to three months) storage in a covered, dry and ventilated location at the job site prior to installation.

For short-term (two to three months) storage not in a covered, dry and ventilated location at the job site prior to installation. For packed-type pumps, remove stuffing box packing and place it in a sealed plastic bag. Apply a film of compatible lube oil over the water displacement rust preventative (Rust-Ban 632 or equal). Seal the end of the stuffing box with rolled vapor phase inhibitor paper and seal with weatherproof tape. For packed-type pumps the packing glands may be left on the pump shaft, but should be securely fastened in position.

All exposed machined surfaces should be thoroughly coated with a firm film rust preventative material (Rust-Ban 373 or equal) that is readily removable with a petroleum distillate product.

All exposed painted surfaces should be dry, clean and free of grease and other contaminants.

After pump has been thoroughly drained, cover the pump suction and discharge flanges with a cover (typically cardboard or wood) to blank off these openings.

Rotate pump shaft per the rotation arrow on pump several revolutions at least once per week to coat the bearing with lubricant and to retard oxidation and corrosion, flat spots and staining. Shaft should end up 90 ° from starting point.

To place the pump in operation, all protective coverings and coatings should be properly removed. For packed-type pumps, repack the stuffing box with the proper number of packing rings from bag. If the packing appears to be damaged or otherwise unfit, it should be replaced.

See section [3.4.4 Long-term storage](#) when the startup of equipment is made over three months from the date of shipment from the factory.

3.4.4 Long-term storage

Long-term storage protection from the factory does not extend the warranty in any manner. Warranty policy is twelve months from startup or eighteen months from time of shipment, whichever occurs first. This warranty is valid only if equipment has been properly handled and stored as per the stated requirements.

Should the equipment be stored or handled improperly, then the warranty is invalid and may be reinstated only after a factory representative is allowed to inspect the equipment prior to startup. Expenses for the representative will be billed in accordance with the latest schedule for field service engineer.

Any repairs or repair parts needed will be billed to the customer at prices in effect at time of shipment of these repairs/parts.

At the time of pump specification and/or order placement

Peerless Pump should be advised about the extended storage duration so that special long-term storage protection can be provided for the equipment prior to shipping to the job site.

Inspection of the equipment by a factory representative prior to startup is normally required to ensure equipment integrity and compliance with warranty requirements.

In addition to complying with the standard short-term and storage atmosphere conditions, the following considerations are required:

Dry pump internals and spray the liquid end with a water displacement rust inhibitor (Rust-Ban 392 or equal).

Enclose vapor inhibitor in pump internals (Shell VPI 260 or equal).

Apply a film of compatible lube oil over the water displacement rust preventative (Rust-Ban 632 or equal).

After pump has been thoroughly drained, cover the pump suction and discharge flanges with full natural rubber gasket material and blank off these openings with metal blank flanges and a minimum of four full sized bolts. Cover the pump stuffing box opening with a non-hygroscopic tape.

Cover the equipment with black polyethylene or equal with a minimum thickness of 0.006" [0.15 mm] and seal it with tape.

Provide a small ventilation hole approximately the size of a small coin.

The pump should be inspected at regular periods.

Rotate the pump shaft per the rotation arrow on the pump several revolutions at least once per week to coat the bearing with lubricant and to retard oxidation and corrosion, flat spots and staining. The shaft should end up 90 ° from starting point.

To place the pump in operation, all protective coverings and coatings should be properly removed. For packed-type pumps, repack the stuffing box with the proper number of packing rings from bag. If the packing appears to be damaged or otherwise unfit, it should be replaced.

3.4.5 Accessories storage

Store accessories according to the manufacturer's instructions.

Long-term storage should not be undertaken without written understanding from manufacturer.

3.5 Disposal of packaging materials

See section 10. *Disposal*.

4. Identification

4.1 Nameplate

Each pump has a nameplate which list serial number. See fig. 1 and 2 for pump supplied. The serial number is needed when contacting Peerless Pump with questions or service request.

When a driver is supplied, there will also be a nameplate on the driver. When requesting information about the driver, both the driver serial number and the pump serial number will be required. Information on the Fire pump nameplate includes the following:

- pump size/model
- serial number
- pump manufacturer and location
- certification mark (UL/FM fire or other), if any
- rated flow rate
- rated speed
- rated head
- rated psi
- impeller diameter.

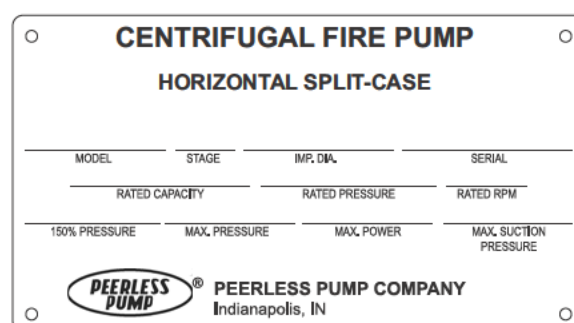


Fig. 1 Fire pump Nameplate

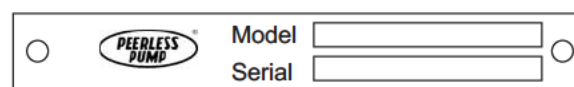


Fig. 2 Flange Nameplate

Information on the flange name plate includes the following:

- pump size/model
- serial number
- pump manufacture and location.

4.1.1 Certifications

If the product carries an industry certification (UL/FM fire or other), it will be noted on the pump nameplate. Contact Peerless Pump for additional information.

4.1.2 Pump

The pump size/model is given with a number, letter(s) followed by a number such as 5AEF12. These would represent the size and model of pump.

4.2 Type key for horizontal split case fire pump

Code Example 6AEF16G 1-A-1/7-P-A-B-R-C

	6	AEF	16	G	-1	-A	-1	/7	-P	-A	-B	-R	-C
Discharge Flange													
Model													
Maximum Impeller Diameter [inches]													
Hydraulic Variation <> - None (blank) G -													
Flange Rating 1 - 125#x125# 2 - 125#x250# 3 - 250#x250# 4 - 125#x400# X - Special													
Listing or Approval of Pump System A - UL and FM B - FM only C - UL only D - NFPA compliant E - ULC F - CCC X - Special													
Casing Material 1 - Cast Iron 2 - Ductile Iron 4 - 316LSS 5 - CD4MCu 9 - Nickel-Aluminium Bronze X - Special													
Impeller Material 1 - Cast Iron 4 - 316LSS 5 - CD4MCu 7 - Silicon Bronze 9 - Nickel-Aluminium Bronze X - Special													
Type of Sealing P - Packing S - Seal Component Style C - Cartridge Seal X - Special													
System Configuration A - Bare Shaft Pump B - Pump + Base C - Pump + Base + Drive D - Pump + Base + Driver + Controller X - Special													

	6	AEF	16	G	-1	-A	-1	/7	-P	-A	-B	-R	-C
Manufacture of Driver													
B - USEM / Nidec													
C - General Electric													
D - Marathon													
E - WEG													
F - Baldor													
N - Clarke													
P - Cummins													
Q - Caterpillar													
R - Deutz													
Z - No Driver													
X - Special													
Pump Rotation													
R - Right Hand / Clockwise													
L - Left Hand / Counter Clockwise													
Controller Type:													
A - No Panel													
C - Firetrol													
D - Tornatech													
E - Master													
F - Cutler Hammer													
X - Special													

5. Installation

5.1 Factory support

For customized products, we recommend that you have a Peerless Pump service engineer supervise installation and startup.

This is to ensure that the machinery is properly installed. You will then also have the opportunity to review, and see implemented, factory-recommended instructions.

Warning

This pumping unit is designed to be operated within certain limits pertaining to fluid pump, driver conditions, etc. These limits are listed on the performance curve, or on original contract documentation.

Do not operate this pump at any pressure, flow rate, or liquid temperature other than those for which the pump was originally purchased. Do not pump any other liquid than the one for which the pump was originally purchased without the consent of Peerless Pump or its authorized representatives. Disregard of this Warning can result in pump failure and serious personal injury or death.

Operation outside of these limits may result in damage to the unit, personal injury, or death. Consult your Peerless Pump representative for approval if a need arises to operate outside of these limits.

Warning

Operation at a reduced capacity for prolonged periods may shorten the useful life of the seals or packing, shaft sleeves, bearings, and the shaft. Fire pumps are applied with full knowledge that operation at reduced capacity will occur.

5.2 Location

Locate pump discharge piping and suction piping as well as auxiliary equipment, control and starting panels so that adequate access is provided for maintenance.

Note

Adequate floor space and working room should also be provided for maintenance

To minimize frictional head loss, locate the pump so that it can be installed with a short and direct discharge pipe and with the least number of elbows and fittings. If practical, it should be placed so that it will be accessible for inspection during operation. Pumps, drivers and controls should be protected against flooding, freezing, etc.

Note

The suction supply system must provide the pump with Net Positive Suction Head (NPSH) equal to or greater than that required by the pump at any capacity on its operating curve. Ask your Peerless Pump representative for assistance if you do not understand how to calculate or measure suction supply system NPSH.

Note

5.3 Foundation

The pump must be installed on a foundation rigid enough to support the entire weight of the pump plus the weight of the fluid contained in it. Weak foundations or foundations on unstable ground can cause misalignment, vibration, and even total foundation failure.

Allowable bearing loads of structural steel and floors can be obtained from engineering handbooks; building codes of local communities give the recommended allowable bearing loads for different types of soil.

Note

The mass of the foundation should be sufficient, preferably five times that of the rotating element of the pumping equipment, to form a permanent and rigid support for the base plate.

Foundation and base plate bolt sizing is critical, particularly on high-pressure pumps, to adequately restrain reaction forces such as from directional flow change, system transients and sudden valve closure. Concrete foundations may have anchor bolts installed in sleeves that are two times the diameter of the bolt to allow alignment and should be located by a drawing or template.

Steel support structures may not be stiff enough even if their mass exceeds five times that of the rotating element. A civil engineer should review and approve a steel support structure before pump installation.

Caution

Whether the base plate is installed prior to the pump installation or at the same time, the pump must be attached to the base plate. Check that the pump feet are clean and free of burrs and nicks. Failure to have each component's surface machined will result in excessive vibration.

Follow the instructions in sections [5.4.1 Leveling](#) and [5.4.2 Grouting](#). After the grout is cured (a minimum of 48 hours), the pump unit may be finished for pump installation. Peerless Pump does not recommend installation of the base plate without the pump.

Position the foundation and the foundation bolts so that pump suction and discharge flanges will be in accurate alignment with the discharge piping.

Caution

5.3.1 Seismic analysis

When pumps are located in seismically active areas and for certain critical installations the pumps, supports and accessories should be earthquake-resistant. The design specifications to achieve earthquake resistance vary, depending upon geographical area, class of the equipment (defining how critical the survival of the equipment is) and the characteristics (acceleration response) of the structure or foundation supporting the pump.

Complete specifications for earthquake-resistance requirements should be supplied by the customer. This includes the following:

- the seismic criteria, such as acceleration, magnitudes, frequency spectrum, location and direction relative to pump
- the qualification procedure required, i.e., analysis, testing or a combination of these, and requirements for operability during and/or after test.

5.4 Rigging and lifting

For typical installations, suitable overhead lifting equipment of adequate capacity to lift the driver, the entire pump (without driver) or the heaviest subassembly of the pump should be available at the job site when installing or removing the pump. Adequate headroom should be provided to accommodate the pump to be handled, including rigging.

Caution

Properly sized slings, chains and shackles should be available for attaching to the lifting lugs (eyes). Eyebolts are required for handling pump sections when lifting lugs are not provided.

5.4.1 Leveling

1. Remove the supporting timbers, rope and any other equipment from the top of the foundation.
2. Disconnect the coupling halves between the pump and driver.

Note

If the base plate is not already grouted in place, be certain that the grouting dam around the foundation opening is in place before lowering the pump assembly onto the foundation.

3. Lower the pump unit until the base plate is just above the foundation bolts.
4. Orient the pump so that the discharge outlet and suction inlet is in the desired direction and the holes in the base align with the foundation bolts.
5. Continue to lower the pump until the bolts just enter the holes in the base.
6. If the foundation is concrete, place the wedges under the base plate, adjacent to the bolt holes, one under each of the four sides.
7. For structural foundations (made up of I-beams or H-beams), use shims under the corners.
8. Continue to slowly lower the pump until the base of the base plate rests on the wedges or anchor bolts with washers and nuts.

Caution

Accurate alignment of the pump shaft in relation to the motor shaft is absolutely essential for smooth and trouble-free operation.

9. By using the wedges or washers and nuts on the anchor bolts, adjust the pump suction flange center line to the correct elevation.
10. While maintaining the correct elevation, adjust the nuts and washers or shims to achieve the specified levelness of 0.005" per ft. [0.4 mm per m] in both directions. The levelness should be measured by placing a precision level on the machined face of the discharge flange.
11. Place a machinist's level on the discharge flange, orienting it parallel with one of the edges of the base.
12. Move the wedges or add more shims until the level reading reaches 0.005" per ft. [0.4 mm per m].
13. Reorient the level on the same surface, 90 ° from the original position.
14. Again adjust the wedges or shims until a 0.005" [0.12 mm] level reading is reached, taking care not to upset the levelness in the first direction.
15. After each adjustment, check for levelness in both directions.
16. Push in or add to any loose shims to distribute the weight evenly.
17. Fit nuts on the foundation bolts and tighten them gradually and uniformly.
18. Check the level readings in both directions.
19. If necessary, loosen the foundation bolts and readjust the wedges or shims, tighten the bolts again and check the level

readings.

Caution

Never attempt to align the pump using a spirit (carpenter's) level.

5.4.2 Grouting

After the base plate is at the correct location and leveled with a precision level, the base plate needs to be grouted to the foundation.

Grout compensates for unevenness in the foundation and base plate and minimizes vibrations levels during operations. It prevents the unit from shifting after mounting and alignment.

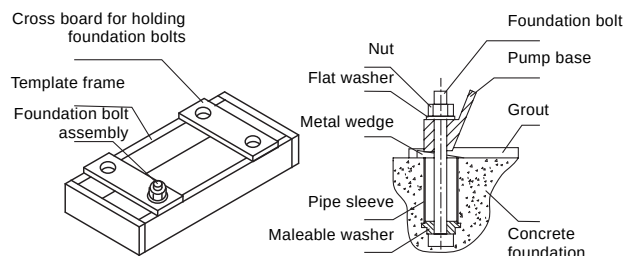


Fig. 3 Typical foundation with base plate

Only non-shrinking grouting material should be used for grouting the base plate to the foundation. Foundation bolts should not be fully tightened until the grout is hardened, usually about 48 hours after pouring.

1. Prepare the foundation surface according to the grout manufacturer's recommendations.
2. Locate the foundation bolts by the use of a template frame and provide anchorage as shown in fig. 4. See the outline drawings furnished with each pump for the exact location of the foundation bolts.
3. Build a dam on the foundation, enclosing an area around the base plate that includes all alignment wedges. Allow for a grout thickness of 0.75 to 1.50" thickness [19.05 mm to 38.1 mm]. See fig. 3.
4. Pour the grout through the holes provided in the base plate or through open ends of steel channel base plates. While pouring, tamp liberally in order to fill all cavities and prevent air pockets. If tamping does not eliminate all air pockets, drill small vent holes through the base surface.
5. Level off the grout flush with the top of the dam.
6. Allow the grout to cure at least 48 hours before tightening the foundation bolts or starting the pump.
7. Tighten pipe connections to suction and discharge flanges.
8. Check the pump alignment in Section 5.9 Alignment.
9. When the grout has thoroughly dried, paint the exposed edges to prevent air and moisture from coming in contact with the grout.

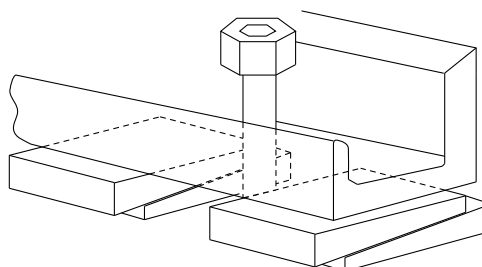


Fig. 4 Foundation Bolting Location and Anchorage Mount and leveling

5.5 Installation preparations

5.5.1 Inspection

All pump parts were carefully inspected before leaving the factory, but may have become soiled or damaged in shipping and handling or storage at site. The installer must therefore check that all parts are clean and undamaged before installing them.

Caution

Do not step or walk on the pump components. Do not place other parts or equipment on the pump components.

Use appropriate solvent to wash off any protective coating from the shaft sections and wipe thoroughly clean and dry.

Dirt, sand, etc. in the system will cause premature wear on the critical pump internal surfaces, resulting in reduced pump performance.

Pumps and drivers mounted on a common base plate were accurately aligned before shipment. All base plates are flexible to some extent and, therefore, must not be relied upon to maintain the factory alignment.

Realignment is necessary after the complete unit has been leveled on the foundation and again after the grout has set and foundation bolts have been tightened. The alignment must be checked after the unit is piped and rechecked periodically as outlined in the following paragraphs. To facilitate accurate field alignment, we do not dowel the pumps or drivers on the base plates before shipment.

5.5.2 Engine Preparation

Safe and efficient operation of a pumping unit driven by an diesel engine, requires the installation to satisfy the following requirements:

1. It is recommended that the operator become familiar with the installation and service manual supplied by the engine manufacturer or Peerless Pump
2. Be well ventilated in order to keep the ambient temperature as low as possible. Taking 60 °F [15.6 °C] as a datum point, every 10 °F [-12 °C] rise in temperature reduces the horsepower of the engine by approximately 1 %.
3. Provide ample air for proper combustion.
4. Provide the engine with an efficient exhaust system so that the combustion gasses discharge with a minimum of backpressure.
5. Provide for a fuel system of adequate capacity that meets the local codes.
6. Provide ample accessibility to service engine.
7. Provide correct rotation of the pump. Engine rotation is determined at the factory. No change of engine rotation can be made in the field.

5.6 Base plate or pump

Warning



Never attempt to lift the pump by means of eyebolts screwed into the driver mounting holes because the bolts are not strong enough to carry the weight of the entire pump.

5.6.1 Leveling

Flat surfaces that might capture air during grouting should be vented to prevent voids between the surface and the grout.

The base plate should be leveled by use of wedges (see section [5.4.1 Leveling](#)) or by use of leveling screws supported on rectangular metal blocks.

The leveling screw threads should be covered with a non-binding material such as grease, putty or tape before grouting, to facilitate their removal.

If shims are used, they should be placed to isolate from the initial application of grout. After the initial grout has cured, the forms and shims may be removed and the void filled with a second application of grout.

A gap of about 0.75 to 1.5" [19.05 mm to 38.1 mm] should be allowed between the base plate and the foundation for grouting. See section [5.2 Location](#).

5.6.2 Grouting

The grout material that supports the base plate is a critical element of the pump support structure and should be carefully selected. The product warranty is void if this Instruction is not followed.

If the grout cracks or fails, the structure will be compromised. When the alignment is correct, the foundation bolts should be tightened evenly but not too firmly. The unit can then be grouted to the foundation. It is not recommended to grout leveling pieces, shims or wedges in place because they introduce discontinuities and stress concentrations that may cause the grout to crack. Foundation bolts should not be fully tightened until the grout is hardened, usually about 48 to 72 hours after pouring. Jacking screws should be removed after the grout has hardened and the holes filled with an appropriate sealing material.

Caution

Do not distort the base plate by over tightening the foundation bolts.

5.6.3 Doweling

Contact Peerless Pump for further information.

5.7 Piping and connections

5.7.1 Pipe supports, anchors or joints

Suction and discharge piping should be anchored, supported and restrained near the pump to avoid application of forces and moments to the pump in excess of those permitted by Peerless Pump.

Caution

Do not exceed the forces or moments specified on the outline drawing when connecting piping to the suction or discharge flanges.

In order to achieve optimum operation and minimum noise and vibration, consider vibration dampening of the pump.

Caution

Piping must be independently supported and arranged so that expansion and contraction, due to temperature changes, will not cause misalignment.

Noise and vibration are generated by the revolutions of the motor and pump and by the flow in pipes and fittings. The effect on the environment is subjective and depends on correct installation and the state of the remaining system.

Elimination of noise and vibrations is best achieved by means of a concrete foundation, vibration dampers and expansion joints.

Note

Piping should be cleaned mechanically and chemically, and flushed prior to installing the pump. A large number of pump packing, seal and seizure troubles are due to improperly cleaned systems.

The pump should also be inspected internally for foreign matter that may have entered the pump.

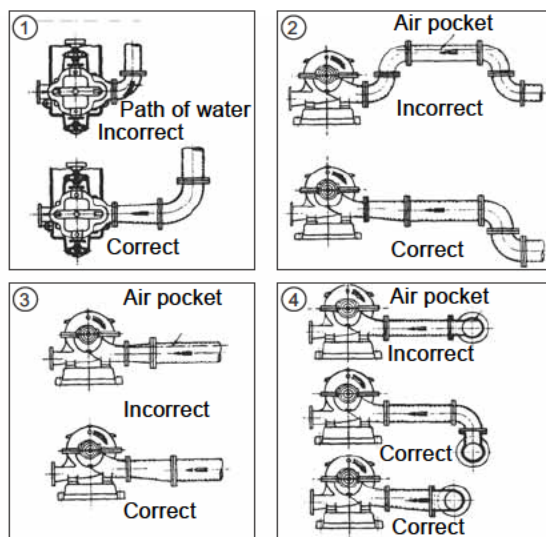


Fig. 5 Piping Arrangement

5.7.2 Vibration dampers

To prevent the transmission of vibrations to buildings, isolate the pump foundation from building parts by means of vibration dampers.

The selection of the right vibration damper requires the following data:

- forces transmitted through the damper
- motor speed considering speed control, if any
- required dampening in %.

The selection of vibration damper differs from installation to installation. In certain cases, a wrong damper may increase the vibration level. Vibration dampers should therefore be sized by the supplier of the vibration dampers.

If you install the pump on a foundation with vibration dampers, always fit expansion joints on the pump flanges. This is important to prevent the pump from "hanging" in the flanges.

5.7.3 Suction piping

The suction and discharge piping should be of sufficient size and be internally free of foreign material.

Considerations for suction piping to achieve optimal performance are:

1. When operating under suction lift, line must be kept absolutely free from air leaks.
2. When operating under suction lift, must be at least one pipe diameter larger than the pump suction nozzle. In order to prevent eddies and vortices, the end of the suction pipe must be at least two pipe diameters below the free liquid surface. If a foot valve is used to facilitate priming, the foot valve must have a minimum flow area 1.5 times the area of the suction pipe. The suction at all points and should not contain loops or high spots in which air can be trapped.
3. When operating under suction pressure, pipe may be equal to, but never less than the suction nozzle size.

Failure of the suction piping to deliver the liquid to the pump in this condition can lead to noisy operation, swirling of liquid around the suspended pump assembly, premature bearing failure and cavitation damage to the impeller and inlet portions of the casing.

Contact Peerless Pump for further information.

5.7.4 Suction valves and manifolds

Block valves may be installed to isolate the pump for maintenance.

Foot valves are specially designed non-return valves sometimes used at the inlet to prevent backspin caused by rapidly draining water in the discharge pipe.

5.7.5 Discharge valves

A non-return valve and an isolation valve should be installed in the discharge pipe. The non-return valve serves to protect the pump from backflow and excessive backpressure. The isolation valve is used when starting and stopping the pump.

We recommend closing the isolation valve before stopping or starting the pump.

Pump backspin and hydraulic shock can cause severe damage to pump and motor. Install at least one non-return valve in the discharge pipe, not more than 25 ft. [7.5 m] after the discharge flange to help prevent this

Operating some pumps at shutoff may cause a dangerous increase in pressure or power. If increasers are used on the discharge side of the pump to increase the size of piping, they should be placed between the non-return valve and the pump.

If expansion joints are used, they should be placed between the pipe anchor and the non-return valve.

5.7.6 Nozzle loads

The piping should be aligned with the pump nozzles to minimize pump nozzle loads. Contact Peerless Pump for allowable nozzle loading for your given design.

5.8 Setting the impeller clearance

To achieve optimal performance and reduce radial loading, the impeller should be centered in the volute passageway of the casing. For new pumps, this is done at the factory, refer to section [7.6 Wear Ring](#).

5.9 Alignment

Pumps and drivers mounted on a common base plate were accurately aligned before shipment. All base plates are flexible to some extent and, therefore, must not be relied upon to maintain the factory alignment.

After the grout has set and the foundation bolts have been properly tightened, the unit alignment should be checked.

After the piping of the unit has been connected, the alignment should be checked again. Alignment may be checked by mounting a dial indicator to measure shaft movement before and after tightening flange bolts. If the unit does not stay in alignment after being properly installed, the following are possible causes:

- setting, seasoning or springing of the foundation
- excessive pipe strain distorting or shifting the machine
- settling of the building
- shifting of pump or driver on the base plate or foundation

To facilitate accurate field alignment, we do not dowel the pumps or drivers on the base plates before shipment.

Reliable, trouble-free, and efficient operation of a pumping unit requires correct alignment of pump and driver shafts.

Misalignment may be the cause of:

- Noisy pump operation
- Vibration
- Premature bearing failure
- Excessive coupling wear

Recheck alignment is required after:

- Mounting
- Grout has hardened
- Foundation bolts are tightened or readjusted
- Piping is connected or adjusted
- Pump, driver or base plate is moved for any reason

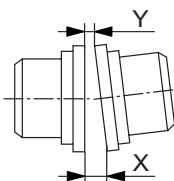
The procedure for alignment verification for units with the pump and driver connected by a flexible coupling, mounted on a common base are:

1. Disconnect the coupling halves.
2. Set the coupling gap to the dimension shown in fig. 6, 7, or on outline drawings.

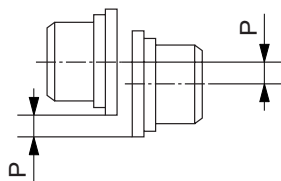
Coupling	Max RPM	Parallel in. [mm]	Angular in. [mm]	Weight lb. [kg]	Torque lb-in. [Nm]
1020	4500	0.006 [0.15]	0.003 [0.08]	4.2 [1.9]	460 [52]
1030	4500	0.006 [0.15]	0.003 [0.08]	5.7 [2.6]	1,320 [149]
1040	4500	0.006 [0.15]	0.003 [0.08]	7.4 [3.4]	2,200 [249]
1050	4500	0.008 [0.2]	0.004 [0.1]	12 [5.4]	3,850 [435]
1060	4350	0.008 [0.2]	0.005 [0.13]	16 [7.3]	6,050 [684]
1070	4125	0.008 [0.2]	0.005 [0.13]	23 [10.4]	8,800 [994]
1080	3600	0.008 [0.2]	0.006 [0.15]	39 [17.7]	18,150 [2,051]
1090	3600	0.008 [0.2]	0.007 [0.18]	56 [25.4]	33,000 [3,729]
1100	2440	0.01 [0.25]	0.008 [0.2]	93 [42.2]	55,550 [6,276]
1110	2250	0.01 [0.25]	0.009 [0.23]	120 [54.4]	82,500 [9,321]
1120	2025	0.011 [0.28]	0.01 [0.25]	179 [81.2]	121,000 [13,671]
1130	1800	0.011 [0.28]	0.012 [0.3]	266 [120.7]	176,000 [19,885]
1140	1650	0.011 [0.28]	0.013 [0.33]	392 [177.8]	253,000 [28,585]

Falk/Clarke/Dodge Coupling Misalignment

Angular misalignment



Parallel misalignment



TM06 0221 4913 - TM06 0222 4913

Fig. 6 Coupling misalignment

ROTEX Size	E distance in. [mm]	Max Parallel in. [mm]	Max Angularity in. [mm]	Max. axial in. [mm]
14	0.51 [13]	0.006 [0.15]	1.1 [28]	-0.02 [-0.5] +0.04 [1]
19	0.63 [16]	0.007 [0.18]	1 [25]	-0.02 [-0.5] +0.05 [1.3]
24	0.71 [18]	0.008 [0.2]	0.08 [2]	-0.02 [-0.5] +0.06 [1.5]
28	0.79 [20.1]	0.009 [0.23]	0.09 [2]	-0.03 [-0.8] +0.06 [1.5]
38	0.94 [23.9]	0.01 [0.25]	0.09 [2]	-0.03 [-0.8] +0.07 [1.8]
42	1.02 [25.9]	0.011 [0.28]	1 [25]	-0.04 [-1] +0.08 [2]
48	1.1 [27.9]	0.013 [0.33]	1.1 [28]	-0.04 [-1] +0.08 [2]
55	1.18 [30]	0.014 [0.36]	1.1 [28]	-0.04 [-1] +0.09 [2.3]
65	1.38 [35.1]	0.015 [0.38]	1.1 [28]	-0.04 [-1] +0.1 [2.5]
75	1.57 [39.9]	0.017 [0.43]	1.1 [28]	-0.06 [-1.5] +0.12 [3]
90	1.77 [45]	0.018 [0.46]	1.2 [30]	-0.06 [-1.5] +0.13 [3.3]
100	1.97 [50]	0.019 [0.48]	1.2 [30]	-0.06 [-1.5] +0.15 [3.8]
110	2.17 [55.1]	0.02 [0.51]	1.2 [30]	-0.08 [-2] +0.17 [4.3]
125	2.36 [59.9]	0.021 [0.53]	1.2 [30]	-0.08 [-2] +0.18 [4.6]
140	2.56 [65]	0.022 [0.56]	1.2 [30]	-0.08 [-2] +0.2 [5.1]
160	2.95 [74.9]	0.022 [0.56]	1.2 [30]	-0.1 [-2.5] +0.22 [5.6]
180	3.35 [85.1]	0.024 [0.61]	1.2 [30]	-0.12 [-3] +0.25 [6.4]

KTR Coupling Chart Gap and Maximum Misalignment

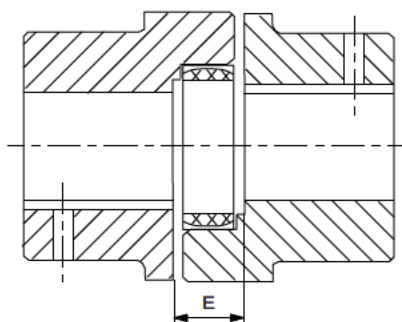


Fig. 7 E distance

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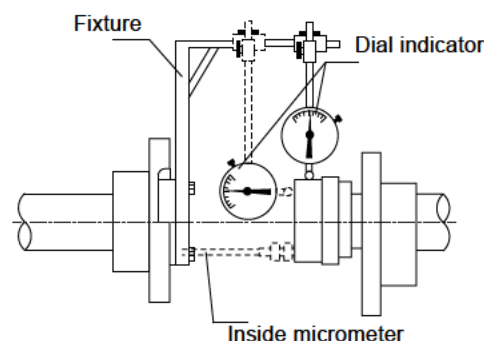


Fig. 8 Dial indicator figure

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- Test for parallel and angular alignment with a straight edge and feeler gauge as shown in manufacturer's instructions (at the end of this section). With coupling halves stationary, make trials at four places 90° apart. Perfect alignment occurs when a straight edge is level across the coupling halves and the same gauge just enters between the halves, both conditions at all points.
- An alternate test for parallel and angular alignment may be made with a dial indicator mounted as shown in fig. 8.
 - Scribe the index lines on the coupling halves (as shown) or mark where the indicator point rests.
 - Set indicator dial to zero.
 - Slowly turn BOTH coupling halves so that index lines match, or indicator point is always on the mark.
 - Observe dial reading to determine whether pump or driver needs adjustment.
 - Acceptable parallel and angular alignment occurs when total indicator reading (complete turn) does not exceed limits shown on either a tag or decal on the unit or on the unit outline drawing.
- When significant operating temperature differential will exist between the pump and driver (i.e. steam turbine drive with pump handling cold liquid), thermal growth will cause the hotter unit to rise. Compensate for this growth by initially setting the hotter unit 0.003" to 0.005" [0.076 mm to 0.127 mm] low. When both units are at normal operating temperature, a final check of coupling alignment must be made. Correct the alignment if necessary.
- NOTE Check for correct electric motor rotation as described in the two bullet points under paragraph 6.3 below while coupling halves are disconnected.
- Correct for excessive parallel and angular misalignment by slightly shifting the leveling wedges under the base plate. Tap lightly (in or out) with a hammer. Retest alignment after each shifting of a wedge.
- In some instances, for factory-aligned pumping units, it may be necessary to change the shims under the pump or driver, or even relocate these factory-positioned units on the base plate. Make such changes only after it is certain alignment cannot be obtained by shifting of the wedges.
- If wedges are shifted or shims changed a substantial amount to obtain proper alignment, recheck the piping alignment and level of the shafts.

5.9.1 Auxiliary (driver, coupling, etc)

Engine drivers

Engine driven unit are typically supplied with pump and drive on a common base plate. For units that are supplied separate, contact Peerless Pump.

1. Check the axial misalignment between pump and engine.
2. Check parallel alignment.
3. Check the angle between the pump shaft and driver when coupled has a Maximum angle of 3 degrees. Consult Manufacture.
4. At least 3/4 of the key is engaged with the coupler and the shaft.
5. Installation of universal drive see manufacturer's Instructions

5.10 Lubrication, priming and cooling systems

If supplied, please see additional documents attached to the pump or contact Peerless Pump.

5.11 Electrical installation

Electrical conduit and boxes should be located to avoid obstruction of pump unit.

A plot of speed versus torque requirements during the starting phase of a pump can be checked against the speed versus torque curve of the driving motor. Contact the drive manufacture for curve availability. The driver should be capable of supplying more torque at each speed than required by the pump in order to accelerate the pump up to rated speed. This condition is generally easily attainable with standard induction or synchronous motors, but under certain conditions, such as high-specific-speed pumps over 5000 US units [100 metric units] or reduced voltage starting, a motor with high pull-in torque may be required. To achieve a smooth start for the pumping equipment, autotransformers may be connected to the starting panel or solid state starters used. These provide a gradual increase in voltage up to rated voltage, ensuring even acceleration.

5.12 Control, monitoring and alarm equipment

All control and alarm systems should be checked for correct installation and functioning in accordance with the manufacturer's instructions. All alarm point settings should be checked.

5.12.1 Stopping the unit/reverse runaway speed

A sudden power and/or discharge valve failure during pump operation against a static head will result in a flow reversal, and the pump will operate as a hydraulic turbine in a direction opposite to that of normal pump operation.

If the driver offers little resistance while running backwards, the rotational speed may approach the pump-specific speed.

This condition is called runaway speed and causes mechanical problems. Contact Peerless Pump for aid in preventing this condition.

6. Startup, operation and shutdown

Warning



The pump 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, have the serial number ready and contact Peerless Pump for advice.

If the conditions of service on you purchase order are going to be changed, (for example liquid pumped, temperature or duty), seek written agreement from Peerless Pump.

6.1 Frost protection

If the pump is to be used in area where there is a potential of freezing or frost, necessary steps should be taken to protect pump and cooling systems from freezing and bursting.

6.2 Lubrication

Before attempting to start the pump, check the following items:

- lubrication fitting at packing (if applicable)
- lubrication for pump bearing
- lubrication of the driver
- oil-cooling connections for the driver (if applicable)
- coupling (if required by manufacturer)

Good practice includes the following:

- Keep lubricant clean. Provide, and use, a dust tight cover on the storage container.
- Use the oldest lubricant first.
- Clean pump lubricant fittings before re-lubricating with grease.
- Use clean dispensing equipment.
- Remove 0.25" [6.4 mm] drain pipe plug on bottom outside of bearing housing cover. Inject clean, new grease, forcing out the old through the drain opening.
- Start and run the pump for a short time to eject any excess grease. Reinstall 0.25" [6.4 mm] pipe plug. Wipe off ejected grease.
- Use the proper amount of lubricant -too much result in churning, unnecessary power consumption, rapid heating to a high temperature and inadequate lubrication.

Note

Normal bearing temperatures vary with the seasons and environment and may range from 0 to approximately 250 °F [-18 to 121 °C]. A continuous rise from the established, normal operating temperature indicates trouble and probable failure of the bearing. Shut down the pump immediately.

6.2.1 Recommended products

The products listed in the following tables are recommended for the applications mentioned. Other lubricants of equal quality may also be used.

Greases for pump bearings

Use a Lithium soap base meeting NLGI Grade 2 specifications with a minimum dropping point 355 °F [179 °C], operating temperature range of -10 °F to 250 °F [-23 °C to 121 °C].

Manufacturer	Product
American Oil Co.	AMOCO Lithium Grease All-Weather
Atlantic Richfield Co.	ARCO Multipurpose Grease
Cato Oil and Grease Co	Mystik JT-6
Cities Service Oil Co.	Citgo H-2
Continental Oil Co.	EP Conolith No. 1 -20 ° to +40 °F [-28 ° to +4 °C]
Continental Oil Co.	EP Conolith No. 2 +40 ° to +120 °F [+4 ° to +50 °C]
Chevron	SRI#2
Gulf Oil Co	Gulf Crown No. 2 or Ep 2
E.F. Houghton and Co.	Cosmolube No. 2
Exxon	POLYREX EM
Hydrotex	Deluxe No. M-33 Super Shield
Imperial Oil and Grease Co.	Molub-Alloy No. 1
Keystone Div., Pennwalt Corp.	80 X LT
Mobil Oil Corp	Mobilux Ep No. 2
The Pennzoil Co.	Pennzoil 705 HDW
Phillips Petroleum Co.	Philube IB and RB
Shell Oil Co.	Alvania EP Grease Alvania EP Grease 1 (for prolonged ambient temperature below 0 °F [-18 °C])
Sun Oil Co.	Sunaplex No. 2 EP Prestige 42
Texaco, Inc.	Novatex Grease No. 2
Union Oil Co	Unoba Ep-2

When packing or regreasing see the below table for amount of grease for bearing type.

Bearing Size	Volume of Grease oz [cm ³]	Amount of Grease [gram]
206/305	1 (29.5)	28
207/306	2 (59.1)	56
208/307	2.25 (65.5)	63
210/308	2.5 (73.9)	70
212/310	3.5 (103.5)	100
213/311	4.5 (133)	128

6.3 Rotation

Motor Driven



Warning

Never do maintenance work when the unit is connected to power.

Prior to checking rotation ensure the power is disconnected and locked out to prevent accidental energizing of the driver.

Disconnect the coupling so that the motor shaft can spin without driving or contacting the pump shaft.

Rotate the motor by hand in both directions to check freedom without binding. Momentarily energize the motor to check that rotation is in the same direction as the arrow on the pump. If motor is three-phase type, reverse rotation (if required) by interchanging any two of the three power leads. The rotation of most single-phase motors is fixed by internal wiring and cannot be easily changed.

After proper rotation has been confirmed, reconnect coupling and shaft guarding.

Engine Driven

Rotation of engine is a constant set by manufacture and confirmed at ordering. No checks are required.

6.4 Guards



Warning

All guards must be in place on the pump prior to startup. Read and follow all recommended guarding and safety instructions for accessories, if any.



Guards must not be removed while the pump is operational

6.5 Check list

6.5.1 System flushing

When the pump is installed in the completed piping system, we recommend to backflush the system to remove debris such as stubs of welding rod, welding slag and loose scale. The pump and other sensitive part should be protected with startup strainers, which should in turn be removed upon completion of the flushing cycle.

6.5.2 System decontamination

After the system has been flushed to remove debris, determine if your system needs to be decontaminated. If so, do that before priming and filling.

6.5.3 Priming

The pump should not be run unless it is completely filled with liquid, as there is danger of damaging some of the pump components.

If the system has suction pressure, bleed all air from the pump casing and suction pipe by the opening of the automatic relief valve at the top of the pump. Rotate the shaft a few times if possible to evacuate any air trapped inside the impeller passages.

6.5.4 Shaft sealing

The function of a stuffing box is to limit or eliminate leakage of the pumped fluid and to prevent air from entering along the shaft. Pumps are equipped with packing seals. These instructions are intended for pumping units handling water.

Packed Type Seal

A packed type stuffing box must correspond to the suction conditions of the installation. The pump is shipped with the packing installed unless otherwise specified by the customer. Check the packing carefully, allowing a slight leakage for lubrication. Never force the packing into a leak-proof position since this will create excessive friction and cause damage to the packing or shaft sleeve. Maximum packing life can be expected when the leakage approximates a minimum of 40-60 drops per minute. A reduction of leakage considerably reduces the life of both the packing and shaft sleeve. If leakage is excessive, tighten the gland bolts evenly, about 1/6 of a turn at a time. Do not be confused if the leakage seems to increase after an adjustment of the packing has been made. The leakage will normally reduce after a period of time as the packing adjusts itself to its new position. It should be kept in mind that it takes time for newly installed packing to "run-in" and that during this initial period, frequent attention and adjustments are necessary. It sometimes takes several days to achieve the desired results. Peerless Pump recommends the use of lantern rings and water seal lines.

Recommended stuffing box packing arrangements for use with water

Suction pressure range	Packing shaft / sleeve	Leakage rate
6.0 psiA - 100 psiG [.41 bar - 6.9 bar]	PTFE graphited synthetic latticed braided Crane C1065 or C1070 SAE 40 Bronze or Stainless Steel	20 to 50 Drops/Minute
100 - 175 psiG [6.9 bar - 12 bar]	Continuous carbon filament yarn, latticed braided packing containing colloidal graphite Crane C1627 SAE 40 Bronze or Stainless Steel	1/3 pint/ minute [.16 Liters/ Minute]
175 - 250 psiG [12 bar - 17 bar]	Continuous carbon filament yarn, latticed braided packing containing colloidal graphite Crane C1627 Hardened Stainless Steel	1 pint/minute [.47 Liters/ Minute]

All UL/ULC listed fire pumps will have water seal piping only when suction pressure is less than 30 psiG [2.1 bar].

All FM approved fire pumps will have water seal piping regardless of the suction pressure.

See supplemental instruction 4850332 for high-pressure fire pump applications.

Caution

The stuffing box gland must not be too tight during startup in order to let sufficient liquid lubricate the shaft and the packing.

Once the stuffing box housing and stuffing box gland have reached approximately the same temperature as that of the pump parts, the running-in of the stuffing box gland has been completed. If the stuffing box leaks too much, retighten slightly and evenly while the pump is running. To ensure continuous lubrication, a few drops should always drop from the stuffing box to protect the packing or shaft sleeve against damage, see chart for recommendations for drop rate.

When the leakage can no longer be controlled by adjusting the gland, all rings of packing should be replaced. The addition of a single ring to restore gland adjustment is not recommended.

If the pump is to be left idle for a long period of time, we recommend to replace the packing prior to restarting the pump 1.

6.6 Startup, operation and shutdown

Starting

Prior to making an initial start, after installation or major maintenance check the following:

- Refer to local fire code.
- Correct installation and rotation of driver.
- Coupling alignment.
- Bearing lubrication on pump and driver.
- Proper lubrication for stuffing boxes. For pumps having mechanical shaft seals, make certain that the liquid temperature, pressure, cooling and lubrication of seal faces all meet the manufacturer's requirements
- Gauges (if used) of correct range and in good condition.
- All foundation, pump, and driver bolts properly tightened. All external fasteners (nuts, bolts, screws) on pump checked against recommended torque values.
- When possible, turn the pump shaft by hand to make sure that parts do not bind.
- Ensure the suction valve is fully open.

After the pump has run a reasonable time, measure the temperature of bearing and stuffing box housings. The temperature of the stuffing box should approximate that of the pumped liquid. If it is too hot (overheats), the packing is too tight and should be checked.

6.6.1 Air in system

Entrained air reduces pump total head and flow rate. To avoid air in the system, take these precautions:

- Return lines into tanks should terminate a minimum of two pipe diameters below the low liquid level.

6.6.2 Lubrication system

Before running the drivers, either separately or connected to the pump, check lubrication requirements in the instructions of the driver. Check that the following points have been fulfilled:

- Grease-lubricated bearings have been properly greased with the driver manufacturer's recommended grade.

6.6.3 Driver settings

Follow the instructions of the manufacturer.

6.6.4 Performance testing

Once the unit is energized, check operating speed, flow rate, suction and discharge pressure, and power input. While it may not be possible to exactly repeat the factory performance, initial field test data becomes a valuable baseline for future checking to determine possible wear and need to perform maintenance. Auxiliary piping and gasket joints should be checked for leaks and proper makeup.

7. Maintenance



Warning

Never do maintenance work when the unit is connected to power.



Warning

Do not attempt to lift the entire pump by the lifting lugs (eyes) of the driver or pump.



Warning

Do not work under suspended object unless you have taken precautions to stop its fall in the event of sling failure

7.1 Schedule

To ensure satisfactory operation of the pumping equipment, frequent inspection and periodic maintenance are required.

An inspection and maintenance log should be kept and the inspector is to immediately report any problems. A suggested guide for preventative maintenance for normal applications is given below. Unusual applications with abnormal heat, moisture, dust, etc., may require more frequent inspection and service.

Item	Action	Frequency
Packing, packing box	Inspect for excessive leakage	First 150 hours of operation, then every 2000 hours of operation or quarterly
Packing, packing box	Adjust gland and replace packing	As necessary
Pump-motor alignment	Check for change in alignment	Annually
Vibration	Check for change in vibration	Annually
Bearings	Lubricate (grease)	
	• Light Duty, approximately 10 hour/ week	• Every 2000 hours or at least once a year
	• Normal Duty, approximately 8 hour/ day	• Every 2000 hours or at least every six months
	• Sever Duty, approximately 24 hour/ day	• Monthly
Fasteners	Check for loose fasteners	Annually

7.2 Recommended spare parts

The list of recommended spare parts will depend on factors such as the following:

- Normal supplier lead time when ordering parts.
- If pumping equipment is for use as normal duty or severe duty, and if there is backup pumping while a unit is down for maintenance and parts replacement.

Below is a suggested list of spare parts.

For intermittent or non-critical service

- Stuffing box packing (Item 13)
- Ball Bearing Set (Item 16 and 18)
- Bearing Seal Set (Item 47 and 169)
- Bearing Cover Gaskets (Item 73B)
- Set of Shaft Sleeves (Item 14 and 14A)
- Set of Sleeve O-Rings (Item 14B)
- Set of Casing Rings (Item 7)
- Set of Impeller Rings, if supplied (Item 8)
- Gasket, Casing (Item 73A)
- Packing gland and studs or gland bolts.

For continuous or critical service (in addition to above)

- Complete Rotating Element preassembled.

7.3 Consumables

Items normally used in the maintenance of pumping equipment may include the following, but depending on the type of unit some items may vary:

- Lubricant (grease or oil)
- Cleaning materials
- Touch-up coating.
- Hand tools
- Measuring equipment (feeler gauges, dial indicator, etc.)

7.4 Tightening torques

Proper tightening of fasteners is very important. The torque values depend on the size and grade of the fasteners used. The values in the table below apply to non-lubricated parts.

Fastener size	Torque lb-ft [Nm]	Torque lb-ft [Nm]
	MEDIUMCARBON STEEL	MEDIUMCARBON ALLOYSTEEL
Fastener Size in. [mm]	SAEJ429GRADE5 105-120,000PSI TENSILE	SAEJ429GRADE8 150,000PSI TENSILE
0.25 - 20 [6.4 - 508]	8 [10.8]	9 [12.2]
0.38 - 16 [9.7 - 406]	25 [33.9]	34 [46.1]
0.50 - 13 [2.7 - 330]	62 [84]	83 [112.5]
0.625 - 11 [15.9]	125 [169.5]	166 [25]
0.75 - 10 [9.1 - 254]	225 [305]	295 [400]
0.88 - 9 [2.4 - 229]	325 [441]	477 [647]
1-8 [5.4 - 203]	465 [630]	715 [969]
shaft sleeve set screws to	130 inch-pounds torque.	176 newton meter [Nm]

When assembling a pump, cross-tighten the screws in order to avoid misalignment, binding and leakage.

Torque value shown are for clean lubricated threads and gasket joints.

7.5 Dismantling



Warning

Drain the pump and isolate pipework before dismantling the pump.

Warning

There may be occasions when a part such as the impeller has either been shrunk-fit onto the pump shaft or has become difficult to remove due to products that are corrosive in nature.



If you elect to use heat to remove the part, it must be applied with great care. Before applying heat, ensure any residual hazardous liquid trapped between the two parts is thoroughly drained out to prevent an explosion or emission of toxic vapor. Impeller design varies and so does the amount heat and the duration of heat application required to loosen the impeller.

Contact Peerless Pump for help in removal of impellers.



Warning

Before opening the terminal box of an electric motor, make sure that the power supply has been switched off.

Before starting disassembly of the pump, it is recommended that a set of spare parts as shown in section [7.2 Recommended spare parts](#) be obtained. Peerless Pump does not recommend reuse of gaskets, O-rings, packing rings, or ball bearings.

1. Shut down pump.



Warning

Disconnect power to the pump driver before starting any repairs.

2. Clear a large area adjacent to the pump as a storage space for pump parts as they are dismantled.
3. Disengage the coupling halves. Refer to the coupling manufacturers' instructions.
4. Remove the nuts from the gland bolts (17B) and remove packing glands (17) from the shaft (6). The packing gland halves are separable.
5. Remove all fasteners securing the upper casing (1B) and from the bearing caps (41 and 43) from lower casing (1A). Match mark bearing caps to lower casing (1A).
6. Use the jack screws on the bottom side of the lower casing split flange to separate the upper and lower casings. Turn the jack screws back below the split flange surface to avoid reassembly interference.
7. Remove the upper casing by use of lifting lugs or customer supplied eye bolt 0.5 - 13" [13-330 mm] UNC threaded into top.

Warning

Parts which are provided with lifting lugs, lifting ears or eyebolts should be lifted by these points only. They may not be used for lifting the entire pump.



When lifting the entire pump, use appropriate slings.

8. Place slings around the shaft near the bearing housings and lift rotating element from lower casing (1A). Tap lightly on the underside of the bearing housings to separate the housings from the brackets as required.
9. Place rotating element in a convenient work surface.
10. Loosen set screws and remove the coupling half.
11. Tap from the back of the hub or use a puller.
12. Remove coupling key (46), and outboard deflector (40B).
13. Take out cap screws to remove bearing covers (35 and 37) and the gaskets (73B). Remove inboard bearing cover seal (47) from cover (35) only if replacement of seal is required.
14. Remove retaining ring (18A) from outboard end of shaft.
15. Remove housings (31 and 33), bearings (16 and 18), and bearing housing seals (169) as units with a bearing puller.
16. Remove deflectors (40A).
17. Remove casing rings (7).
18. Remove packing rings (13), lantern rings (29) if provided, and stuffing box bushings (63).
19. Loosen shaft sleeve set screws then loosen shaft sleeves (14 and 14A) with a spanner wrench.

Note

Sleeve (14) has right-hand thread, sleeve (14A) has left-hand thread. Remove sleeves from shaft.

20. A seal between the shaft and sleeve is made with an O-ring (14B) in a groove in the sleeve. Use care not to damage the O-ring.
21. Remove the impeller from shaft with an arbor press.

Note

The interference between impeller hub ID and shaft OD meets ANSI B4.1 standards for "Preferred Limits and Fits for Cylindrical Parts" and corresponds to standard fit LC-.

22. Remove impeller key (32).
23. Clean all parts.
24. Clean all metal parts (except bearings) with a solvent. Use a bristle brush (NOT metal or wire) to remove tightly adhering deposits.
25. A fiber scraper may be used to remove the gasket and shellac from casing flanges.
26. Recondition or replace worn parts. Perform detail inspection as follows:
27. Check O-rings and bearing cover gaskets for cracks, nicks or tears; packing rings for excessive compression, fraying or shredding, embedded particles (dirt or metal). Replace if defective in any way.
28. Mount the shaft between centers or on vee blocks. Check for eccentricity throughout entire length with a dial indicator; eccentricity must not exceed 0.003" [0.08] total indicator reading. Check that threads are clean and sharp. Surfaces on which bearings mount must be smooth, have a finish of 32 µin [0.81 µm] or better, and the shoulders square and free from nicks.
29. Examine passages for cracks, dents, gouges or embedded material.

7.6 Wear Ring

Wear rings provide a close-running, renewable clearance to reduce the quantity of liquid leaking from the high-pressure side to the suction side. These rings depend on the liquid in the pump for lubrication. They will eventually wear so that the clearance becomes greater and more liquid passes into the suction. This rate of wear depends on the characteristics of the liquid pumped. Badly worn wear rings will result in severe degradation of pump head and flow rate, particularly on small pumps. Examination of wear patterns can provide valuable information in diagnosing pump problems and determining their origin.

Worn wear rings or surfaces can be replaced to restore hydraulic performance.

Standard pumps are furnished without impeller rings; the wear surface is an integral part of the impeller. Impeller wear rings may be field installed by machining. Refer to note following paragraph 2-2b for standard fits to be produced when making such repair. Replace impellers which cannot be salvaged by such repair.

Note

Measure the OD of the impeller wear surface or impeller ring (8) and the ID of the casing ring (7). Compute the diametrical clearance (ID minus OD) and compare with the limits below. If measured diametrical clearance exceeds two times values, repair or replace to restore design clearance. ID surface of casing ring must be smooth and concentric with ring OD.

Pump Size	Diametrical Clearance in. [mm]
3AEF9, 4AEF10, 4AEF11, 4AEF12, 5AEF8, 5AEF11, 5AEF12, 5AEF14, 5AEF15, 6AEF10, 6AEF12, 6AEF14, 6AEF16, 6AEF18, 8AEF13, 8AEF14, 8AEF15, 8AEF17, 8AEF20	0.015 to 0.019 [0.381 to 0.48]
10AEF16, 10AEF20	0.018 to 0.022 [0.457 to 0.559]
6AEF17	0.025 to 0.029 [0.635 to 0.737]

Clearances in are for standard bronze or cast iron fitted pumps. For materials with a tendency to gall, such as stainless steel, increase clearances by 0.010" [0.25 mm].

Note

For bronze impellers and rings, the rings are shrunk on the hub according to standard fit FN-4 of ANSI B4.1. Hardened impeller rings are installed according to ANSI B4.1 standard fit FN-1.

Note

If impeller clearance is found to be out of tolerance, replace casing wear ring. It may be necessary to consider machining impeller wear surface for wear ring installation (if not originally supplied) to return to approved clearance. If the impeller must be machined to install new impeller rings, be sure machining is concentric with impeller bore.

Note

Use care not to reduce impeller hub OD when machining off old impeller rings.

7.7 Inspection and Repair

Inspection. Visually inspect parts for damage affecting serviceability or sealing. Emphasize inspection of mating parts having relative motion- wear rings, for example. Perform detail inspection as follows:

1. Check O-rings and bearing cover gaskets for cracks, nicks, or tears; packing rings for excessive compression, fraying or shredding, embedded particles (dirt or metal). Replace if defective in any way.
2. Mount the shaft between centers or on vee blocks. Check for eccentricity throughout entire length with a dial indicator; eccentricity must not exceed 0.003" [0.08 mm] total indicator reading. Check that threads are clean and sharp. Surfaces, on which bearings mount must be smooth, have a finish of 32 μ in [0.81 μ m] or better, and the shoulders square and free from nicks.
3. Examine impeller passages for cracks, dents, gouges or embedded material.

Repair. Make needed repairs in the following manner:

1. If ID of casing rings (7) is grooved, scored or eccentric, replace the casing rings.
2. If impeller wear surfaces or impeller rings (8) are defective, the impeller must be machined to install new impeller rings. Be sure machining is concentric with impeller bore. Use care NOT to reduce hub OD when machining off old impeller rings.
3. Install new impeller rings (8) on the impeller (shrink or press depending on material).
4. Replace worn shaft sleeves.
5. Replace shafts having excessive run-out (eccentricity).

7.8 Assembly

Caution

Take care not to damage any components and avoid contamination (dirt, debris, moisture, etc.) of the unit.

See section [7.4 Tightening torques](#) for torque values.

1. Support pump shaft in blocks and rails to protect it from bending or being damaged during the re-assembly process.
 2. Check that the shaft is straight and free of nicks and scratches. Remove with a fine file all burrs and scratches.
 3. Coat the shaft (6) lightly with oil.
 4. Place impeller key (32) in shaft key way.
 5. Align impeller (2) on shaft and install with an arbor press or brass tubular sleeve and hammer. When assembled, the impeller vanes must rotate in the proper direction.
 6. Impeller hub must be centered on shaft journal.
 7. Install shaft sleeve set screws in shaft sleeves. Assemble shaft sleeves to the shaft and hand tighten against the impeller. Do not tighten shaft sleeve set screws.
 8. Install the stuffing box bushings (63).
 9. Locate casing rings (7) on impeller.
 10. If casing and or impeller wear rings are required, fit wear rings into the casing or onto the impeller skirt. Contact Peerless Pump if rings should be pressed or secured to part as needed. Rings final clearance should provide the clearance shown in the table in section [7.6 Wear Ring](#). If clearance is not achieved, machine rings prior to proceeding.
 11. Place in board defectors (40A) on shaft.
 12. If previously removed, install bearing housing seals (169) into housings (31 and 33).
 13. Press housing-bearing-seal assemblies on shaft to seat bearings against shaft shoulders.
 14. Install bearing retaining ring (18A) in groove against the out board bearing.
 15. Install gaskets (73B) on bearing covers. Use factory supplied parts or cut replacement gaskets from 0.06" [1.52 mm] No. 444 Vellumoid. (SAEP3415A).
- EXCEPTION: For all models using 3306 size outboard bearing, gasket 73B is 0.03" [0.8 mm].
16. Attach in board and outboard bearing covers (35 and 37). In the assembled position, the greased rain tap must be located at bottom in a horizontal plane.
 17. Install outboard deflector (40B), and coupling key (46); assemble coupling half on the shaft and tighten the setscrews.
 18. Affix the new casing gasket (73A) to the lower casing (1A) with shellac.

Caution

It is very important that specified material and thickness be used for casing gasket. Machined surfaces of both casings must be perfectly clean and free from burrs or nicks.

19. Use slings around the shaft near bearings to set rotating element into lower casing.
20. Position the casing rings (7) and both bearing housings so that all dowel pins engage in slots in the lower case split surface.
21. Assemble both bearing caps per match marks and tighten the cap screws.

22. Adjust the shaft sleeves (14 and 14A) to center the impeller in the lower casing volute, and tighten both shaft sleeves with a spanner wrench, then add Loctite to the shaft sleeve set screws. Then tighten shaft sleeve set screws according to section [7.4 Tightening torques](#).
23. Cover the top side of the casing gasket with a mixture of graphite and oil.
24. Install the gland bolts (17B). Carefully locate the upper casing on the lower, making certain the dowel pins engage.
25. Install cap screws and tighten working from the center of the casing to each end, to the torque values in section [7.4 Tightening torques](#). If any cap screws require replacement, use only parts with equal or greater tensile strength. See [7.4 Tightening torques](#).
26. Rotate shaft by hand to check that it turns freely.
27. Push the stuffing box bushings (63) to the rear of the stuffing boxes.
28. If the stuffing box is not packed from factory, it should be packed prior to startup following the below guide.
29. Clean the stuffing box.
30. Check that the packing rings are of proper cross-section and length.
31. Stagger the joints 90° apart.
32. The rings should butt tightly but not overlap at the joints.
33. Tamp down the individual packing rings, but not too tightly, as this may result in burning the packing and scoring the shaft or shaft sleeve.
34. Where compatible, lightly lubricate the inner and outer packing diameter with a suitable lubricant. When a lantern ring is required, make sure that sufficient packing is placed in below the lantern ring so that the bypass line intersects the packing container bore adjacent to the lantern ring and is not blocked by the packing.
35. The pipe supplying sealing liquid should be fitted tightly so that no air enters. If the liquid to be pumped is dirty or gritty, clean sealing liquid should be piped to the stuffing box in order to prevent damage to the packing and shaft sleeves.
36. Clear sealing liquid is also required if the stuffing box materials are not completely compatible with the pump liquid. The sealing liquid should be at a pressure sufficient to ensure a flow of clean liquid into the pump but not so high as to require excessive tightening of the packing.
37. Insert two packing rings, lantern ring (29) if provided, and three packing rings. Insert each ring separately and stagger the joints of successive rings 90degrees.
38. Insert the packing glands (17) and set the gland bolt nuts finger tight.

Caution

The stuffing box gland must not be too tight during startup in order to let sufficient liquid lubricate the shaft and the packing.

39. Rotate shaft by hand to check that it turns freely.
40. Replace all drain plugs if removed during disassembly.
41. Re-lubricate the bearings. See section [6.2 Lubrication](#).
42. Make sure that the pump shaft spins freely.

7.9 Accessories

See the manuals supplied with the accessories.

8. Fault finding (Trouble Shooting)

Note

When direct-connected to electric motors, determine whether or not the motor is direct-on-line and receives full voltage.

Fault	Cause	Remedy
1. Discharge pressure too low.	a) Speed too low.	Check speed/rotation.
	b) System pressure lower than anticipated.	Check the system curve.
	c) Air or gas in liquid.	Check liquid to remove air.
	d) Worn wear rings.	Check clearance between wear surfaces.
	e) Impeller damaged.	Check that parts are not damaged.
	f) Impeller diameter too small.	Check specified diameter.
	g) Wrong direction of rotation.	Check rotation.
	h) Pump lost prime.	Re-prime pump.
	i) Insufficient available NPSH.	Confirm NPSH available.
	j) Restricted passages.	Clean impeller and casing passages.
	k) Leaking joints.	• Tighten joints. • Tighten packing. • Check o-ring between sleeve and shaft. • Check gaskets.
2. Insufficient suction head.	a) Suction line drawing air.	Tighten line connections.
	b) Suction lift too high or insufficient NPSH.	Check NPSHA.
	c) Air or gas in liquid.	Remove air/gas from liquid.
	d) Clogged strainer.	Clean the strainer.
3. Noise level increased.	a) Poor alignment of pump. Suction and discharge pipe clamps loose.	• Ensure proper alignment of the pump and the driver. • Support the suction and discharge piping. • Check vibration dampers, flexible piping and conduit connectors.
	b) Cracked foundation.	Check foundation.
	c) Worn ball bearings.	• Check bearings. • Check lubrication.
	d) Driver unbalanced.	Disconnect driver and operate it alone. Check pump for large pieces of debris, such as wood, rags, etc.
	e) Hydraulic resonance.	• Alter the resonant piping. • Change the pump speed. • Insert a pulsation damper on the pump/piping system. • Insert flow straighteners.
4. Insufficient flow.	a) Pump not primed.	Check suction conditions.
	b) System head exceeds shut off head.	Check system head curve vs. performance curve.
	c) Speed too low.	Check rotation speed.
	d) Suction lift too high or insufficient NPSH.	Check NPSHA.
	e) Clogged strainer or impeller.	Clean the strainer and impeller passages.
	f) Wrong direction of rotation.	Check rotation.
	g) Leaking joints.	Tighten joints.
	h) Broken shafting or coupling	Rotate shaft and inspect.
	i) Closed suction valve.	Check suction valve.
	j) Not enough suction head for hot or volatile liquids.	Check NPSHA.
	k) Foot valve too small;	Check foot valve.
	l) Worn or damaged hydraulic parts.	Inspect part.
	m) Excessive clearance between wear surfaces.	See section 7.6 Wear Ring for ring clearance.

Fault	Cause	Remedy
5. Pump loses prime after starting.	a) Leaking joints.	• Tighten joints. • Tighten packing. • Check o-ring between sleeve and shaft. • Check gaskets.
	b) Suction lift too high or insufficient NPSH.	Check NPSHA.
6. Excessive power required.	a) Speed too high.	Check rotation speed.
	b) Pump operating outside of the allowable operating region (AOR).	• Check system curve. • Check valve settings.
	c) Specific gravity or viscosity of liquid pumped is too high.	Check predicted performance based on liquid conditions.
	d) Bent shaft or rotating element.	Check parts and straighten as needed.
	e) Stuffing-boxes too tight.	Check drip rate of liquid from packing.
	f) Impeller clearance too small causing rubbing or worn wear surfaces.	Check clearance between wear surfaces.
	g) Electrical or mechanical defect in motor	Contact local service center for diagnostics.
	h) Restriction in rotation.	Check for binding of rotating elements.
	i) Incorrect lubrication of driver.	Check lubrication type and amount.

9. Parts list and sectional drawing

(b) (3) (B)

(b) (3) (B)

10. Disposal

This product or parts of it must be disposed of in an environmentally sound way. Contact the nearest Peerless Pump company or service workshop.

Subject to alterations.

Peerless Pump Indianapolis
2005 Dr. Martin Luther King Jr
US-46202 Indianapolis, Indiana U.S.A.
Phone: (+1) 317.925.9661

www.peerlesspump.com

98692495 0514

ECM: 1137721



Reliability | When It Matters

Attachment 8:
Moanalua Terrace Booster Pump System
Information

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MOANALUA

TERRACE

CUSTOM BOOSTER PUMP SYSTEM

FOR: NAVY PWC

BY : DOONWOOD ENGINEERING

PH 262-2344

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2. CONTROL PANEL

3. FLOW SENSOR/MONITOR

4. PRESSURE REGULATORS

5. ACCESSORIES

1. PUMPS

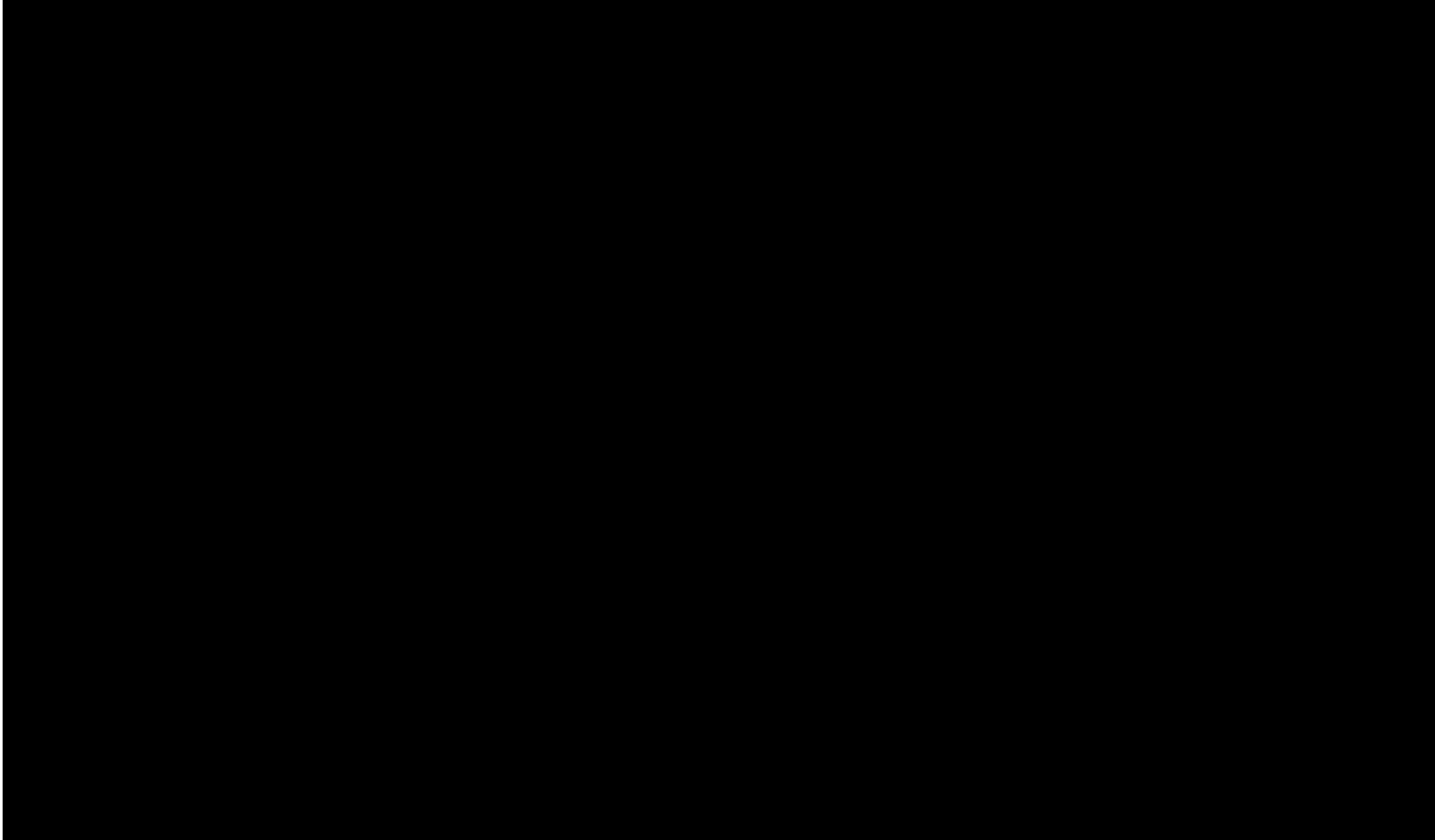
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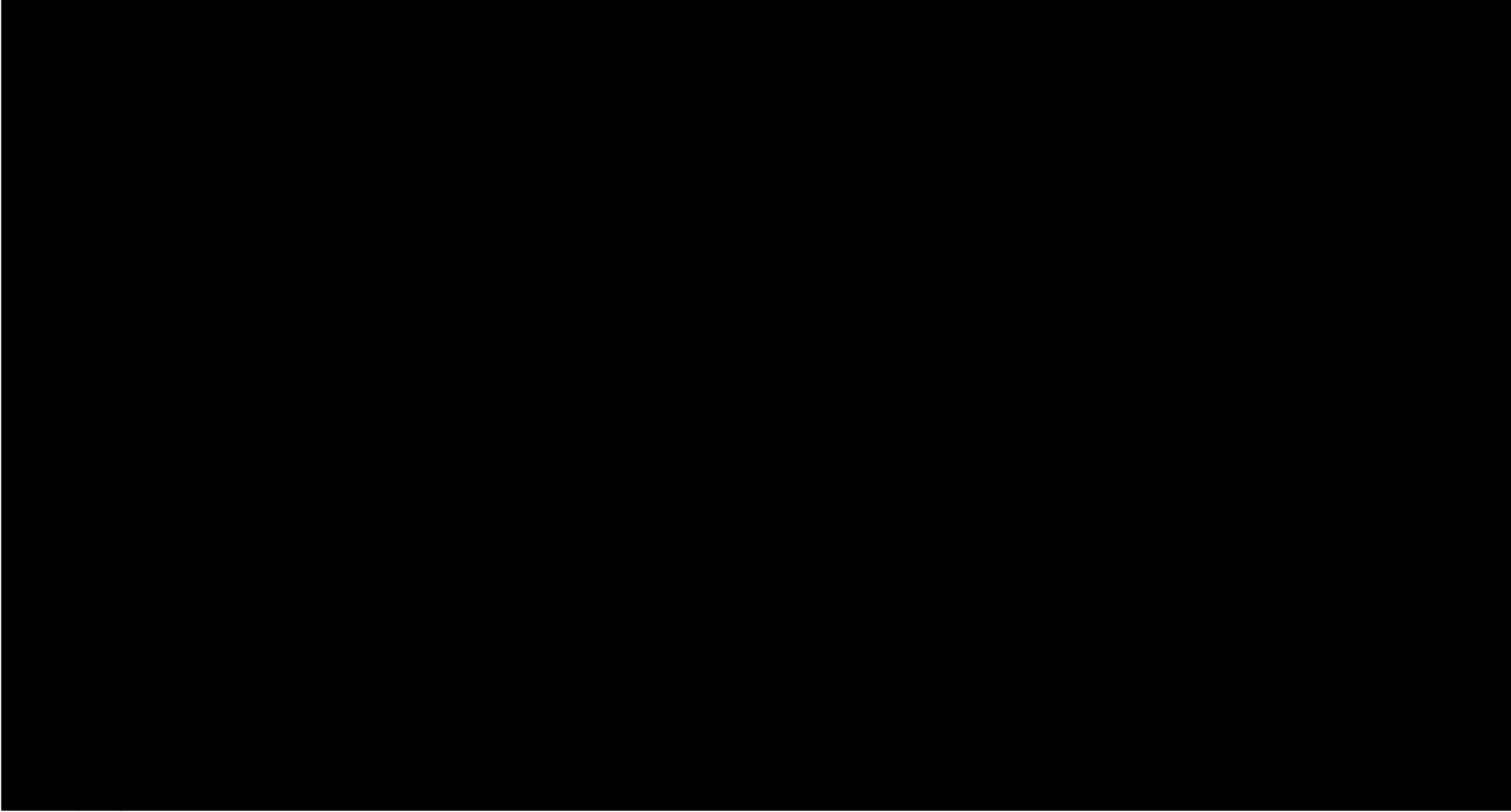
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(b) (3) (B)



(b) (3) (B)



END SUCTION PUMPS

REPLACEMENT PARTS GUIDE

PACO SMART PUMP™			
CAT#:			
STOCK#:			
SER#:			
GPM:	TDH:	IMP. DIA.	"
PACO PUMPS, INC. OAKLAND, CALIFORNIA			
84514412			

While PACO End Suction Pumps are designed and built to provide maximum life while requiring minimum attention and service, replacement parts may at times be required. **VIRTUALLY ALL REQUIRED PARTS ARE AVAILABLE IN KIT FORM.**

These kits (easily selected from the charts on the following pages) have been designed to insure that any parts needed when replacing any End Suction component is furnished when you need it, with minimum effort.

Here are some guidelines and suggestions:

GENERAL NOTES: The pump nameplate contains all data required in the selection and ordering of the proper replacement parts kit. The PUMP MODEL AND SERIAL NUMBER should be referenced whenever any replacement parts kit is ordered, while the PUMP CONDITIONS (GPM/TDH) and IMPELLER TRIM are REQUIRED data for the ordering of replacement impellers.

NOTE: SEAL/PACKING KITS ARE ALWAYS RECOMMENDED AS SPARE PARTS

To replace a mechanical seal.

You will need the correct Seal Kit, which contains all gaskets and Impeller Hardware.

Shaft sleeve inspection is suggested.

To replace the packing

You will need the correct Packing Kit, which contains all gaskets, Impeller Hardware and Lantern Ring. If the packing gland is damaged it may be replaced by ordering the proper Gland Kit. A shaft sleeve or adapter shaft will probably be required.

To replace the shaft sleeves.

Select sleeve from sleeve chart. A Seal or Packing Kit will provide other normally needed parts.

NOTE: For close-coupled units, motor frame type is required for proper sleeve replacement. Motor type is indicated by frame designation, found on motor nameplate:
Gyropoise Motors - Frame XXX TG
JM Motors - Frame XXX JM or JMZ
CCP Motors - All Others
(Fractional construction X0XXXX and X1XXXX do not require sleeves.)

To replace the Bearing Frame.

Select the correct Bearing Frame assembly.

To replace impeller.

You will need the correct Impeller Kit which contains all gaskets and Impeller Hardware. A Wear Ring Kit is highly recommended, and a Seal or Packing Kit will probably be required.

Shaft sleeve inspection is suggested.

To replace wear rings.

You will need the correct Wear Ring Kit. An Impeller Kit may be indicated if wear is excessive. A Seal/Packing Kit will provide all other normally replaced components.

To replace bearings. (Frame mounted pumps only.)

You will need the correct Bearing Frame Kit, which contains the bearings and moisture seals.

To replace the shaft.

You will need the correct Shaft Kit. A Bearing Frame Kit and shaft sleeve will also be required. A Seal or Packing Kit will probably be required.

To replace lost/damaged hardware.

Select the correct Hardware Kit.

To overhaul the pump.

You will need an Impeller Kit, Wear Ring Kit, Hardware Kit, Seal or Packing Kit, and a Sleeve or Adapter Shaft. Bearing replacement may also be indicated.

To overhaul the bearing frame.

You will need a Bearing Frame Kit and a Shaft Kit.

To replace slinger. (Included in Shaft Kit)

If not replacing shaft, order individually.

ORDERING: After determining and selecting the required Kit(s), or for selection assistance, contact your local PACO Sales Office, Representative or Distributor.

July 1989

(b) (3) (B) Suction Pumps

**INSTALLATION, OPERATING AND
MAINTENANCE INSTRUCTIONS**

(b) (3) (B)

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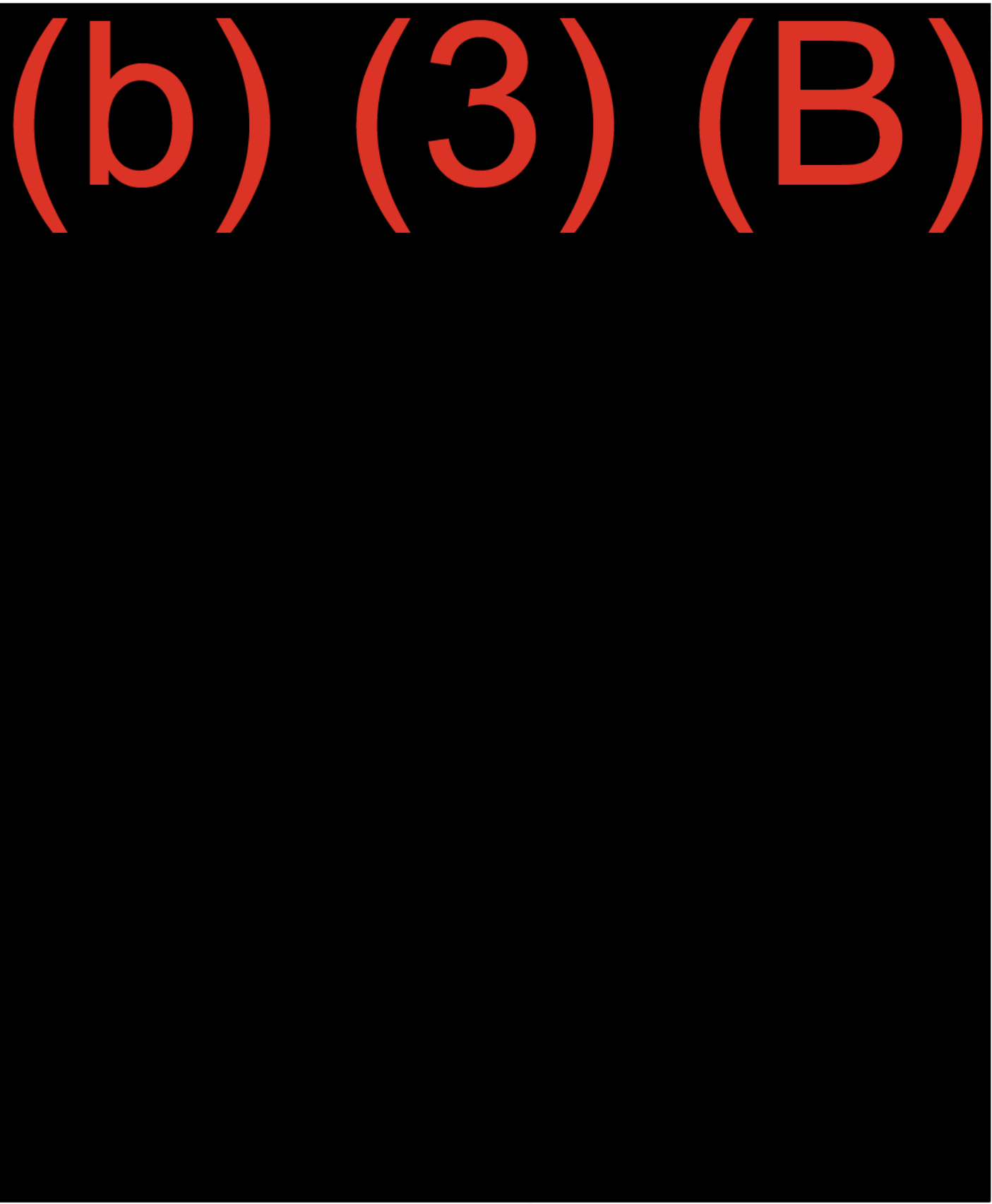
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Power:

(b) (3) (B)

Units Of Measure:

Flow rate:

- 19 standard, 1 custom programmable
- standard flow rate units:
 - GPM** gallons/minute
 - GPS** gallons/second
 - GPH** gallons/hour
 - MGD** millions of gallons/day
 - L/SEC** liters/second
 - L/MIN** liters/minute
 - L/HR** liters/hour
 - FT3/SEC** cubic feet/second
 - FT3/MIN** cubic feet/minute
 - FT3/HR** cubic feet/hour
 - CM/SEC** cubic meters/second
 - CM/MIN** cubic meters/minute
 - CM/HR** cubic meters/hour
 - ACF/SEC** acre-feet/second
 - ACF/MIN** acre-feet/minute
 - ACF/HR** acre-feet/hour
 - BBL/SEC** barrels (oil)/second
 - BBL/MIN** barrels (oil)/minute
 - BBL/HR** barrels (oil)/hour
- custom flow rate unit:
 - 7 letter label
 - 7 digit floating point conversion from gallons/minute to custom unit

Flow total:

(b) (3) (B)

Totalizer:

- two 7 digit, non-resettable, electro-mechanical counters
- user configurable output in any standard or custom flow total units

Analog Output:

Current Output:

(b) (3) (B)

Warranty

Data Industrial Corporation ("Seller") of 11 Industrial Drive, Mattapoisett, Massachusetts 02739-0740, U.S.A., warrants to the original purchaser of its product that such product manufactured by Data Industrial Corporation shall be free from defects in materials or workmanship when installed, serviced and operated according to Data Industrial Corporation instructions or in other such normal use. This warranty is effective for a period of 12 months from the date of installation by the Purchaser or 18 months from the date of shipment by the "Seller" whichever occurs or terminates first. This limited warranty does not cover damage or loss resulting from corrosion or erosion caused by acids or other chemicals or by severe environmental conditions or negligent or improper installation or improper operation, misuse, accident, unauthorized repair or substitution of components other than those provided by the "Seller", and does not cover limited life components such as bearings, shafts, impellers where wear rate is a function of application and environment. Any component not manufactured by the "Seller" but included in its products shall not be covered by this warranty and is sold only under such warranty as the manufacturer may provide.

If Buyer or Purchaser wishes to make a claim hereunder, he shall send written notice of any defect within the warranty period, to "Seller" at the above address. "Seller" may at its sole option instruct Buyer to ship subject part, postage prepaid, to the "Seller" at above address or authorize a representative to inspect the part on site. "Seller" will at its sole option repair or replace any defective product covered by this warranty. If Buyer makes repairs or alterations to any product or part covered by this warranty without "Seller's" prior written approval, this warranty shall be null and void.

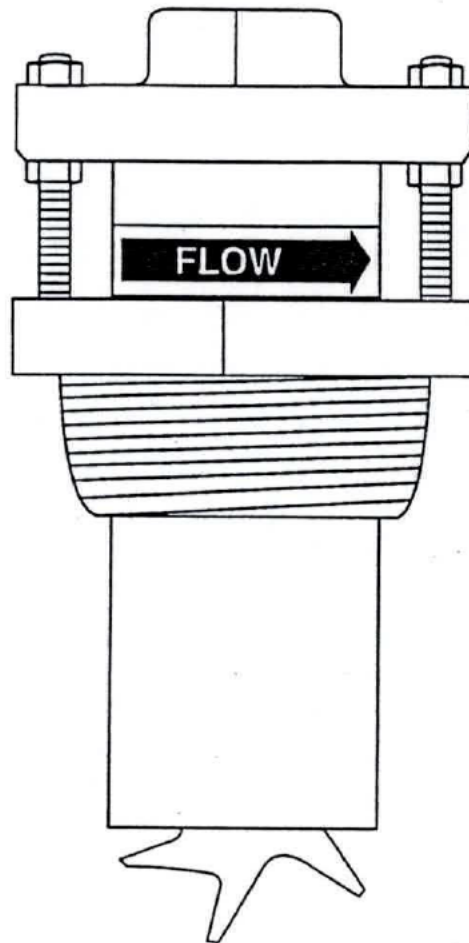
The foregoing shall constitute Buyers or Purchasers sole and exclusive remedy against "Seller", and no other remedy, including but not limited to, incidental or consequential damages for personal injury, loss of fluids, gases or other substances or for loss of profits or injury to property or person shall be available to the Buyer or Purchaser. The warranty extended herein shall be in lieu of any other implied warranty of merchantability or fitness for a particular purpose, and seller shall bear no liability for representatives or retail sellers. In no event shall Data Industrial Corporation be liable for any contingent, incidental, or consequential damage or expenses due to partial or complete inoperability of its product.

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FAX: 508-758-4057

Series (b) (3) (B)

Flow Sensors by Data Industrial



Owner's Manual

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Introduction

Used in conjunction with any Data Industrial flow monitor, Data Industrial non-magnetic flow sensors provide an accurate reading of the rate of liquid flow as well as total accumulated flow. A number of sensor models are offered, which cover applications for a wide range of pipe sizes and pressure/temperature specifications.

The flow sensors generate a frequency which is proportional to flow rate. An internal preamplifier allows the pulse signal to travel up to 2000 feet without amplification. Power to operate the sensor is provided by the flow monitor or external source. The impeller, shaft, O-rings, and impeller bearings are replaceable in the field.

Data Industrial flow sensors feature a closed, six-bladed impeller design, using a proprietary, non-magnetic sensing technology. The forward-swept impeller shape provides higher, more constant torque than four-bladed impeller designs, and is less prone to be fouled by water-borne debris. The forward-curved shape, coupled with the absence of magnetic drag, provides improved operation and repeatability even at lower flow rates. As the liquid flow turns the impeller, a low impedance 8VDC signal is transmitted with a frequency proportional to the flow rate.

Sensors of similar type are interchangeable, so there is no need for recalibration after servicing or replacement.

Models

Data Industrial provides several basic sensor configurations using the same impeller element. This allows for a wide range of applications and pipe sizes. Sensors are normally supplied with 20 feet of Belden Type 9320 (two conductor shielded) cable. Optional models feature two conductors, 24 inches in length of 18 AWG stranded copper wire, with U.L. Style 1056 direct burial insulation. These sensors designated with the prefix "IR" are used in below grade applications such as irrigation, municipal, and ground-water monitoring. These models can be expressed as follows:

Metal Insert sensors for 2.5" or larger pipe sizes

- 220B, 220SS, IR220B, IR220SS and 220SSPF

PVC Insert sensors for 2.5" or larger pipe sizes

- 220PVCS

Hot tap metal Insert sensors with Isolation valves for 2.5" or larger pipe sizes

- 225B, 226B, 226SS, IR225B, IR226B, and IR226SS

Metal tee-type sensors for pipe sizes 2" and 2 1/2"

- 228B, 228CB, 228SS, 228CS, IR228B, IR228CB, IR228CS and IR228SS

Special cast bronze tee-type sensors for pipe sizes less than 2"

- 250B and IR250B

Plastic tee-type sensors for PVC and PVDF pipe sizes from 1" to 4"

- 220P, 228PD, 228PF, and IR220P

All 200 series sensor electrical components are self-contained.

Pressure/temperature ratings for the various models are contained in the *Specifications* section of this manual.

Models 220B, 220SS, IR220B, IR220SS, 220PVCS and 220SSPF

Model 220B, IR220B

This insert style sensor is 5 1/4" long, and uses brass and bronze hardware. It is used in all pipe sizes from 2.5" to 40.0" in diameter. A bronze 2" NPT externally threaded hex adapter is provided. The adapter may be mounted to the pipe using a welded-on threaded fitting such as a Thredolet® or pipe saddle. Wetted materials are brass, bronze, Glass Reinforced Polyphenylene Sulfide (PPS), nylon, tungsten carbide, ethylene propylene (EPDM), and Pennlon®.

Model 220SS, IR220SS

This is the same as Model 220B/IR220B respectively, except that the sensor, sleeve and hex adapter are made of 300 Series stainless steel.

Model 220PVCS

This insert style sensor is 8" long, and uses PVC and stainless steel hardware. It is used in all pipe sizes from 2.5" to 40.0" in diameter. A PVC 2" NPT externally threaded hex adapter is provided. The adapter may be mounted to the pipe using a welded-on threaded fitting such as a Thredolet® or pipe saddle. Wetted materials are Polyvinyl Chloride (PVC), TEFZEL, Zirconia Ceramic, Glass Reinforced Polyphenylene Sulfide (PPS), and ethylene propylene (EPDM).

Models 225B, 226B, 226SS, IR225B, IR226B and IR226SS

Model 225B, IR225B

This insert style sensor is 16 3/8" long, and uses brass and bronze hardware for hot tap installations. It has a bronze isolation gate valve, and is meant to be used for applications where pipe is drained for initial installation but cannot be drained for service. Check the diagram on page 22 of the *Specifications* section for pressure/temperature ratings.

Model 226B, IR226B

This is the same as Model 225B/IR226B respectively, except that it has an isolation ball valve. The ball valve allows for higher pressure use. Check the diagram on page 22 of the *Specifications* section for pressure/temperature ratings. We recommend this sensor when installation is to be made under pressure, in a true "hot tap" installation. The ball valve cannot be fouled by the tailings from the cutting operation.

Model 226SS, IR226SS

This is the same as Model 226B/IR226B respectively, except that the hot tap hardware, ball valve, and sensor sleeve are made of 300 Series stainless steel.

Model 225H

This is the insertion tool for use with any of the Hot Tap Sensor units. It is used to insert and remove the sensor while under pressure. Generally, only one 225H tool is needed on each job site.

Mechanical Installation

General

The accuracy of flow measurement for all flow measuring devices is highly dependent on proper location of the sensor in the piping system. Irregular flow velocity profiles caused by valves, fittings, pipe bends, etc. can lead to inaccurate overall flow rate indications even though local flow velocity measurement may be accurate. A sensor located in the pipe where it can be affected by air bubbles, floating debris, or sediment may not achieve full accuracy and could be damaged. Data Industrial flow sensors are designed to operate reliably under adverse conditions, but the following recommendations should be followed to ensure maximum system accuracy:

- 1) Choose a location along the pipe where 10 pipe diameters upstream and 5 pipe diameters downstream of the sensor provide no flow disturbance. Pipe bends, valves, other fittings, pipe enlargements and reductions should not be present in this length of pipe.
- 2) The preferred location around the circumference of a horizontal pipe is on top. If trapped air or debris will interfere, then the sensor should be located further around the pipe from the top but not more than 45 degrees from top dead center. The sensor should never be located at the bottom of the pipe, as sediment may collect there. Locations off top dead center cause the impeller friction to increase, which may affect performance at low flow rates. Any circumferential location is correct for installation in vertical pipes.
- 3) An insertion depth of 1 1/2" for pipe sizes  and larger is required for accurate flow rate calibration. Detailed installation instructions for various sensor mounting configurations on the following pages include methods for ensuring correct insertion depth.
- 4) Alignment of the sensor to ensure that impeller rotation is parallel to flow is important. Alignment instructions are also included on the following pages.

Installation for 220B, 220SS, IR220B, IR220SS and 220SSPF

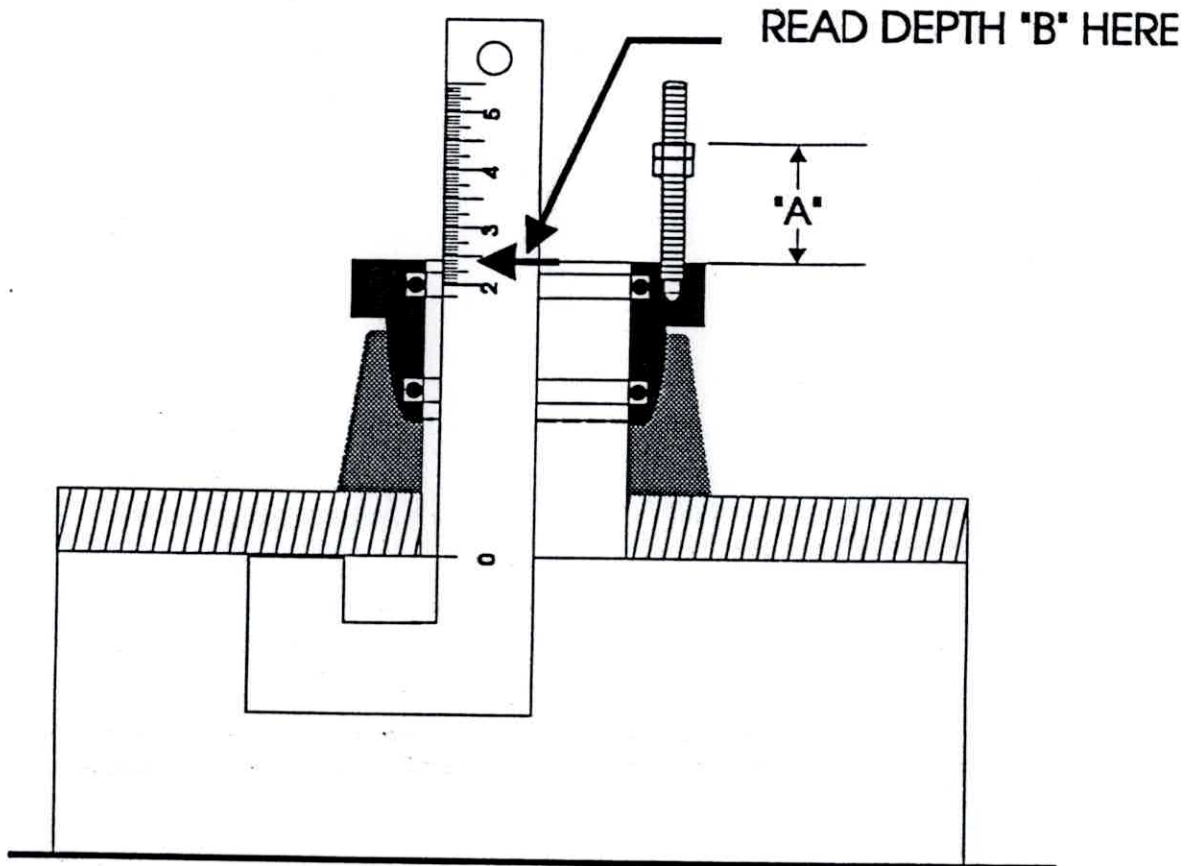
Installation Procedure

There are two methods of mounting these Data Industrial sensors in a 2.5" or larger pipe. One is with a 2" NPT threaded pipe saddle. The other is with a welded-on fitting such as a Thredolet®, also tapped for a 2" NPT connection. In either case, cut a 2" hole through a depressurized pipe and then secure the saddle or weld-on fitting to the pipe. (For drilling into a pressurized pipe, see instructions for 225 and 226 sensors.) Install the 2" NPT adapter provided, using a thread sealant to prevent leakage. Tighten as necessary. Data Industrial flow monitors are designed to provide accurate calibration when the sensor is inserted 1 1/2" into the pipe flow.

To determine the proper insertion depth, proceed as follows:

- 1) Use the insertion depth gauge contained in the Installation Kit 120IK supplied with these sensors. Measure the distance from the inside top wall of the pipe to the top of the 2" NPT adapter. Refer to Figure 1, "B" Dimension.

Figure 1
Installation for 220B and 220SS

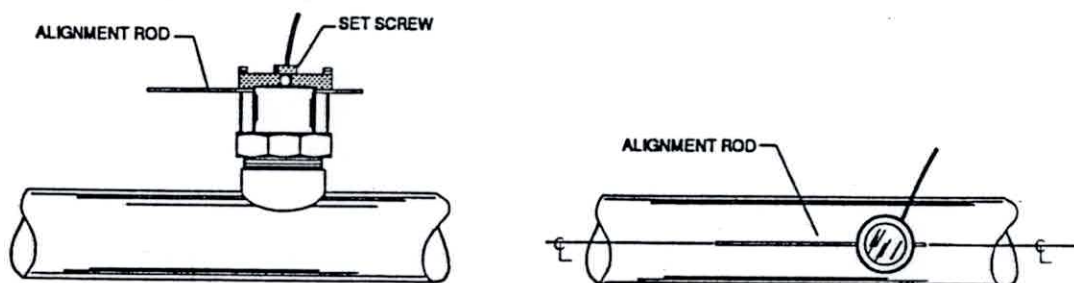


- 2) Apply Anti-Seize thread lubricant , supplied with the sensor, to the threaded studs of the mounting adaptor.
- 3) Determine the height to the upper adjusting nuts on the three 1/4" studs above the 2" NPT adapter (A Dimension): $A = 3.75" - B$
Note: For 220PVCS: $A = 6.5" - B$
- 4) Adjust the first nut on each stud, so the distance from the top surface of each nut to the top surface of the mounting adapter is equal to Figure 1, "A" Dimension.
- 5) Clean O-Rings and flow sensor sleeve, and lightly lubricate O-Rings with silicone grease from the packet provided or some other acceptable lubricant. Take care not to get grease on the impeller or bearing.
- 6) Insert the flow sensor into the 2" NPT adapter so that the mounting holes in the positioning collar fit over the studs on the adapter. Lower the sensor onto the previously adjusted nuts. Install the lock nuts on top of the positioning collar and tighten. Now tighten the lower jam nuts firmly against the upper adjusting nuts to secure them for future removal of the sensor for inspection or service.

Alignment of Flow Sensor

- 1) Loosen positioning collar set screws with a 3/32" Allen wrench. Place the alignment rod through the sight holes in the flow sensor. Refer to Figure 2. Using the alignment rod as a guide, align the flow sensor so that the flow label arrow matches pipe flow direction and so that the alignment rod is exactly parallel to the pipe. This procedure aligns the impeller directly into the fluid flow.

Figure 2
Alignment of Flow Sensor In 220B and 220SS



- 2) As a backup to the flow arrow label, there is a small hole next to the larger sighting hole of the upstream side. With a 3/32" Allen wrench, tighten positioning collar set screws.
- 3) Double check that the distance from the top of the mounting adapter to the bottom of the positioning collar equals "A" Dimension, and that the sighting holes in the sleeve are parallel down the pipe and that the flow arrow label matches pipe liquid flow direction.
- 4) Cable routing: The positioning collar is threaded for connection of a standard 1/2" electrical conduit (flex cable) or a wire strain relief. Route cable as required. Be sure to leave enough flex in cable or conduit to allow future removal of sensor for service or cleaning if necessary.

Installation for 220P, 228PD, IR220P and 228PF Plastic Tee Sensors

- 1) Note intended direction of flow as indicated by arrows on the tee. There must be free, unrestricted pipe for at least 10 diameters upstream and 5 diameters downstream of the tee.
- 2) Remove the clevis pin and remove the sensor from the tee.
- 3) Properly clean the pipe ends and tee sockets.
- 4) For 220P, IR220P and 228PD, solvent cement the pipe to the tee. For 228PF, thermally weld the pipe to the tee, ensuring that the pipe has been properly chamfered at the end to prevent excess material at the weld joint.
- 5) Reinstall sensor in tee as follows:
 - a) Align the flow arrow on the top of the sensor housing in the direction of flow.
 - b) Carefully press sensor straight into tee. **CAUTION: Impeller may strike sides of the tee if misaligned, causing damage to the impeller or shaft.**
 - c) Lead the sensor cable through the conduit cap, if so equipped. The cap will fit standard 1/2" conduit fittings.
 - d) Install clevis pin through tee, sensor, and conduit cap, and install cotter ring.

Electrical Installation

- 1) Route the cable from the sensor to a Data Industrial flow monitor. The cable may be extended up to 2000 feet, using 2-conductor shielded 20 AWG or larger stranded copper wire. Be sure to leave enough flexibility in the cable or conduit to allow for future service of sensor, if necessary.
- 2) When connecting to a Data Industrial flow monitor or transmitter, locate the section of terminal strip on the monitor labeled "SENSOR" or "TRANSDUCER" or "XDUCER". Connect the red wire at "+ IN", the black wire at "- IN", and the shield drain wire (if used) at "SLD".
- 3) When interfacing with other equipment, the signal wave forms and power requirements are as shown in the Specifications section.

Calibration

Please refer to the calibration instructions in your Data Industrial flow monitor or transmitter manual.

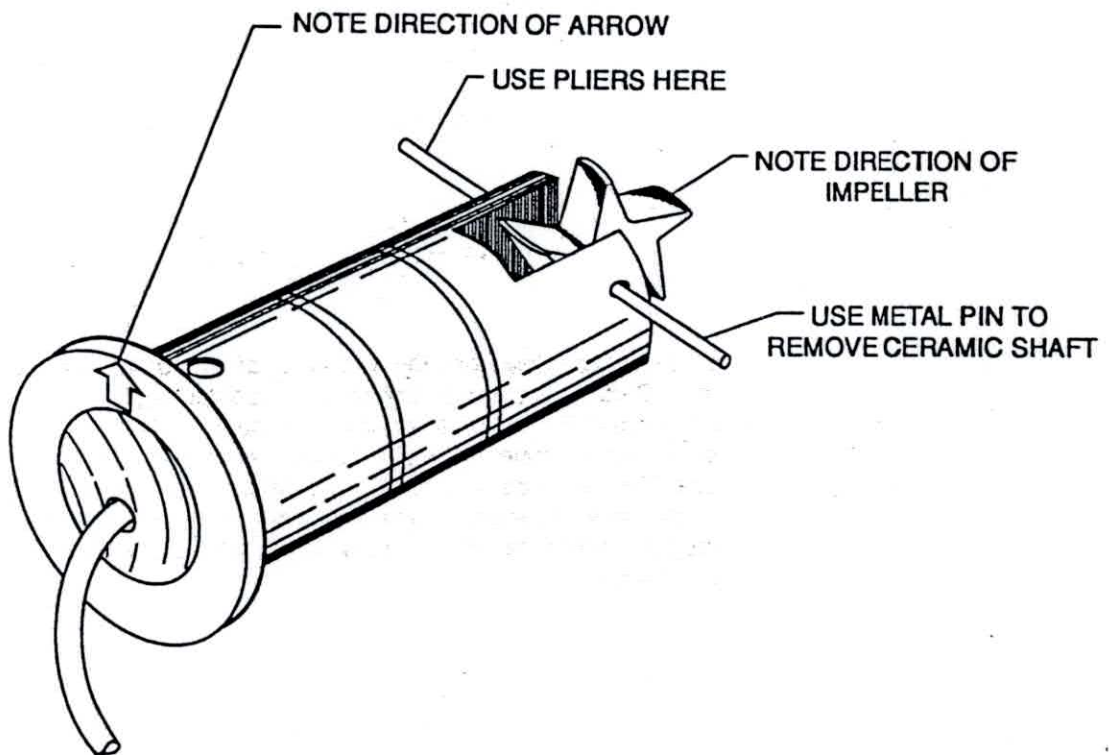
Impeller Assembly and Shaft Replacement

If you are replacing an existing Data Industrial sensor and have already calibrated your flow monitor, no calibration changes are necessary. For installation of a new flow monitor or for relocation of a sensor in a new pipe size, please refer to the calibration instructions in flow monitor manual.

- 1) Depressurize pipe from which sensor is to be removed. If the sensor is one of the 225/IR225 or 226/IR226 series, consult the installation section on Hot Tap Sensors. **NEVER disturb the securing lock nuts with pipe under pressure without hot tap Insertion tool Model 225H installed.**
- 2) Remove the three (3) lock nuts that secure the positioning collar to the threaded rods of metal sensor. **NOTE:** Before removing lock nuts, record the dimension from top of 2" NPT adapter to the bottom of the positioning collar. This dimension will be required later to reinstall. For 250B and plastic tee sensors, remove the clevis pin.
- 3) Remove the sensor from the hex adapter or the tee.
- 4) Note the impeller blade orientation relative to flow arrows and the alignment hole in metal sensors beside one of the sighting holes. In order to maintain proper calibration, the impeller will have to be reinstalled in the same manner with the impeller blades pointing toward the small alignment hole, and into the flow direction as indicated by the flow arrows.
- 5) To remove the old impeller blade assembly, push the old shaft out of the sleeve with the new shaft (or small diameter rod) just far enough to grab the end with a pair of pliers and pull the shaft completely out. The impeller assembly will now be free, and will drop out. **NOTE:** If your sensor is the 228PD or 228PF type, do not use the new ceramic shaft to press out the old one. Instead, use the bronze rod provided in your impeller kit to remove the old shaft.
- 6) Inspect the shaft and bearings for wear, and replace as necessary.
- 7) Refer to Figure 5. To reinstall, position the impeller in the cavity oriented as in Step 4 so that the impeller blades point into the flow direction and toward the small alignment hole located beside one of the sighting holes on metal sensors. For 250B and plastic tee sensors, the flow direction arrow on the top of the sensor housing should point downstream with the impeller blades pointing upstream.
- 8) Carefully push the shaft through the sleeve and impeller, taking care not to damage bearings. Make sure that the shaft is inserted far enough so that it clears the sleeve on each side of the impeller housing. **NOTE:** If shaft is not carefully installed, the bearing can be deformed, preventing free rotation.
- 9) Inspect the O-rings for damage and replace as necessary. Clean the O-rings and the sleeve and relubricate with silicone grease from the packet provided or some other acceptable lubricant.
- 10) Install the sensor into the 2" NPT adapter or tee so that alignment hole is facing upstream and flow arrows point in the direction of the actual flow. Since the positioning collar was not loosened during this operation, the studs should all line up perfectly when the sighting holes are parallel to pipe. If this has been accidentally loosened, please refer to the installation instructions for the alignment of the flow sensor unit.

- 11) Install and tighten the nuts or replace the clevis pin.
- 12) For metal sensors, double check that the distance from the top of the 2" NPT adapter to the bottom of the positioning collar equals the dimension as measured in Step 2, and holes in sleeve sight exactly down the pipe, the arrows point in direction of flow and alignment holes located beside one sighting hole is pointing towards the source. If not, refer to *Installation* section in this manual.
- 13) This completes the replacement procedure. The system may now be repressurized and tested.

Figure 5
Impeller Assembly and Shaft Replacement



Calibration Tables

The table on pages 16 through 18 provides calibration and operation data for most scheduled pipe sizes from 3" through 18". For tee-mounted sensors, see the table on page 19.

Description of Column Information for Pipe Sizes 3" through 18"

Column 1	Nominal Pipe Size
Column 2	Pipe O.D. as defined by ASA B36.10 and other standards
Column 3	Pipe I.D. as defined by ASA B36.10 and other standards
Columns 4 and 5	The K value and Offset that should be used in our frequency equation:

$$FREQ = \frac{GPM}{K} - \text{Offset}$$

This equation describes the frequency of the output signal of all Data Industrial flow sensors. By substituting the appropriate K and Offset values from the table, the sensor's output frequency can be calculated for each pipe size. This information is required when calibrating an output board or when using the raw sensor data as direct output to interface with a device that is not a Data Industrial product.

Column 6	This column indicates the minimum flow rate, in GPM, at which dependably accurate readings can be expected. Data Industrial sensors are designed to have an accuracy of 1% of FS (FS = Full Scale) within a flow rate of 1 ft/sec to 30 ft/sec. Below this minimum, performance is somewhat unpredictable and readings can be unreliable.
Column 7	This column represents the minimum flow rate, in GPM, that Data Industrial recommends as the full scale indication of its current and voltage output options. If a lesser flow rate is chosen, an insufficient span exists for the proper operation of these circuits. This can result in excessive ripple and fluctuations in signal, which can adversely affect system performance.

CALIBRATION TABLE FOR PIPE SIZES 3" THROUGH 18"

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Pipe Size	Pipe O.D.	Pipe I.D.	K Value	Offset	Min. Flow In GPM	Min. Flow In GPM for Full Scale
3" Sch 10S	3.500"	3.260"	5.009	.090	26	130
Std. Wt.	3.5"	3.068"	4.362	.063	23	115
Sch 40	3.5"	3.068"	4.362	.063	23	115
Extra Strong	3.5"	2.900"	3.858	.043	20	100
Sch 80	3.5"	2.900"	3.858	.043	20	100
PVC Class 125	3.5"	3.284"	5.094	.093	26	132
PVC Class 160	3.5"	3.230"	4.902	.085	26	128
PVC Class 200	3.5"	3.166"	4.682	.076	25	123
4" Sch 10S	4.5"	4.260"	9.597	.241	45	220
Std. Wt.	4.5"	4.026"	8.340	.229	40	200
Sch 40	4.5"	4.026"	8.340	.229	40	200
Extra Strong	4.5"	3.826"	7.354	.188	36	180
Sch 80	4.5"	3.826"	7.354	.188	36	180
PVC Class 125	4.5"	4.224"	9.396	.240	44	218
PVC Class 160	4.5"	4.154"	9.013	.240	42	211
PVC Class 200	4.5"	4.072"	8.578	.239	41	203
5" Sch 10S	5.563"	5.295"	16.305	.250	69	340
Std. Wt.	5.50"	5.047"	14.674	.248	62	310
Sch 40	5.50"	5.047"	14.674	.248	62	310
Extra Strong	5.50"	4.813"	13.165	.246	57	280
Sch 80	5.50"	4.813"	13.165	.246	57	280
6" Sch 10S	6.625"	6.357"	24.089	.260	100	495
Std. Wt.	6.5"	6.065"	21.574	.257	90	450
Sch 40	6.5"	6.065"	21.574	.257	90	450
Extra Strong	6.5"	5.761"	19.457	.254	81	406
Sch 80	6.5"	5.761"	19.457	.254	81	406
PVC Class 125	6.625"	6.217"	22.853	.258	95	473
PVC Class 160	6.625"	6.115"	21.968	.257	92	458
PVC Class 200	6.625"	5.993"	21.068	.256	88	440

Continued on Pages 18 and 19

Data Industrial Flow Sensor Manual

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Pipe Size	Pipe O.D.	Pipe I.D.	K Value	Offset	Min. Flow In GPM	Min. Flow In GPM for Full Scale
8" Sch 10S	8.625"	8.329"	43.914	.286	170	850
Sch 20	8.625"	8.125"	41.653	.283	162	800
Sch 30	8.625"	8.071"	41.063	.283	160	800
Std. Wt.	8.625"	7.981"	40.086	.281	156	780
Sch 40	8.625"	7.981"	40.086	.281	156	780
Sch 60	8.625"	7.813"	38.288	.279	150	750
Extra Strong	8.625"	7.625"	36.315	.276	142	710
Sch 80	8.625"	7.625"	36.315	.276	142	710
PVC Class 125	8.625"	8.095"	41.324	.283	160	802
PVC Class 160	8.625"	7.961"	39.869	.281	155	776
PVC Class 200	8.625"	7.805"	38.203	.279	149	746
10" Sch 10S	10.75"	10.420"	70.195	.321	265	1320
Sch 20	10.75"	10.250"	67.668	.318	257	1280
Sch 30	10.75"	10.136"	66.069	.316	252	1260
Std. Wt.	10.75"	10.020"	64.532	.314	245	1230
Sch 40	10.75"	10.020"	64.532	.314	245	1230
Sch 60	10.75"	9.750"	61.016	.309	233	1160
Extra Strong	10.75"	9.750"	61.016	.309	232	1160
Sch 80	10.75"	9.564"	58.644	.306	224	1120
PVC Class 125	10.75"	10.088"	65.431	.315	249	1246
PVC Class 160	10.75"	9.924"	63.272	.312	241	1205
PVC Class 200	10.75"	9.728"	60.733	.309	231	1158
12" Sch 10S	12.75"	12.390"	104.636	.367	376	1880
Sch 20	12.75"	12.250"	102.553	.364	367	1840
Sch 30	12.75"	12.090"	99.347	.360	358	1790
Std. Wt.	12.75"	12.000"	97.576	.358	353	1760
Sch 40S	12.75"	12.000"	97.576	.358	352	1760
Sch 40	12.75"	11.938"	97.369	.356	350	1740
Sch 60	12.75"	11.625"	90.441	.348	330	1650
Extra Strong	12.75"	11.750"	92.775	.351	338	1690
Sch 80	12.74"	11.376"	85.922	.342	450	1580
PVC Class 125	12.75"	11.966"	96.912	.357	351	1753
PVC Class 160	12.75"	11.770"	93.152	.352	339	1696
PVC Class 200	12.75"	11.538"	88.842	.346	326	1629

Specifications

Wetted Materials for all sensors except 228PD, and 228PF

- Impeller: Glass-filled nylon containing two ferrite slugs
- Housing: Glass-reinforced polyphenylene sulfide (PPS) Fortron®
- Shaft: tungsten carbide
- Bearings: Ultrahigh molecular weight polyethylene (UHMWPE) Pennlon®
- O-rings: Ethylene Propylene (EPDM)

Wetted Materials for 228PD, and 228PF sensors

- Impeller, Bearings: TEFZEL
- Housing: Pure Polyvinylidene Fluoride (PVDF)
- Shaft: Zirconia Ceramic
- O-rings: VITON

Wetted Materials for 220PVCS sensors

- Impeller, Bearings: TEFZEL
- Housing: Glass-reinforced polyphenylene sulfide (PPS) Fortron®
- Shaft: Zirconia Ceramic
- O-rings: Ethylene Propylene (EPDM)
- Sleeve: Polyvinyl Chloride (PVC)

Sensor Sleeve and Hex Adapter for 220B, 226B, 228B, 228CB, IR220B, IR226B, IR228CB, IR228B

- Sleeve: Admiralty Brass, UNS C44300; Hex Adapter: Valve Bronze, UNS C83600

Sensor Sleeve and Hex Adapter for 220SS, 226SS, 228SS, IR220SS, IR226SS, IR228SS, 228CS, IR228CS, 220SSPF

- 300 Series Stainless Steel

Tee for 228B and IR228B

- Cast Bronze, Class 125 Per ASME B16.15, and Copper Coupling

Tee for 228SS and IR228SS

- Cast 316 Stainless, Class 150

Tee for 228CB, 228CS, IR228CB and IR228CS

- Cast Iron, Class 125 Per ASME B16.4

Tee for 220P, 228PD and IR220P

- Schedule 80 PVC per ASTM D-2462 and D-2467. Virgin, unplasticized PVC resin, Type 1 cell classification 12454-B. Fittings and solvent carry approval for potable water by NSF and IAMPO.

Tee for 250B and IR250B

- Cast valve bronze, UNS C83600

Tee for 228PF

- Pure PVDF

Pressure, Temperature Ratings

- Depends on hardware configurations. See Diagrams at end of this section.

Data Industrial Flow Sensor Manual

Recommended Design Flow Range

- 1 to 30 ft/sec for all except 250B and PVDF
- 0.5 to 15 ft/sec for 250B
- 1 to 30 ft/sec for 228PF

Accuracy

- $\pm 1.0\%$ of full scale over recommended design flow range

Repeatability

- $\pm 0.3\%$ of full scale over recommended design flow range for all except 250B and 228PF
- $\pm 0.7\%$ of full scale over recommended design flow range for 250B
- $\pm 0.5\%$ of full scale over recommended design flow range for 228PF

Linearity

- $\pm 0.2\%$ of full scale over recommended design flow range for all except 250B, 220PVCS and 228PF
- $\pm 0.7\%$ of full scale over recommended design flow range for 250B
- $\pm 0.5\%$ of full scale over recommended design flow range for 228PF
- $\pm 1.0\%$ of full scale over recommended design flow range for 220PVCS

Transducer Excitation

- Typically provided by Data Industrial flow monitor. Any alternate supply must be of a resistance-limited type meeting the following constraints:
 - Source current @ 8 Volts: 1 mA minimum, 20 mA maximum
 - Short Circuit Current: 200 mA maximum

Output Frequency

- 3.2 Hz to 200 Hz for all except 250B and 228PF
- 0.8 Hz to 80 Hz for 250B and 228PF

Output Pulse Width

- 5 msec $\pm 25\%$

Electrical Cable for Series 200 Sensors

- 22 feet of Belden shielded 2-conductor stranded copper AWG 20 with AWG 22 drain wire provided for connection to display or analog transmitter unit. Rated to 105°C. May be extended to a maximum of 2000 feet with similar cable and insulation appropriate for application.

Electrical Cable for Series IR200 Sensors

- 2 feet of U.L. Style 1056 direct buriable copper stranded AWG 18 wire. Rated to 105°C.

Troubleshooting

- 1) Using a voltmeter on the 0-20VDC scale, connect the voltmeter across the sensor wires which are connected to the sensor input on the barrier strip. The voltage reading should be 8v $\pm$ 0.5v with no flow in the pipe. If the reading is in range, go to step 2. If not, go to step 3.
- 2) With the sensor installed in the pipe and flow through the pipe, connect the volt meter across the sensor wires at the sensor input of the barrier strip. The voltage should fall between 4VDC and 8VDC. The higher the flow rate, the lower the DC voltage level should drop. It should not drop below 4VDC as your meter averages the DC level of the square wave signal generated by the sensor.

If this is correct, the flow sensor should be operational, and the flow monitor should display a flow rate or the transmitter output should change with a change in flow at the sensor. The signal generated by the sensor is a square wave with 5msec pulses up to 100 Hz (at which time the pulses narrow to a 50% duty cycle), the use of an oscilloscope on the 5 msec time base, 2VDC/division would indicate that the sensor is operating properly.

- 3) If the voltage at the sensor input is less than 7VDC in a No Flow situation or less than 3VDC in a flow situation, disconnect the sensor from the barrier strip and measure the voltage at the sensor input terminals of the barrier strip again. It should be between 8VDC and 12VDC. If the voltage is between 8-12VDC, the sensor is bad. If the voltage at the sensor input is still below 7VDC or 3VDC, the problem may be with the monitor.
- 4) If you suspect that the sensor is bad, you can test the monitor circuitry by connecting a piece of wire to one of the sensor input terminals and tap the other side of the wire to the other sensor input terminal. Shorting across the sensor input terminals ON and OFF repeatedly allows the display to respond by trying to calculate a flow rate for the frequency of your shorting action. If the display does not show a change from 0.00, it indicates a problem with the monitor.

4. PRESSURE REGULATING VALVES

(b) (3) (B) MODEL (b) (3) (B)

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C.

TROUBLE-SHOOTING CHECKLIST

PUMP DOES NOT DELIVER ANY LIQUID

- LACK OF PRIME** Repeat priming procedure outlined in Section 3A and make sure pump is completely primed with liquid. Make sure all air is bled from pump and suction piping, and piping is completely filled with liquid.
- SPEED TOO LOW** Make sure power is directly across-the-line, and motor is receiving full voltage. If frequency is too low, or if motor has an open phase, refer to Section: 2 and make necessary correction. If power is supplied from separate generator source, make sure generator is running at proper speed for voltage required.
- WRONG ROTATION** Make sure that pump (motor) is rotating in a clockwise direction, as viewed from back of motor. Check rotation arrow on top of pump volute casing.
- DISCHARGE HEAD TOO HIGH** Check piping for friction losses, and make sure discharge head matches conditions for which pump was selected (pump rating). Larger diameter piping may correct conditions of excessively high discharge head. Make sure that no obstructions exist in discharge piping.
- SUCTION LIFT TOO HIGH** Check for obstructions at suction inlet, and check for possible friction losses in suction piping (use a friction table). To determine if *static lift* is too great, measure suction pressure with a mercury column or gauge while pump is operating. Static lift can be reduced either by raising the surface level of liquid being pumped, or by lowering the pump.
- IMPELLER CLOGGED** Disassemble pump volute casing and completely clean impeller passageways.

PUMP DOES NOT DELIVER ENOUGH LIQUID

- SUCTION PIPING LEAKS AIR** Make sure all flange and valve connections in suction line are airtight. If liquid being pumped is *non-explosive*, and *explosive gas or dust is not present*, air leakage can be checked by holding a match near pipe joints and checking flame for flutter. If *flammable* liquid is being pumped, suction line can be tested by closing off suction inlet and submitting line to pressure. Make sure all leaks are completely sealed
- SPEED TOO LOW** (See above.)
- DISCHARGE HEAD TOO HIGH** (See above.)
- SUCTION LIFT TOO HIGH** (See above.)
- IMPELLER PARTIALLY CLOGGED** (See above.)
- INSUFFICIENT NPSH FOR HOT WATER** Condition can be determined by connection pressure gauge to suction piping, or to gauge tap on pump suction nozzle. Gauge indicator will oscillate if water is flashing to steam in suction line.
- WEAR RING EXCESSIVELY WORN** Inspect case wear ring for excessive wear. If wear ring is defective, replace with new wear ring.
- IMPELLER DAMAGED** Inspect pump impeller. Check impeller wear ring surface. If impeller is excessively damaged or impeller vanes badly worn (eroded), replace with new impeller.
- FOOT VALVE TOO SMALL** Inspect foot valve and make sure area through ports of valve is at least as large as area of pump suction piping (preferably 1 1/2 times as large). If strainer is used with foot valve, the net clear area should be three to four times that of suction piping.
- INLET NOT DEEP ENOUGH IN LIQUID SOURCE** If inlet cannot be lowered, or if swirling eddies are created which permit air to enter suction line, chain a board to suction piping (near inlet). Board will be drawn into whirlpool, smothering the vortex and preventing air funnels from entering line.

(Checklist continued on Pg. 8)

TROUBLE-SHOOTING CHECKLIST (Cont'd.)

PUMP DOES NOT PRODUCE ENOUGH PRESSURE

SPEED TOO LOW (See above.)

AIR OR GASES IN LIQUID To determine whether gases are present in liquid being pumped, e.g., marsh gas in swamp water, test liquid in laboratory by simulating suction line pressure and checking for bubble formation. It may be possible to overrate pump to a point where it will provide adequate pressure, despite existing conditions. A better solution is to install a gas-separation chamber in the suction line near the pump, and periodically exhaust accumulated gas.

IMPELLER DAMAGED (See above.)

WEAR RING EXCESSIVELY WORN (See above.)

IMPELLER DIAMETER TOO SMALL ... Check with Company representative to determine if larger impeller can be used. Otherwise, reduce pipe friction losses or increase speed of impeller rotation. (Make sure motor is not seriously overloaded.)

PUMP OPERATES BRIEFLY, THEN STOPS

IMPROPER PRIMING Repeat priming procedure outlined in Section 3a.

SUCTION LIFT TOO HIGH (See above.)

SUCTION PIPING LEAKS AIR (See above.)

AIR OR GASES IN LIQUID (See above.)

PUMP USES TOO MUCH POWER

DISCHARGE HEAD LESS THAN PUMP RATING Reduce outside diameter of pump impeller. Impeller diameter may be turned down on a lathe and rebalanced, or replaced with smaller diameter impeller.

LIQUID TOO HEAVY (VISCOSITY, OR SPECIF. GR.) Use motor with greater horsepower rating or reduce RPM.

WRONG ROTATION (See above.)

VOLUTE CASING DISTORTED BY PIPING STRESS Check pump alignment. Examine pump interior for excessive or unusual friction between impeller and casing. Check wear ring and rotating elements, and replace worn or damaged parts.

MISALIGNMENT Realign pump and motor and clean all mating surfaces.

VOLTAGE INCORRECT (See page 5, section "D.")

2. CONTROL PANEL

TLC CUSTOM BUILT , TRIPLEX CONTROL PANEL

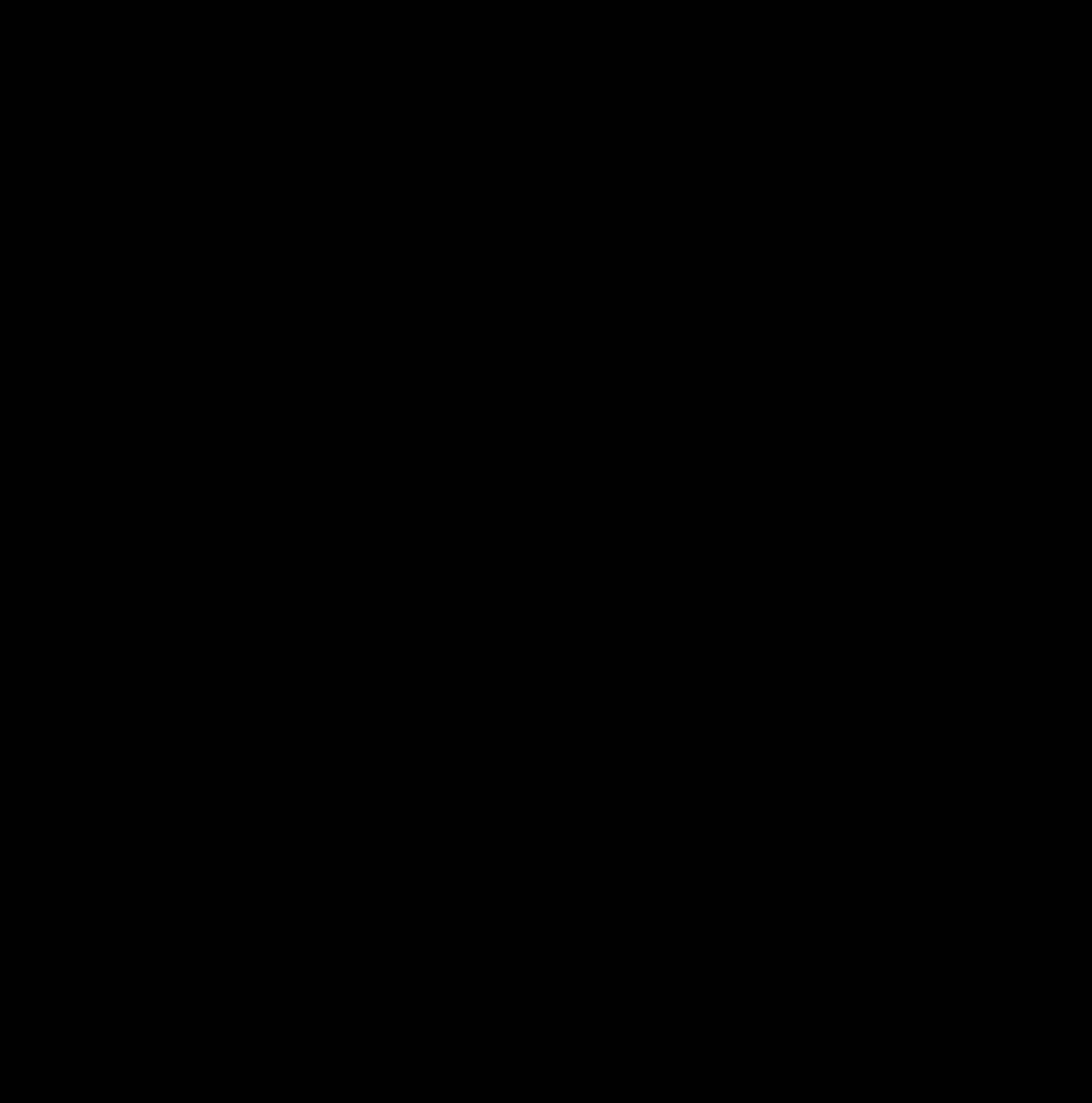
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TLC CUSTOM TRIPLEX CONTROL PANEL TO OPERATE

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To: Panel Buyers

January 1999

From: Todd L. Conforti
President
TLC Controls Inc.

TLC Controls Incorporated is celebrating its 20th year in the business. TLC offers broad single source custom design and fabrication services for industrial, water and wastewater process automation. Products include constant or variable speed control panels, PLC controllers, VFD drives, panels, consoles, motor control centers, SCADA systems, and assorted controls for lift pumps, boosters, aeration, grit removal, dewatering or irrigation systems; filter, elevated tank or chemical feed pump operation. TLC markets to companies who sell them to the;

- MUNICIPAL MARKET (cities, towns and villages)
- HVAC MARKET (heating, ventilating, and air conditioning applications)
- INDUSTRIAL PLANTS (companies who process raw materials)

We strive to produce high quality Control Panels built to our own TLC standards that meet or exceed the highest standards as set forth by UL, NEMA, CSA, IEC or JIC. We do this at a very competitive price, so that you, our customer, can enjoy your share of the available business in the market place.

Our company uses the latest technology in development and production of Control Panels, and will change our thinking as this new technology is developed. Our engineering department is computerized to enable us to develop quick and accurate quotations and drawings. Our production staff and facilities are such that we can build a wide variety of Control Panels to meet your specifications. We have an extensive inventory that allows us to provide quick deliveries, next day if required.

A TLC Control Panel is the best you can buy at any price. Solidly built, proudly built, for many years of trouble-free operation.



Todd L. Conforti

TLC CONTROLS INC. WARRANTY

Standard products manufactured by TLC Controls Inc., (TLC), are warranted to be free from defects in workmanship and material for a period of one year from the date of shipment, and products which are defective in workmanship or material will be repaired or replaced, at the option of TLC, at no charge to the Buyer. Final determination as to whether a product is actually defective rests with TLC. The obligation of TLC hereunder shall be limited solely to repair and replacement of products that fall within the fore-going limitations, and shall be conditioned upon receipt by TLC of written notice of any alleged defects or deficiency promptly after discovery within the warranty period, and in case of components or units purchased by TLC, the obligation of TLC shall not exceed the settlement that TLC is able to obtain from the supplier thereof. No products shall be returned to TLC without its prior consent. Products which TLC consents to have returned shall be shipped f.o.b. to TLC's factory. The life of the products of TLC depends, to a large extent, upon type of usage thereof, and TLC makes no warranty as to fitness of its component products for specific applications by the buyer nor as to period of service unless TLC specifically agrees otherwise in writing after the proposed usage has been made known to it.

This warranty does not apply to, nor is any expense or other liability assumed for any equipment to which unauthorized repairs or modifications have been made even though such equipment is defective or not in accordance with the specifications. Any such repairs or modifications must be authorized by TLC in writing. TLC cannot assume responsibility or accept invoices for unauthorized repairs to its components, even though defective.

TLC's responsibility does not extend to equipment not manufactured by TLC. The supplier's warranty, only, applies to purchased components.

TLC shall not be liable for any damages resulting from any improper installation of any equipment sold, or from any accidental or intentional attempt to operate it in excess of its rating or in abnormal atmosphere or environments.

TLC shall not be liable, under any circumstances, for any loss of profits or other contingent, consequential or special damages.

The foregoing warranty is exclusive and expressly in lieu of all other warranties (except title) whether expressed or implied, including, but not limited to any warranty of merchant ability or of fitness, and of any other obligation, and shall constitute the sole remedy of the purchaser and sole liability of TLC.

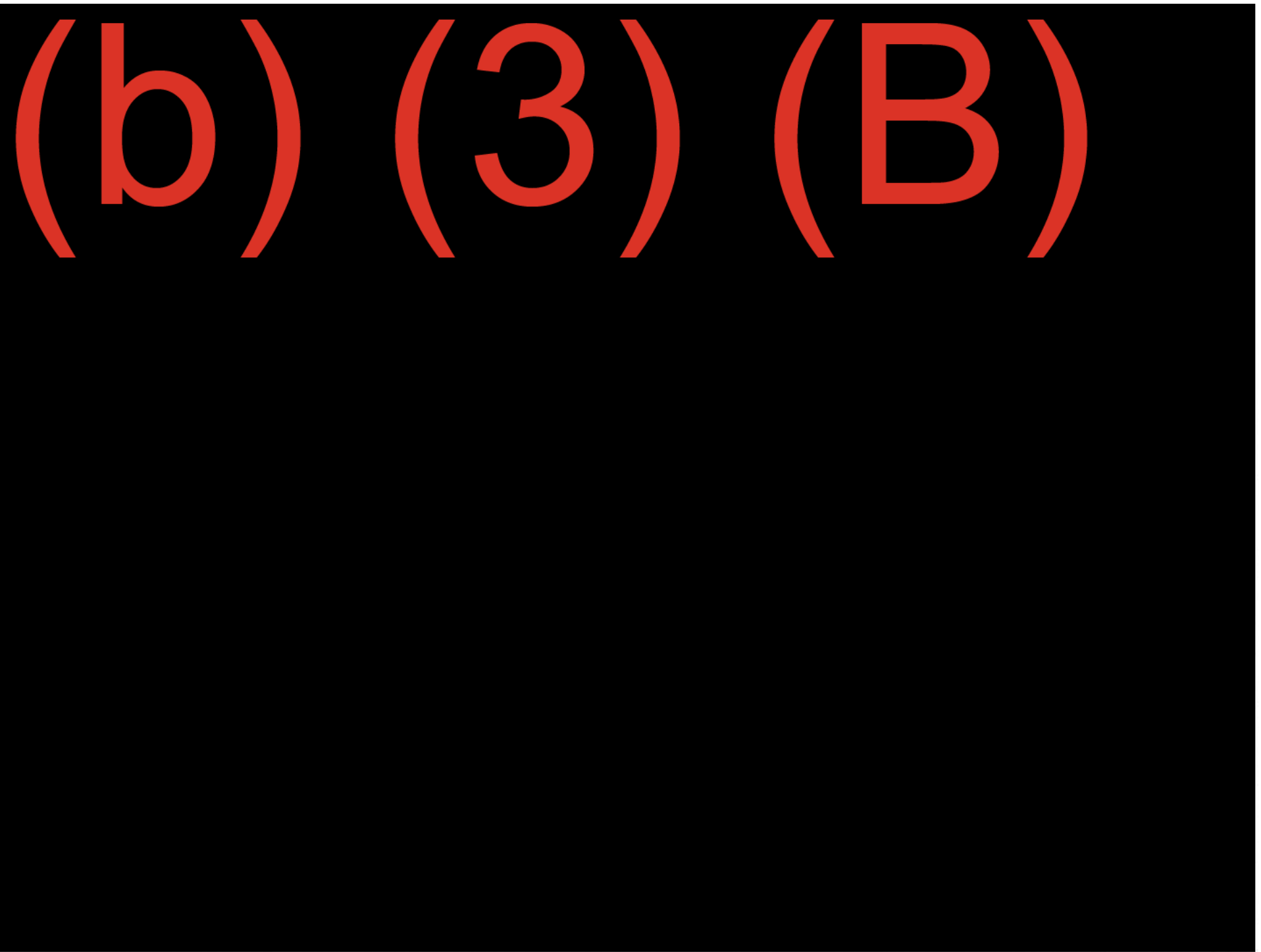
This warranty does not apply to experimental or developmental products.

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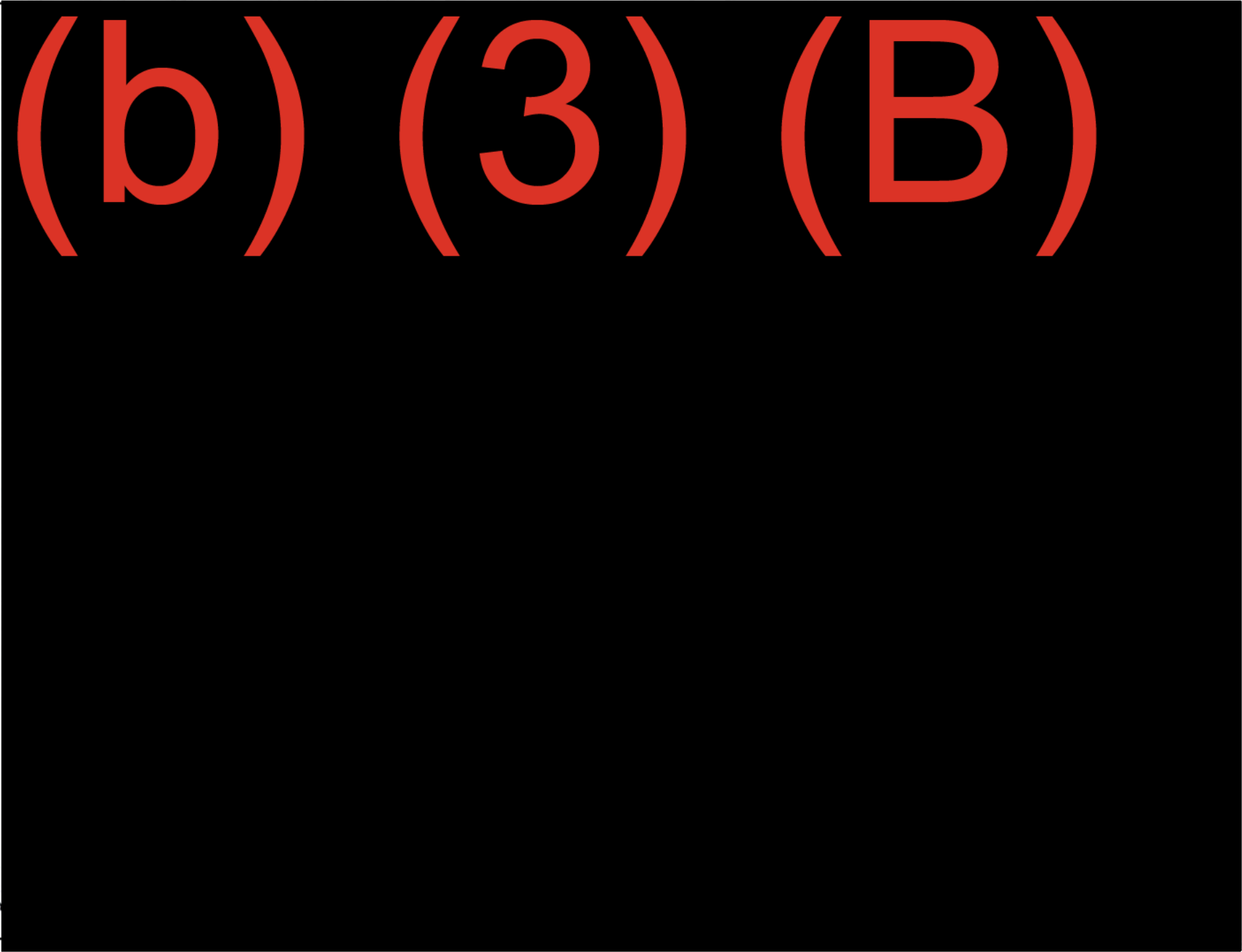
Standard Design

DATE	REVISIONS	
2/12/97	ORIGINAL	RNA
 TLC CONTROLS INC. MT. PROSPECT, IL		
CUSTOMER: ENGINEERED SYSTEMS INC.		
CUSTOMER JOB NAME:		
CUSTOMER ORDER NO.:		
(b) (3) (B)		
DRAWING NUMBER: ENG2127TLC (3 OF 3)		

(b) (3) (B)



(b) (3) (B)



Moanlua Terrace HSG

Program for

(b) (3) (B)

As set

(b) (3) (B)

(b) (3) (B)

(b) (3) (B)

(b) (3) (B)

(b) (3) (B)

(b) (3) (B)

(b) (3) (B)

(b) (3) (B)

(b) (3) (B)

(b) (3) (B)

3. FLOW SENSOR/MONITOR

DATA INDUSTRIAL FLOW SENSOR MODEL (b) (3) (B)

WITH DATA INDUSTRIAL MONITOR MODEL (b) (3) (B)

(b) (3) (B)

The Data Industrial Series (b) (3) (B) is a versatile, compact sized, digital flow monitor.

The two line X 16 character alphanumeric display can be configured by the user to display flow rate and total simultaneously. Rate or total may also be displayed with other information such as optional relay status or control information.

The panel meter has a NEMA 4X rated front and conforms to DIN Standard dimensions, 192 mm X 96 mm, for meter sizes and panel cutouts. Versions of the Series (b) (3) (B) are also available in NEMA 4 or NEMA 4X wall mount configurations.

Like all Data Industrial flow monitors, the Series (b) (3) (B) may be field calibrated by the user. Data Industrial sensors are calibrated by entering "K" and "offset" numbers, while other pulse or frequency output sensors may use a "K" factor only. The Series (b) (3) (B) also accepts analog, sine wave, a scaled pulse per gallon signal or a sixteen point linearization equation.

Programming is menu driven. All data is entered using five, front panel mounted keys. A software lock allows the user to enter a password to prevent changes in flow total, calibration or control settings. Programming flexibility is extended to units of measure. Series (b) (3) (B) software contains nineteen rate of flow units of measure and seven total flow units of measure. There is also a provision for adding custom units. The software contains a self-diagnostic program to assist the operator in troubleshooting.

The Series (b) (3) (B) provides a standard pulse output to interface with external data collection devices that accept a pulse or dry contact closure. The resolution of this TTL compatible signal may be programmed from the front keypad.

All calibration information, units of measure and flow totals are stored in a non-volatile memory that does not require battery back-up for data retention.

The Series (b) (3) (B) is expandable with a wide variety of options to customize units for individual requirements.

The Model (b) (3) (B) is a dual channel version that accepts two flow inputs. These inputs are independent and need not be the same format. Each channel can accept a digital pulse, sine wave or analog input. Optional counters, relays and analog outputs may be assigned to either channel.

The LCD Display may be programmed to show both flow rates, both flow totals or other combinations.

The Model (b) (3) (B) requires at least one optional input card for the second channel. If Data Industrial sensors are used, one con-



nects to the normal sensor input terminals, the other to a pulse input option card. If two other sensors are used, two option cards must be used.

Options Include:

- Display backlighting- with variable contrast for low light situations.
- Power supplies- in addition to standard 12 VDC; choose 24 VAC, 12-36 VDC, 115 VAC or 230 VAC.
- Mechanical counters- built-in, non-resettable seven digit mechanical counters.
- Control relays- Form C mechanical relays, either two or four available, independently programmed from the keypad by rate for alarms or pump control, or by total for counting or proportioning.
- Analog output- isolated 4-20 mA, 0-20 mA, 0-5 Volt or 0-10 Volt outputs, programmed from the keypad.
- Analog input- allows the use of other flow devices with analog outputs.
- Second flow channel- converts the (b) (3) (B) a (b) (3) (B) a two channel device.
- RS232/485 port- allows two way serial communication with the (b) (3) (B)

(b) (3) (B)

Specifications: Series

(b) (3) (B)

(b) (3) (B)

The Data Industrial flow sensor features a six-bladed impeller design with a proprietary, non-magnetic sensing mechanism. The forward-swept impeller shape provides higher, more constant torque than four-bladed impeller designs and is less prone to be fouled by water-borne debris. The forward curved shape coupled with the absence of magnetic drag provides improved operation and repeatability even at lower flow rates. This is more

important where the impeller may be exposed to metallic or rust particles found in steel or iron pipes. As liquid flow turns the impeller, a low impedance 8VDC square wave signal is transmitted with a frequency proportional to the flow rate. This signal can travel up to 2,000' between the sensor and the display unit without the need for amplification. All sensors are supplied with 20' of Belden type 9320 (two conductor shield) cable.

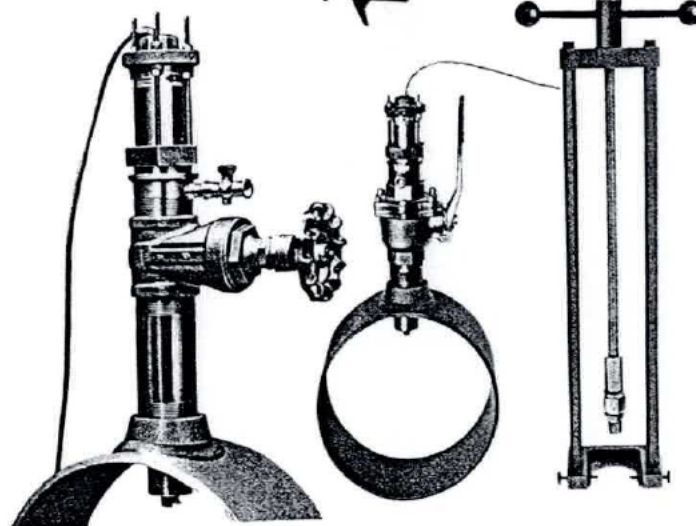
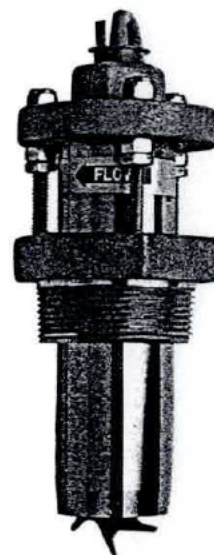
Model (b) (3) (B) (Brass) and (b) (3) (B) (Stainless Steel) Sensor

The Model (b) (3) (B) (Brass) and (b) (3) (B) (Stainless Steel) sensors are used in most general flow measuring applications in metallic, non-metallic, or PVDF Pipes. The sensor mounts in a 2" NPT pipe saddle or Thredolet® for installation in pipe sizes from 2½" to over 40". Positioning nuts on the three threaded retaining rods allow the sensor to be accurately positioned to a standard insertion depth of 1½ inches into the pipe. When this insertion depth is maintained, and there is at least 10 upstream and 5 downstream diameters of straight uninterrupted flow, an accuracy of +/- 1% of full scale can be obtained between flow velocities of 1 to 30 feet/second. (Specification details are listed on reverse side.)

Hot Tap Sensor Model (b) (3) (B)

The Hot Tap Sensor Series features an elongated sensor, special mounting adapter, pipe nipple, and isolation valve, to allow the non-magnetic impeller sensor to be installed into a pressurized pipe while the pipe is in service. This is accomplished by first attaching a saddle or Thredolet® to the pipe and screwing the nipple and isolation valve into the saddle or Thredolet fitting. A hole is then drilled through the pipe using a commercial tapping machine. When completed the tapping apparatus is removed, the isolation valve is closed, and the sensor is installed.

The Hot Tap Sensor is also recommended for any application where it would be difficult to shut down or drain the pipeline to remove the sensor for service. The overall length of the sensor tube is 18 inches (457mm). However, a clearance height of 50 inches (127cm) should be allowed for the fully extended length of the insertion tool.



Model (b) (3) (B)

Brass unit with a gate-type isolation valve.

Model (b) (3) (B)
and (b) (3) (B)

Brass or stainless steel sensor and ball type isolation valve.

Model (b) (3) (B)

Insertion tool is provided separately to insert or remove the sensor when under pressure.

DIMENSIONS (b) (3) (B)

(b) (3) (B)

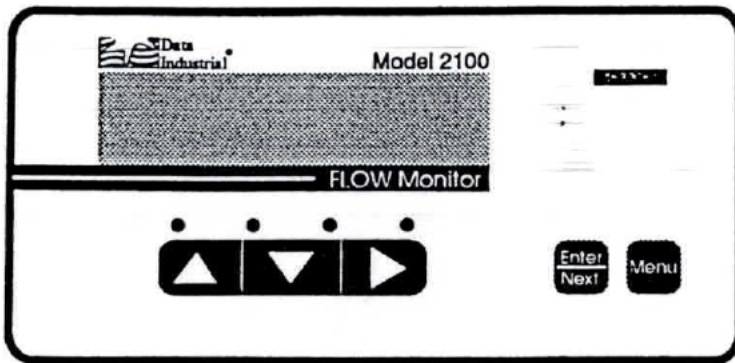
(b) (3) (B)

Consult Factory for other Impeller, Shaft, Bearing, O-Ring Options



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Series (b) (3) (B)

by Data Industrial

Owners Manual

The Data Industrial Series (b) (3) (B) is a versatile, compact sized, digital flow monitor.

The two line X 16 character alphanumeric display can be configured by the user to display flow rate and total simultaneously. Rate or total may also be displayed with other information such as optional relay status or control information.

The panel meter has a NEMA 4X rated front and conforms to DIN Standard dimensions, 192 mm X 96 mm, for meter sizes and panel cutouts. Versions of the Series (b) (3) (B) are also available in NEMA 4 or NEMA 4X wall mount configurations.

Like all Data Industrial flow monitors, the Series (b) (3) (B) may be field calibrated by the user. Data Industrial sensors are calibrated by entering "K" and "offset" numbers, while other pulse or frequency output sensors may use a "K" factor only. The Series (b) (3) (B) also accepts analog, sine wave, a scaled pulse per gallon signal or a sixteen point linearization table.

Programming is menu driven. All data is entered using five, front panel mounted keys. A software lock allows the user to enter a password to prevent changes in flow total, calibration or control settings. Programming flexibility is extended to units of measure. Series (b) (3) (B) software contains nineteen rate of flow units of measure and seven total flow units of measure. There is also a provision for adding custom units. The software contains a self-diagnostic program to assist the operator in troubleshooting.

The Series (b) (3) (B) provides a standard pulse output to interface with external data collection devices that accept a pulse or dry contact closure. The resolution of this TTL compatible signal may be programmed from the front keypad.

All calibration information, units of measure and flow totals are stored in a non-volatile memory that does not require battery back-up for data retention.

The Series (b) (3) (B) is expandable with a wide variety of options to customize units for individual requirements.

The Model (b) (3) (B) is a dual channel version that accepts two flow inputs. These inputs are independent and need not be the same format. Each channel can accept a digital pulse, sine wave or analog input. Optional counters, relays and analog outputs may be assigned to either channel.

The LCD Display may be programmed to show both flow rates, both flow totals or other combinations.

The Model (b) (3) (B) requires at least one optional input card for the second channel. If Data Industrial sensors are used, one connects to the normal sensor input terminals, the other to a pulse input option card. If two other sensors are used, two option cards must be used.

Note:

The Series (b) (3) (B) hardware allows the installation of up to three option cards to accommodate many combinations of inputs and outputs. However, limitations in the microprocessor, its operating software or power requirements restrict certain combinations.

Options Include:

- Display backlighting with variable contrast for low light situations.
- Power supplies- in addition to standard 12-36 VDC; choose 24 VAC, 115 VAC or 230 VAC
- Mechanical counters- built-in, non-resettable seven digit mechanical counters
- Control relays- 1 Form C mechanical relays, either two or four available, independently programmed from the keypad by rate for alarms or pump control, or by total for counting or proportioning.
- Analog output- isolated 4-20 mA, 0-20 mA, 0-5 Volt or 0-10 Volt outputs, programmed from the keypad.
- Analog input- allows the use of other flow devices with analog outputs.
- Second flow channel- converts the (b) (3) (B) to a (b) (3) (B) a two channel device
- RS232/485 port- allows two way serial communication with the (b) (3) (B)

 Data Industrial[®]
PN# 72003
Rev A 4/16/96

(b) (3) (B) Series Ordering Matrix

EXAMPLE:		21	x	x	-	x	x	x	x	-	x	x	x	x
SERIES														
FLOW MONITOR		21												
MONITORING CAPABILITY														
STANDARD		0												
16 POINT LINEARIZATION		1												
CHANNEL MONITORING														
SINGLE CHANNEL			0											
DUAL CHANNEL			1											
CARD OPTION 1														
NO OPTION		0												
ANALOG OUTPUT		1												
ANALOG INPUT		2												
DIGITAL/SINE WAVE INPUT-10 VDC EXCITATION		3												
DIGITAL/SINE WAVE INPUT-24 VDC EXCITATION		4												
RS-232 SERIAL COMMUNICATIONS OUTPUT		5												
RS-485 SERIAL COMMUNICATIONS OUTPUT		6												
CARD OPTION 2														
NO OPTION		0												
ANALOG OUTPUT		1												
ANALOG INPUT		2												
DIGITAL/SINE WAVE INPUT-10 VDC EXCITATION		3												
DIGITAL/SINE WAVE INPUT-24 VDC EXCITATION		4												
RS-232 SERIAL COMMUNICATIONS OUTPUT		5												
RS-485 SERIAL COMMUNICATIONS OUTPUT		6												
CARD OPTION 3														
NO OPTION		0												
ANALOG OUTPUT		1												
ANALOG INPUT		2												
DIGITAL/SINE WAVE INPUT-10 VDC EXCITATION		3												
DIGITAL/SINE WAVE INPUT-24 VDC EXCITATION		4												
RS-232 SERIAL COMMUNICATIONS OUTPUT		5												
RS-485 SERIAL COMMUNICATIONS OUTPUT		6												
OPTIONS-RELAY														
NO RELAYS		0												
2 RELAYS		1												
4 RELAYS		2												
INPUT VOLTAGE / BACKLIGHTING														
12 VDC - ONLY WITHOUT LCD ILLUMINATION											A			
24 VAC / 12-36 VDC WITHOUT LCD ILLUMINATION											B			
115 VAC WITHOUT LCD ILLUMINATION											C			
230 VAC WITHOUT LCD ILLUMINATION											D			
12 VDC WITH LCD ILLUMINATION											E			
24 VAC / 12-36 VDC WITH LCD ILLUMINATION											F			
115 VAC WITH LCD ILLUMINATION											G			
230 VAC WITH LCD ILLUMINATION											H			
COUNTER														
NO MECHANICAL COUNTER		0												
ONE MECHANICAL COUNTER		1												
TWO MECHANICAL COUNTERS		2												
MOUNTING														
PANEL MOUNT, NEMA 4X FRONT PANEL												0		
WALL MOUNT, NEMA 4 - HINGED METAL ENC.												1		
WALL MOUNT, NEMA 4X - MOLDED CASE												2		
WALL MOUNT, NEMA 4X - HINGED POLYMER ENC.												3		

Installation

Location

In any mounting arrangement, the primary concern is easy viewing and convenient operation of the keypad. The unit generates very little heat, so no consideration need be given to cooling or ventilation.

Wall Mount Installation

The Model (b) (3) (B) Wall Mount is designed to mount onto a wall with 4 bolts or screws. The mounting hole pattern and box dimensions for the (b) (3) (B) panel mount are shown in Figure 1.

Panel Mount Installation

The Model (b) (3) (B) Panel Mount is designed for through panel mounting, which allows access to the back of the unit. The (b) (3) (B) is secured to the panel by two draw brackets. The Panel cutout is shown in Figure 2.

Figure 1: Wall Mount Hole Pattern and Dimensions

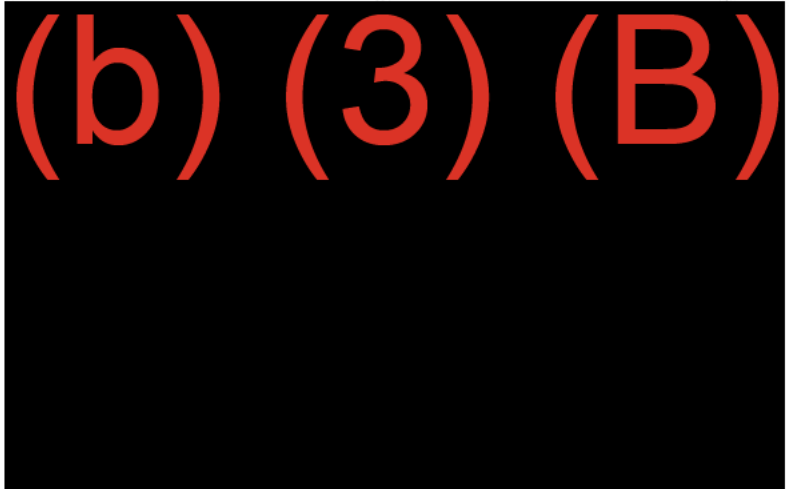
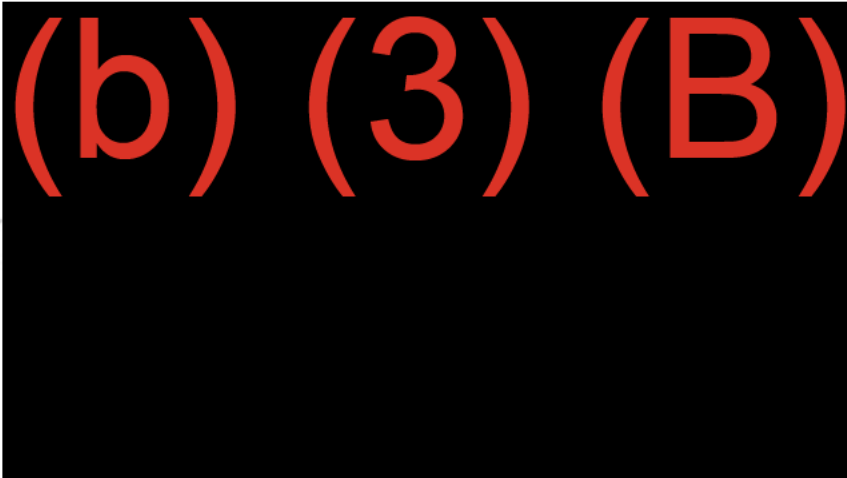


Figure 2: Panel Cutout and Panel Mount Dimensions



Electrical Power

The Model (b) (3) (B) is available with four different options for power supplies. How the unit is wired depends on the power option that was chosen. Listed below are the four power options and how to connect each type of power supply. Reference Figure 3 for the proper terminal strip.

Note: Always check to see what power option was chosen before wiring or **DAMAGE COULD RESULT**. The power option is shown by the letter designation of the model number printed on the back of the unit. Compare this to the matrix on page one of this manual.

THE SERIES (b) (3) (B) IS A MICROPROCESSOR BASED UNIT, LIKE ALL MICROPROCESSOR BASED UNITS IT IS SUSCEPTIBLE TO ELECTRICAL INTERFERENCE. TO HELP PREVENT ELECTRICAL INTERFERENCE PROBLEMS THE GROUND TERMINAL ON THE AC SIDE MUST BE CONNECTED TO A SOLID EARTH GROUND.

Wiring the (b) (3) (B) for 120 VAC Option

The power requirement for this option is a nominal 120 VAC, 50/60Hz. Looking at the back of the of the unit, locate the 6 position terminal strip on the left side of unit. The terminals that are used are three on the left side. Refer to Figure 3 on page 3 for location of power supply input on terminal strip. Wire as described below.

1. Connect the AC Common to the Series (b) (3) (B) terminal marked (C).
2. Connect AC Load of the power supply to the Series (b) (3) (B) terminal marked (L).
3. Connect Earth Ground to the Series (b) (3) (B) terminal marked (to the Series 2100 terminal marked (A)).

DO NOT CONNECT ANY OTHER SUPPLY TO EITHER THE AC OR DC TERMINALS.

Wiring the (b) (3) (B) for 230 VAC Option

The power requirement for this option is a nominal 230VAC, 50/60Hz. Looking at the back of the of the unit, locate the 6 position terminal strip on the left side of unit. The terminals that are used are three on the left side. Wire as described below.

1. Connect the AC Common to the Series (b) (3) (B) terminal marked (C).
2. Connect AC Load of the power supply to the Series (b) (3) (B) terminal marked (L).
3. Connect Earth Ground to the Series (b) (3) (B) terminal marked (H).

DO NOT CONNECT ANY OTHER SUPPLY TO EITHER THE AC OR DC TERMINALS.

Wiring the (b) (3) (B) for 24 VAC/12-36 VDC Option

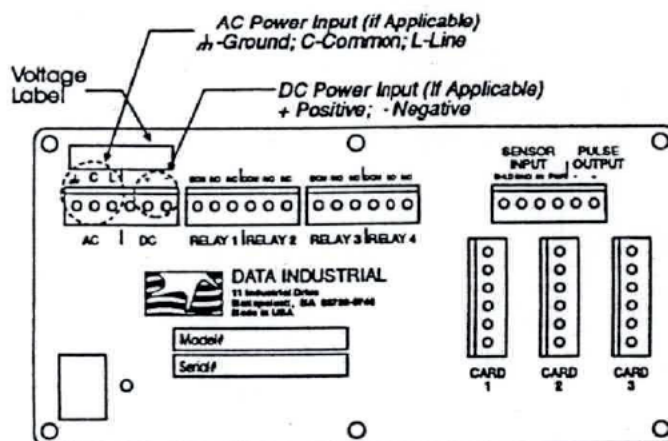
The power requirements for this option are either 10-26 VAC or 12-36 VDC. If the Model (b) (3) (B) is being powered with AC voltage, locate the 6 position terminal strip on the back left side of unit and connect the power supply using three terminals on the left side. Wire as described below.

1. Connect the AC Common to the Series (b) (3) (B) terminal marked (C).
2. Connect AC Load of the power supply to the Series (b) (3) (B) terminal marked (L).
3. Connect Earth Ground to the Series (b) (3) (B) terminal marked (H).

If the Model (b) (3) (B) is being powered with DC voltage, locate the same terminal strip that is used with an AC power supply but use the two screw terminals on the right side of terminal strip Wire as described below.

1. Connect the DC Positive to the Series (b) (3) (B) terminal marked (+).
2. Connect DC Negative of the power supply to the Series (b) (3) (B) terminal marked (-).
3. Connect Earth Ground to the Series (b) (3) (B) terminal marked (H) located on the left side of terminal.

Figure 3: Rear panel connections for the power supply options



Wiring the (b) (3) (B) for 12 VDC Option

The power requirements for this option is 10.6 VDC to 16.0 VDC. Looking at the back of the of the unit, locate the 6 position terminal strip on the left side of unit and use the two terminals on the right side of the connector. Wire as described below.

1. Connect the DC Positive to the Series (b) (3) (B) terminal marked (+).
2. Connect DC Negative of the power supply to the Series 2100 terminal marked (-).
3. Connect Earth Ground to the Series (b) (3) (B) terminal marked (H) located on the left side of terminal.

DO NOT CONNECT POWER TO THE AC INPUT TERMINALS.

Sensor Wiring

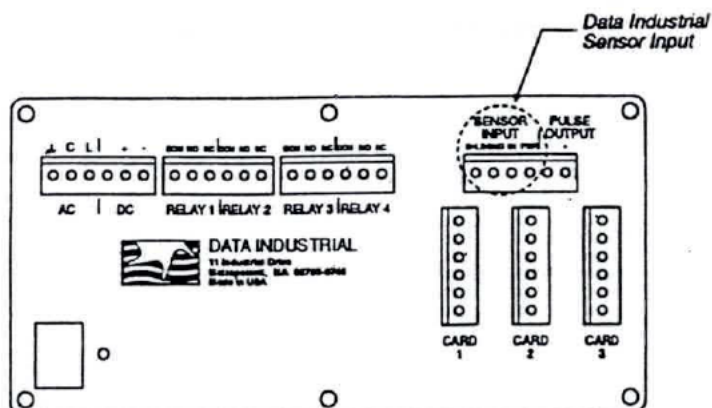
Electrical Power to the Mode (b) (3) (B) must be off before the flow sensor can be connected. Reference Figure 4 right for sensor terminal strip location.

Data Industrial 200 Series Sensor Wiring

Locate the sensor terminal strip on the far right side of unit. Use small screwdriver to loosen terminal strip. Wire as Described below.

1. Connect the Red Wire from flow sensor to the terminal marked "IN", the third terminal from the left.
2. Connect the Black Wire from the Flow sensor to the terminal marked "GND", the second terminal from the left.
3. Connect the Shield Wire (if applicable) from the Flow Sensor to the terminal marked "SHLD" which is the first terminal from the left.

Figure 4: Data Industrial Sensor Input Location



Data Industrial 4000 Series Sensor Wiring

1. Connect the Red Wire from flow sensor to the terminal marked "PWR", the fourth terminal from the left.
2. Connect the Black Wire from the Flow Sensor to the terminal marked "GND", the second terminal from the left.
3. Connect the White or Clear Wire from the flow sensor to the terminal marked "IN", the third terminal from the left.
4. Connect the Shield Wire from the Flow Sensor to the terminal marked "SHLD" which is the first terminal from the left.

Data Industrial Sensor Input Programming (for 200 and 4000 Series Sensors using Flow Channel 1)

Press Menu, then **SETUP - FLOW1 - SENSR - DICAL - KNUM**, then enter the "K" number from the table in the Sensor Owner's Manual then press the Enter/Next key to save number. The unit will prompt you **"CHANGING THE SETTINGS WILL RESET THE TOTALIZER"** If the settings that were entered in are OK, press the UpArrow key under **YES** if a mistake was made the press the DownArrow key under **NO** and press **KNUM** to reenter. The next thing to do is enter the "offset" number from the same table the "K" number came from. Press the key under **OFFSET** and enter in the offset number. Press the Enter/Next key to save number. The unit will prompt you **"CHANGING THE SETTINGS WILL RESET THE TOTALIZER"** If the settings that were entered in are ok, press the UpArrow key under **YES** if a mistake was made the press the DownArrow key under **NO** and press **OFFSET** to reenter. Press the Menu Key to return to the operation display.