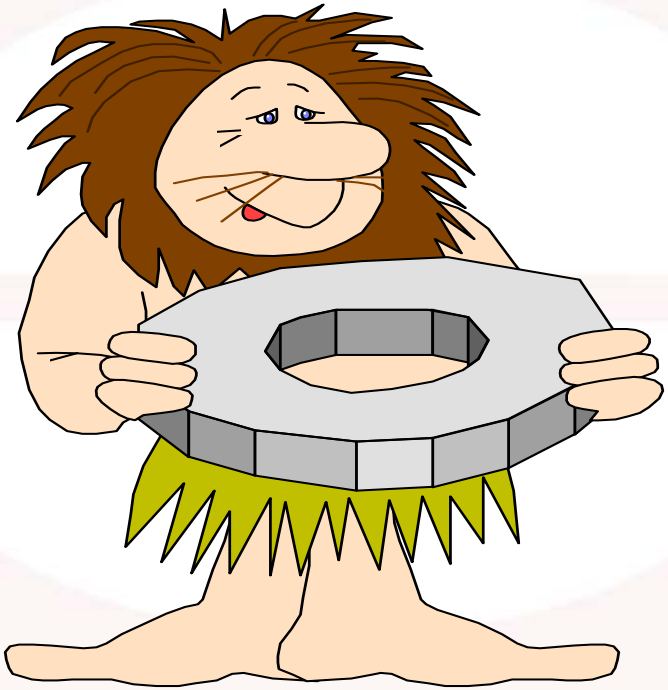
Introduction

"Pumps and Motors in Small Distribution Systems"

Presenter

Christopher Huyghue, P.Eng.
Sansom Equipment Ltd.

THE PUMP IS ONE OF THE OLDEST MECHANICAL DEVICES USED BY MAN



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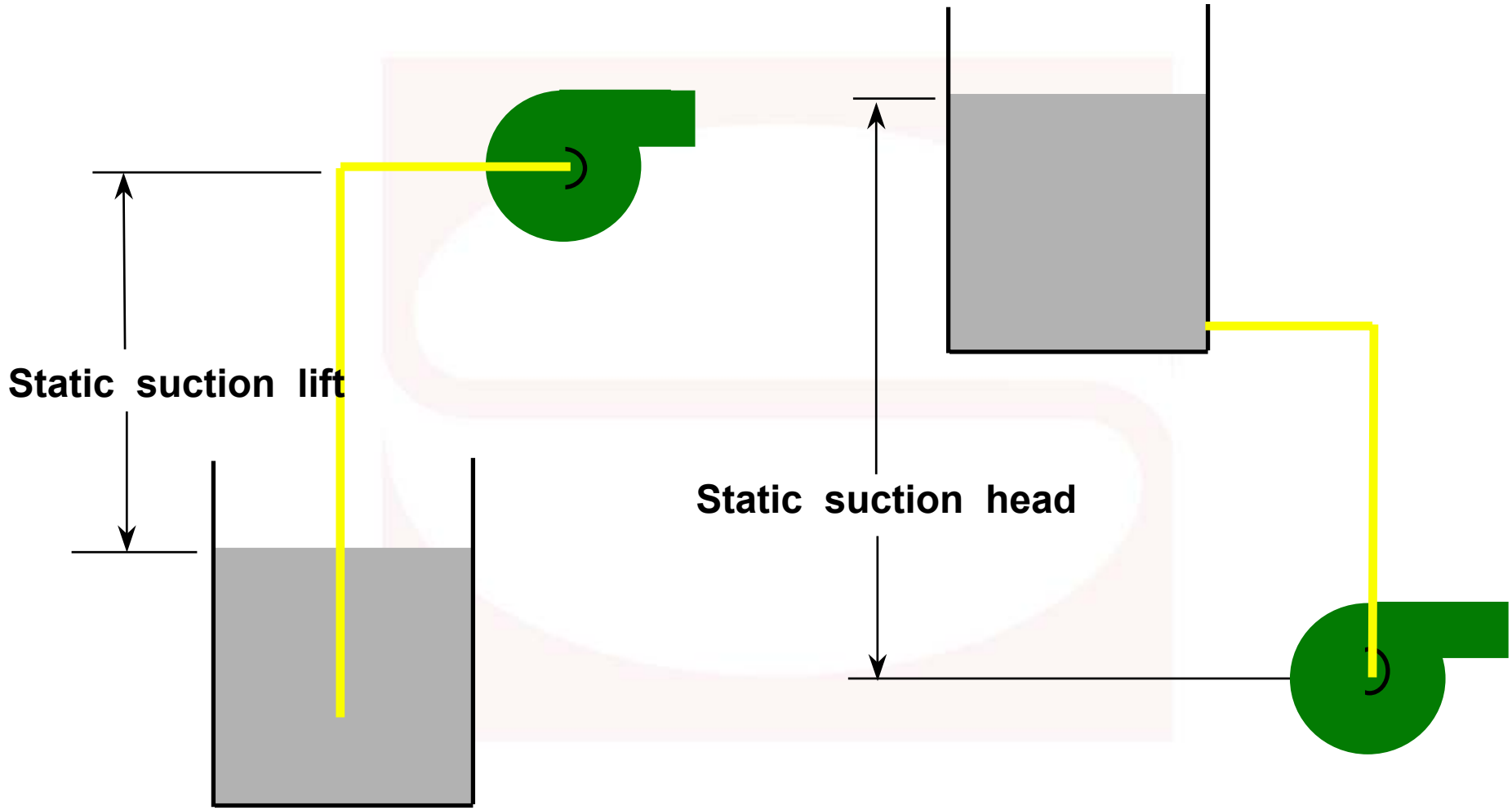
Basic Selection Criteria

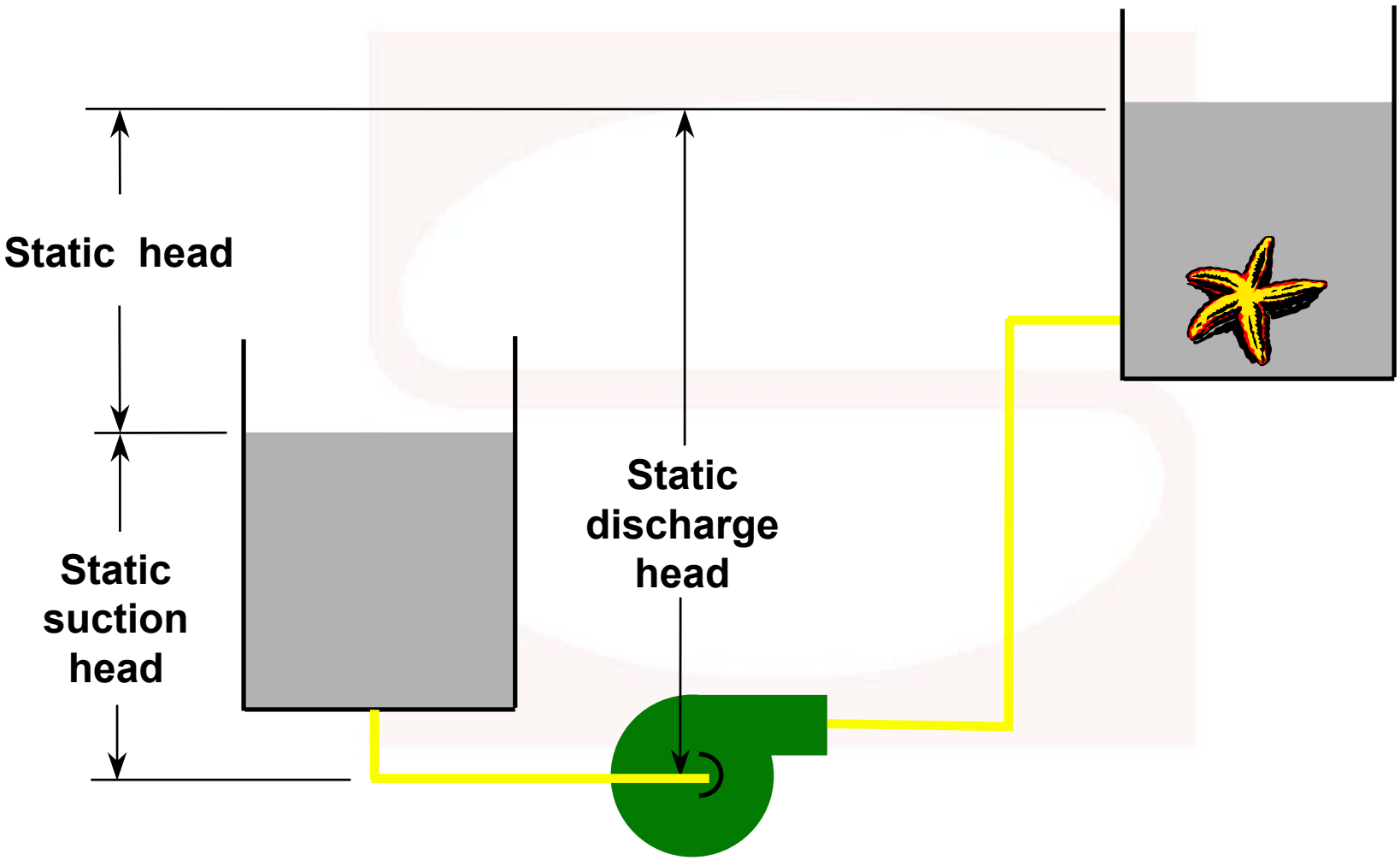
- Suction Conditions
- Static Head
- What is the pumpage (solids, hazardous, abrasives, aerated,corrosive)
- Capacity (or flow)
- Total Dynamic Head (TDH)

Continued

Basic Selection Criteria cont'd

- Specific Gravity (water, oil, acid)
- Temperature
- Mechanical Seal or Packing
- Site Voltage and Phase
- Site Conditions (Hazardous, Humid, Hot)





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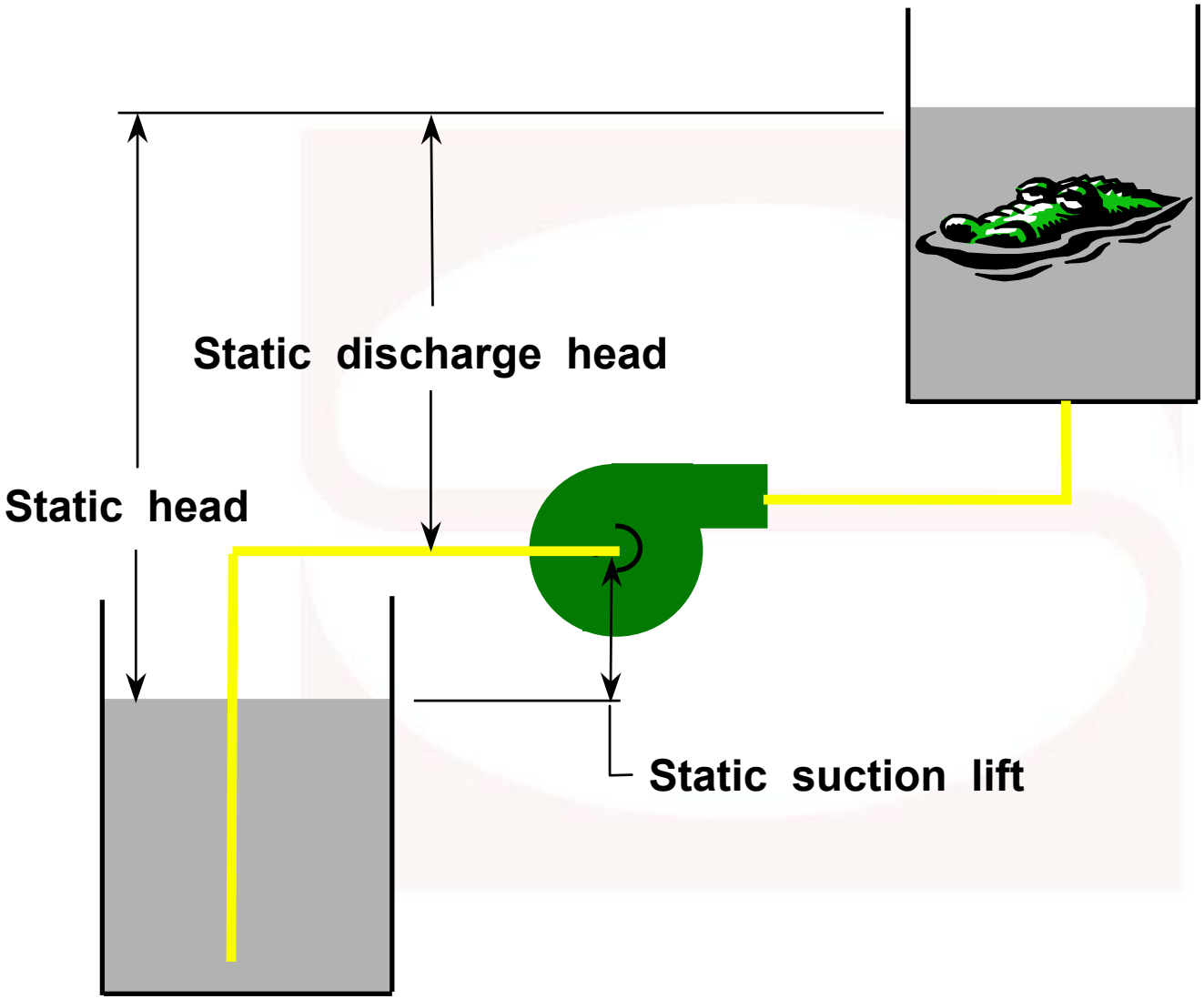

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Static Head

+

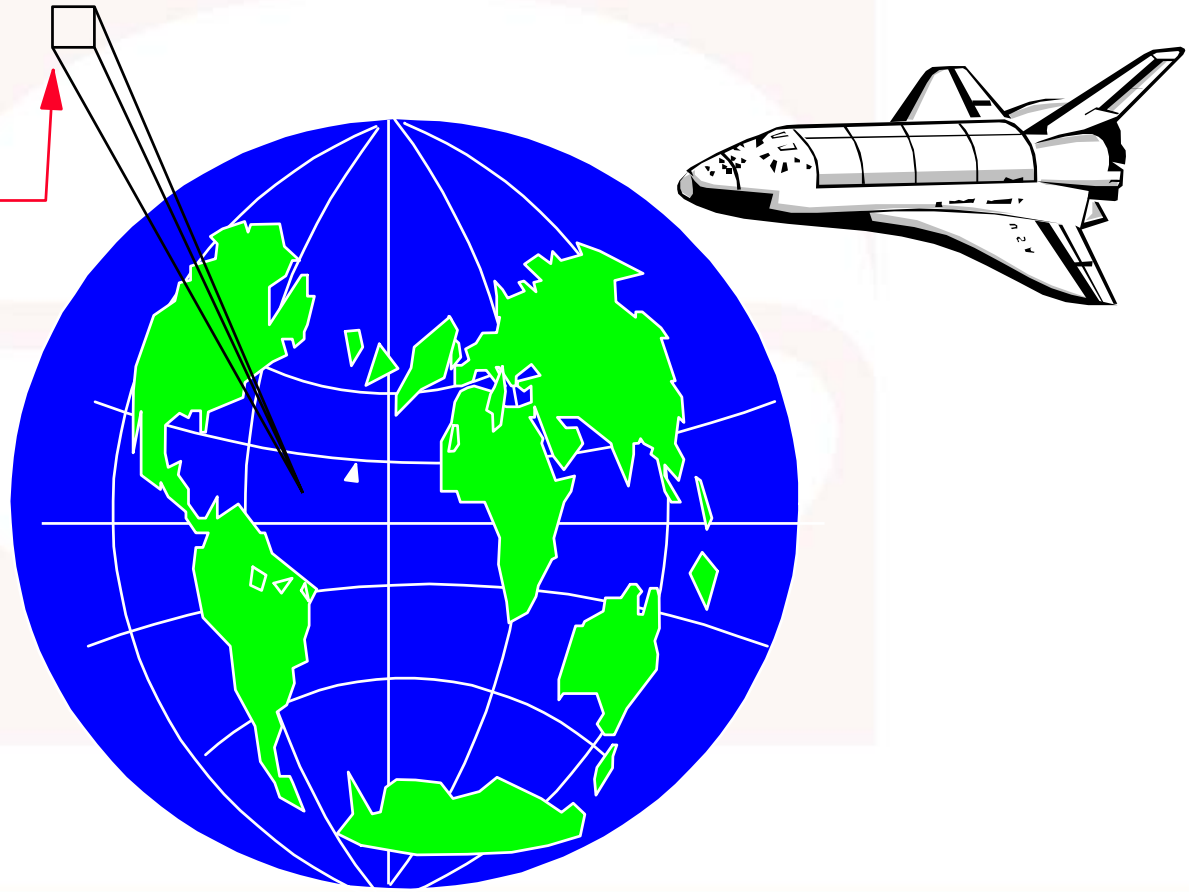
Friction Head

Total Dynamic Head

ATMOSPHERIC PRESSURE

1" SQUARE

14.7 psia
SEA LEVEL



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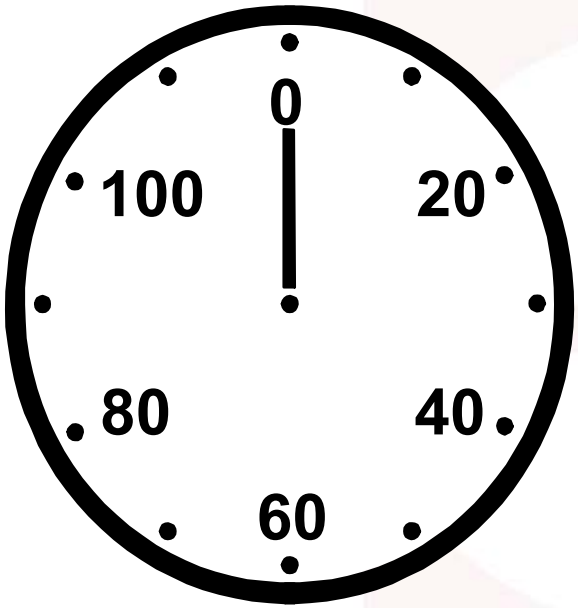
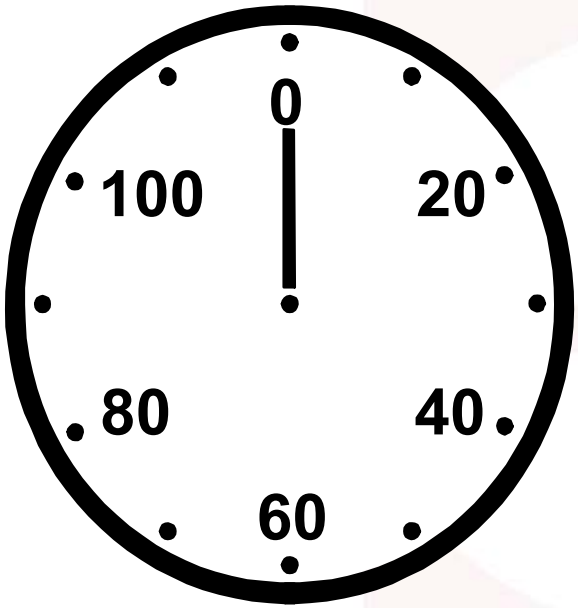
GAUGE PRESSURE



0 psig

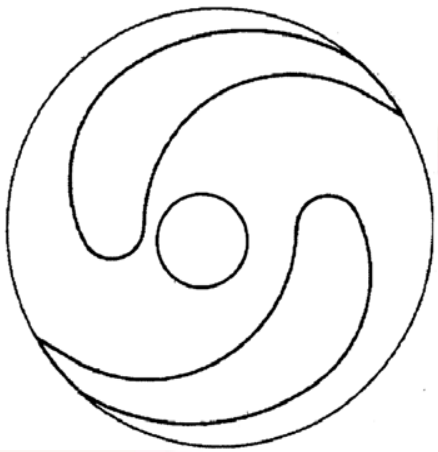
GAUGE PRESSURE



0 psig

= 14.7 psia

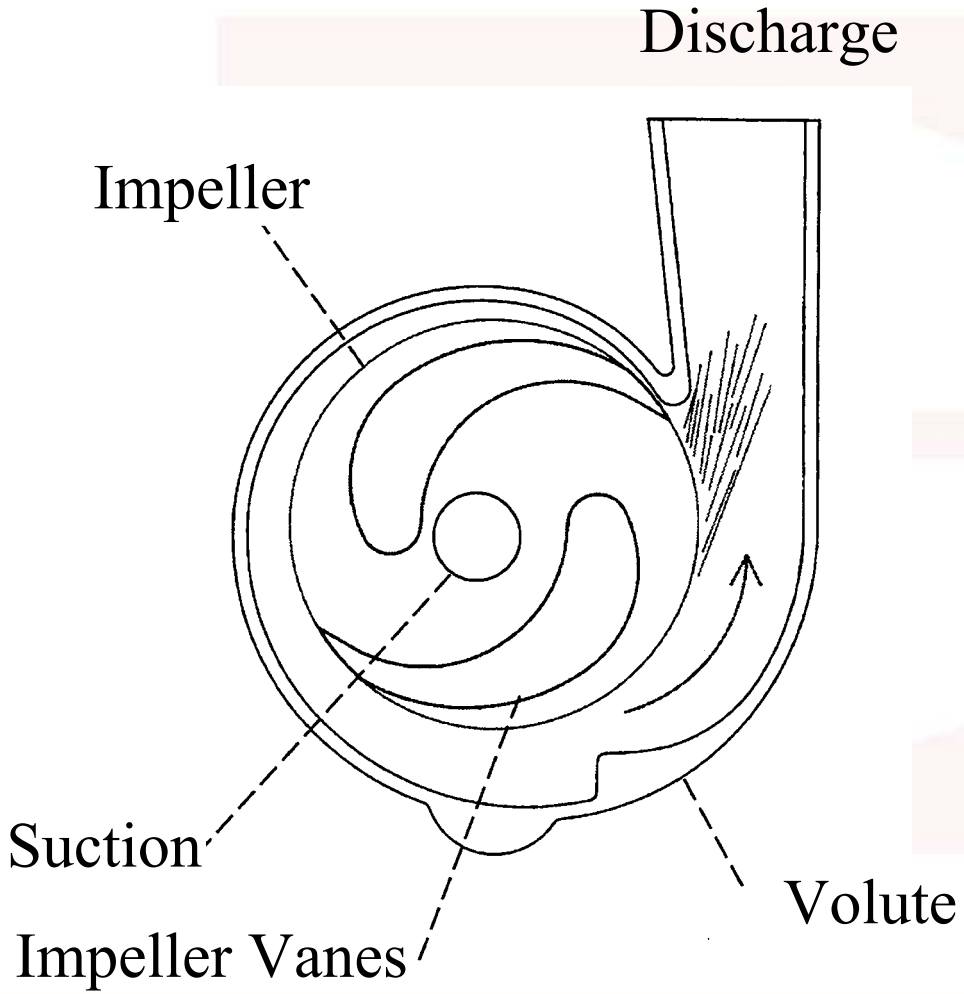
Centrifugal Pump Impeller



Which way should the impeller rotate?

CW or CCW?

Impeller and Volute



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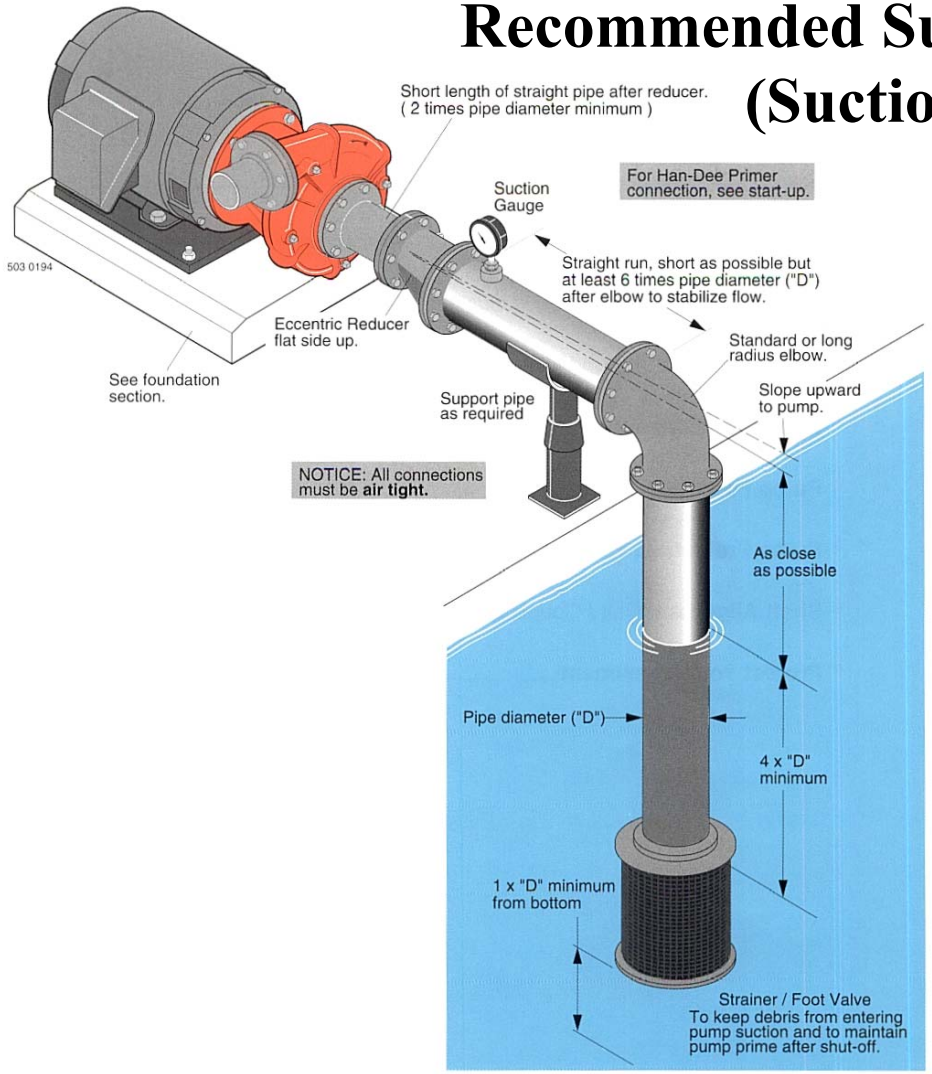
Recommended Suction Connections (Suction Lift)



- Use pipe, tubing, or reinforced hose to make suction connection. Hose must have sufficient strength to resist collapse under the atmospheric pressure differential that occurs while pump is running.
- Piping run and connection fittings should be properly aligned and independently supported to reduce strain on pump case.
- Suction pipe size should be at least one commercial pipe size larger than opening of pump inlet. Flow velocity should not exceed 8 ft./sec.
- Suction screen must screen out solids that could clog pump impeller.
- Suction screen area must be at least four times suction pipe area.
- Net Positive Suction Head Available (NPSHA) must exceed Net Positive Suction Head Required (NPSHR) by the pump or reduced performance and severe pump damage may result.
- All suction piping must have a continuous rise to the pump suction inlet. A 1/4 inch per foot minimum slope is recommended.

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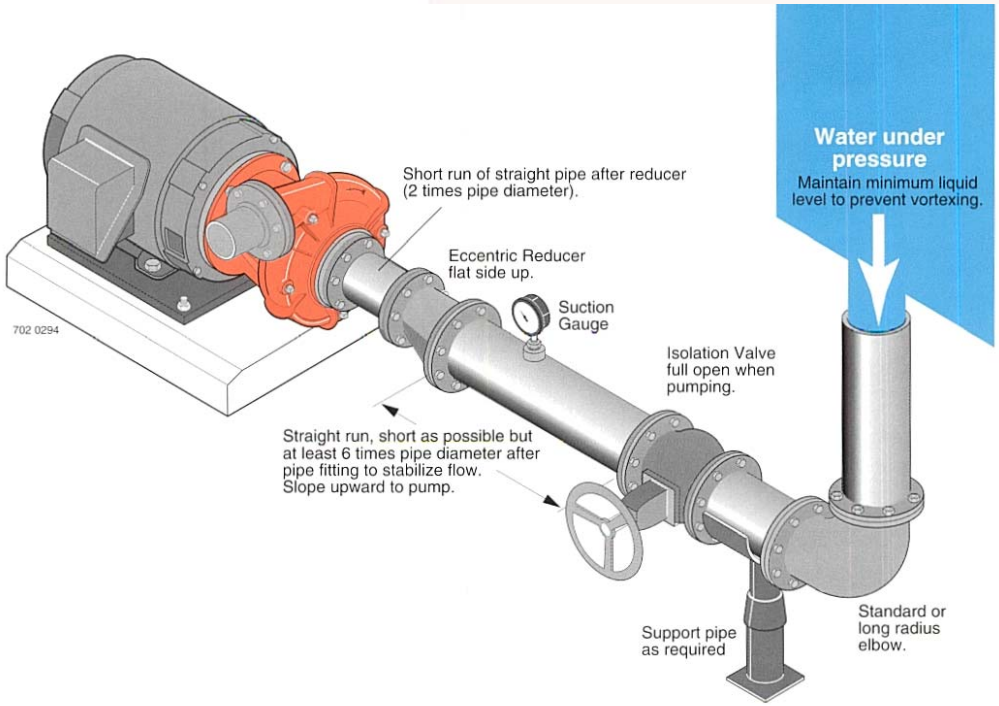
Recommended Suction Connections (Flooded Suction)



- Use pipe, tubing, or reinforced hose to make suction connection. Hose must have sufficient strength to resist collapse under the atmospheric pressure differential that may occur while pump is running.
- It is important, even with a flooded suction condition, that proper pipe fittings are used so water is delivered to impeller eye with a smooth flow and constant velocity.
- Suction pipe size should be at least one commercial pipe size larger than opening of pump inlet. Flow velocity should not exceed 8 ft./sec.
- An isolation valve is used in a pressurized suction pipe to permit servicing pump.
- Piping run and connection fittings should be properly aligned and independently supported to reduce strain on pump case.
- If solids are present, a strainer should be used to protect the pump.

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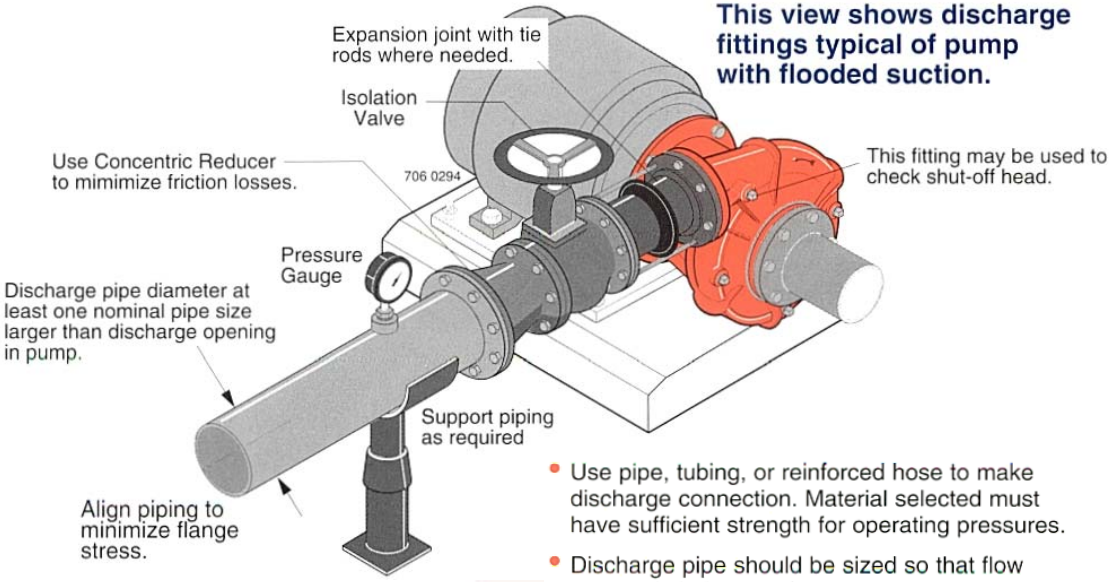
Recommended Discharge Connections

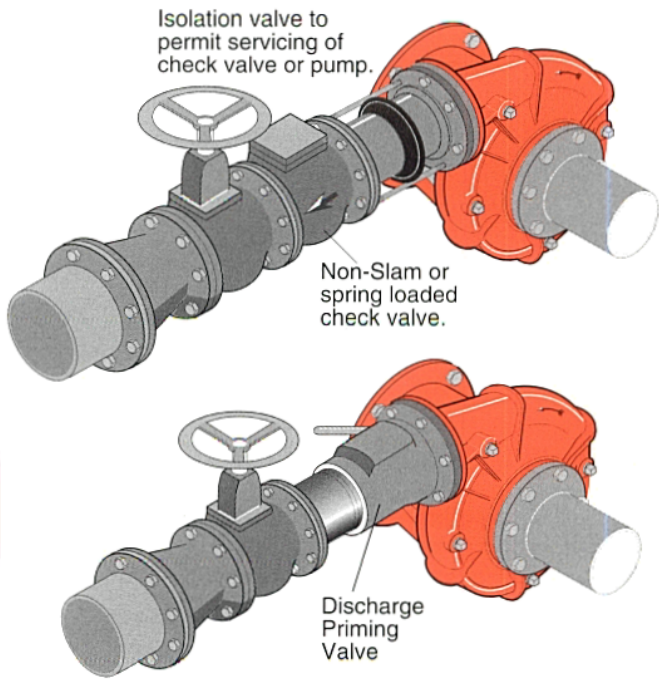


This view shows discharge fittings typical of pump with flooded suction.

This fitting may be used to check shut-off head.

- Use pipe, tubing, or reinforced hose to make discharge connection. Material selected must have sufficient strength for operating pressures.
- Discharge pipe should be sized so that flow velocity is below 8 ft./sec.
- Use only non-slamming check valves to prevent hydraulic shock (water hammer).
- Use gate, ball, or butterfly valve for isolation. Valve should be full open during operation.
- Maintain proper pipe size throughout discharge system, using as few elbows and tees as possible to keep friction loss to a minimum.
- Install pressure gauge after reducer as shown to check operating pressure.

These two views show discharge fittings typical of pump with suction lift.



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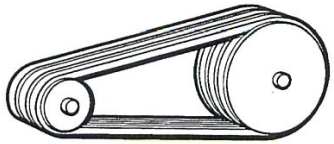
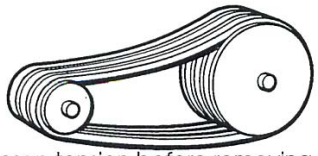
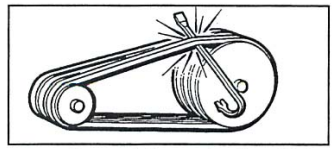
V-Belt Drives



Use a matched set of V-belts.

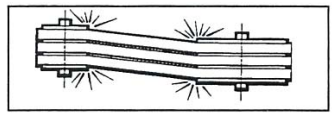


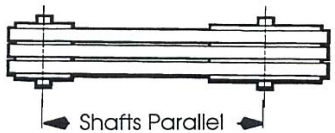
Loosen tension before removing or installing belts



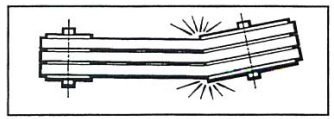
Do not force belts off sheaves.

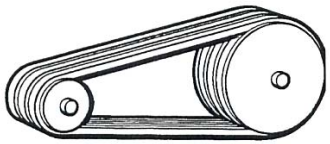
Align sheave grooves like this ..... Not this!



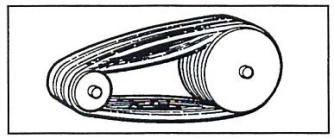


Align shafts like this like this ..... Not this!





Tighten the take-up until the belts are Snug. Run drive at full speed and adjust take-up until only slight bow appears in back side of belts. Vertical drives must be operated tighter than others.



If the belts slip, they are too loose or overloaded. Never use belt dressings.

Don't Forget!
Install Belt Guard
Before Operating

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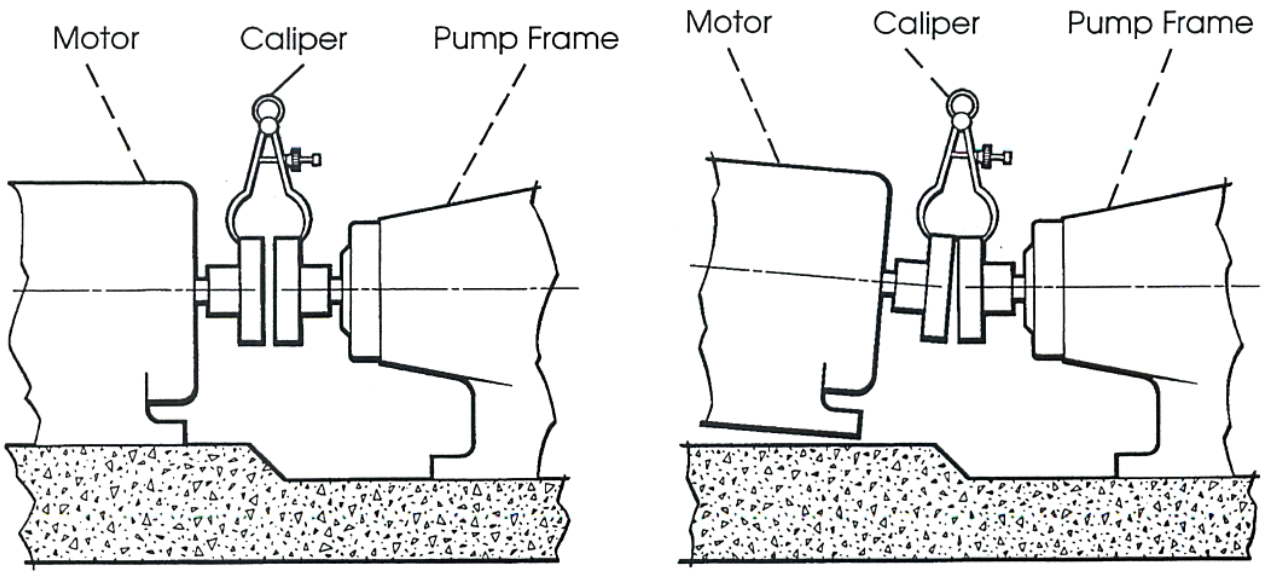
Drive Coupling Alignment

Check angular alignment with a caliper or micrometer. Measure from the outside of one flange to the outside of the other (Do Not rotate coupling).



CORRECT ALIGNMENT

INCORRECT ALIGNMENT

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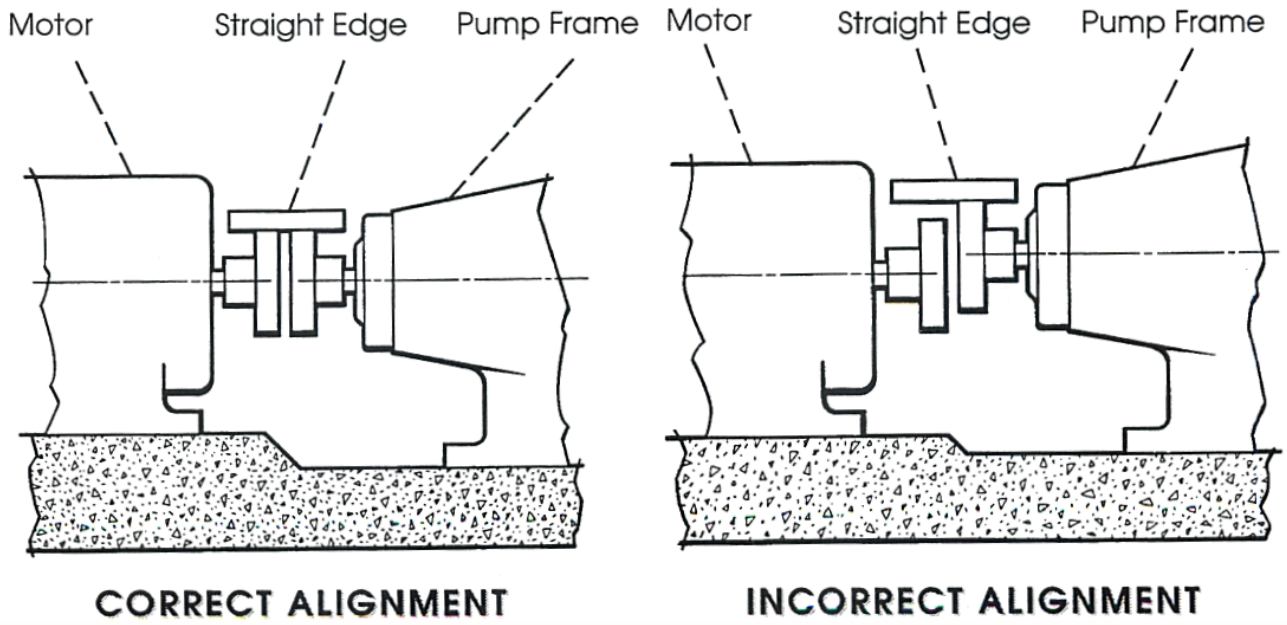
Drive Coupling Alignment

Check parallel alignment by placing a straight edge across two the coupling flanges and measuring the maximum offset around the periphery (Do Not rotate the coupling).



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Start-up Checklist

- ☐ Read and be familiar with the pump Installation, Operation and Maintenance Manual. Check to see that all aspects of these instructions have been complied with.
- ☐ Pipe connections must be securely fastened and air tight. All piping must be clean and free of debris.
- ☐ Is pump and all piping properly supported and are all supports securely fastened?
- ☐ Are required screens in place?
- ☐ Are all valves in the system in the proper open or close position for start-up?
- ☐ Confirm power source voltage matches the motor nameplate.
- ☐ Verify that belt or coupling alignment is properly adjusted if applicable, and that all safety guards are in place.

Start-up Checklist cont'd

- ☐ Does the impeller / shaft rotate freely?
- ☐ Is pump primed?
- ☐ Verify that rotational direction is correct for pump by **VERY** short "on-off" of power source.
- ☐ Slowly open discharge valve to obtain desired flow rate of pumping system.

Do not start pump until above checks have been made and all start-up instructions in the pump I.O.M. have been complied with. Failure to do so may result in severe damage to equipment, cause personal injury, and may void warranty.

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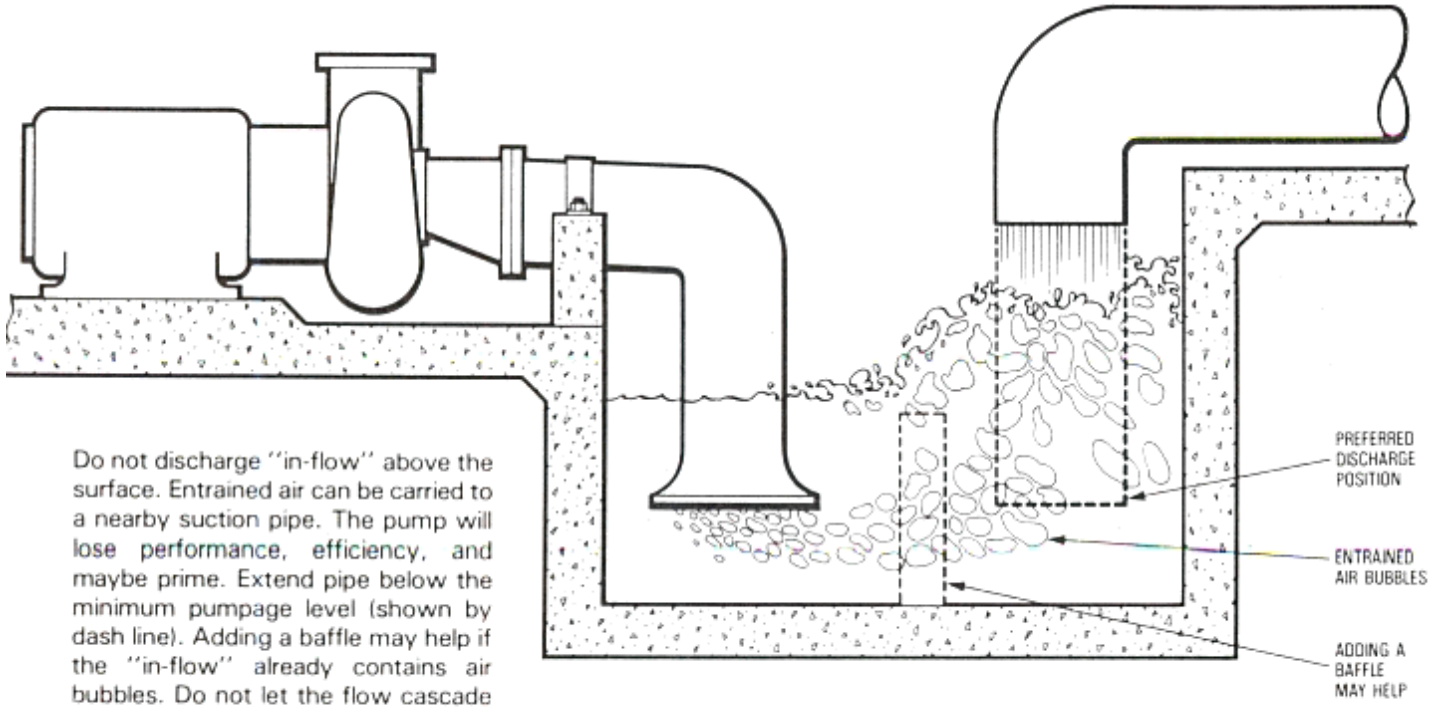
Air Entrainment



Do not discharge "in-flow" above the surface. Entrained air can be carried to a nearby suction pipe. The pump will lose performance, efficiency, and maybe prime. Extend pipe below the minimum pumpage level (shown by dash line). Adding a baffle may help if the "in-flow" already contains air bubbles. Do not let the flow cascade over the baffle.

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Submergence

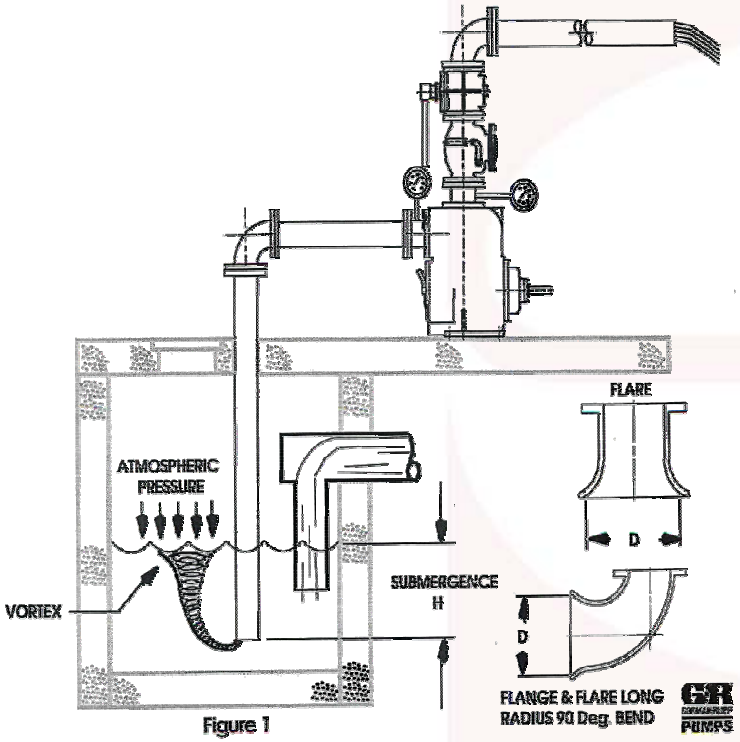
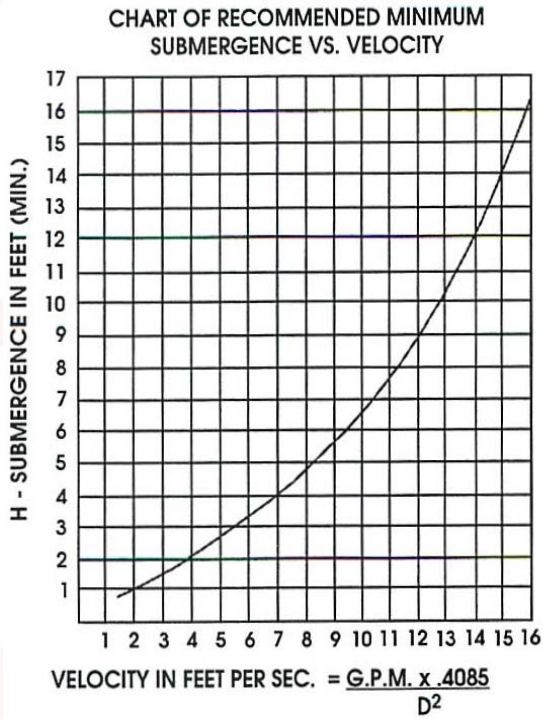


Figure 1



Inadequate submergence will lead to vortex formation. In extreme cases, the vortex tail will trail from suction inlet permitting air entry into the pump suction see Figure 1.

Entrained air in pumped liquid will cause a reduction in pump delivery. Noisy operation and vibration usually accompanies this condition. Broken impeller shafts may occur in extreme cases due to uneven loading of impeller. Motor loads may be decreased.

Well developed vortices are visable on the surface. However, just because they cannot be seen does not mean that this condition cannot be present and affecting the pump performance.

Where 'D' is in inches

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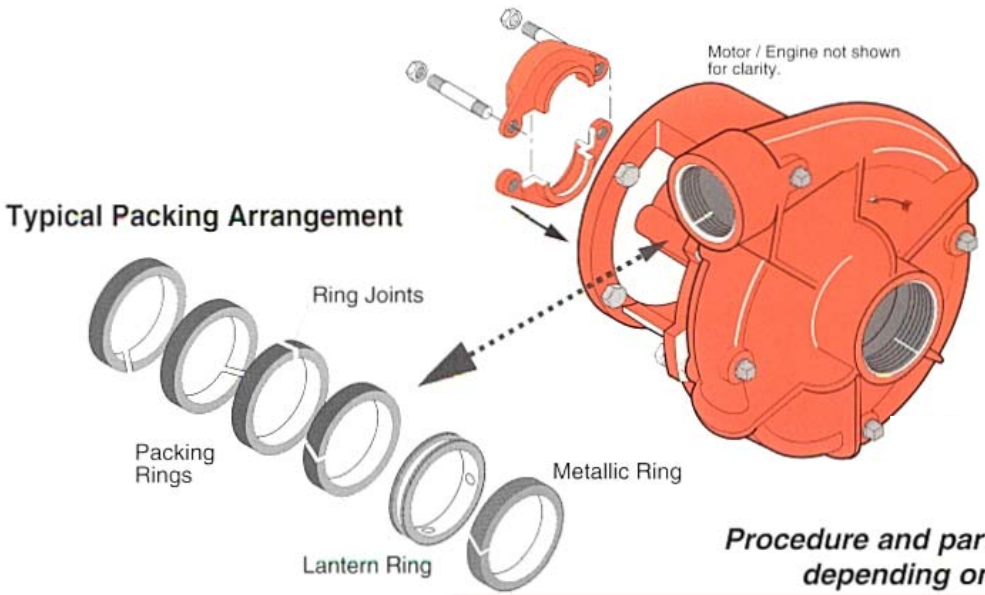
Installing New Packing



- Clean shaft sleeve and Packing Gland.
- Inspect shaft sleeve for wear, replace if needed.
- Install new packing rings in stuffing box by placing over shaft sleeve and pushing them in as far as they will go.
- Rotate ring joint 90 degrees when installing each ring as shown.
- Slide packing gland into position, then gently and evenly tighten nuts to force rings into place and seat (do not overtighten). Loosen nuts again to hand tight.
- Start primed pump and allow packing to leak liberally.
- Evenly tighten gland nuts one complete turn at a time until leakage is reduced to 40 to 60 drops per minute.

Procedure and parts will vary slightly depending on pump style.

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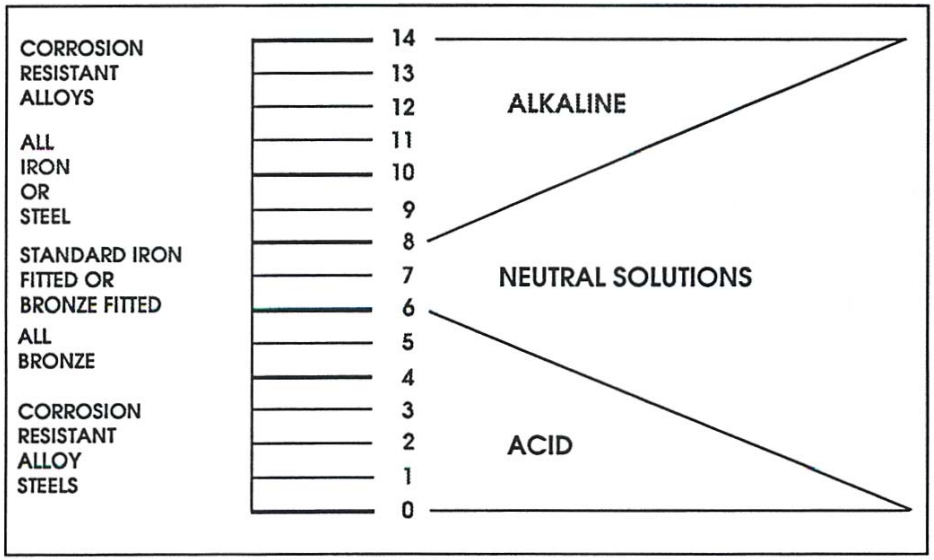
Materials of Construction

pH Factor: pH value of a liquid is a measure of its corrosive qualities, either acidic or alkaline or, more correctly stated, it is a measure of hydrogen ion concentration. A pH of 7 is neutral, below 7 is acidic, above 7 is alkaline.



pH VALUE	MATERIAL OF CONSTRUCTION
10 to 14	Corrosion Resistant Alloys
8 to 10	All Iron
6 to 8	Bronze Fitted
4 to 6	All Bronze
0 to 4	Corrosion Resistant Alloys

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Preventative Maintenance Schedule

Weekly

- record suction/discharge gauge readings for all pumps.
- record elapsed time meter readings.
- check air flow indicator to ensure proper bubbler system air flow.
- monitor station during at least one pump down cycle to check for proper pump and control operation along with leaks.
- check oil levels in seal and bearing chambers.
- check belts for wear and tension.
- check sump pump, blower, and dehumidifier for proper operation (dry pit operation).

Monthly

- exercise all isolation valves.
- make sure check valves open and close properly (clean the seat area if necessary).
- lubricate air release valves and check for proper operation.
- retention and align belt drives if necessary (after initial run/tension intervals).
- check impeller to wear plate clearance (depending on application, this may need to be done quarterly, monthly or every couple of weeks).
- clean air pump filter.

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Preventative Maintenance Schedule cont'd

Annually

- change oil in pump seal chamber and bearing chamber if applicable (depending on application, this may need to be done semiannually, quartly, monthly or every couple of weeks).
- grease motor bearings, in accordance with motor manufacturer's recommended schedule
- test alarms for proper operation.

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Motor Maintenance

1. **INSPECTION**
   Inspect motor at regular intervals. Keep motor clean and vent opening clear.

2. **LUBRICATION**
   a. **Frame 143T thru 256T** are furnished with double sealed ball bearings, prelubricated prior to installation. Grease fittings are not supplied and bearings are designed for average 100,000 hours operation under standard conditions. (See table 2 below.)
   b. **Frame 284T thru 587JZ** are furnished with double shielded or open ball or roller bearings. (Depending on HP size and/or speed.)
   It is necessary to relubricate anti-friction bearing motors periodically. (See table 2 below.)
   These motors are supplied with provision for greasing and have been lubricated prior to test, however before start-up it is recommended to apply approximately 30 grams (1 oz.) of grease.

Motor Maintenance cont'd

Table 2. Frequency of Relubrication

SYNC. R.P.M. RANGE	FRAME RANGE	TYPE OF SERVICE	
		STANDARD (8Hr day operation)	(24Hr day operation)
3600	143T - 256T	* 5 years	* 5 years
	284TS - 256TS	210 days	70 days
	324TS - 587USS	150 days	50 days
1800	143T - 256T	* 7 years	* 3 years
	284T - 326T	4 years	1.5 years
	364T - 365T	390 days	130 days
	404T - 447TZ	270 days	90 days
	505US - 587UZ	210 days	70 days
1200	143T - 256T	* 7 years	* 3 years
	284T - 326T	4 years	1.5 years
	364T - 447TZ	390 days	130 days
	505US - 587UZ	270 days	90 days

NOTES:

1. Remarks * : We recommend changing bearings after these operations, but if not changeable, you can relubricate by removing the seal, cleaning and refilling the bearing and the cavity with recommended grease.
2. For easy service (1 Hr/day operation) multiply tabled value by 2.
3. For very severe service (High vibration, shock) 1/3 of tabled value.

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Motor Maintenance cont'd

3. **INSPECTIONS FOR LUBRICATING**

Motors (284T - 587UZ) are furnished with grease fittings. Before greasing, be sure fittings are clean and free from dirt. Remove relief plug or plate and using a low pressure grease gun, pump in the required grease until new grease appears at the relief hole. Relubrication intervals is specified in table 2 above. After relubricating, allow motor to run for 10 minutes before replacing relief hardware.

4. **RECOMMENDED GREASE**

Use the following greases or some equivalent lithium based greases unless a special grease is specified on the nameplate.

MOBILUX #2	**MOBIL OIL CO.**	**BEACON 325**	**EXXON**
ALVANIA #2	**SHELL OIL CO.**	**CHEVRON SRI NO. 2**	**STD. OIL CO. OF CALIF.**

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PREVENTIVE MAINTENANCE CHECK LIST

(Where Applicable)

STATION: _____

Pump No. 1 S/N: _____ Pump No. 2 S/N: _____

G.P.M. _____ T.D.H. _____

	MON.	TUE.	WED.	THU.	FRI.	SAT.	SUN.	COMMENTS:
CHECKED BY:								
DATE:								
TIME:								
Hours								
Suction Gauge								
Discharge Gauge								
R.P.M.								
Seal Oil								
Bearing Oil if Applicable								
Motor Oil if Applicable								
Amps L1, L2, L3								
Hours								
Suction Gauge								
Discharge Gauge								
R.P.M.								
Seal Oil								
Bearing Oil if applicable								
Motor Oil if Applicable								
Amps L1, L2, L3								
Monitor 1 Pump Cycle								
Sump Pump								
Blower								
Dehumidifier								
Air Pump								
Back-up Air Pump								
Exercise Isolation Valves								
Check Valve								
Adjust Imp. Clearance								
Clean Air Pump Filter								
Locks								
Lights								
Heater								

GORMAN-RUPP PUMPS

Take Gauge Reading While Pumps Are Running
And At The OFF Level.

GORMAN-RUPP MAINTENANCE PROCEDURES

FILL IN ALL BLOCKS WITH THE CORRECT INFORMATION REQUIRED

LOCATION

CUSTOMER DATA:

Pump Location: _____

Address: _____

_____

Contact Person: _____

Phone No. (_____) _____

DISTRIBUTOR DATA:

Name: _____

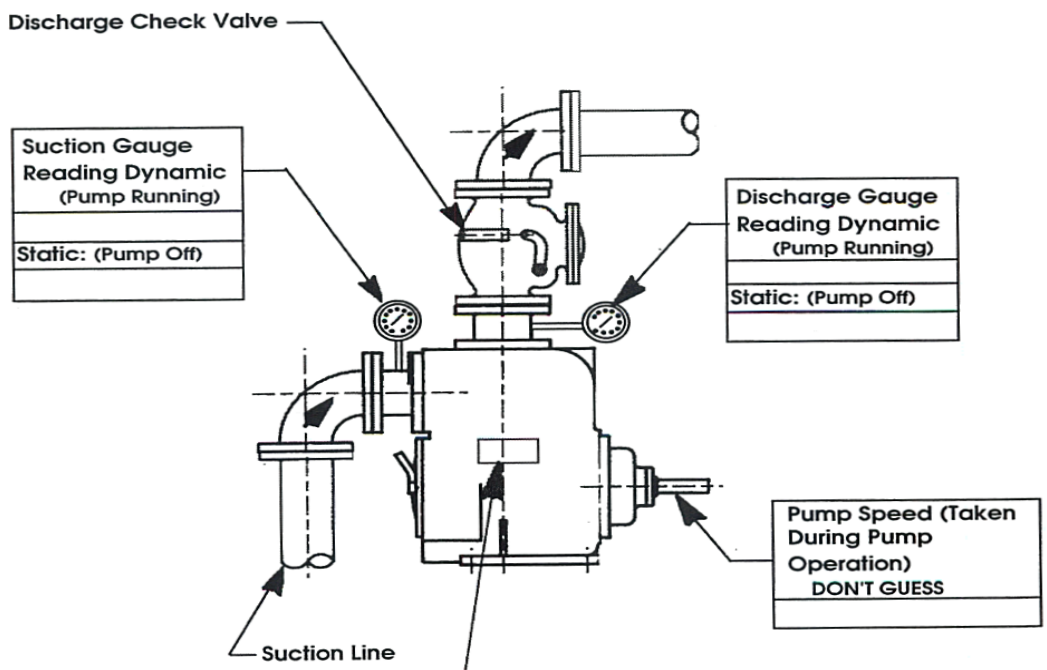
Address: _____

_____

Contact Person: _____

Phone No. (_____) _____

CONFIGURATION



Pump Model No.	Pump Serial No.	Impeller Dia.

GAUGES

SUCTION GAUGE CALIBRATION SCALE:

Pounds per square inch (P.S.I.): _____

Feet of water (ft).: _____

Inches of mercury (In Hg.): _____

DISCHARGE GAUGE CALIBRATION SCALE:

Pounds per square inch (P.S.I.): _____

Feet of water (ft).: _____

Put a check to indicate your gauge scale.

GORMAN-RUPP PUMPS

CENTRIFUGAL PUMP TROUBLESHOOTING DATA SHEET

GORMAN-RUPP PUMPS

FILL IN ALL BLOCKS WITH THE CORRECT INFORMATION REQUIRED

APPLICATION

LIQUID DATA:

Liquid Being Pumped: _____
Temp. Of Liquid: _____
Specific Gravity: _____
Viscosity In SSU: _____
Static Suct. Lift: _____
pH: _____
Solids Content & Size: _____

ENVIRONMENTAL DATA:

Ambient Temperature: _____
Pumps Mounted Inside/Outside: _____
Duty Cycle: _____
Additional Info:. _____
_____
_____
_____

ELECTRIC MOTOR

NAME PLATE DATA:

H.P. _____
Speed: _____
Voltage rating: _____
Enclosure: _____
Service Factor: _____
Full Load Amps: _____

MEASURED VALUES:

Voltage
To Motor: _____
Amp Reading
Under Load: _____
Amp Reading
No Load: _____

DRIVE DATA:

Close Coupled: _____
Flex Coupled: _____
V-Belt Drive: _____
Additional Info: _____
_____
_____

ENGINE

NAME PLATE DATA:

Manufacturer: _____
Model: _____
Fuel _____
Additional Info: _____
_____
_____

MEASURED VALUES:

Speed During
Operation: _____
Idle R.P.M. _____

DRIVE DATA:

Flywheel: _____
Drive Arm: _____
Drive Plate: _____
Clutch: _____
Coupling: _____
V-Belt Drive: _____

DETAILED DESCRIPTION

CURRENT PROBLEM: _____
_____
_____
_____
_____
_____

PUMP HISTORY: _____
_____
_____
_____
_____

Typical Installation

Town of Windsor
Pumping Station

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Typical Installation Cont'd

Duplex Controller - ABB VFD's
Milltronics Ultrasonic Level
Control

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Typical Installation Cont'd

Water Booster System - Ottawa

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Typical Installation Cont'd

Vertical Turbine Pumps – Goosebay WTP

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Typical Installation Cont'd

Town Of Liverpool Pumping Station

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