



A RUTHMAN COMPANY

Installation, Operation, and Maintenance Manual

7550 Series Vertical Pumps

MODELS

52 Heavy Duty, 53 Heavy Duty & 54 Heavy Duty
Power Frames

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This Installation, Operation, and Maintenance manual is designed to help you get the best performance and longest life from your Gusher 7550 Series vertical end suction centrifugal pump.

If there are any questions regarding the pump or its applications which are not covered in this manual, or in other literature accompanying this unit, please contact your Gusher distributor, or contact:

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For information or technical assistance on the power source, contact the power source manufacturer's local dealer or representative.

WARRANTY

Gusher Pumps, Inc. will replace or repair, within one year of shipment from our plant, any pump that, in our judgment, has failed due to defects in materials or workmanship, provided the pump has been properly installed and maintained and has not been subject to abuse.

These pumps must return to Gusher Pumps, Inc. with complete history of service for inspection and warranty consideration.

Gusher Pumps, Inc. does not accept the responsibility for transportation to and from our plant. Furthermore, we do not assume any responsibility for consequential damage or loss of production.

WARRANTY IS ONLY VALID WHEN GENUINE GUSHER PARTS ARE USED.

RECEIVING AND INSPECTION

The utmost care has been taken at the factory to assure proper coupling alignment and impeller adjustment. However, due to circumstances beyond our control, YOU MUST inspect the pump upon receipt and follow the installation instructions completely before start-up.

RECEIVING:

1. Rotate shaft by hand. If it does not rotate freely:
 - A. Check impeller adjustment.
 - B. Check for bent coupling guard.
 - C. Check slinger.
 - D. Check for bent shaft.
2. Check for cracked or damaged parts. If upon receipt, you find the pump damaged, file a claim with the delivering carrier.
3. If drive motor has been supplied, check the rpm and horsepower to be sure it is correct as ordered.
4. Check the pump name tag to be sure you have received the pump as ordered:
 - A. Model Number
 - B. Head in feet (Ft. Hd.)
 - C. Gallons per minute (gpm)
 - D. Construction:
 - a. All iron.
 - b. All iron with stainless steel shaft and impeller.
 - c. All stainless steel.
5. If there is anything that appears to be incorrect, call the factory immediately.

INSTALLATION

After careful preliminary inspection, you may proceed with the installation of the pump into your system.

- A. Lower the pump into tank, making sure the mounting plate rests firmly on a proper support structure. The cover plate must be mounted level and remain at least 1" above high liquid level at all times. Appropriate shims may be used between the plate and support structure to level cover plate.
- B. Secure mounting plate by using hold-down screws in all four corners. Again, care must be taken to make sure plate is firm and level. DO NOT force bowed plate level. Use metal shims if necessary.
- C. Making pipe connections:
 1. Extreme care must be taken to support piping without causing any strain on the pump.
 2. Install pipe hanger on the discharge pipe so all piping weight is supported by the hanger and not by the pump or the casing.
 3. Bolt holes must line-up without prying to insert bolts.
 4. When tightening flange bolts, pipe flanges must not be forced together.
 5. Check valve should be placed in discharge line between gate valve and pump discharge pipe to prevent liquid from running back through the pump and causing reverse rotation. This is extremely important in applications with intermittent duty where the pump may be rotating backwards when service is resumed. This will cause damage to the pump and the drive motor.
 6. Pressure gauge should be located at the pump discharge, as all performance data is taken at pump discharge.
 7. If intake piping is used to pump the tank down, it must also be supported independently of the pump.
- D. Once piping is installed, remove coupling guard and rotate pump shaft by hand. Pump should rotate freely at this point. If it does not, check for:
 1. Piping strain: without exception, piping must not rest on pump in any manner. (See 4, above for pipe connection info.)

2. Impeller adjustment-standard pump; for high speed pump impeller adjustment, contact factory. (**Fig.1**):
 - a. Disconnect coupling (#32) and remove sleeve (#32a).
 - b. Loosen three locking screws (#57).
 - c. Loosen three adjusting screws (#55).
 - d. Lightly tap shaft (#1) until impeller bottoms on the intake flange.
 - e. Tighten three adjusting screws by hand until they touch ball bearing housing.
 - f. Tighten three adjusting screws just up to the point where the shaft turns freely; then tighten each screw an additional ¼ turn.
 - g. Tighten locking screws (#57) and jamb nuts (#56).
 - h. Rotate coupling by hand to be sure impeller does not rub intake flange. If impeller does rub, repeat steps a through g.
 - i. Connect Coupling.

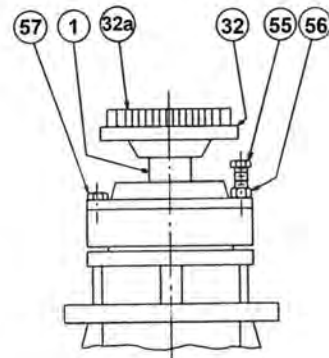


Fig. 1

3. Slinger adjustment: The slinger is set at the factory and normally causes no problems, but should be checked when unit is inspected upon arrival at your plant site and before unit is lowered into position in your system.
- E. Coupling alignment (Chair Mounted Model ONLY): MUST BE CHECKED before and after system start-up.
 1. Check **Parallel Alignment (Fig. 2)** by placing a straight- edge across the two coupling flanges and measuring the maximum offset at various points around the periphery of the coupling. If

the maximum offset exceeds .010", realign the coupling.

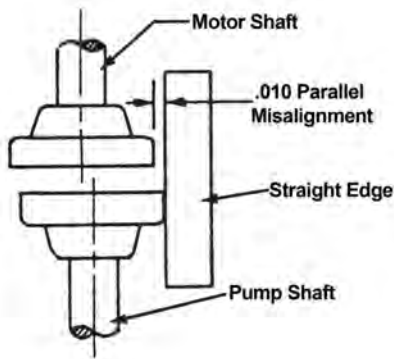


Fig. 2

2. Check **Angular Alignment (Fig. 3)** with a micrometer or caliper. Measure from the outside of the 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 difference between the maximum and the minimum must not exceed .010". If a correction is necessary, be sure to recheck the parallel alignment.

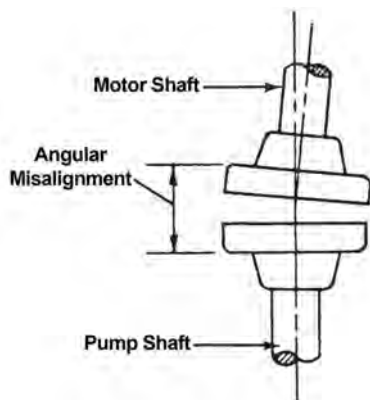


Fig. 3

3. If coupling alignment is out, adjustment can be made by the following steps:
 - a. **Lateral Parallel Misalignment** is adjusted by loosening the four motor retaining bolts (#49) (Fig. 4) after which you loosen the lateral adjusting screws (#58) (Fig. 5) on the side of the motor that has to be shifted and tighten the remaining lateral adjustment screws until lateral parallel alignment is achieved. (Fig. 5) If misalignment is out more than .020" see step e.

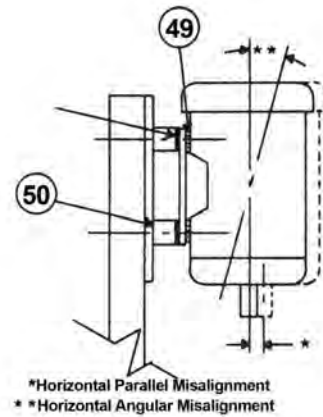


Fig. 4

- b. **Horizontal Parallel Misalignment** is adjusted by loosening the four motor retaining bolts (#49) (Fig. 4) after which you add or subtract shims from between motor base and motor support pads (#50) (Fig. 5). If more than 0.1875" total shims are required or alignment cannot be achieved without any shims, see step v. Tighten all screws before operating pump.
- c. **Lateral Angular Misalignment** is adjusted by loosening the four motor retaining bolts (#49) (Fig. 4) after which you loosen the angular alignment screws (#59) (Fig. 5) on the side of motor that has to be lowered and tighten the angular alignment screws on side of motor that has to be raised, until angular alignment is achieved. (Fig. 5) Tighten all screws before operating.
- d. **Horizontal Angular Misalignment** is adjusted by loosening the four motor retaining bolts (#49) (Fig. 4) after which you add or subtract shims from between motor base and motor support pads (#50) (Fig. 4). Tighten all screws before operating pump.
- e. If lateral alignment and horizontal parallel alignment cannot be achieved with the above steps use the following operation:
 - Loosen nuts or screws that hold bearing housing to mounting plate.

- Tap ball bearing housing with lead hammer to move coupling into alignment.
- If unable to align coupling by tapping the ball bearing housing then insert a prybar between the ball bearing housing and the burned out hole in the mounting plate and shift coupling into alignment by prying housing from one position to another as required.
- Tighten all screws before operating pump.

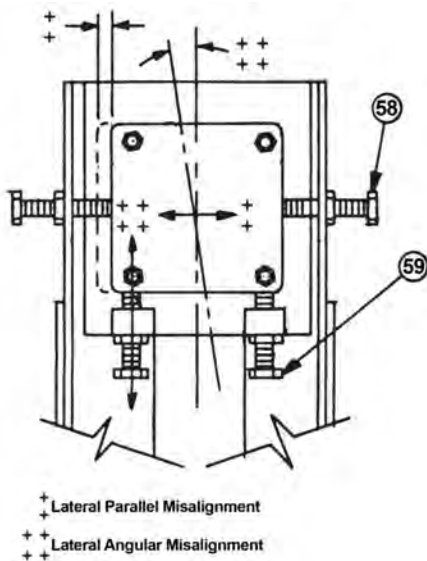


Fig. 5

! NOTE !

DO NOT loosen the four motor screws too much, as this will cause difficulty when trying to align coupling. Motor screws must be snug so a slight force must be applied to move motor.

If an adjustment in either parallel or angular alignment is required, you must check both after adjustment is made.

Coupling alignment must be checked after system has been operating for 300 hours. Then as a preventative maintenance procedure, it should be checked every 1200 hours of normal operation. More severe duty operation requires more frequent attention.

- f. Electrical connections should conform with state and local codes. (It is advised to use approximately 4' length of flexible conduit to facilitate removal of chair, if repair is required.)

Upon initial start-up, pumps may seem to run tight and hot. This is caused by the breaking in of oil seals and ball bearings. Pump will operate normally after approximately 150 hours of service.

Ball bearings should not run over 225°F. When checking temperature, use a pyrometer.

START UP

FINAL CHECKS:

1. Verify **mounting plate height**-pump should be securely mounted with the bottom of the plate at least 1" above the highest possible liquid level.
2. Check **liquid level**-it should be at least 2" above the point at which the shaft exits the top of the pump end.
3. Test **shaft rotation**-momentarily energize (bump) the motor to assure shaft is rotating in clockwise direction when viewed from the top.

After completing these checks, it is safe to **start the pump**.

AFTER START UP:

After at least 30 seconds after starting the pump, measure and make note of the following readings to establish a baseline for future reference:

1. Discharge pressure
2. Flow rate
3. Motor amp draw
4. Location of the pressure gauge in relation to the liquid level

MAINTENANCE

- A. **Lubrication:** All 7550 pumps are grease-lubricated. The initial grease lubrication is done at the factory prior to shipment. Additional lubrication should not be required for approximately 1200 hours of operation if run at 1750 rpm, or 600 hours if run at 3450 rpm.

A well-planned maintenance schedule can only be devised after careful observation of the pump for the first six months of operation and the lubrication that has been required. Each pump installation is unique and requires a different lubrication schedule compatible with that specific operation.

! NOTE !

DO NOT mix grease types as it will cause bearing failure (e.g. lithium/oil base).

Use Chevron SRI #2 ball bearing grease, or equivalent. If any other grease is used, the initial fill grease must be purged from the system prior to installing a suitable alternative grease.

! NOTE !

DO NOT OVER GREASE as it will cause ball bearings to run hot.

Upon initial startup, bearings may seem to run tight and hot. This is caused by the

breaking in of oil seals and ball bearings. Pump will operated normally and bearing temperatures should drop after approximately 150 hours of service. Bearings should not run over 225°F.

! CAUTION !

DO NOT LUBRICATE A PUMP IN OPERATION. Shut down pump prior to lubrication.

To lubricate:

- A. Shut down pump.
 - B. Remove relief from back of ball bearing housing.
 - C. Fill with grease until fresh grease flows from opening.
 - D. If automatic lubrication system is being used, reliefs must be placed in the tapped hole (1/8" N.P.T.).
- B. **Coupling Alignment:** This must be checked before and after system start-up; after 300 hours of operation; and again after 1200 hours of operation.

Follow procedure given in **Step F** of the **INSTALLATION** section of this manual. Again, we recommend strongly that a routine preventative maintenance schedule be devised and followed to achieve optimum life and performance of the pump.

DISASSEMBLY

CHAIR AND DRIVE MOTOR

- A. Disconnect electrical leads. During installation it was advised to allow sufficient flexible conduit (approximately 4 feet) to allow removal without disconnection of electrical leads.
- B. Remove coupling guard.
- C. Disconnect coupling.
- D. Remove four motor retaining bolts. Motor can now be removed from chair.
- E. Break welds loose that hold discharge pipe cover plate to mounting plate.

- F. Remove bolts & nuts that hold discharge pipe to impeller housing.
 - G. Remove discharge pipe.
- On 52VHD Power Frame:**
1. Remove bolts, nuts & washer that hold chair to stem.
 2. Remove chair from pump.
- On 53VHD & 54VHD Power Frames:**
1. Remove Intake Flange. (not applicable on all models)
 2. Remove impeller housing.
 3. Remove impeller retaining nut.

4. Remove impeller retaining washer. (not applicable on all models)
5. Remove impeller.
6. Remove impeller drive and tape it to the hub of the impeller so it will not get lost.
7. Loosen set screws in slinger.
8. Remove stem plate. (not applicable on all models)
9. Remove stem.
10. Remove power frame assembly from chair.

BARREL AND DRIVE MOTOR

- A. Disconnect electrical leads. During installation it was advised to allow sufficient flexible conduit (approximately 4 feet) to allow removal without disconnection of electrical leads.
- B. Remove coupling guard.
- C. Disconnect coupling.
- D. Remove bolts that hold barrel to bearing housing.
- E. Remove barrel & motor from power frame.

PUMP

! NOTE !

READ ALL instructions thoroughly before beginning disassembly.

A. 52VHD Barrel Mount or Chair Mount

1. Follow Chair/Barrel and Drive Motor instructions above.
2. Remove bolts nuts and washers that hold discharge pipe to the impeller housing. Remove bolts, nuts and washers that hold mounting plate to stem. Remove mounting plate (barrel mount only).
3. Remove intake flange (not applicable on all models)
4. Remove impeller housing.
5. Remove impeller retaining screw.
6. Remove impeller retaining washer.
7. Remove impeller.
8. Remove impeller drive key. Tape it to the hub of the impeller so it will not get lost.
9. Loosen set screw in slinger.
10. Remove stem plate. (not applicable on all models)
11. Remove stem.
12. Remove ball bearing retainer.

13. Slide shaft, telescoping ball bearing housing, ball bearing, grease and radial bearing retainer and radial bearing out of bearing housing as one unit.
14. Remove ball bearing lock nut from shaft.
15. Remove ball bearing from shaft.
16. Remove telescoping ball bearing housing from shaft.
17. Remove oil seal from telescoping ball bearing housing.
18. Remove grease and radial ball bearing retainer and radial ball bearing together from shaft.
19. Remove oil seal from ball bearing housing.
 - a. Remove throttle bushing retainer. (not applicable on all models)
 - b. Remove throttle bushing.

B. 53VHD & 54VHD Chair Mount

1. Follow Chair and Drive Motor instructions above.
2. Remove 3 bolts.
3. Slide shaft, ball bearing retainer, thrust ball bearing and radial ball bearing out of ball bearing housing as one unit.
4. Remove ball bearing retainer.
5. Slide telescoping ball bearing housing down off of the thrust bearing.
6. Remove ball bearing housing from shaft.
7. Remove thrust ball bearing from shaft.
8. Slide telescoping ball bearing housing off shaft.
9. Remove bearing and grease retainer and radial ball bearing from shaft. Remove both at the same time so as not to damage retainer.
10. Remove oil seal from telescoping ball bearing housing.
11. Remove oil seal from ball bearing housing.
12. Remove throttle bushing retainer. (not applicable on all models)
13. Remove throttle bushing.

C. 53VHD & 54VHD Barrel Mount

1. Follow Barrel Mount and Drive Motor instructions above.
2. Break welds loose that hold discharge pipe cover plate to mounting plate.

3. Remove bolts and nuts holding discharge pipe to impeller housing.
4. Remove discharge pipe.
5. Remove intake flange. (not applicable on all models)
6. Remove impeller housing.
7. Remove impeller retaining nut.
8. Remove impeller retaining washer. (not applicable on all models)
9. Remove impeller.
10. Remove impeller drive key and tape it to the hub of the impeller so it will not get lost.
11. Loosen set screws in slinger.
12. Remove stem plate. (not applicable on all models)
13. Remove stem.
14. Remove power frame from mounting plate.
15. Remove 3 bolts.
16. Slide shaft, ball bearing retainer, thrust ball bearing and radial ball bearing out of ball bearing housing as one unit.
17. Remove ball bearing retainer.
18. Slide telescoping ball bearing housing down off of the thrust bearing.
19. Remove ball bearing lock nut from shaft.
20. Remove thrust ball bearing from shaft.
21. Slide telescoping ball bearing housing off shaft.
22. Remove bearing and grease retainer and radial ball bearing from shaft. Remove both at the same time so as not to damage retainer.
23. Remove oil seal from telescoping ball bearing housing.
24. Remove oil seal from ball bearing housing.
25. Remove throttle bushing retainer. (not applicable on all models)
26. Remove throttle bushing.

REASSEMBLY

To reassemble pump, reverse the disassembly steps while making sure of the following:

1. For bearing installation see next section.
2. Check grease seals for wear. Replace if worn.
3. Install retainer and telescoping ball bearing housing on shaft. Before putting bearing on shaft.
4. Install slinger on shaft while connecting stem to bearing housing.
5. Check throttle bushing for wear. Replace if worn.

! NOTE !

There are two different versions of throttle bushings. One is a TEFLON TYPE that has a

retainer. The other is a CARBON TYPE that is pressed in place.

6. Clearance between impeller and housing or intake flange should not exceed .015". To adjust clearance see **INSTALLATION**, section 5B (for SE models only).

! NOTE !

Certain models have an enclosed impeller. These models are supplied with a carbon wear ring that is press fitted into the intake flange. Upon disassembly check the wear ring for wear. Replace if worn.

BEARING INSTALLATION

! NOTE !

Begin by cleaning your work area thoroughly, contaminants can cause bearing failures.

When a bearing is installed, the mounting force should be applied against the ring, and only the ring, which is being press-fitted. A bearing

should never be forced onto a shaft by pressure or hammer blows applied to the other ring, nor should the bearing be press-fitted into housing by force applied to the inner ring.

Using an arbor press, the bearing may be laid on a face block which contacts only the bearing inner ring and which has a hole diameter

greater than the bearing bore (**Fig. 6**). The shaft is pressed through the bearing until it is seated firmly against the shaft shoulder.

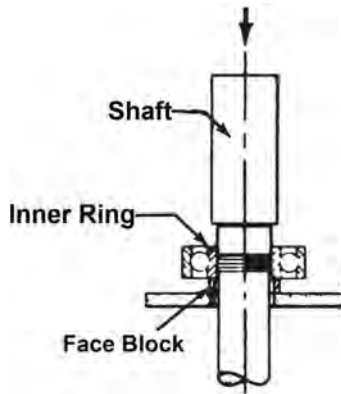


Fig. 6

If the shaft is not too long, it can be supported beneath the table of the arbor press and the bearing pressed onto it by ram pressure against a piece of soft metal tubing (**Fig. 7**). The tubing must be clean, inside and out, and the diameter of the tubing should be slightly greater than the bearing journal. The end of the tubing should be square (with corners chamfered to avoid flaking) and should contact only the bearing inner ring. The shaft must be held in line with the ram of the arbor press to avoid cocking the bearing on the shaft seat.

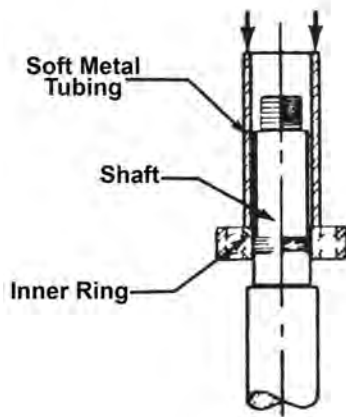


Fig. 7

When an arbor press is not available, the bearing can be driven onto the shaft seat by light hammer blows against the end of the soft metal tubing. These blows should be made alternately against opposite sides of the tubing face, and great care must be taken to avoid cocking the bearing as it is driven onto the shaft seat.

When a ball bearing is installed into the housing it is normally a slip fit, however if force is necessary to install bearing, the force should be exerted on the outer ring of the bearing (**Fig. 8**). Again the force must be applied evenly so as not to cock the bearing in the bore.

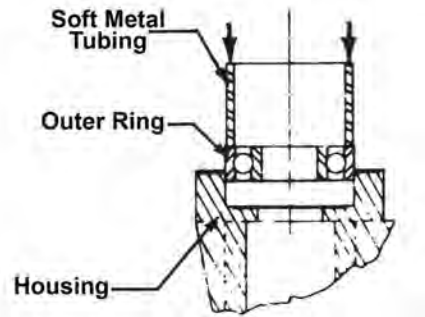


Fig. 8

TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	PROBABLE REMEDY
No Water Delivered	Pump not primed.	Check that water level comes above the pump housing.
	Speed too low.*	Check motor rpm.
	Suction line or suction strainer is clogged.	Check line and strainer and clean if needed.
	Impeller completely clogged.	Check impeller and clear all debris.
	Wrong direction of rotation.	Consult factory for re-wiring instruction.
	Too much clearance between impeller and intake flange.	Re-adjust impeller.
	Suction or discharge piping is plugged.	Assure shipping port plugs have been removed and there are no obstructions
Not Enough Flow or Pressure Delivered	Speed too low.*	Check motor rpm.
	Discharge head higher than anticipated.	Consult factory for resizing to accommodate pressure needed.
	Too much clearance between impeller and intake flange.	Re-adjust impeller.
	Impeller partially clogged.	Check impeller and clear all debris.
	Not enough suction head for hot water.	Consult factory.
	Wear ring is worn.	Replace wear ring.
	Impeller damaged.	Replace impeller.
	Impeller diameter too small.	Consult factory.
	Suction opening not submerged deep enough.	Raise liquid level.
	Fluid too viscous or characteristics different than engineered.	Consult factory.
	Pump running backward.	Verify proper pump direction.
	More than 3% air in fluid.	Check for cavitation and air entrainment. Try to reduce percentage of air in liquid.
	Cavitation	Not enough NPSH at given flow rate. Consult Factory.
	Impeller diameter too small.	Consult factory.
Vibration	Bent shaft.	Check shaft run out.
	Pipe strain.	Unbolt discharge flange and look for movement or separation between pump flange and pipe flange.
	Impeller clogged.	Check impeller and clear all debris.
	Coupling alignment off.	Re-align coupling.
Pump Works For a While, Then Loses Flow or Pressure	Leaky suction line.	Check for leaks in suction line and flanges and repair or replace.
	Impeller clogged.	Check impeller and clear all debris.
	Air or gasses in liquid.	Check for air entrainment and confirm liquid temperature.
Pump Takes Too Much Power	Speed too high.*	Check motor rpm.
	Head lower than rating, pumps too much water.	Adjust discharge to meet pump design point.
	Specific gravity or viscosity too high.	Consult factory.
	Shaft bent.	Check run out on shaft.
	Power frame in bind.	Check run out on shaft. Look for buildup on bushings and/or inside the housing.
	Impeller diameter too large.	Consult factory.
	Pump delivering too many gallons.	Adjust discharge to meet pump design point.

* When directly connected to electric motors, check for full voltage across all electrical leads.

MAINTENANCE HISTORY

SERIAL NO. _____

MODEL NO. _____ IMP. DIA. _____

OPERATING COND. _____ GPM @ _____ FT. THD _____

HP _____ SPEED/RPM _____

START UP DATE _____ AMPS AT STARTUP _____

PRESSURE AT START UP _____

ENGINEERING DATA

POWER FRAME	52 HD	53 HD	54HD
1. RADIAL BRG.	41211	41316	41319
2. THRUST BRG.	41308-DR	41312-DR	41314-DR
3. BALL BRG. SPAN	9.032	12.750	12.750
4. SHAFT DIA'S.			
@ RADIAL BRG.	2.1655	3.1497	3.7403
@ THRUST BRG.	1.5750	2.3623	2.7560
@ THROTTLE BUSHING	1.735	1.875*	2.500
@ IMPELLER	1.375	1.500	1.750
BET. BALL BRG'S.	1.937	3.125	3.625
BET. RADIAL BRG. & THROTTLE SLV.	2.250	3.250	4.250

*2.010 (6x6-14)

GREASE LUBRICATION

Date	Greased	Date	Greased	Date	Greased

Type of Grease Used _____

COUPLING ALIGNMENT

Date Checked	Amount Out	Date Checked	Amount Out	Date Checked	Amount Out	Date Checked	Amount Out	Date Checked	Amount Out	Date Checked	Amount Out

Notes:

FREQUENTLY USED FORMULAS AND EQUIVALENTS

HEAD & PRESSURE

FORMULA
 Head in feet = $\frac{(\text{Head in psi}) \times 2.31}{(\text{Sp. Gr})}$

Head in psi = $\frac{(\text{Head in ft}) \times (\text{Sp. Gr})}{(2.31)}$

NET POSITIVE SUCTION HEAD

Flooded Suction:

$$\text{NPSH} = h_a - h_v + h_s - h_f$$

Suction Lift:

$$\text{NPSH} = h_a - h_v - h_s - h_f$$

h_a = the absolute pressure in feet of liquid on the surface of the supply liquid.

h_v = the vapor pressure of the liquid being pumped expressed in feet of head.

h_s = the height in feet of the supply liquid surface with respect to the pump inlet.

h_f = the suction line friction losses expressed in feet of head.

These calculations yield the available net positive suction head for a given system.

This must be compared to the required net positive suction head NPSH_R calculated by the manufacturer. NPSH_A must exceed NPSH_R .

PRESSURE EQUIVALENT TABLE

Convert to:											
Convert from:	lb/in ²	lb/ft ²	Atmospheres	kg/cm ²	kg/m ²	in. water (68°F)	ft. water (68°F)	in. mercury (32°F)	mm mercury (32°F)	Bars ‡	Mega-Pacals (MPa)‡
lb/in ² .	1.0	144.00	0.068046	0.070307	703.070	27.7276	2.3106	2.03602	51.7150	0.06895	0.006895
lb/ft ² .	0.0069444	1.0	0.00473	0.000488	4.88241	0.1926	0.01605	0.014139	0.35913	0.000479	0.0000479
Atmospheres	14.696	21116.22	1.0	1.0332	10332.27	407.484	33.9570	29.921	760	1.01325	0.101325
kg/cm ²	14.2233	2048.155	0.96768	1.0	10000.0	394.38	32.8650	28.959	735.559	0.98067	0.098067
kg/m ²	0.001422	0.204768	0.0000968	0.0001	1.0	0.03944	0.003287	0.002896	0.073556	0.000098	0.0000098
in. water*	0.036092	5.1975	0.002454	0.00253	25.375	1.0	0.08333	0.073430	1.8651	0.00249	0.000249
ft. water*	0.432781	63.3205	0.029449	0.03043	304.275	12.0	1.0	0.88115	22.3813	0.029839	0.0029839
in. mercury**	0.491154	70.7262	0.033421	0.03453	345.316	13.6185	1.1349	1.0	25.40005	0.033864	0.0033864
mm mercury**	0.0193368	2.78450	0.0013158	0.0013595	13.595509	0.53616	0.044680	0.03937	1.0	0.001333	0.001333
Bars	14.5038	2088.55	0.98692	1.01972	10197.2	402.156	33.5130	29.5300	750.062	1.0	0.1
MPa	145.038	20885.5	9.8692	10.1972	101972.0	4021.56	335.130	295.300	75000.62	10.0	1.0

* Water at 68°F (20°C) ** Mercury at 32°F (0°C) 1 MPa (MegaPascal) = 10 Bars = 1,000,000 N/m² (Newtons/Meter²)

FLOW EQUIVALENT TABLE

Convert to:						
Convert from:	U.S. gal/min	Imperial gal/min	U.S. Million gal/day	Cu. ft. per sec (sec-ft.)	Cu. m Per/hour	Liters per/sec
U.S. gal/min	1.0	0.8327	0.00144	0.00223	0.2271	0.0631
Imperial gal/min	1.201	1.0	0.00173	0.002676	0.2727	0.0758
U.S. Million gal.day	694.4	578.25	1.0	1.547	157.7	43.8
Cu. ft/sec	448.83	373.7	0.646	1.0	0.060	28.32
Cu. m/sec	15852	13200	22.83	35.85	3600	1000
Cu. m/min	264.2	220	0.3804	0.5886	60.0	16.667
Cu. m/hr	4.403	3.67	0.00634	0.00982	1.0	0.2778
Liters/sec	15.85	13.20	0.0228	0.0353	3.60	1
Liters/min	0.2642	0.220	0.000380	0.000589	0.060	0.0167

VOLUME & WEIGHTS EQUIVALENT TABLE

Convert to:	Volume and weight equivalents – any liquid						*Weight equivalent basis: water 60°F (15.6°C)		
	U.S. Gallons	Imperial Gallons	Cubic Inches	Cubic Feet	Liters	Cubic Meters	Pounds	U.S. Tons	Kilograms
U.S. Gallons.	1.0	0.8327	231.0	0.13368	3.7854	0.0037854	8.338	0.00417	3.782
Imperial Gallons.	1.20094	1.0	277.39	0.16054	4.546	0.004546	10.0134	0.005	4.542
Cubic Inches	0.004329	0.003605	1.0	0.0005787	0.016387	0.000016387	0.036095	55409.0	0.016372
Cubic Feet	7.48052	6.229	1728.0	1.0	28.317	0.02832	62.3714	0.03119	28.291
Liters	0.2642	0.2200	61.024	0.035315	1.0	0.001	2.2029	0.0011	0.1
Cubic Meters	264.2	220.0	61024	35.315	1000.0	1.0	2202.65	1.10133	1000.0
Pounds	0.1199	0.09987	27.71	0.016033	0.4539	.000454	1.0	0.0005	0.45359
U.S. Tons	239.87	199.7	55409.0	32.066	907.9	0.908	2000.0	1.0	907.2
Kilograms	0.2644	0.2202	61.08	0.03534	1.0	.001	2.205	0.0011	1.0

VACUUM PRESSURE EQUIVALENTS

1 atmosphere = 29.92 in hg = 760mm hg = 14.7 psi

1 mm Hg = 1 Torr = (3.937 x 10²) in Hg = 1000μHg = 1.333 millibars

1 bar = 10³ millibars = 10⁶ microbars = 750.06 mm Hg

1 microbar = 0.75 micron

1 inch Hg = 254x 10³ mm Hg

x in. hg vacuum = (29.92 - x) in. hg absolute

y mm Hg vacuum = (760 - y) mm Hg absolute

z PSIG = (z + 14.7) PSIA

w PSIA = (w - 14.7) PSIG

GENERAL ENGINEERING DATA

VISCOUS LIQUIDS

(viscosity measures a liquid's resistance to flow)

VISCOSITY CONVERSION TABLE

SAYBOLT UNIVERSAL SSU	STOKES	CENTI STOKES	POISES*	CENTI POISES*	ENGLER SECONDS	REDWOOD NO. 1 SECONDS	TYPICAL LIQUIDS AT 70°F
31	0.010	1.00	0.008	0.8	54.0	29.0	WATER
35	0.025	2.56	0.20	2.05	59.0	32.1	KEROSENE
50	0.074	7.40	0.59	5.92	80.0	44.3	NO. 2 FUEL OIL
80	0.157	15.7	0.126	12.6	125.0	69.2	NO. 4 FUEL OIL
100	0.202	20.2	0.162	16.2	150.0	85.6	TRANSFORMER OIL
200	0.432	43.2	0.346	34.6	295.0	170.0	HYDRAULIC OIL
300	0.654	65.4	0.522	52.2	470.0	254.0	SAE 10W OIL
500	1.10	110.0	0.88	88.0	760.0	423.0	SAE 10 OIL
1,000	2.16	220.0	1.73	173.0	1,500	896.0	SAE 20 OIL
2,000	4.40	440.0	3.52	352.0	3,000	1,690	SAE 30 OIL
5,000	10.8	1,080	8.80	880.0	7,500	4,230	SAE 50 OIL
10,000	21.60	2,160	17.0	1,760	15,000	8,460	SAE 60-70-OIL
50,000	108.0	10,800	88.0	8,800	75,000	43,660	MOLASSES B
100,000	216.0	21,600	173.0	17,300	150,000	88,160	MOLASSES C

*Poises and centipoises are given for oil of 0.8 specific gravity. Relationship: centistokes x specific gravity = centipoises

PUMPING VISCOUS LIQUIDS WITH CENTRIFUGAL PUMPS

VISCOSITY SSU	30	100	250	500	750	1000	1500	200
Flow Reduction GPM %	–	3	8	14	19	23	30	40
Head Reduction Feet	–	2	5	11	14	18	23	30
Horsepower Increase %	–	10	20	30	50	65	85	100

CONVERSION CHART

BARS	x	14.5	=	LBS / SQ. INCH
CELSIUS	=	0.556	x	(°F-32)
CUBIC METERS PER HOUR	x	4.403	=	GALLONS-U.S. PER MINUTE
FAHRENHEIT	=	(1.8 x °C)	+	32
FEET	x	0.3048	=	METERS
FEET OF WATER	x	0.4335	=	POUNDS / SQ. INCH
GALLONS-IMPERIAL	x	1.20095	=	GALLONS-U.S.
GALLONS-U.S.	x	0.83267	=	GALLONS-IMPERIAL
GALLONS-U.S.	x	3.785	=	LITERS
GALLONS-U.S. PER MINUTE	x	0.2271	=	CUBIC METERS PER HOUR
HORSEPOWER	x	0.746	=	KILOWATT
INCHES	x	25.4	=	MILLIMETERS
KILOWATT	x	1.34048	=	HORSEPOWER
LITERS	x	0.2642	=	GALLONS-U.S.
METERS	x	3.281	=	FEET
MILLIMETERS	x	.03937	=	INCHES
POUNDS / SQ. INCH	x	2.307	=	FEET OF WATER
POUNDS / SQ. INCH	x	.0689	=	BARS

PIPE FRICTION CALCULATIONS

CAPACITY AND HEAD IN FEET: Gallons per minute (gpm) and Foot Heads in the performance charts in this manual were compiled from actual tests. The Maximum gpm shown is the pump capacity at rated horsepower. The maximum Head in Feet is at full rated speed (60 cycle current). For Maximum gpm, all piping should be straight, short and large as possible. Heads and gpm are based on tests with specific gravity of 1 and a temperature of 70°F.

HOW TO FIGURE HEAD:

1. Determine static lift (height liquid is to be raised above reservoir)
2. Determine friction loss (losses due to piping depend on size, length and condition of piping system in relation to gpm needed, see table below. Friction losses also include loss due to valves and fittings)
3. Determine velocity head (refer to table below)

$$V_H = \left(\frac{Vel}{8.02} \right)^2$$

4. Total all three of the above and compare to performance chart. Select pump which delivers total head at desired gpm.

PIPE FRICTION

Loss of Head in Feet per 100 ft of 15-year-old ordinary iron pipe due to friction.

Gallons per Minute	1/2" Pipe		3/4" Pipe		1" Pipe		1 1/4" Pipe		1 1/2" Pipe		2" Pipe		2 1/2" Pipe		3" Pipe	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
1	1.05	2.1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2	2.10	7.4	1.20	1.9	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
3	3.16	15.8	1.80	4.1	1.12	1.26	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
4	4.21	27.0	2.41	7.0	1.49	2.14	0.86	0.57	0.63	0.26	-----	-----	-----	-----	-----	-----
5	5.26	41.0	3.01	10.5	1.86	3.25	1.07	0.84	0.79	0.39	-----	-----	-----	-----	-----	-----
10	10.52	147.0	6.02	38.0	3.72	11.7	2.14	3.05	1.57	1.43	1.02	0.5	0.65	0.17	0.45	0.07
15	-----	-----	9.02	80.0	5.60	25.0	3.2	6.5	2.36	3.0	1.53	1.0	0.98	0.36	0.68	0.15
20	-----	-----	12.03	136.0	7.44	42.0	4.29	11.1	-----	-----	-----	1.83	1.31	0.61	0.91	0.25
25	-----	-----	-----	-----	9.30	64.9	5.36	16.6	3.94	7.8	2.55	2.73	1.63	0.92	1.13	0.38
30	-----	-----	-----	-----	11.15	89.0	6.43	23.5	4.72	11.0	3.06	3.84	1.96	1.29	1.38	0.54
35	-----	-----	-----	-----	13.02	119.0	7.51	31.2	5.51	14.7	3.57	5.1	2.20	1.72	1.59	0.71
40	-----	-----	-----	-----	14.88	152.0	8.58	40.0	6.3	18.8	4.08	6.6	2.61	2.20	1.82	0.81
45	-----	-----	-----	-----	-----	-----	9.65	50.0	7.08	23.2	4.60	8.2	2.94	2.80	2.05	1.15
50	-----	-----	-----	-----	-----	-----	10.72	60.0	7.87	28.4	5.11	9.9	3.29	3.32	2.27	1.38
70	-----	-----	-----	-----	-----	-----	15.01	113.0	11.02	53.0	7.15	18.4	4.58	6.2	3.18	2.57
90	-----	-----	-----	-----	-----	-----	-----	-----	14.17	84.0	9.19	29.4	5.88	9.8	4.09	4.08
100	-----	-----	-----	-----	-----	-----	-----	-----	15.74	102.0	10.21	35.8	6.54	12.0	4.54	4.96
120	-----	-----	-----	-----	-----	-----	-----	-----	18.89	143.0	12.25	50.0	7.84	16.8	5.45	7.0
140	-----	-----	-----	-----	-----	-----	-----	-----	22.04	190.0	14.30	67.0	9.15	22.3	6.35	9.2
160	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	16.63	86.0	10.48	29.0	7.26	11.8
180	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	18.38	107.0	11.76	35.7	8.17	14.8
200	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	20.42	129.0	13.07	43.1	9.08	17.8
220	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	22.47	154.0	14.38	52.0	9.99	21.3
240	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	24.51	182.0	15.69	61.0	10.89	25.1
260	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	26.55	211.0	16.99	70.0	11.80	29.1
280	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	18.30	81.0	12.71	33.4
300	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	19.61	92.0	13.62	38.0

PIPE FRICTION (continued)

Loss of Head in Feet per 100 ft of 15-year-old ordinary iron pipe due to friction.

Gallons per Minute	4" Pipe		5" Pipe		6" Pipe	
	Vel.	Fric.	Vel.	Fric.	Vel.	Fric.
40	1.02	0.22	-----	-----	-----	-----
5	1.17	0.28	-----	-----	-----	-----
50	1.28	0.34	-----	-----	-----	-----
70	1.79	0.63	1.14	0.21	-----	-----
75	1.92	0.73	1.22	0.24	-----	-----
100	2.55	1.23	1.63	0.39	1.14	0.14
120	3.06	1.71	1.96	0.57	1.42	0.25
125	3.19	1.86	2.04	0.64	1.48	0.28
150	3.84	2.55	2.45	0.88	1.71	0.32
175	4.45	3.36	2.86	1.18	2.0	0.48
200	5.11	4.37	3.27	1.48	2.28	0.62
225	6.32	6.61	3.67	1.86	2.57	0.74
250	6.40	6.72	4.08	2.24	2.80	0.92
275	7.03	7.99	4.50	2.72	3.06	1.15
300	7.66	8.38	4.90	3.15	3.40	1.29
350	8.90	12.32	5.72	4.19	3.98	1.69
400	10.20	15.82	6.54	5.33	4.54	2.21
450	11.50	19.74	7.35	6.65	5.12	2.74
475	12.30	22.96	7.88	7.22	5.55	3.21
500	12.77	22.08	8.17	8.12	5.60	3.26
550	-----	-----	9.09	9.66	6.16	3.93
600	-----	-----	9.80	11.34	6.72	4.70
650	-----	-----	10.62	13.16	7.28	5.60
700	-----	-----	11.44	15.12	7.84	6.38
750	-----	-----	12.26	17.22	8.50	7.0
800	-----	-----	-----	-----	9.08	7.90
850	-----	-----	-----	-----	9.58	8.75
900	-----	-----	-----	-----	10.30	10.11
950	-----	-----	-----	-----	10.72	10.71
1000	-----	-----	-----	-----	11.32	12.04
1100	-----	-----	-----	-----	12.50	14.31
1200	-----	-----	-----	-----	13.52	16.69

Friction of Water in 90° Elbows

Size of Elbow, Inches	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6
Friction Equivalent, Feet Straight Pipe	5	6	6	8	8	8	11	15	16	18	18

To Compute Break Horsepower

$$BHP = \frac{GPM \times H \times S.G.}{3960 \times \text{pump eff}^*}$$

- S.G. = Specific Gravity
- BHP = Break Horsepower
- GPM = Gallons per Minute
- H = Head in Feet
- Eff = Efficiency

Horsepower and Pressure (PSI) vary in direct proportion to the Specific Gravity.

Effect of Speed Changes

1. Capacity (GPM) is directly proportional to the change in speed.
2. Head is proportional to the square of the change in speed.
3. Horsepower is proportional to the cube of the change in speed.

THEORETICAL DISCHARGE OF NOZZLES IN U. S. GALLONS PER MINUTE

Head		Velocity of Discharge Feet Per Second	Diameter of Nozzle in Inches								
Pounds	Feet		1/16"	1/8"	3/16"	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"
10	13.1	38.6	0.37	1.48	3.32	5.91	13.5	23.6	36.9	53.1	72.4
15	34.6	47.25	0.45	1.84	4.06	7.24	16.3	28.9	45.2	65.0	88.5
20	46.2	54.55	0.52	2.09	4.69	8.35	18.8	33.4	52.2	75.1	102.0
25	57.7	61.0	0.58	2.34	5.25	9.34	21.0	37.3	58.3	84.0	114.0
30	69.3	66.85	0.64	2.56	5.75	10.2	23.0	40.9	63.9	92.0	125.0
35	80.8	72.2	0.69	2.77	6.21	11.1	24.8	44.2	69.0	99.5	135.0
40	92.4	77.2	0.74	2.96	6.64	11.8	26.6	47.3	73.8	106.0	145.0
45	103.9	81.8	0.78	3.13	7.03	12.5	28.2	50.1	78.2	113.0	153.0
50	115.5	86.25	0.83	3.30	7.41	13.2	29.7	52.8	82.5	119.0	162.0
55	127.0	90.4	0.87	3.46	7.77	13.8	31.1	55.3	86.4	125.0	169.0
60	138.6	94.5	0.90	3.62	8.12	14.5	32.5	57.8	90.4	130.0	177.0
65	150.1	98.3	0.94	3.77	8.45	15.1	33.8	60.2	94.0	136.0	184.0
70	161.7	102.1	0.98	3.91	8.78	15.7	35.2	62.5	97.7	141.0	191.0
75	173.2	105.7	1.01	4.05	9.08	16.2	36.4	64.7	101.0	146.0	198.0
80	184.8	109.1	1.05	4.18	9.39	16.7	37.6	66.8	104.0	150.0	205.0
85	196.3	112.5	1.08	4.31	9.67	17.3	38.8	68.9	108.0	155.0	211.0
90	207.9	115.8	1.11	4.43	9.95	17.7	39.9	70.8	111.0	160.0	217.0
95	219.4	119.0	1.14	4.56	10.2	18.2	41.0	72.8	114.0	164.0	223.0
100	230.9	122.0	1.17	4.67	10.0	18.7	42.1	74.7	117.0	168.0	229.0
105	242.4	125.0	1.20	4.79	10.8	19.2	43.1	76.5	120.0	172.0	234.0
110	254.0	128.0	1.23	4.90	11.0	19.6	44.1	78.4	122.0	176.0	240.0
115	265.5	130.9	1.25	5.01	11.25	20.0	45.1	80.1	125.0	180.0	245.0
120	277.1	133.7	1.28	5.12	11.5	20.5	46.0	81.8	128.0	184.0	251.0
125	288.6	136.4	1.31	5.22	11.7	20.9	47.0	83.5	130.0	188.0	256.0
130	300.2	139.1	1.33	5.33	12.0	21.3	48.0	85.2	133.0	192.0	261.0
135	311.7	141.8	1.36	5.43	12.2	21.7	48.9	86.7	136.0	195.0	266.0
140	323.3	144.3	1.38	5.53	12.4	22.1	49.8	88.4	138.0	199.0	271.0
145	334.8	146.9	1.41	5.62	12.6	22.5	50.6	89.9	140.0	202.0	275.0
150	346.4	149.5	1.43	5.72	12.9	22.9	51.5	91.5	143.0	206.0	280.0
175	404.1	161.4	1.55	6.18	13.9	24.7	55.6	98.8	154.0	222.0	302.0
200	461.9	172.6	1.65	6.61	14.8	26.4	59.5	106.0	165.0	238.0	323.0

Head		Velocity of Discharge Feet Per Second	Diameter of Nozzle in Inches								
Pounds	Feet		1"	1 1/8"	1 1/4"	1 3/8"	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"
10	23.1	38.6	94.5	120.0	148.0	179.0	213.0	289.0	378.0	479.0	591.0
15	34.6	47.25	116.0	147.0	181.0	219.0	260.0	354.0	463.0	585.0	723.0
20	46.2	54.55	134.0	169.0	209.0	253.0	301.0	409.0	535.0	676.0	835.0
25	57.7	61.0	149.0	189.0	234.0	283.0	336.0	458.0	598.0	756.0	934.0
30	69.3	66.85	164.0	207.0	256.0	309.0	368.0	501.0	655.0	828.0	1023.0
35	80.8	72.2	177.0	224.0	277.0	334.0	398.0	541.0	708.0	895.0	1106.0
40	92.4	77.2	188.0	239.0	296.0	357.0	425.0	578.0	756.0	957.0	1182.0
45	103.9	81.8	200.0	235.0	313.0	379.0	451.0	613.0	801.0	1015.0	1252.0
50	115.5	86.25	211.0	267.0	330.0	399.0	475.0	647.0	845.0	1070.0	1320.0
55	127.0	90.0	221.0	280.0	346.0	418.0	498.0	678.0	886.0	1121.0	1365.0
60	138.6	94.5	231.0	293.0	362.0	438.0	521.0	708.0	926.0	1172.0	1447.0
65	150.1	98.3	241.0	305.0	376.0	455.0	542.0	737.0	964.0	1220.0	1506.0
70	161.7	102.1	250.0	317.0	391.0	473.0	563.0	765.0	1001.0	1267.0	1565.0
75	173.2	105.7	259.0	327.0	404.0	489.0	582.0	792.0	1037.0	1310.0	1619.0
80	184.8	109.1	267.0	338.0	418.0	505.0	602.0	818.0	1010.0	1354.0	1672
85	196.3	112.5	276.0	349.0	431.0	521.0	620.0	844.0	1103.0	1395.0	1723.0
90	207.9	115.8	284.0	359.0	443.0	536.0	638.0	868.0	1136.0	1436.0	1773.0
95	219.4	119.0	292.0	369.0	456.0	551.0	656.0	892.0	1168.0	1476.0	1824.0
100	230.9	122.0	299.0	378.0	467.0	565.0	672.0	915.0	1196.0	1512.0	1870.0
105	242.4	125.0	306.0	388.0	479.0	579.0	689.0	937.0	1226.0	1550	1916.0
110	254.0	128.0	314.0	397.0	490.0	593.0	705.0	960.0	1255.0	1588.0	1961.0
115	265.5	130.9	320.0	406.0	501.0	606.0	720.0	980.0	1282.0	1621.0	2005.0
120	277.1	133.7	327.0	414.0	512.0	619.0	736.0	1002.0	1310.0	1639.0	2050.0
125	288.6	136.4	334.0	423.0	522.0	632.0	751.0	1022.0	1338.0	1690.0	2090.0
130	300.2	139.1	341.0	432.0	533.0	645.0	767.0	1043.0	1365.0	1726.0	2132.0
135	311.7	141.8	347.0	439.0	543.0	656.0	780.0	1063.0	1390.0	1759.0	2173.0
140	323.3	144.3	354.0	448.0	553.0	668.0	795.0	1082.0	1415.0	1790.0	2212.0
145	334.8	146.9	360.0	455.0	562.0	680.0	809.0	1100.0	1400.0	1820.0	2250.0
150	346.4	149.5	366.0	463.0	572.0	692.0	824.0	1120.0	1466.0	1853.0	2290.0
175	404.1	161.4	395.0	500.0	618.0	747.0	890.0	1210.0	1582.0	2000.0	2473.0
200	461.9	172.6	423.0	535.0	660.0	799.0	950.0	1294.0	1691.0	2140.0	2645.0

NOTE-Actual quantities will vary from these figures, the amount of variation depending upon the shape of nozzle and size of pipe at the point where the pressure is determined. With smooth taper nozzles the actual discharge is about 94 per cent of the figures given in the labels.



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Ruthman Companies: A family-owned business supplying pumps for over 100 years



Ruthman Companies was co-founded in 1912 by brothers Alois and Edward Ruthman as the "Ruthman Machinery Company." Based in Cincinnati, the company serviced the steamboats that traveled the Ohio River.

In 1924, Alois conceived the first sealless centrifugal pump, coining the term 'coolant pump.' The brothers named this new pump "Gusher," giving birth to what is now Ruthman Companies' flagship brand, Gusher Pumps.

Alois' son Thomas R. Ruthman joined the family business in 1949, growing the business globally through organic growth and the acquisition of complementary technologies. In the early 1990's, Alois' grandson, Thomas G. Ruthman, became the third generation of Ruthmans in the pump business. Over the years, Ruthman Companies has expanded its product line from the original centrifugal coolant pumps to include valves, vertical turbine pumps, positive displacement pumps, gear pumps, and other specialized pump equipment, while upholding its reputation as a leader in the custom engineering of pumps for the most challenging applications.

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