Pumps

40+ Year History: Centrifugal Effluent Pumps

Single Stage (low-head)

- Application adapted from 70's technology
- Used originally in sumps and sewage applications
- Passes solids up to 3/4"
  - Used in effluent sewers **30 years ago**

40+ Year History: Centrifugal Pumps

Multiple Stage (high-head)

- Application adapted from water well industry in the 80’s
- Well pump design modified by several manufacturers
- Improved via “evolutionary discoveries”
- Only passes solids up to 1/8"
  - Passing solids smaller than 1/8" protects drainfields, sand filters

Centrifugal Pumps in Use Today

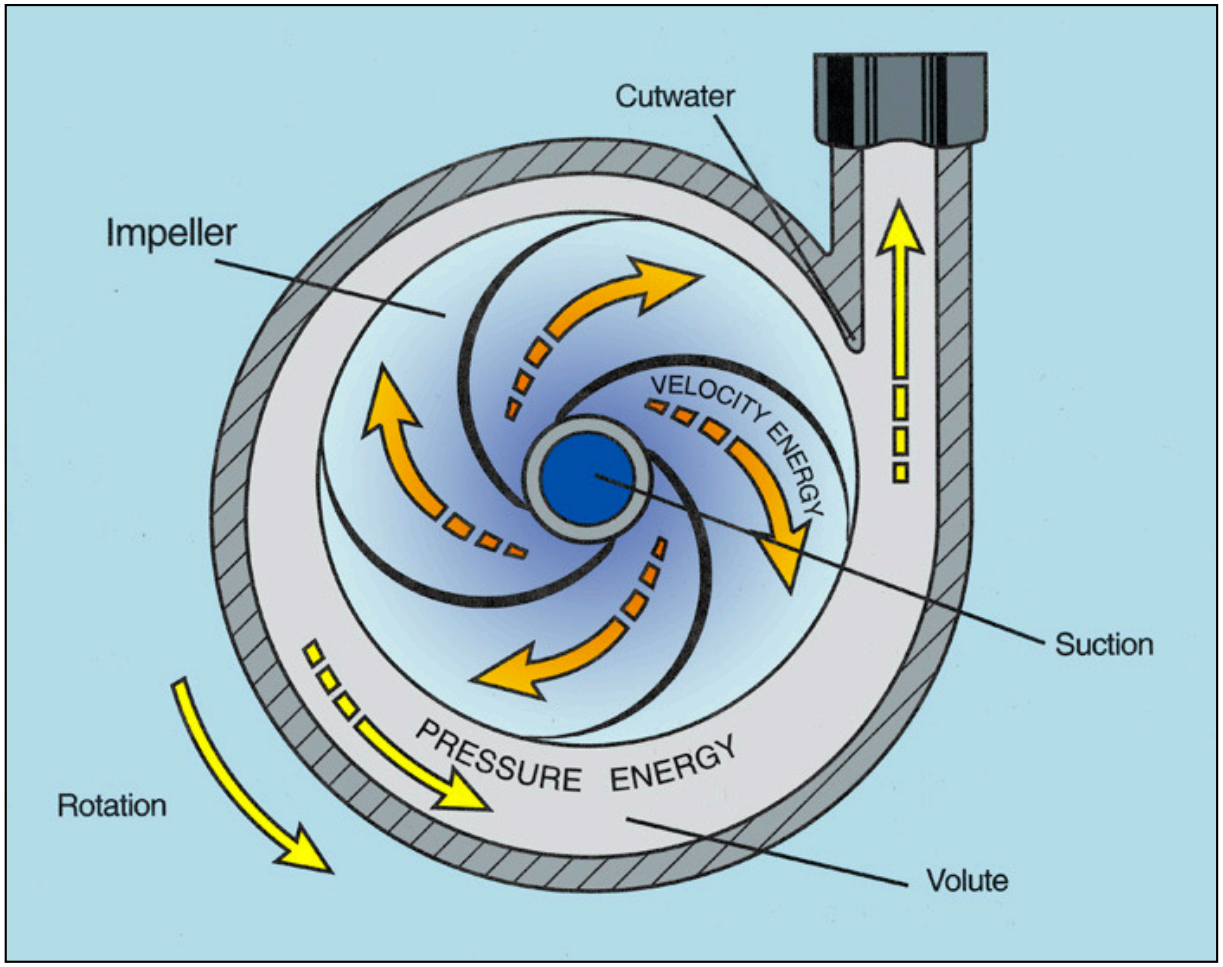
- Multiple stage high-head pumps
- Single stage low-head pump, 3/4” or smaller solids
- Sewage pump, solids 3/4” to 2”
- Grinder pump, produces a slurry (cutter blades)

Basic Differences

Single Stage (low-head)	Multiple Stage (high-head)
Handles higher volumes of effluent*	Handles lower volumes of effluent*
Produces lower head*	Produces higher head*; can scour laterals/orifices
Has a flat curve*	Has a steep curve*
Passes up to 3/4" solids (some 3/8")	Passes up to 1/8" solids
Has a shorter life	Has a longer life
Rated for fewer on/off cycles*	Rated for more on/off cycles*
Costs more to maintain	Costs less to maintain
Not typically repairable/serviceable	Is typically repairable/serviceable

** for comparable HPs*

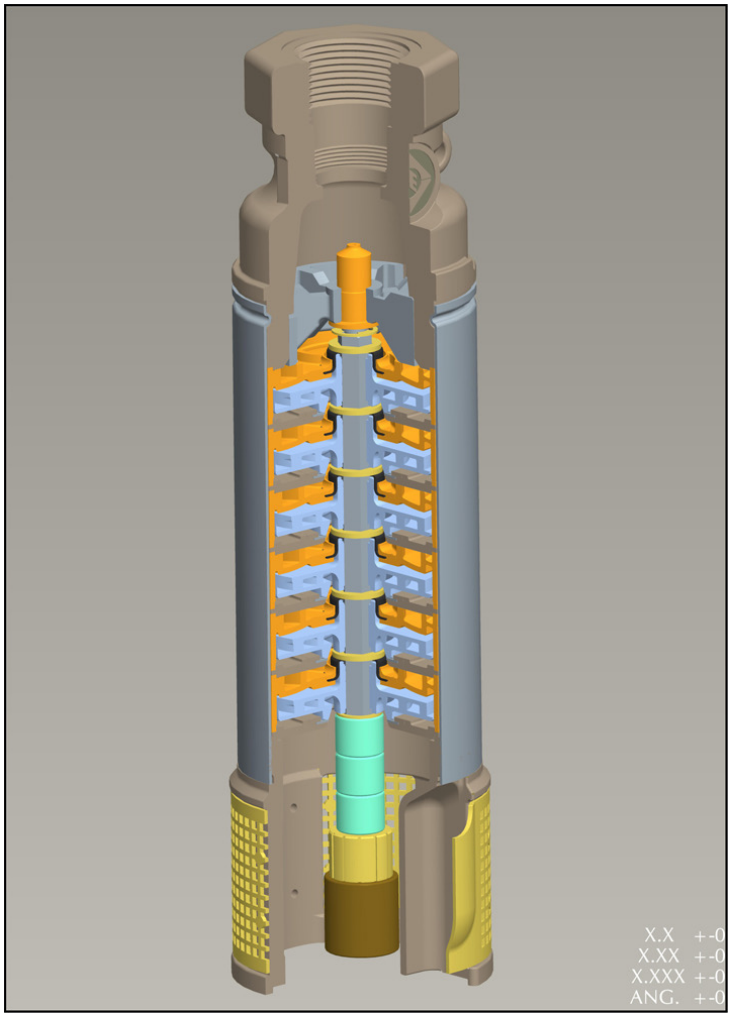
Impeller Concept



In a pump, impellers create centrifugal force and the velocity energy is converted to pressure energy.

Impellers and Stages

- Low-head pumps are single stage
- In high-head, multi-stage pumps
  - Passageways exist between stacked impellers
  - Energy from centrifugal force is channeled out the passages and upwards to the next stage
  - At each stage, velocity energy decreases and pressure increases
  - Increased pressure means higher head



Pump Considerations (Single Stage)

- Performance features requiring evaluation
  - Performance and power curves?
  - Rated for continuous operation?
  - Minimum run time?
  - Minimum liquid level (MLL) requirements?
  - “Run dry” capability?
  - Solids handling capacity and down stream impacts?
  - Screening requirements?
  - CSA/UL listing?
  - Thermal overload protection?
  - Dry or filled?

Pump Considerations (Single Stage)

- Materials features requiring evaluation
  - Corrosion resistance?
  - Seals?
  - Bearings or sleeves?
- Cost/warranty features requiring evaluation
  - Cost to purchase and maintain?
  - Warranty?

Pump Considerations (Multiple Stage)

- Performance features requiring evaluation
  - Performance and power curves?
  - Floating stack (PF50, PF75)
  - Floating impeller (PF10, PF20, PF30)
  - 24-hr “run dry” capability?
    - No deterioration in performance or impact on pump life
  - Minimum liquid level (MLL) requirements?
  - Frequency of starts?
  - Factory wet testing? How many points?

Pump Considerations (Multiple Stage) cont.

- Thermal overload protection (only on single phase through 1.5hp)
- Rapid starts?
- Bypass orifice? Does published TDH curve include this?
- Screening requirements (limited solids handling ability)?
- Screening Surface area (vault and pump)?
- Surge / Lightning protection?
- CSA / UL listing?
- Serviceable / repairable liquid end?

Pump Considerations (Multiple Stage)

- Materials features requiring evaluation
  - Corrosion resistance?
  - Stainless suction connection (motor mount)
  - Motor seals and bearings
  - Start / Run windings vs. capacitor starting
  - Motor filled with propylene glycol/water or oil
- Cost/warranty features requiring evaluation
  - Cost to purchase and maintain?
  - Liquid end is reparable?
  - Extended warranty included or available?

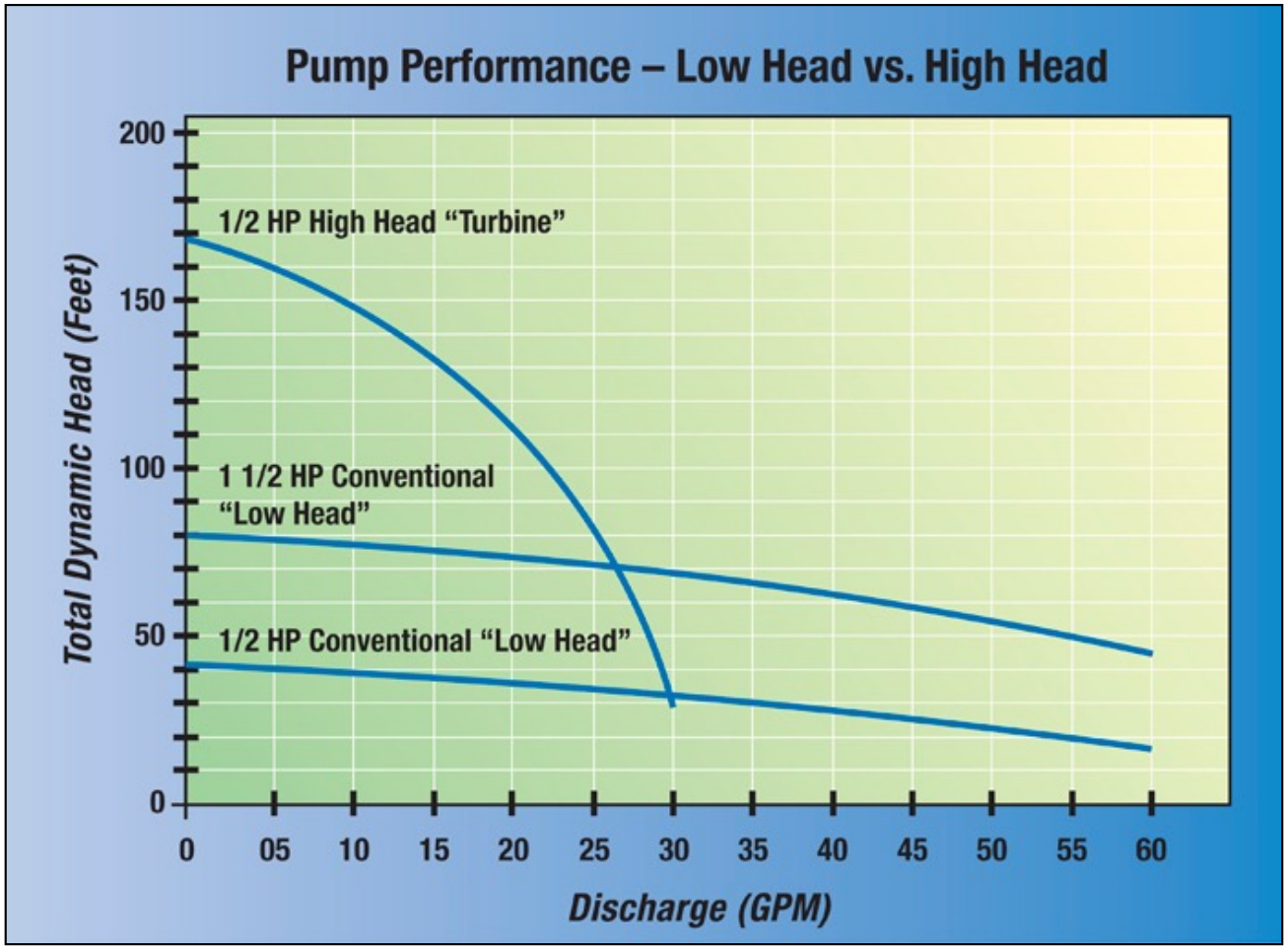
Electrical Considerations

- Applicable regulations
- Voltages and voltage drop
- Cable types and conductor sizes
  - SOOW vs. SJOOW
- Single-phase and Three-phase power
- Use of capacitor packs
  - Single phase 2 HP and up

Electrical Considerations

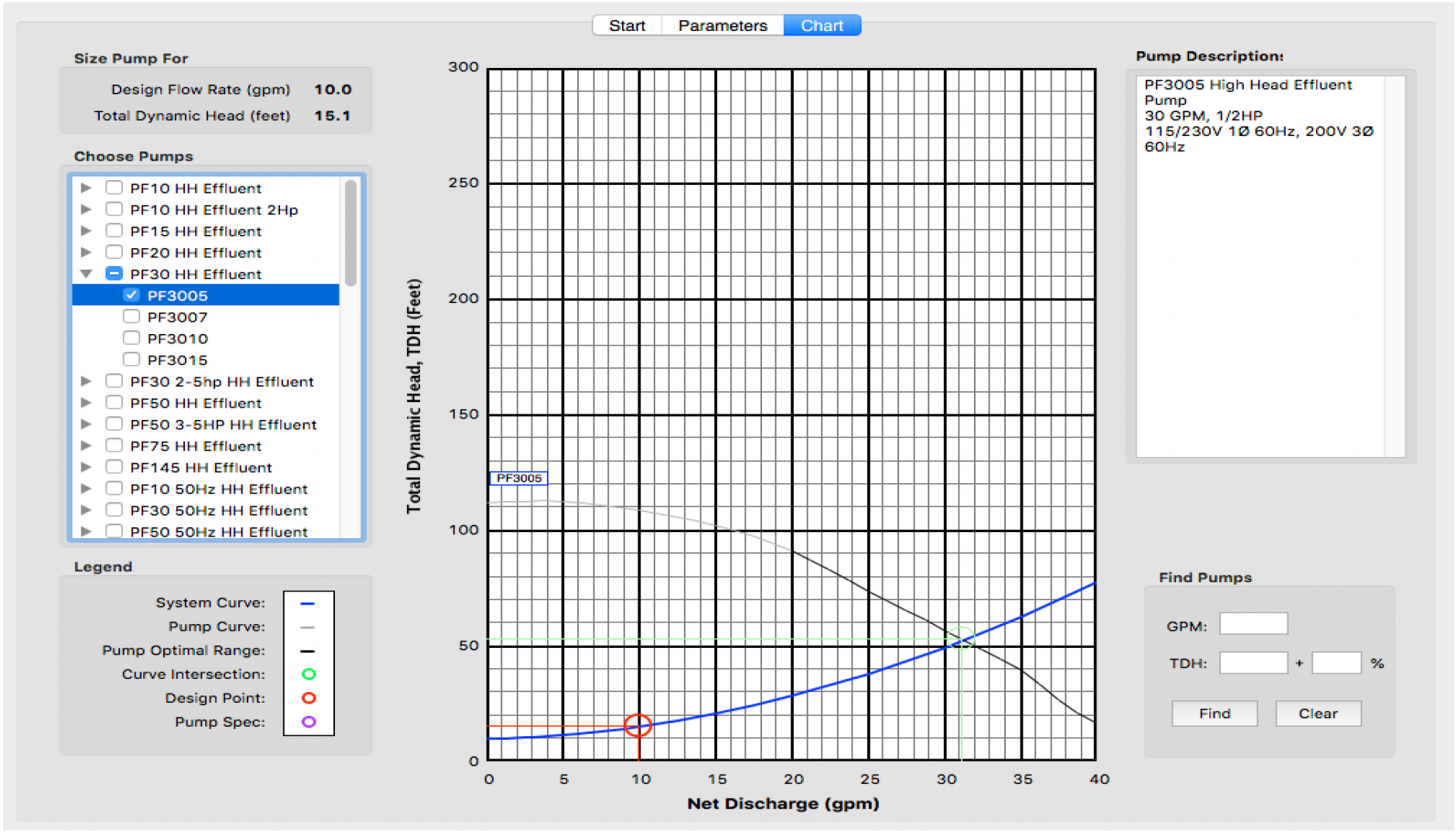
- 16/3 maximum 50 ft 1/2 HP thru 11/2 HP
- 14/4 SOOW now available
  - 10 FT, 30 Ft and 50 FT (ok for all hp's up to and including 5 hp)
- 50 FT cords may eliminate splice box
- Use of generators
- Power costs

Total Dynamic Head (TDH) Requirements

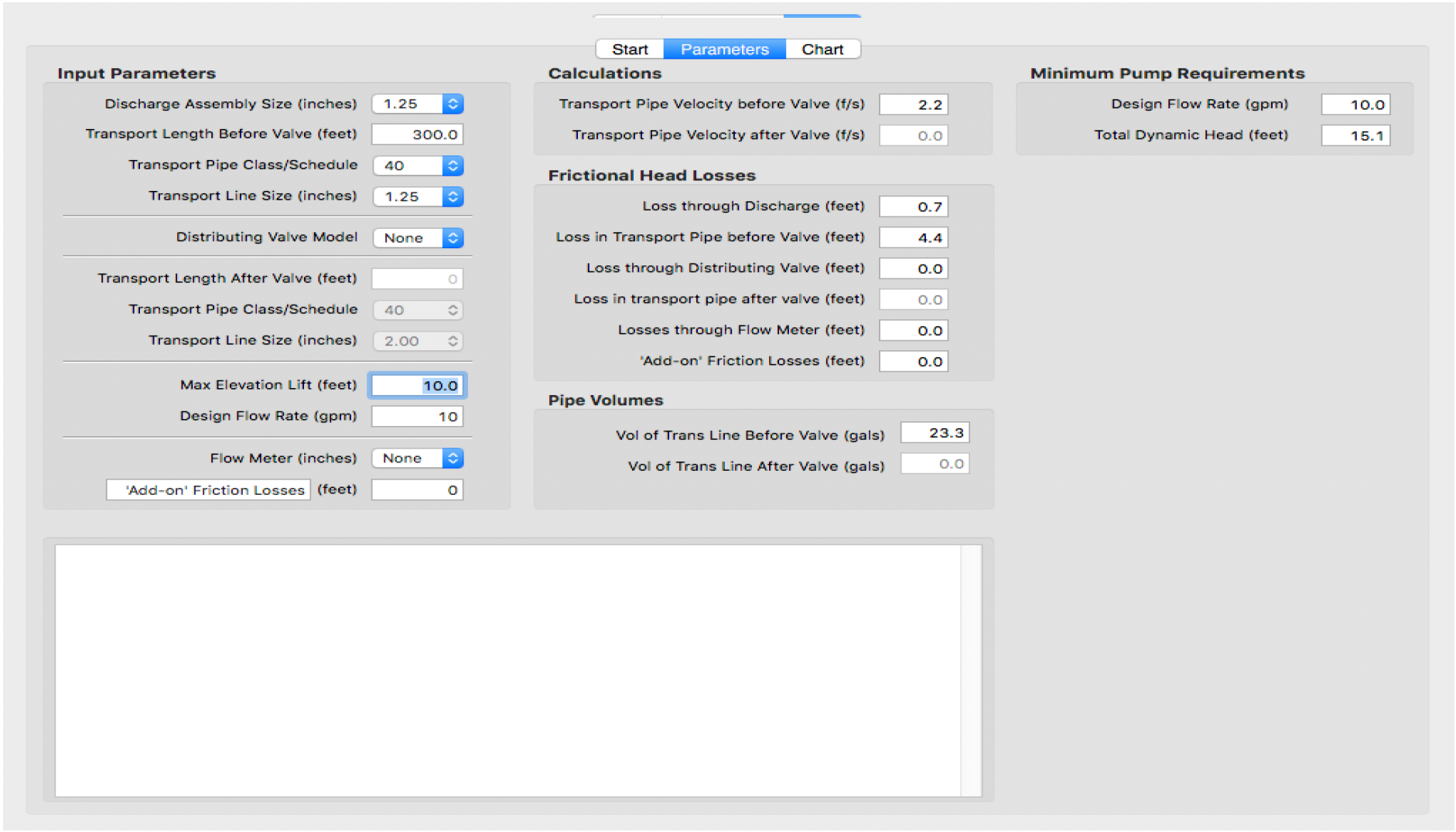


Pump curves show how various pump models perform (measured in Total Dynamic Head).

Pump Curves


Start
Parameters
Chart
Size Pump For
Design Flow Rate (gpm) 10.0
Total Dynamic Head (feet) 15.1
Choose Pumps
PF10 HH Effluent
PF10 HH Effluent 2Hp
PF15 HH Effluent
PF20 HH Effluent
PF30 HH Effluent
PF3005
PF3007
PF3010
PF3015
PF30 2-5hp HH Effluent
PF50 HH Effluent
PF50 3-5HP HH Effluent
PF75 HH Effluent
PF145 HH Effluent
PF10 50Hz HH Effluent
PF30 50Hz HH Effluent
PF50 50Hz HH Effluent
Legend
System Curve:
Pump Curve:
Pump Optimal Range:
Curve Intersection:
Design Point:
Pump Spec:
Total Dynamic Head, TDH (Feet)
300
250
200
150
100
50
0
PF3005
0
5
10
15
20
25
30
35
40
Net Discharge (gpm)
Pump Description:
PF3005 High Head Effluent Pump
30 GPM, 1/2HP
115/230V 1Ø 60Hz, 200V 3Ø 60Hz
Find Pumps
GPM:
TDH:
+
%
Find
Clear

Pump Select


Start
Parameters
Chart
Input Parameters
Discharge Assembly Size (inches) 1.25
Transport Length Before Valve (feet) 300.0
Transport Pipe Class/Schedule 40
Transport Line Size (inches) 1.25
Distributing Valve Model None
Transport Length After Valve (feet) 0
Transport Pipe Class/Schedule 40
Transport Line Size (inches) 2.00
Max Elevation Lift (feet) 10.0
Design Flow Rate (gpm) 10
Flow Meter (inches) None
'Add-on' Friction Losses (feet) 0
Calculations
Transport Pipe Velocity before Valve (f/s) 2.2
Transport Pipe Velocity after Valve (f/s) 0.0
Frictional Head Losses
Loss through Discharge (feet) 0.7
Loss in Transport Pipe before Valve (feet) 4.4
Loss through Distributing Valve (feet) 0.0
Loss in transport pipe after valve (feet) 0.0
Losses through Flow Meter (feet) 0.0
'Add-on' Friction Losses (feet) 0.0
Pipe Volumes
Vol of Trans Line Before Valve (gals) 23.3
Vol of Trans Line After Valve (gals) 0.0
Minimum Pump Requirements
Design Flow Rate (gpm) 10.0
Total Dynamic Head (feet) 15.1

Troubleshooting Pump Problems

- The pump is often innocent, but is guilty until proven innocent
- Problem frequently has nothing to do with the pump
  - The pump gives you clues as to the problem's source
- Check most obvious things first
  - Power/ wiring (use amp/volt/ohm meters properly)
  - Pump vault screen or Biotube® filter
  - Plumbing/valves (including check valves)
  - Frozen/blocked lines
  - Follow checklist – Orenco's or yours
- As a last resort, pull the pump and test/inspect in the daylight

Troubleshooting Pump Problems

- Controls
  - Does the pump run in auto or manual
  - Is the motor contactor closing?
  - Is there an alarm lock out preventing the pump from running?
    - Ex. Redundant off alarm
    - Ex. Discharge High level
    - Ex. UV alarm

Troubleshooting Pump Problems

- Checking Incoming Power
  - Confirm the voltage of the pump
  - Start at the pump terminals in the control panel to check the voltage.
  - If the voltage at the pump terminals is incorrect work upstream
  - If the voltage at the pump terminals is correct work downstream towards the pump

Troubleshooting Pump Problems

- Testing the motor for Franklin 2-wire motors

MOTOR MODEL PREFIX	NAMEPLATE HORSE POWER	NAMEPLATE VOLTS	LINE-TO-LINE RESISTANCE OHMS
244504	1/2	115	1.0 - 1.3
244505	1/2	230	4.2 - 5.2
244507	3/4	230	3.0 - 3.6
244508	1	230	2.2 - 2.7
244509	1 1/2	230	1.5 - 1.9

If OHM values are normal, the motor windings are neither shorted nor open.
If OHM value is less than normal, the motor or lead is shorted.
If OHM value is greater than normal, the motor or lead has a poor connection.

Troubleshooting Pump Problems

- Generator Use
  - Must be sized to overcome motor startup torque

Motor Rating *		Minimum Rating of Generator			
HP	KW	Externally Regulated		Internally Regulated	
		KW	KVA	KW	KVA
0.50	0.37	3.0	3.75	2.25	2.85
0.75	0.55	4.5	5.70	3.00	3.75
1.00	0.75	6.0	7.50	3.75	4.69
1.50	1.10	7.5	9.38	4.50	5.70

* *These ratings are for Orenco pumps utilizing Franklin Electric 2-wire motors.*

Troubleshooting Pump Problems

Trouble Shooting Guide/Form For Orenco High Head Pumps

Pump Model #: **Date of Installation:** **Application:**

Customer Name: **Initiated By:** **RGA#:**

* Also refer to the "Pump Troubleshooting Tips" document, DCN SIN-OM-TIPS-1

Problem		Check	Corrective Action
Motor will not start but circuit breakers do not trip.			
Cause: Panel Alarm Condition	☐	Redundant off float in down position and/ or sand filter high level alarm?	☐ Correct alarm condition(s).
Cause: No Voltage	☐	No voltage at float switch?	☐ Replace faulty float switch.
	☐	No voltage at control panel?**	☐ Rewire supply to control panel.
	☐	Cable or splices bad?	☐ Consult licensed electrician or serviceman.
	☐	Control panel incorrectly wired?	☐ Reconnect control panel correctly.
	☐	Bad Motor Contactor?***	☐ Replace Motor Contactor
Circuit breakers trip or overload protector trips when motor starts.			
Cause: Wire size to small	☐	Verify correct wire size?	☐ Install correct wire size.
Cause: Low or high voltage	☐	Check that line voltage is within +/- 3% of voltage, 120V/240V, while motor is running?**	☐ If voltage variation is greater then +/- 3%, call power company to adjust voltage.
Cause: Broken wire in control panel.	☐	Examine all connections and wiring in control panel.	☐ Disconnect power and repair or replace faulty wire.
Cause: Pump or motor stuck or binding.	☐	Check for locked rotor in pump.	☐ If necessary, pull pump (make all possible above ground checks first). If pump is locked, replace it. Clean tank before reinstalling pump.
Circuit breakers trip or overload protector trips when motor is running.			
Cause: Low or high voltage	☐	Check that line voltage is within +/- 3% of voltage, 120V/240V, while motor is running.**	☐ If voltage variation is greater then +/- 3%, call power company to adjust voltage.
C[illegible]ambient	☐	[illegible]temperature of control box.	☐ Do not mount control box in direct sunlight.

High-Head Pump, Field or Shop Repairs

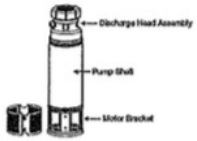
- You can change out:
  - Motor
  - Cord
  - Liquid end
  - Stack (rotating assembly)
- You can clean:
  - Pump screen
  - Pump internals (rotating assembly)
- Maintain a log of all installations, repairs and cleaning

High-Head Pump, Field or Shop Repairs

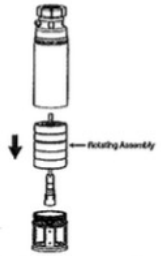
Orenco Systems®
Pump Rotating Assembly Replacement
PF Series 10, 20 and 30 gpm models

Removing Old Rotating Assembly

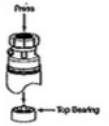
1. Remove suction screen from motor bracket. Unbolt pump end from motor. Clamp motor bracket of pump in a chain vise. Do not clamp around the stainless steel pump shell. Unthread pump shell from the motor bracket by rotating the shell clockwise.



2. Remove old rotating assembly from pump shell. Insure that all parts are removed from the shell/ discharge head assembly.



3. If replacing the top bearing, remove the bearing assembly from the bearing holder in the discharge head by pushing it down from the inlet side of the discharge.

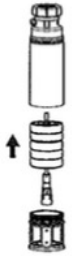


Installing New Rotating Assembly

The new rotating assembly is furnished as a complete unit. No other assembly is required.

1. Install new top bearing assembly into the bearing holder by inserting the bearing up through the pump shell. Make sure the alignment tabs are properly seated in the notches of the bearing holder and the bearing is fully pressed into the holder. A small amount of lubricant should be added to the inside cavity of the bearing.

2. Slide new rotating assembly up through the bottom of the shell making sure the pump shaft fits into the top bearing and the top hydraulic stage seats into the bottom of the discharge head.



3. Thread motor bracket on to the bottom of the shell. Make sure the bracket does not cross thread with the threads on the shell. Turn the motor bracket counter-clock wise to tighten the assembly. Tighten to 70 ft-lbs.

4. Replace inlet suction screen.

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106331101 (Rev. 01/06)

War Stories

- What we see in the pump service lab
  - Not cost effective to repair low head pumps
  - Over 90% of returned high-head pumps have no problem
  - Pumps returned with corroded pumps leads
  - Pumps plugged with hair, grease, you name it
  - Pumps operated with insufficient power
  - False outages due to lack of knowledge about BIAC switch

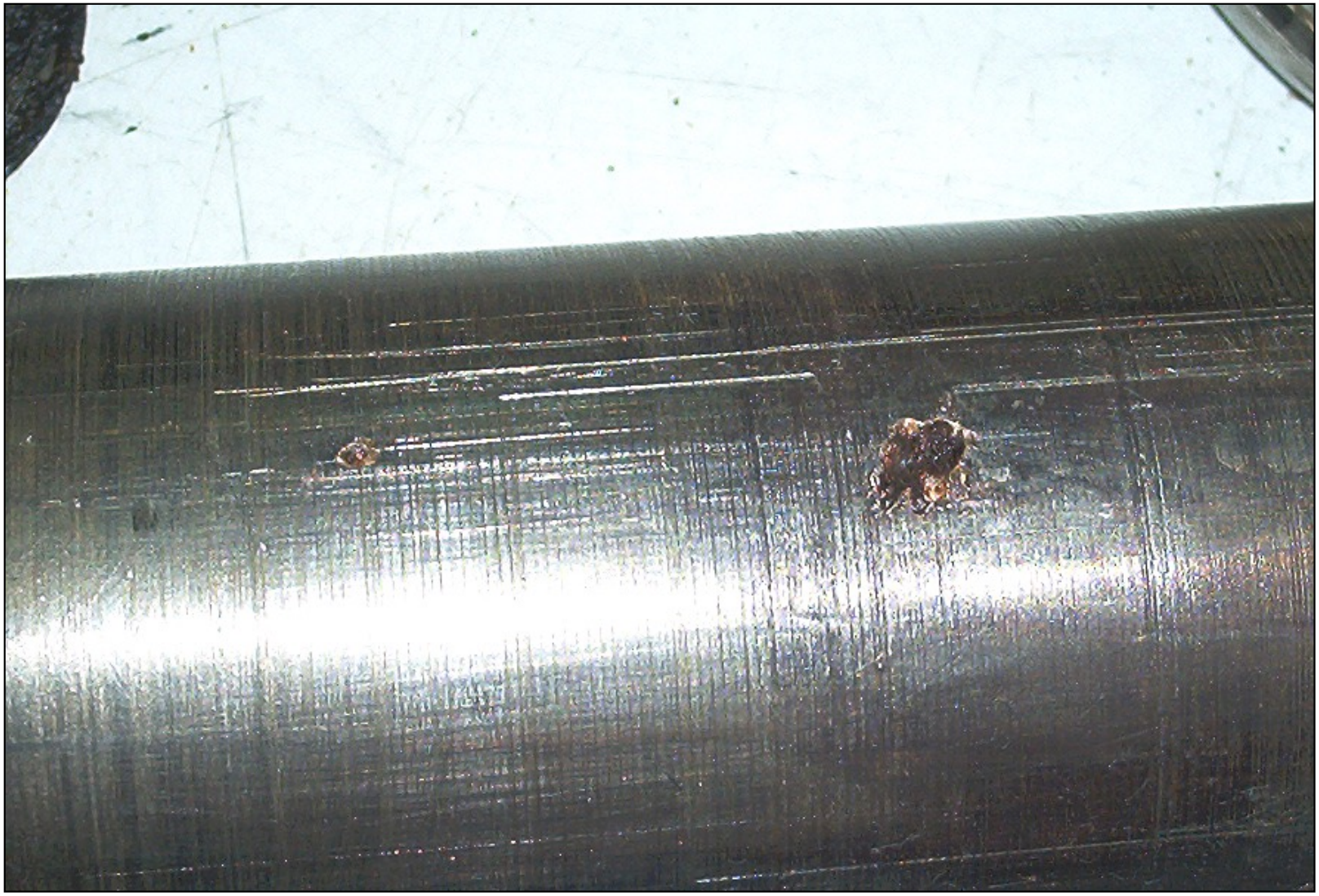
War Stories, cont.

- What we see in the pump service lab
  - 3-phase pumps will run backward if wired wrong
  - Single-phase pumps on cap-packs run backward and burn up if black and red wires are switched
  - Waterlogged cords (leaky splices and wrong wirenuts)
  - This is becoming less prevalent with external splice boxes
  - Pumps blamed for poor performance where actual problem was defective check valve (s)
  - H/V assemblies broken when there is no torque lock used on higher HP pumps

Abused and Neglected Pump

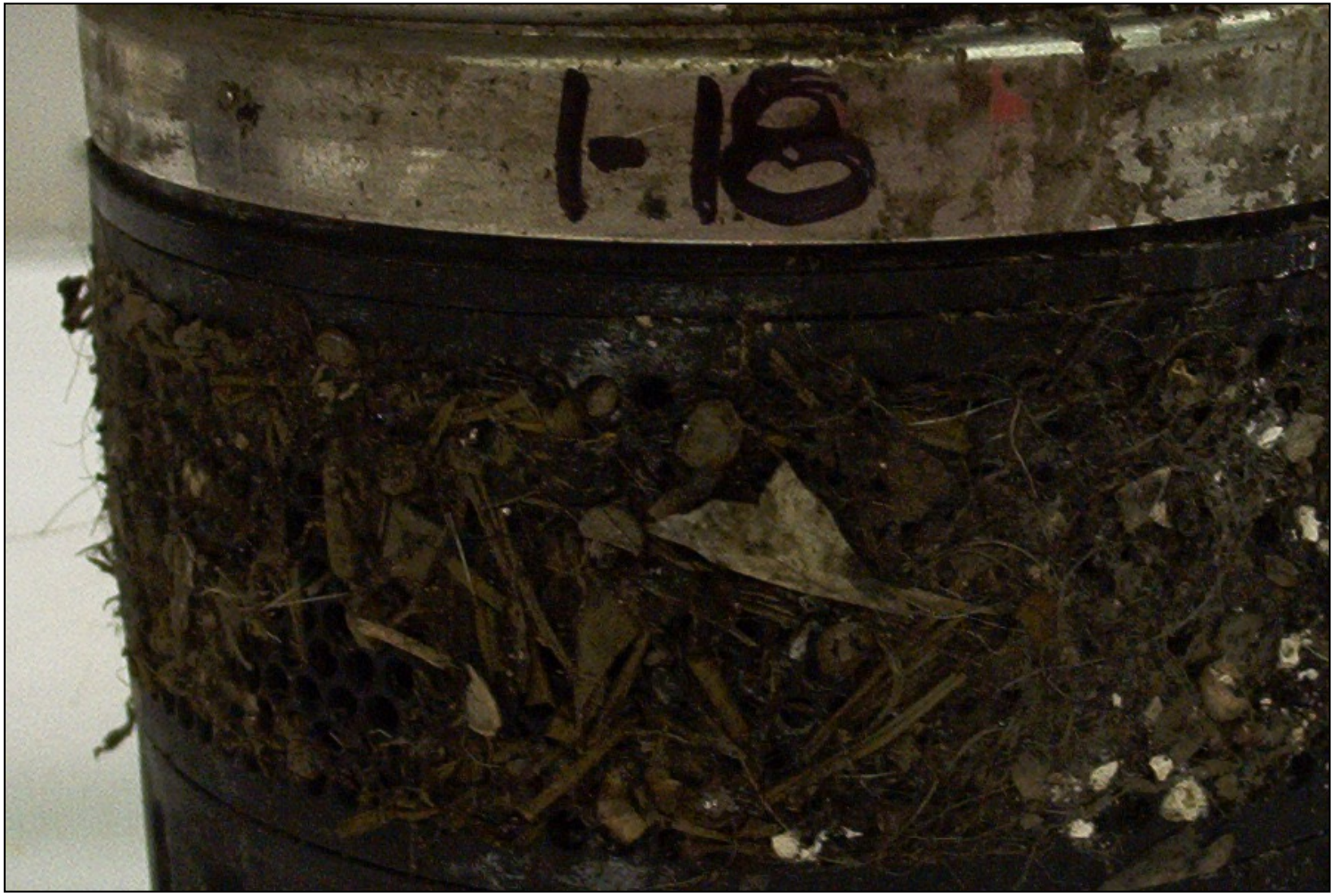
Damage Due to Abrasives

Lightning Damage



Corrosion Cracks Due to Salt Water

Blind Screen



Debris In a Pump

Grease Filled Liquid End

Crusted and Blocked Impellers

Pump Performance Report

Orenco Systems®, Inc. | Pump Performance Report

PA300511 VRS PA300511 Standards

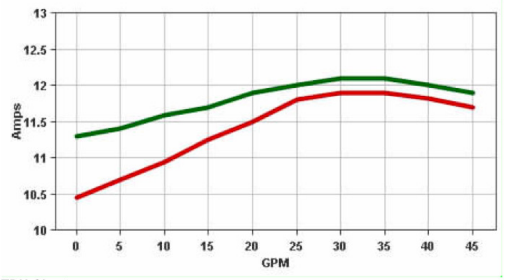
Printed **Oct 27, 2008**

PA300511 Motor S/No: **28-0302** Moter Date Code: **06H14** Liquid End Date Code: **01L07A** RGA Number: **20746**

GPM	HP	Plate Voltage	HZ	Line Voltage	Phase	Station	1/8th Hole	Operator	Date
30	0.5	115	60	120	1	4	Yes	Brad Boisen	07/24/08

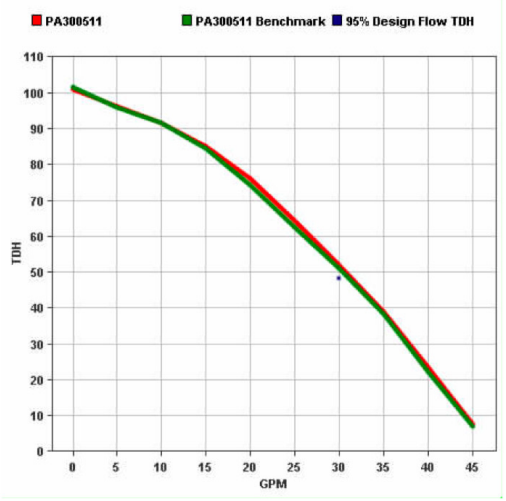
Comments Received with all waterways and both screens blocked with grease. Photos available if you want to see it. Cleaned pump completely and curved against benchmarks. No issues found other than grease blockage.

Amps Chart



	Pump Tested PA300511		Benchmark PA300511	
GPM	AMPS	TDH	AMPS	TDH
0	10.45	100.97	11.30	101.40
5	10.70	96.12	11.40	95.98
10	10.95	91.50	11.60	91.64
15	11.26	85.03	11.70	84.33
20	11.50	76.02	11.90	74.22
25	11.80	64.23	12.00	62.44
30	11.90	51.76	12.10	50.85
35	11.90	38.82	12.10	38.24
40	11.82	23.33	12.00	22.12
45	11.70	7.62	11.90	7.00

TDH Chart



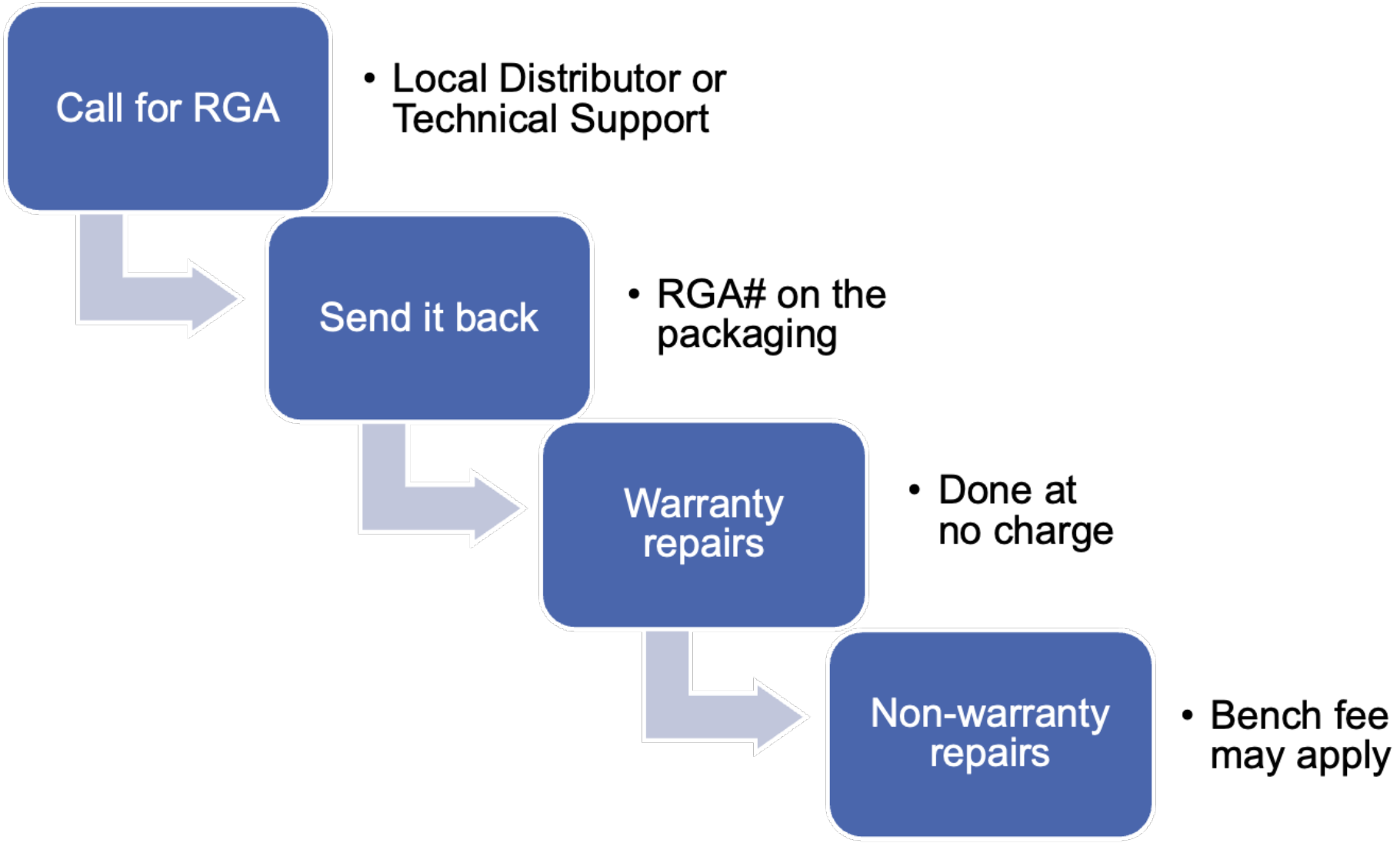
BENCHMARK NOTE:
- All 115 V. nameplate pumps are tested at 119 to 121 V.
- All 200 V. three phase nameplate pumps are tested at 209 to 211 V.
- All 220/230 V. (50HZ) nameplate pumps are tested at 228 to 230 V.
- All 230 V. (60HZ) nameplate pumps are tested at 240 to 242 V.

O-12/20/01

How to Increase a Pump's Life

- Low-head and high-head
  - Use proper screen
  - Control MLL (measured relative to bottom of pump)
  - Avoid frequent starts
  - Provide proper power
  - Use check valves properly
  - Perform regular inspections, service, and maintenance
- Additionally, for high-head
  - Avoid up thrust / down thrust
  - Use flow control disc if needed
  - Avoid abrasives
  - Use a flow inducer to keep motor cool

Return Good Authorization Process (RGA)



The Do's ...

- Run high-head pumps within 30%± of rated gpm for best efficiency and pump life
- Use flow control disc if needed to stay within ± 30%
- Select pump based on accurate hydraulic profile
- Match pump to the application
- Use proper controls
  - Use floats properly
- Perform preventative maintenance
  - Compare pump volume to spec
  - Pull pump, inspect screen
  - If plugged, clean screen
  - Maintain install / service logs

The Don’ts …

- Don’t neglect your pump
- Don’t neglect pump screen or Biotube®
- Don’t neglect check valves
- Don’t lift pump by its cord
- Don’t use pump discharge assembly as the float hanger
- Prevent rapid pump cycling
- Final Don’t compromise on quality

Questions?