Valve Sizing

Physical Properties

Gas or Vapor	M Molecular Weight	k Specific Heat Ratio	C Gas Constant
Hexane	86.18	1.06	322
Hydrogen	2.02	1.41	357
Hydrogen Chloride, Anhydrous	36.46	1.41	357
Hydrogen Sulfide	34.08	1.32	349
Isobutane (2-Methylpropane)	58.12	1.10	327
Isoprene (2-Methyl-1, 3 Butadiene)	68.12	1.09	326
Isopropyl Alcohol (Isopropanol)	60.10	1.09	326
Krypton	83.80	1.71	380
Methane	16.04	1.31	348
Methyl Alcohol (Methanol)	32.04	1.20	337
Methylamines, Anhydrous			
Monomethylamine (Methylamine)	31.06	1.02	317
Dimethylamine	45.08	1.15	332
Trimethylamine	59.11	1.18	335
Methyl Mercapton (Methanethiol)	48.11	1.20	337
Naphthalene (Napthaline)	128.17	1.07	323
Natural Gas (specific gravity = 0.60)	17.40	1.27	344
Neon	20.18	1.64	375
Nitrogen	28.01	1.40	356
Nitrous Oxide	44.01	1.30	347
Octane	114.23	1.05	321
Oxygen	32.00	1.40	356
Pentane	72.15	1.07	323
Propadiene (Allene)	40.07	1.69	379
Propane	44.10	1.13	330
Propylene (Propene)	42.08	1.15	332
Propylene Oxide	58.08	1.13	330
Styrene	104.15	1.07	323
Sulfur Dioxide	64.06	1.28	345
Sulfur Hexafluoride	146.05	1.09	326
Steam	18.02	1.31	348
Toluene (Toluol or Methylbenzene)	92.14	1.09	326
Triethylene Glycol (TEG)	150.18	1.04	320
Vinyl Chloride Monomer (VCM)	62.50	1.19	336
Xenon	131.30	1.65	376
Xylene (p-Xylene)	106.17	1.07	323

Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Acetaldehyde	0.779	68	20
Acetic Acid	1.051	68	20
Acetone	0.792	68	20
Ammonia, Anhydrous	0.666	68	20
Automotive Crankcase and Gear Oils:			
SAE-5W Through SAE 150	0.88-0.94	60	15.6
Beer	1.01	60	15.6
Benzene (Benzol)	0.880	68	20
Boron Trifluoride	1.57	-148	-100
Butadiene - 1, 3	0.622	68	20
Butane-n (Normal Butane)	0.579	68	20
Butylene (1-Butene)	0.600	68	20
Carbon Dioxide	1.03	-4	-20
Carbon Disulfide (C. Bisulfide)	1.27	68	20
Carbon Tetrachloride	1.60	68	20
Chlorine	1.42	68	20
Chloromethane (Methyl Chloride)	0.921	68	20
Crude Oils:			
32.6 Deg API	0.862	60	15.6
35.6 Deg API	0.847	60	15.6
40 Deg API	0.825	60	15.6
48 Deg API	0.79	60	15.6
Cyclohexane	0.780	68	20
Cyclopropane (Trimethylene)	0.621	68	20
Decane-n	0.731	68	20
Diesel Fuel Oils	0.82-0.95	60	15.6
Diethylene Glycol (DEG)	1.12	68	20
Dimethyl Ether (Methyl Ether)	0.663	68	20
Dowtherm A	0.998	68	20
Dowtherm E	1.087	68	20
Ethane	0.336	68	20
Ethyl Alcohol (Ethanol)	0.79	68	20
Ethylene (Ethene)	0.569	-155	-104
Ethylene Glycol	1.115	68	20
Ethylene Oxide	0.901	68	20

Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Fluorocarbons:			
R12, Dichlorodifluoromethane	1.34	68	20
R13, Chlorotrifluoromethane	0.916	68	20
R13B1, Bromotrifluoromethane	1.58	68	20
R22, Chlorodifluoromethane	1.21	68	20
R115, Chloropentafluoromethane	1.31	68	20
Fuel Oils, Nos. 1, 2, 3, 5 and 6	0.82-0.95	60	15.6
Gasolines	0.68-0.74	60	15.6
Glycerine (Glycerin or Glycerol)	1.26	68	20
Heptane	0.685	68	20
Hexane	0.660	68	20
Hydrochloric Acid	1.64	60	15.6
Hydrogen Sulfide	0.78	68	20
Isobutane (2-Methylpropane)	0.558	68	20
Isoprene (2-Methyl - 1, 3-Butadiene)	0.682	68	20
Isopropyl Alcohol (Isopropanol)	0.786	68	20
Jet Fuel (average)	0.82	60	15.6
Kerosene	0.78-0.82	60	15.6
Methyl Alcohol (Methanol)	0.792	68	20
Methylamines, Anhydrous:			
Monomethylamine (Methylamine)	0.663	68	20
Dimethylamine	0.656	68	20
Trimethylamine	0.634	68	20
Methyl Mercapton (Methanethiol)	0.870	68	20
Nitric Acid	1.50	60	15.6
Nitrous Oxide	1.23	-127	-88.5
Octane	0.703	68	20
Pentane	0.627	68	20
Propadiene (Allene)	0.659	-30	-34.4
Propane	0.501	68	20
Propylene (Propene)	0.514	68	20
Propylene Oxide	0.830	68	20
Styrene	0.908	68	20
Sulfur Dioxide	1.43	68	20

Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Sulfur Hexafluoride	1.37	68	20
Sulfuric Acid:			
95–100%	1.839	68	20
60%	1.50	68	20
20%	1.14	68	20
Toluene (Toluol or Methylbenzene)	0.868	68	20
Triethylene Glycol (TEG)	1.126	68	20
Vinyl Chloride Monomer (VCM)	0.985	-4	-20
Water, fresh	1.00	68	20
Water, sea	1.03	68	20
Xylene (p-Xylene)	0.862	68	20

Sizing - Determining K_v and K_w

U.S. Units

$$R = \frac{V_L\,(2{,}800\ G)}{\mu\sqrt{A}}$$

or

$$R = \frac{12{,}700\ V_L}{U\sqrt{A}}$$

Metric Units

$$R = \frac{31{,}313\ V_L\ G}{\mu\sqrt{A}}$$

Determining K_v

V_L = Flow rate at the flowing temperature, in U.S. gpm [m³/hr]

V_L = Flow rate at the flowing temperature, in U.S. gpm [m³/hr]

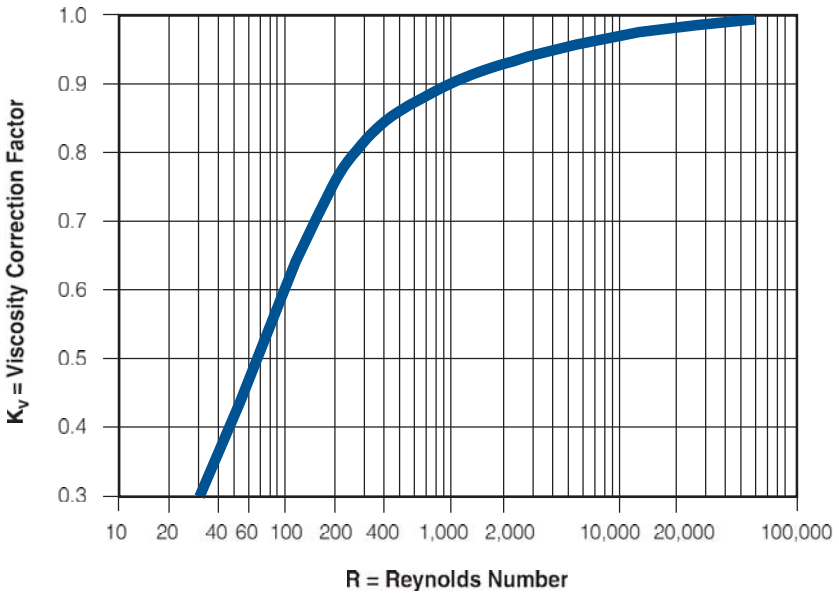
G = Specific gravity of liquid at flowing temperature referred to water = 1.00 at 70°F [21°C]

μ = Absolute viscosity at the flowing temperature, in centipoises

A = Effective discharge area, in square inches [cm²] (from manufacturer's standard orifice areas)

U = Viscosity at the flowing temperature, in Saybolt Universal seconds

After the value of R is determined, the factor K_V is obtained from the graph. Factor K_V is applied to correct the "preliminary required discharge area." If the corrected area exceeds the "chosen standard orifice area," the calculations should be repeated using the next larger standard orifice size.



Conversion Factors

Absolute Viscosity

Given	To find desired value, multiply "Given" value by factor below			
	poise	Centipoise	$\frac{gm}{cm-sec}$	$\frac{lb}{ft-sec}$
poise	—	100	1	0.0672
centipoise	0.01	—	0.01	0.000672
$\frac{gm}{cm-sec}$	1	100	—	0.0672
$\frac{lb}{ft-sec}$	14.88	1488	14.88	—

Notes

1. Kinematic viscosity x specific gravity = absolute viscosity.
2. Centistokes x specific gravity = centipoise.
3. Saybolt Second Universal (SSU) x 0.216 x specific gravity = centipoise.

Kinematic Viscosity

Given	To find desired value, multiply "Given" value by factor below			
	stoke	Centistoke	$\frac{cm^2}{sec}$	$\frac{ft^2}{sec}$
stoke	—	100	1	0.001076
centistoke	0.01	—	0.01	1.076 x 10-5
$\frac{cm2}{sec}$	1	100	—	0.001076
$\frac{ft2}{sec}$	929.0	92900	929.0	—

Liquid Flow Conversions

Given	To find desired value, multiply "Given" value by factor below				
	l/hr	gpm - US	gpm - Imp	barrels/day	m^3/hr
l/hr (litres/hour)	—	0.00440	0.003666	0.1510	0.0010
gpm (US gallons per minute)	227.1	—	0.8327	34.29	0.2271
gpm (Imperial gallons per minute)	272.8	1.201	—	41.18	0.2728
barrels/day (petroleum - 42 US gallons)	6.624	0.02917	0.02429	—	0.006624
$m^3$3/hr (cubic meters per hour)	1000	4.403	3.666	151.0	—
m^3/s (cubic meters per second)	3.6×10^6	0.02917	0.02429	—	0.006624
kg/hr (kilograms per hour)	$\frac{1}{G}$	$\frac{1}{227.1G}$	$\frac{1}{272.8G}$	$\frac{0.151}{G}$	$\frac{1}{1000G}$
lb/hr (pounds per hour)	$\frac{1}{2.205G}$	$\frac{1}{500.8G}$	$\frac{1}{601.5G}$	$\frac{1}{14.61G}$	$\frac{1}{2205G}$

Note

1. G = Specific gravity of liquid at its relieving temperature compared to that of water at 68°F [20°C], where $G_{water} = 1.00$.

Conversion Factors

Notes

1. M = Molecular weight of vapor or gas.
2. Volumetric flow (per time unit of hour or minute as shown) in standard cubic feet per minute at 14.7 psia [1.013 bara], 60°F [16°C].
3. Weight flow in pounds per hour.
4. Weight flow in kilograms per hour.
5. Volumetric flow (per time unit of hour or minute as shown) at 1.013 bara 32°F [0°C]. This represents the commercial standard, known as the Normal Temperature and Pressure (NTP).

   Conversions from one volumetric flow rate to another or to weight flow (and vice versa) may only be done when the volumetric flow is expressed in the standard conditions shown above. If flows are expressed at temperature or pressure bases that differ from those listed above, they must first be converted to the standard base.

Gas Flow Conversions

Given	To find desired value, multiply "Given" value by factor below					
	SCFM	SCFH	lb/hr	[kg/hr]	[Nm³/hr]	[Nm³/min]
scfm[2]	—	60	$\frac{M}{6.32}$	$\frac{M}{13.93}$	1.608	0.0268
scfh[2]	0.01677	—	$\frac{M}{379.2}$	$\frac{M}{836.1}$	0.0268	0.000447
lb/hr[3] or #/hr[3]	$\frac{6.32}{M}$	$\frac{379.2}{M}$	—	0.4536	$\frac{10.17}{M}$	$\frac{0.1695}{M}$
kg/hr[4]	$\frac{13.93}{M}$	$\frac{836.1}{M}$	2.205	—	$\frac{22.40}{M}$	$\frac{0.3733}{M}$
Nm³/hr[5]	0.6216	37.30	$\frac{M}{10.17}$	$\frac{M}{22.40}$	—	0.01667
Nm³/min[5]	37.30	2238	5.901 M	2.676 M	60	—

If flow is expressed in actual volume, such as cfm (cubic feet per minute) or acfm (actual cfm) as is often done for compressors, where the flow is described as displacement or swept volume, the flow may be converted to scfm as follows (or from flow expressed in m³/hr to Nm³/hr).

Inch-Pound Units

$$SCFM = \left(\begin{matrix}cfm \\ or \\ acfm\end{matrix}\right) x \frac{14.7 + p}{14.7} \times \frac{520}{460 + t}$$

Where:

p = gauge pressure of gas or vapor in psig

t = temperature of gas or vapor in °F

Metric Units

$$Nm^3/hr = m^3hr = x \frac{1.013 + p}{1.013} \times \frac{273}{273 + t}$$

Where:

p = gauge pressure of gas or vapor in barg

t = temperature of gas or vapor in °C

Notes

1. Also expressed as kp/cm² and kgf/cm².
2. Normal Temperature and Pressure (NTP) Conditions are, at sea level, equal to 1.013 bara or 1.033 kg/cm² (kilograms force per square centimeter absolute) at a base temperature of 32°F [0°C]. This differs slightly from Metric Standard Conditions (MSC), which uses 1.013 bara 60°F [15°C] for the base temperature.
3. Inch-Pound Standard Conditions are, at sea level, equal to 14.7 psia (pounds force per square inch absolute), rounded up from 14.696 psia, and at a base temperature of 60°F [16°C].

Pressure Conversion

Given	To find desired value, multiply "Given" value by factor below			
	kPa	psig	kg/cm²	barg
kPa (kilopascal)	—	0.1450	0.0102	0.0100
psig (pounds/in²)[3]	6.895	—	0.0703	0.06895
kg/cm²[1][1](kilograms/cm²)	98.07	14.22	—	0.9807
barg	100.00	14.50	1.020	—

Area Conversion

Given	To find desired value, multiply "Given" value by factor below			
	in²	ft²	mm²	cm²
in²	—	0.006944	645.16	6.4516
cm²	0.155	1.076×10^{-3}	100	—
ft²	144	—	92900	929
mm²	0.00155	1.076×10^{-5}	—	0.01

Temperature Conversion

Degrees Celsius (°C)	Degrees Fahrenheit (°F)
C + 273.15 = K (Kelvin)	F + 459.67 = R (Rankine)
(C x 1.8) + 32 = F (Fahrenheit)	(F - 32) x 0.556 = C (Celsius)

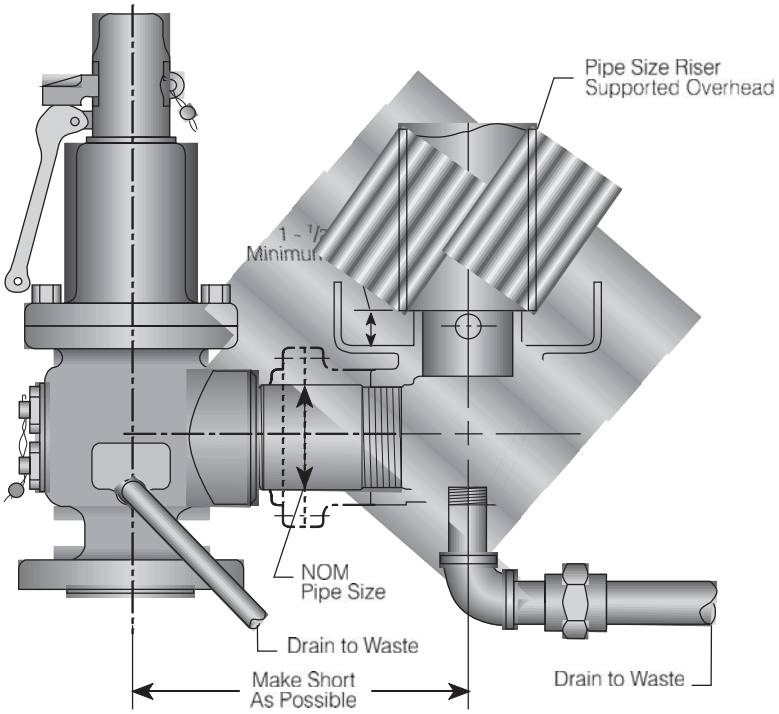
Installation

1. Before installing a new safety/relief valve, we recommend that a pipe tap be used to assure clean-cut and uniform threads in the vessel opening and to allow for normal hand engagement followed by a half to one turn by wrench.
2. Install the valve in a vertical position so that discharge piping and code required drains can be properly piped to prevent build-up of back pressure and accumulation of foreign material around the valve seat area.
3. Avoid over-tightening as this can distort safety/relief valve seats. One need only remember that as the vessel and valve are heated, the expansion involved will grasp the valve more firmly.
4. When installing flange connected valves, use new gaskets and draw the mounting bolts down evenly.
5. Do not use the valve outlet or cap as a lever for installation. Use only flat jawed wrenches on the flats provided.
6. Avoid excessive "popping" of the safety/relief valve as even one opening can provide a means for leakage. Safety/relief valves should be operated only often enough to assure that they are in good working order.
7. Avoid wire, cable, or chain pulls for attachment to levers that do not allow a vertical pull. The weight of these devices should not be directed to the safety/relief valve.
8. Avoid having the operating pressure too near the safety/relief valve set pressure. A very minimum differential of 5 psig or 10 percent (whichever is greater) is recommended. An even greater differential is desirable, when possible, to assure better seat tightness and valve longevity. Safety/relief valves in high-temperature hot water and organic fluid service are more susceptible to damage and leakage than safety valves for steam. It is recommended that the maximum allowable working pressure of the boiler and the safety/relief valve setting be selected substantially higher than the operating pressure. A differential of 30-40 percent is recommended.
9. Avoid discharge piping where its weight is carried by the safety/relief valve. Even though supported separately, changes in temperature alone can cause piping strain. We recommend that drip pan elbows or flexible connections be used wherever possible (see Type A, B, C Installation, page 29).
10. Apply a moderate amount of pipe compound to male threads only, leaving the first thread clean. Compound applied to female threads or used to excess can find its way into the valve, causing leakage.

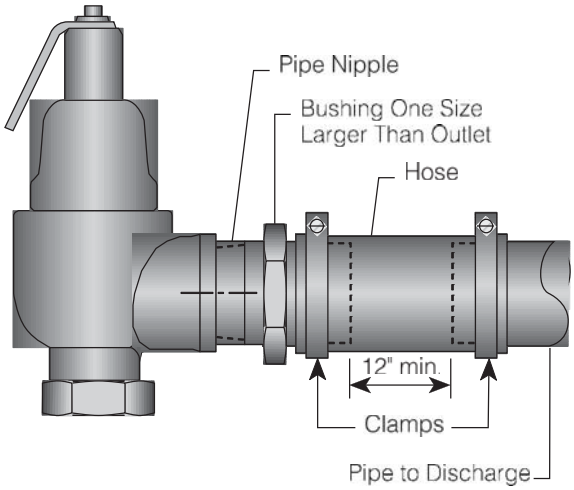
Installation

Recommended Discharge Installation

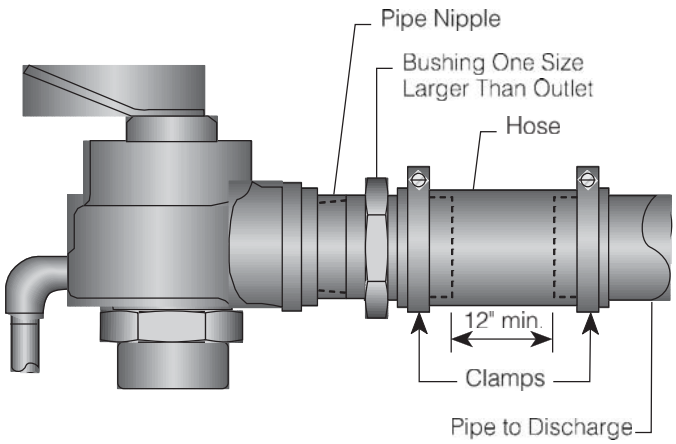
Type "A" Installation



Type "B" Installation



Type "C" Installation



Maintenance

1. Develop a regular program of visual inspection, looking for clogged drains and discharge pipe, dirt build-up in and around the valve seat and broken or missing parts.
2. Test the valve every two to six months (depending on valves' age and condition) preferably by raising the system pressure to the valves set pressure or operating the hand lever (see #3 in Operation).
3. Do not paint, oil, or otherwise cover any interior or working parts of any safety valve. They do not require any lubrication or protective coating to work properly.

When safety/relief valves require repair, service adjustments, or set pressure changes, work shall be accomplished by the manufacturer, or holders of "V," "UV," and/or "VR" stamps.

Guarantee

Tyco Valves & Controls LP, Black Mountain (Kunkle) warrants only that the goods delivered hereunder when paid for and properly installed, operated, and maintained shall be free from defects in material and workmanship under normal use and service for a period of twelve (12) months from the date of installation by the first user of such goods or eighteen (18) months from date of shipment from the factory, whichever period shall be first completed. The warranty hereunder granted does not apply to products or components (such as electric or pneumatic mechanisms) manufactured by other companies or to any goods manufactured by Tyco Valves & Controls LP, Black Mountain (Kunkle) that have been subjected to misuse, improper installation, improper storage or protection prior to installation or use, negligence by buyer or user, accident, corrosion, chemical attack, or misapplication, or that have been modified or repaired by unauthorized persons. Tyco Valves & Controls LP, Black Mountain's (Kunkle) obligation and buyer's remedy under this warranty are limited to: (a) correction, repair, or replacement, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, of any defective unit of goods or (b) refund to buyer of the purchase price allocable to the defective unit of goods if Tyco Valves & Controls LP, Black Mountain (Kunkle) is unable to repair, replace or correct such defect in a reasonable time. Tyco Valves & Controls LP, Black Mountain's (Kunkle) liability under this warranty is conditioned upon buyer giving Tyco Valves & Controls LP, Black Mountain (Kunkle) immediate (but in any event within five (5) working days) written notice of any such defect. Any goods repaired or replaced hereunder shall continue to be warranted for the remainder of the unexpired warranty period, if any. Any repair or replacement of defective goods or parts shall, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, occur at its plant in Black Mountain, North Carolina and Tyco Valves & Controls LP, Black Mountain (Kunkle) shall reimburse buyer all reasonable freight costs incurred in transporting defective goods or parts to and from Tyco Valves & Controls LP, Black Mountain's (Kunkle) plant in the event of a valid warranty claim. In the event Tyco Valves & Controls LP, Black Mountain (Kunkle) elects to provide replacement goods or parts to buyer to repair defective goods, buyer agrees to install sold replacement parts or goods at its cost and, further, Tyco Valves & Controls LP, Black Mountain (Kunkle) shall in no event be liable for any labor or material costs of buyer with respect to de-installing or repairing defective goods or installing replacement parts or goods. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall have the option of requiring the return of the defective goods or parts thereof, transportation prepaid, to establish the claim. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall not be held liable for damages caused by delays in repair or replacement of any defective items. Certification by a separate writing as to compliance with specifications, blueprints, part numbers, quality tests or otherwise will not create any warranty by or obligation of Tyco Valves & Controls LP, Black Mountain (Kunkle) The provisions in Tyco Valves & Controls LP, Black Mountain's (Kunkle) literature and specifications are descriptive only, unless expressly stated as warranties. Except for the limited express warranty set forth in this section, Tyco Valves & Controls LP, Black Mountain (Kunkle) expressly disclaims all warranties, express and implied, oral and written, including, without limitation, any warranties regarding services rendered ancillary hereto, and the implied warranties of merchantability and fitness for a particular purpose, whether arising from statute, common law, civil code, custom or otherwise. Tyco Valves & Controls LP, Black Mountain's (Kunkle) warranty obligations and buyer's remedies for breach of warranty, except as to title, are solely and exclusively as stated in this section. No modification or addition to this document with respect to the foregoing warranty by Tyco Valves & Controls LP, Black Mountain (Kunkle), either before or after execution of this document, shall be made except in writing by the President, Vice President, or Director, Sales and Marketing of Tyco Valves & Controls LP, Black Mountain (Kunkle).

Terms and Conditions of Sales

1. Offer or Acceptance. If this document constitutes an offer to sell by Seller (sometimes referred to as 'Tyco Valves & Controls LP, Black Mountain (Kunkle)'), Seller's offer is expressly subject to Buyer's acceptance of all the terms and conditions contained herein and no other, unless otherwise mutually agreed to by both Seller and Buyer in a writing signed by both parties, and any response by Buyer which constitutes additional or different terms shall not operate as an acceptance if such acceptance would vary, delete or add to the terms and conditions contained herein. If this document constitutes an acceptance by Seller of Buyer's offer to buy the goods or services specified on the face hereof, such acceptance is expressly subject to all the terms and conditions contained herein and no others, unless otherwise mutually agreed to by both Seller and Buyer in a writing signed by both parties. Any of Buyer's proposed terms and conditions which are in addition to or different from those contained herein are hereby objected to and shall be of no effect. Buyer will in any event be deemed to have assented to all terms and conditions contained herein if any part of the goods sold hereunder are accepted.
2. Shipping Dates. The shipping dates, if any, set forth herein are approximate and are not guaranteed. Seller shall not be liable for any loss or damage for delay, non-delivery or other impairment of performance due to the actions or inactions of government, military authority, or Buyer, or by any reason of "force major," which shall be deemed to mean all other causes whatsoever not reasonably within the control of Seller, including, but not limited to, acts of God, war, riot, sabotage, fires, floods, strikes, lockouts or other industrial disturbances, delays of carriers, and inability to secure materials, fuel labor, transportation or manufacturing facilities at Seller's expected prices. Any delay resulting from any such cause shall extend shipping dates correspondingly. Seller shall in no event be liable for any special, incidental or consequential damages arising from delay irrespective of the reason thereof, and receipt by Buyer shall constitute acceptance of delivery and waiver of any claims due to delay. Should delivery be delayed due to Buyer's actions or inactions, or should delivery be delayed at the request of Buyer, the selling price of the goods shall automatically escalate at the rate of two percent [2%] per month for the duration of the delay or in an amount equal to Seller's increased cost, whichever is greater.
3. Drawings. If drawings are submitted herewith they are submitted only to show the general style, arrangement and approximate dimensions of the goods offered. No work is to be based on drawings unless the drawings are certified. Dimensional drawings certified by Seller will be furnished if agreed. In no event will manufacturing or proprietary drawings be supplied.
4. Risk of Loss. Buyer bears the risk of loss for damage to or destruction of the goods from and after the time same said goods are delivered either to the carrier for shipment to Buyer or to the Buyer, whichever occurs first, and regardless of whether or not Buyer may have the right to reject or revoke acceptance of said goods.
5. Shipment. If delivery specified is F.O.B. Seller's plant with freight allowed, Buyer shall pay to Seller, in addition to the purchase price, any and all transportation charges (including insurance).
6. Taxes. In addition to any prices specified herein, Buyer shall pay the gross amount of any present or future sales, use, excise, value-added, or other tax (whether federal, state, local or foreign) applicable to the price, sale, possession, or delivery of any goods or services furnished hereunder or to the use thereof by Buyer, or Buyer shall furnish Seller with a tax-exemption certificate acceptable to the levying taxing authority.
7. Payments. Buyer shall make payment in full for all goods ordered hereunder prior to shipment to Buyer, unless Buyer has entered into and agreed to Seller's Standard Credit Application and Agreement, in which event such Agreement is incorporated herein by reference and made a part hereof, unless and until such Agreement is terminated. The prices specified are in USA currency.
8. Warranties; Remedies. Tyco Valves & Controls LP, Black Mountain (Kunkle) warrants only that the goods delivered hereunder when paid for and properly installed, operated, and maintained shall be free from defects in material and workmanship under normal use and service for a period of twelve (12) months from the date of installation by the first user of such goods or eighteen (18) months from date of shipment from the factory, whichever period shall be first completed. The warranty hereunder granted does not apply to products or components (such as electric or pneumatic mechanisms) manufactured by other companies or to any goods manufactured by Tyco Valves & Controls LP, Black Mountain (Kunkle) that have been subjected to misuse, improper installation, improper storage or protection prior to installation or use, negligence by Buyer or user, accident, corrosion, chemical attack or misapplication, or that have been modified or repaired by unauthorized persons. Tyco Valves & Controls LP, Black Mountain's (Kunkle) obligation and Buyer's remedy under this warranty are limited to: (a) correction, repair, or replacement, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, of any defective unit of goods or (b) refund to Buyer of the purchase price allocable to the defective unit of goods if Tyco Valves & Controls LP, Black Mountain (Kunkle) is unable to repair, replace or correct such defect in a reasonable time. Tyco Valves & Controls LP, Black Mountain's (Kunkle) liability under this warranty is conditioned upon Buyer giving Tyco Valves & Controls LP, Black Mountain (Kunkle), immediate (but in any event within five (5) working days) written notice of any such defect. Any goods repaired or replaced of defective goods or parts shall, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, occur at its plant in Houston, Texas and Tyco Valves & Controls LP, Black Mountain (Kunkle) shall reimburse Buyer all reasonable freight costs incurred in transporting defective goods or parts to and from Tyco Valves & Controls LP, Black Mountain's (Kunkle) plant in the event of a valid warranty claim. In the event Tyco Valves & Controls LP, Black Mountain (Kunkle) elects to provide replacement good or parts to buyer to repair defective goods, Buyer agrees to install said replacement parts or goods at its cost and, further, Tyco Valves & Controls LP, Black Mountain (Kunkle), shall in no event be liable for any labor or material costs of Buyer with respect to de-installing or repairing defective goods or installing replacement parts or goods. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall have the option of requiring the return of the defective goods or parts thereof, transportation prepaid, to establish the claim. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall not be held liable for damages caused by delays in repair or replacement of any defective items. Certification by a separate writing as to compliance with specifications, blueprints, part numbers, quality test or otherwise will not create any warranty by or obligation of Tyco Valves & Controls LP, Black Mountain (Kunkle). The provisions in Tyco Valves & Controls LP, Black Mountain's (Kunkle) literature and specifications are descriptive only unless expressly stated as warranties. EXCEPT FOR THE LIMITED EXPRESS WARRANTY SET FORTH IN THIS SECTION, KUNKLE EXPRESSLY DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, ORAL AND WRITTEN, INCLUDING, WITHOUT LIMITATION, AND FITNESS FOR A PARTICULAR PURPOSE, WHETHER ARISING FROM STATUTE, COMMON LAW, CIVIL CODE, CUSTOM OR OTHERWISE. KUNKLE'S WARRANTY OBLIGATIONS AND BUYER'S REMEDIES FOR BREACH OF WARRANTY, EXCEPT AS TO TITLE, ARE SOLELY AND EXCLUSIVELY AS STATED IN THIS SECTION. No modification or addition to this document with respect to the foregoing warranty by Tyco Valves & Controls LP, Black Mountain (Kunkle) either before or after execution of this document, shall be made except in writing by the President or a Vice President of Tyco Valves & Controls LP, Black Mountain (Kunkle).
9. Limitation of Liability. In any event, the total liability of Tyco Valves & Controls LP, Black Mountain (Kunkle) arising from any cause of action or claim whatsoever, whether (a) in contract, (b) in tort, (including negligence, whether sole, joint, contributory, concurrent or antipollution law or regulation), (c) connected with any toxic or hazardous substance or constituent, (d) arising out of any representation or instruction, or under any warranty, (e) or otherwise, arising out of, connected with, or resulting from the design, manufacture, sale, resale, delivery, repair, replacement or use of any goods or the furnishing of any service shall in no event exceed the price allocable to and paid to Tyco Valves & Controls LP, Black Mountain (Kunkle) for the individual unit of goods or services or part thereof which gives rise to the cause of action or claim. In no event shall Tyco Valves & Controls LP, Black Mountain (Kunkle) or its affiliates be liable for any special, indirect, incidental or consequential damages whenever occurring including, but not limited to, damages for loss of use of plant or property, damage to or destruction of equipment, downtime cost, cost of capital, economic loss, loss of good will, labor cost, loss of profits or revenues, or claims resulting from

Terms and Conditions of Sales

contracts between Buyer, its customers and/or suppliers, regardless of whether any of the foregoing arises from this document or Tyco Valves & Controls LP, Black Mountain (Kunkle) by any human being for personal injury or wrongful death. Tyco Valves & Controls LP, Black Mountain (Kunkle) and Buyer acknowledge and agree that the exclusions of remedies and limitations of liability and damages herein reflect a bargained-for allocation and limitation of risk, liability and damages. Tyco Valves & Controls LP, Black Mountain (Kunkle) will not defend, indemnify or hold harmless Buyer or others for any claim, expense or liability. This Section shall apply notwithstanding any other provision of this document.

10. Limitation of Liability to Third-Party Purchases. Prior to Buyer's transfer or sale of any goods sold pursuant hereto, or the transfer or sale of any interest in such goods, Buyer shall notify the Transferee of the full text of Sections 8 and 9 hereof in writing and shall provide Seller with written acknowledgment and acceptance by the transferee of the terms of Sections 8 and 9 hereof. Further, Buyer shall incorporate verbatim Sections 8 and 9 hereof in any contract between Buyer and any Transferee concerning any such transfer or sale. Buyer shall also include a written copy of Section 8 and 9 hereof with any goods covered hereby that are transferred or sold to a transferee. IF TRANSFER IS MADE CONTRARY TO THE PROVISIONS OF THIS SECTION 10, BUYER SHALL, IN ADDITION TO ANY OTHER LEGAL OR EQUITABLE RIGHTS OF SELLER, INDEMNIFY SELLER AGAINST ANY LIABILITIES, CLAIMS, COSTS, DAMAGES AND ATTORNEY'S FEES INCURRED BY SELLER IN EXCESS OF THOSE SET FORTH IN SECTIONS 8 AND 9 HEREOF. This Section 10 shall apply notwithstanding any other provisions of this document.
11. Returns; Cancellations. No goods may be returned except on prior written approval of Seller. Orders placed with and accepted by Seller may not be canceled except with the written consent of Seller prior to shipment and Buyer's acceptance of Seller's cancellation charges which shall protect Seller against all costs and losses. Seller shall have the right to cancel the sale of any or all of the goods sold hereunder, without liability to Buyer except for the refund of monies already paid hereunder, the event manufacture or sale of the goods is or becomes technically or economically impractical.
12. Product Modification. Seller reserves the right to discontinue the manufacture of, or charge or modify the design and/or construction of goods sold pursuant to this document for the purpose of product improvement, without incurring any obligation to Buyer with respect thereto.
13. Patents. Seller agrees as its option, to defend at its safe cost and expense, and to pay any damages and cost awarded against Buyer, from any claim, suit or proceeding against Buyer to the extent such claim, suit or proceeding is based on an allegation that goods manufactured by Seller and delivered to Buyer hereunder infringe any United Sates letter patent, provided: (1) Seller is notified promptly in writing by Buyer of any such claim, suit or proceeding; (2) Seller is given information and assistance by Buyer as may be requested by Seller; and (3) Seller is given full authority (including authority to settle) by Buyer to conduct such defense as Seller deems appropriate. Seller's obligation under this Section does not apply to any goods the designs, instructions and/or specifications for which are partially or completely supplied by Buyer or to any claim, suit or proceeding in which the allegec infringement results from alteration of goods, use of goods for purposes other than those for which the goods were intended, or use of the goods in combination with products not manufactured by Seller. If in any suit covered by this Section, the use of goods is enjoined, Seller shall at its option and sole cost and expense either: (a) procure for Buyer the right to continue using the goods; (b) replace the goods with non-infringing goods; (c) modify the goods to be non-infringing; or (d) refund to Buyer the purchase price of the goods and transportation costs related thereto. Seller shall have no liability with respect to patent or trademark rights of countries foreign to the USA. The foregoing shall be Seller's sole and entire liability for patent infringement by the goods furnished pursuant hereto.
14. Data. Buyer agrees that all drawings, prints and other technical material (collectively 'Materials') which Seller provides to Buyer, whether prepared by Seller or by third parties under contract to Seller, contain data which embody trade secrets and confidential know-how of commercial value to Seller or to third parties under contract to Seller. Buyer agrees that Buyer and its agents and employees; (a) will keep confidential all such Materials; (b) will not disclose such Materials to any other person, corporate division or entity, except to employees of Buyer who need such Materials in order to perform Buyer's obligations hereunder; (c) will not use such Materials, except in connection with goods supplied hereunder; and (d) will not sell, lease, loan or permit any other person, corporate division or entity to use such Materials for any purpose, without Seller's prior written consent. Nothing herein shall restrict use of data or information available to the general public.
15. Applicable Law; Section Headlines. This document shall be deemed to have been executed and entered into the State of Texas, USA, and this document, and its formation, operation and performance, shall be governed, construed, performed and enforced in accordance with the substantive laws of the State of Texas, USA. The parties hereto agree that any civil action or lawsuit arising out of this document or the subject matter hereof shall be brought and maintained solely in state or federal courts located in Harris County, Texas, USA, and Buyer and Seller each hereby consents and submits to the personal jurisdiction of said courts. Any action or claim in any part arising out of or related to this document or the subject matter hereof, may be commenced or brought within one (1) year from the date the claim or action shall first arise or accrue, or be barred forever. The Section headings herein contained are for ease of reference only and shall not be construed to be part of this document.
16. Merger. Seller and Buyer agree that there are no understandings, agreements, representations or warranties between or by either of them, either oral or written, relative to the goods or services sold, pursuant hereto, including any made in or implied from past dealings, relative to the goods or services sold pursuant hereto, except those that are fully expressed herein. The provisions of this document supercede and control any previous understanding or agreement between the parties with respect to the subject matter hereof and this document is an expression of the complete and final understanding of the parties. Any representation, promise, course of dealing or trade usage not contained or referenced herein will not be binding on the parties hereto. Seller's branch managers or sales representatives, distributors, and dealers appointed by Seller are not authorized to make modifications, waivers or changes in or to these terms and conditions of sale. Buyer represents and agrees that it is Buyer's sole obligation and responsibility to determine the suitability of the goods for Buyer's use and application and any statements made by Seller's salespersons are opinion only and not representations or warranties of Seller and will not be relied on by the Buyer.

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SMALL COMPACT FILTER SILENCERS
w/ "Hockey Puck" *Patented* Element
"FS" Series 1/4" - 1" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Piston Compressors
- Screw Compressors
- Blowers - Side Channel & Roots
- Hydraulic Breathers – fine filtration
- Engines
- Construction\Contractor Industry
- Workshop
- Medical\Dental Industry
- Hobby
- Pneumatic Conveying
- Waste Water Aeration
- Nailers and Staplers

FEATURES & SPECIFICATIONS

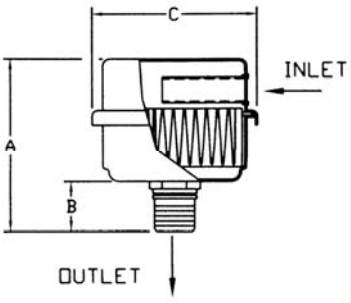
- Patented high grade element w/**Built-in** Butterfly gasket seal
  Creates positive seal between housing hemispheres
  New seal with each element, Minimizes parts
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable **Compact** carbon steel construction with black powder coated finish
- Ability to mount vertically, horizontally
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- A single noise attenuation graph is insufficient; please inquire for your specific requirement

OPTIONS (Inquiries Encouraged)

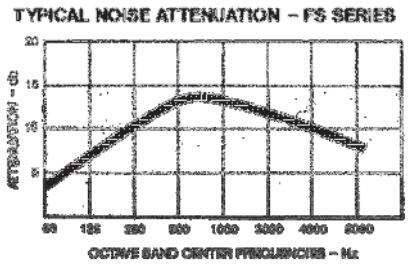
- Various media available
- Epoxy coated housings
- Straight Through Design (Vertical)
- Custom connections

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm



- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
I	FS-05-025	FS-04-025	1/4"	70	16	64	7	7	14	1	0.11
I	FS-05-038	FS-04-038	3/8"	70	16	64	10	14	14	1	0.11
S	FS-07-038	FS-06-038	3/8"	90	16	83	14	14	20	1	0.23
I	FS-05-050	FS-04-050	1/2"	76	22	64	10	14	14	1	0.11
I	FS-07-050	FS-06-050	1/2"	97	22	83	17	20	20	1	0.23
S	FS-11-050	FS-10-050	1/2"	105	22	105	20	20	60	1	0.45
I	FS-07-075	FS-06-075	3/4"	106	32	83	20	20	20	1	0.23
I	FS-11-075	FS-10-075	3/4"	114	32	105	34	43	60	1	0.45
I	FS-11-100	FS-10-100	1"	114	32	105	43	60	60	1	0.45

Note: Model offerings and design parameters may change without notice.

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SMALL COMPACT FILTER SILENCERS
w/ Standard Filter Design
"FS" Series 1/2" - 3" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Piston Compressors
- Screw Compressors
- Blowers - Side Channel & Roots
- Hydraulic Breathers – fine filtration
- Engines
- Construction\Contractor Industry
- Workshop
- Medical\Dental Industry
- Pneumatic Conveying
- Waste Water Aeration
- Nailers and Staplers
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

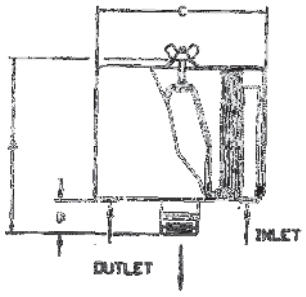
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with baked enamel finish and powder coated weatherhood
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- Pressure drop graphs available upon request

OPTIONS (Inquiries Encouraged)

- 1/8" tap holes
- Pressure Drop Indicator
- Available in ***Stainless Steel***
- Epoxy coated housings
- Various media available
- Custom connections, MPT

CONFIGURATION

DRAWING



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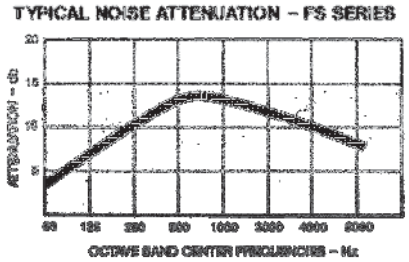

- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
I	FS-15-050	FS-14-050	1/2"	102	38	152	17	17	60	1	0.8
I	FS-15-075	FS-14-075	3/4"	102	38	152	34	43	60	2	0.9
I	FS-15-100	FS-14-100	1"	102	38	152	43	60	60	3	0.9
S	FS-19P-100	FS-18P-100	1"	168	41	152	60	94	170	3	1.4
I	FS-19P-126	FS-18P-126	1 1/4"	168	41	152	94	119	170	5	1.5
I	FS-19P-151	FS-18P-151	1 1/2"	168	41	152	119	145	170	5	2
I	FS-31P-201	FS-30P-201	2"	184	57	254	145	230	332	5	4
S	FS-231P-201	FS-230P-201	2"	311	57	254	230	230	510	5	6
I	FS-31P-251	FS-30P-251	2 1/2"	191	64	254	170	332	332	5	4
S	FS-231P-251	FS-230P-251	2 1/2"	318	64	254	332	332	510	9	7
I	FS-231P-301	FS-230P-301	3"	330	76	254	340	510	510	9	7

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COMPACT FILTER SILENCERS

"FS" Series 3" - 6" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction\Contractor Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Factory Air
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

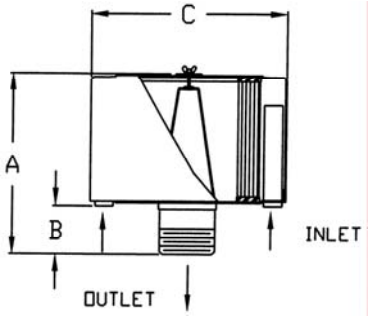
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish and powder coated weatherhood
- Low pressure drop center bracket and outlet pipe design
- 1/8" tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380mm H_2O over initial delta P
- Pressure drop graphs available upon request

OPTIONS (Inquiries Encouraged)

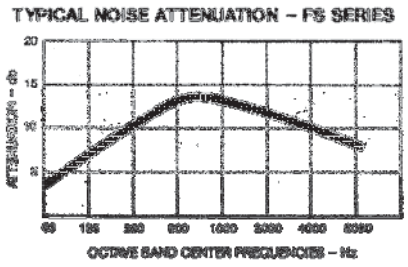
- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in ***Stainless Steel***
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm



- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
S	FS-235P-301	FS-234P-301	3"	330	76	406	340	510	970	9	13
S	FS-245P-301	FS-244P-301	3"	330	76	406	340	510	1500	9	14
E	FS-275P-301	FS-274P-301	3"	330	76	406	340	510	1870	9	15
I	FS-235P-401	FS-234P-401	4"	356	102	406	510	885	970	9	14
S	FS-245P-401	FS-244P-401	4"	356	102	406	765	885	1500	9	14
E	FS-275P-401	FS-274P-401	4"	356	102	406	765	885	1870	9	15
I	FS-245P-501	FS-244P-501	5"	356	102	406	850	1360	1500	14	15
S	FS-275P-501	FS-274P-501	5"	356	102	406	1105	1360	1870	14	16
I	FS-275P-601	FS-274P-601	6"	394	133	406	1105	1870	1870	18	17

Note: Model offerings and design parameters may change without notice.

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COMPACT FILTER SILENCERS

"FS" Series DN80 - DN150 PN10 Pattern Flange

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction\Contractor Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Factory Air
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

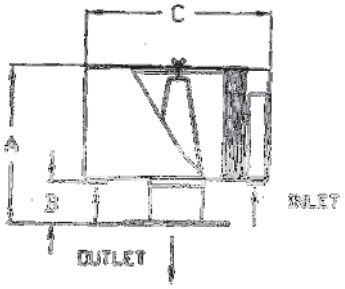
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish and powder coated weatherhood
- Low pressure drop center bracket and outlet pipe design
- 1/8" tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- Pressure drop graphs available upon request

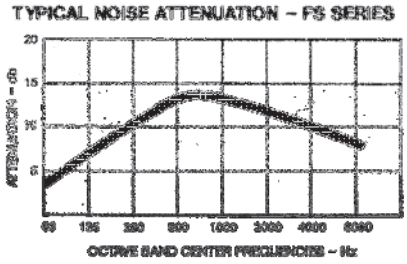
OPTIONS (Inquiries Encouraged)

- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in ***Stainless Steel***
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION

DRAWING





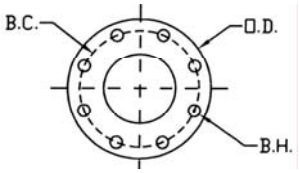
- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

Dimension tolerance ± 6 mm

	with Polyester Element	with Paper Element	Flange Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
S	FS-235P-DN80	FS-234P-DN80	DN80	330	76	406	340	510	970	9	13
S	FS-245P-DN80	FS-244P-DN80	DN80	330	76	406	340	510	1500	9	14
E	FS-275P-DN80	FS-274P-DN80	DN80	330	76	406	340	510	1870	9	15
I	FS-235P-DN100	FS-234P-DN100	DN100	356	102	406	510	885	970	9	15
S	FS-245P-DN100	FS-244P-DN100	DN100	356	102	406	765	885	1500	9	16
E	FS-275P-DN100	FS-274P-DN100	DN100	356	102	406	765	885	1870	9	18
I	FS-245P-DN125	FS-244P-DN125	DN125	356	102	406	850	1360	1500	14	17
S	FS-275P-DN125	FS-274P-DN125	DN125	356	102	406	1105	1360	1870	14	18
I	FS-275P-DN150	FS-274P-DN150	DN150	394	133	406	1105	1870	1870	18	19

PN10 Pattern Flg	DIMENSIONS - mm O.D.	B.C.	B.H.	No. of Holes	Thickness Flg - mm
DN80	200	160	18	8	10
DN100	220	180	18	8	10
DN125	250	210	18	8	10
DN150	285	240	22	8	10



Note: Model offerings and design parameters may change without notice.

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E-mail: sales@solbergmfg.com ♦ Web Site: www.solbergmfg.com

“BIG BOY” FILTER SILENCERS

"FS" Series DN200-DN300 PN10 Pattern Flange

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Cement
- Power Plants
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

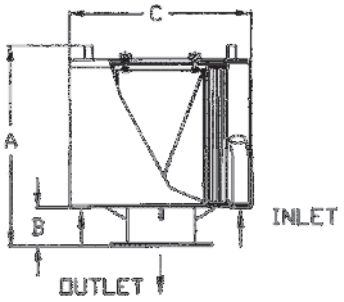
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish
- Low pressure drop center bracket and outlet pipe design
- 1/8” tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Several element sizes available per given connection (safety factor)
- Interchangeable media: Polyester, Paper, HEPA
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- Pressure drop graphs available upon request

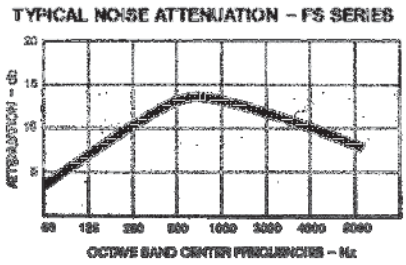
OPTIONS (Inquiries Encouraged)

- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in ***Stainless Steel***
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION

DRAWING





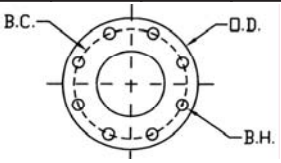
- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

Dimension tolerance ± 6 mm

	with Polyester Element	with Paper Element	Flange Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
I	FS-377P-DN200	FS-376P-DN200	DN200	584	152	572	2450	3060	3105	12	54
S	FS-385P-DN200	FS-384P-DN200	DN200	584	152	724	2450	3060	5605	12	56
E	FS-485P-DN200	FS-484P-DN200	DN200	787	152	724	3060	3060	8000	12	62
I	FS-385P-DN250	FS-384P-DN250	DN250	584	152	724	3060	5610	5610	16	59
S	FS-485P-DN250	FS-484P-DN250	DN250	787	152	724	4420	5610	8000	16	64
E	FS-685P-DN250	FS-384P(2)-DN250	DN250	965	152	724	4900	5610	11220	16	74
I	FS-385P-DN300	FS-384P-DN300	DN300	584	152	724	4420	5610	5610	24	61
S	FS-485P-DN300	FS-484P-DN300	DN300	787	152	724	4420	7990	8000	24	70
E	FS-685P-DN300	FS-384P(2)-DN300	DN300	965	152	724	5950	7990	11220	24	79
E	FS-485P(2)-DN300	FS-484P(2)-DN300	DN300	1346	152	724	7345	7990	16000	24	88

PN10 Pattern Flg	DIMENSIONS - mm O.D.	B.C.	B.H.	No. of Holes	Thickness Flg - mm
DN200	340	295	22	8	14
DN250	395	350	22	12	14
DN300	445	400	22	12	14



Note: Model offerings and design parameters may change without notice.

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B-301/2 - Blower, Elmo, 2BH7420-0AH267 2.4HP

Contents

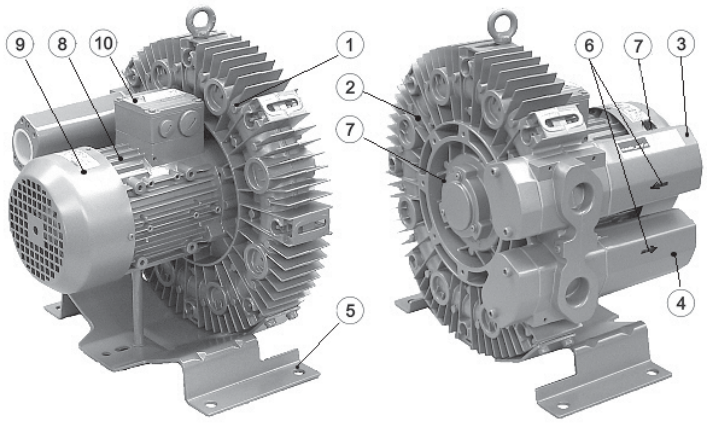

Fig. 1: Design of gas-ring vacuum pump/compressor

1 Vacuum pump/compressor housing
2 Vacuum pump/compressor cover
3 Inlet connection with muffler
4 Discharge connection with muffler
5 Base
6 Flow direction arrow
7 Rotating direction arrow
8 Drive motor
9 Fan guard (over external fan)
10 Terminal box

1 Safety

1.1 Definitions

To point out dangers and important information, the following signal words and symbols are used in these operating instructions:

1.1.1 Safety alert symbol

The **safety alert symbol** ⚠ is located in the safety precautions in the highlighted heading field on the left next to the signal word (DANGER, WARNING, CAUTION).

Safety precautions **with** a safety alert symbol indicate a danger of **injuries**.

Be sure to follow these safety precautions to protect against **injuries or death**!

Safety precautions **without** a safety alert symbol indicate a danger of **damage**.

1.1.2 Signal words

DANGER
WARNING
CAUTION
NOTICE
NOTE

The **signal words** are located in the safety precautions in the highlighted heading field.

They follow a certain hierarchy and indicate (in conjunction with the safety alert symbol, see Chapter 1.1.1) the **seriousness of the danger** and the **type of warning.**

See the following explanations:

1.3 Residual risks

2 Intended Use

These operating instructions

- apply to gas-ring vacuum pumps/compressors of the G-BH7 series, models 2BH72, 2BH73, 2BH74, 2BH75 and 2BH76,
- contains instructions concerning transport and handling, installation, commissioning, operation, shut-down, storage, servicing and disposal of the G-BH7,
- must be completely read and understood by all operating and servicing personnel before beginning to work with or on the G-BH7,
- must be strictly observed,
- must be available at the site of operation of the G-BH7.

About the operating and servicing personnel of the G-BH7

- These persons must be trained and authorized for the work to be carried out.
- Work on electrical installations may be carried out by trained and authorized electricians only.

The G-BH7s

- are pump-motor units for generating vacuum or gauge pressure;
- are used to **extract, pump and compress the following gases**:
  - Air,
  - Non-flammable, non-aggressive, non-toxic and non-explosive gases or gas-air mixtures.
  - For differing gases/gas-air mixtures, inquire with the Service Department.
- are equipped with one of the following kind of drive motors:
  - 3-phase AC drive motor with a standard or explosion-protected design
  - Single-phase AC drive motor

  These operating instructions apply **only to** pump-motor units with a **standard design**.

  For the explosion-protected design

3 Technical Data

3.1 Mechanical data

Weight

Single-impeller design		
Model	**Weight**	
	[kg] approx.	**[lbs] approx.**
2BH7210-0..1.-.	**16**	35
2BH7310-0..1.-.	**16**	35
2BH7310-0..2.-.	**17**	38
2BH7410-0..1.-.	**23**	51
2BH7510-0..1.-.	**26**	57
2BH7510-0..2.-.	**29**	64
2BH7610-0..1.-.	**32**	71
2BH7610-0..3.-.	**35**	77

Two-impeller design		
Model	**Weight**	
	[kg] approx.	**[lbs] approx.**
2BH7220-0..2.-.	**24**	53
2BH7220-0..5.-.	**28**	62
2BH7320-0..5.-.	**30**	66
2BH7420-0..2.-.	**33**	73
2BH7420-0..5.-.	**39**	86
2BH7520-0..2.-.	**40**	88
2BH7520-0..7.-.	**51**	112
2BH7620-0..3.-.	**48**	106
2BH7620-0..5.-.	**65**	143

Three-impeller design		
Model	**Weight**	
	[kg] approx.	**[lbs] approx.**
2BH7530-0..8.-.	**68**	150
2BH7630-0..6.-.	**94**	207

Minimum distances

Minimum distance to fan guard (for sucking in cooling air):

Model	[mm] approx.	[inches] approx.
2BH72	**34**	1.34
2BH73	**34**	1.34
2BH74	**52**	2.05
2BH75	**52**	2.05
2BH76	**53**	2.09

Minimum distance to face of vacuum pump/compressor cover:

Model	[mm] approx.	[inches] approx.
2BH7…	**30**	1.18

Vibrations

The following table provides information on the maximum permissible loading due to vibrations.

Model	Vibration velocity V_{eff}	
	[mm/s] ≤	**[ft/s] ≤**
2BH72.. - 2BH75..	**3.0**	0.010
2BH76..	**3.5**	0.011

Noise level

Measuring-surface sound-pressure level as per EN ISO 3744, measured at a distance of **1 m** [3.28 ft] at an operating point of approximately 2/3 of the permissible total pressure difference with the lines connected without a vacuum or pressure relief valve, tolerance ±3 dB (A).

Single-impeller design

Model	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz	60 Hz
2BH7210-0..1.-.	70	70
2BH7310-0..1.-.		70
2BH7310-0..2.-.		70
2BH7410-0..1.-.		70
2BH7510-0..1.-.		70
2BH7510-0..2.-.		70
2BH7610-0..1.-.		71
2BH7610-0..3.-.		71

Two-impeller design

Model	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz	60 Hz
2BH7220-0..2.-.	70	70
2BH7220-0..5.-.		70
2BH7320-0..5.-.		70
2BH7420-0..2.-.		70
2BH7420-0..5.-.		70
2BH7520-0..2.-.		70
2BH7520-0..7.-.		71
2BH7620-0..3.-.		71
2BH7620-0..5.-.		72

Three-impeller design

Model	1-m measuring-surface sound pressure level L [dB (A)]	
	50 Hz	60 Hz
2BH7530-0..8.-.	67	73
2BH7630-0..6.-.	77	80

Temperature increase

The information listed in the following tables corresponds to the heating of vacuum pump/compressor housings and the air exiting compared to the ambient temperature during operation with a permissible total pressure difference and an air pressure of **1,013 mbar** [14.7 psi]. At lower air pressures these values increase.

Single-impeller design

Model	Temperature increase			
	ΔT [K] approx.		Δϑ [F] approx.	
	50 Hz	60 Hz	50 Hz	60 Hz
2BH7210-0..1.-.	**52**	**61**	94	110
2BH7310-0..1.-.	**61**	**61**	110	110
2BH7310-0..2.-.	**81**	**86**	146	155
2BH7410-0..1.-.	**90**	**101**	162	182
2BH7510-0..1.-.	**93**	**111**	167	200
2BH7510-0..2.-.	**120**	**112**	216	202
2BH7610-0..1.-.	**118**	**124**	212	223
2BH7610-0..3.-.	**118**	**124**	212	223

Two-impeller design

Model	Temperature increase			
	ΔT [K] approx.		Δϑ [F] approx.	
	50 Hz	60 Hz	50 Hz	60 Hz
2BH7220-0..2.-.	**55**	**77**	99	139
2BH7220-0..5.-.	**74**	**110**	133	198
2BH7320-0..5.-.	**81**	**124**	146	223
2BH7420-0..2.-.	**89**	**80**	160	144
2BH7420-0..5.-.	**121**	**117**	218	211
2BH7520-0..2.-.	**89**	**102**	160	184
2BH7520-0..7.-.	**125**	**110**	225	198
2BH7620-0..3.-.	**124**	**126**	223	227
2BH7620-0..5.-.	**124**	**128**	223	230

Three-impeller design

Model	Temperature increase			
	ΔT [K] approx.		Δϑ [F] approx.	
	50 Hz	60 Hz	50 Hz	60 Hz
2BH7530-0..8.-.	**120**	**120**	216	216
2BH7630-0..6.-.	**120**	**120**	216	216

Tightening torques for screw connections

The following values apply if no other information is available.

With non-electrical connections, property classes of 8.8 and 8 or higher as per ISO 898-1 are assumed.

3.2 Electrical data

See rating plate.

3.3 Operating conditions

Temperatures

Temperature of pumped gases:	max. permissible temperature: **+40°C** [+104°F] Nominal value: **+15°C** [+59°F] Pump-motor units for higher fluid temperatures on request.
Ambient temperature (standard design)[1]:	max. permissible temperature: **+40°C** [+104°F] min. permissible temperature: **-15°C** [+5°F] Nominal value: **+25°C** [+77°F] Ambient temperatures between **25°C** [+77°F] and **40°C** [+104°F] affect the permissible total pressure difference (see Section "Permissible total pressure difference"). At higher temperatures the winding may be damaged and the grease change interval may be shortened.

Pressures

Min. inlet pressure:	See rating plate.
Max. discharge pressure during compressor operation:	See rating plate.
Max. permissible pressure in pump-motor unit:	**2.5 bar abs.** [36.2 psia] At this pressure the operation of the pump-motor unit may be considerably impaired. Provide a corresponding protective device (e.g. pressure relief valve) if necessary.
Permissible total pressure difference:	The total pressure difference specified on the rating plate only applies under the following conditions: • Ambient temperature: **25°C** [77°F]. • Inlet temperature (temperature of pumped gases at inlet connection): **15°C** [59°F]. • Pressure: during vacuum-pump operation: **1,013 mbar** [14.7 psia] at discharge connection; during compressor operation: **1,013 mbar** [14.7 psia] at inlet connection; At an ambient temperature of **40°C** [104°F] the total pressure difference specified on the rating plate must be reduced by 10%. If the ambient temperature is between **25°C** [77°F] and **40°C** [104°F], then the total pressure difference specified on the rating plate must be reduced linearly to the temperature by between 0 and 10 %.

Installation altitude

Max. of **1,000 m** [3,280 ft] above sea level.

When installing the pump-motor unit at an altitude of more than **1,000 m** [3,280 ft] above sea level, first inquire with the Service department.

[1] For design with frequency converter, see separate operating instructions.

4 Transport and Handling

5 Installation

The pump-motor unit is ready to connect on delivery.

However, if the time from delivery to commissioning of the pump-motor unit exceeds a certain period, the lubrication of the rolling bearings must be renewed.
See Chapter 8.2, "Storage conditions", Section "Lubrication of rolling bearings after longer storage", Pg. 23 for information on this topic.

Carry out the following work to install the pump-motor unit:

- Installation and securing,
- Attachment of the included loose muffler if necessary,
- Attachment of threaded flange or hose flange (available as accessories) for the connection of inlet or discharge pipe to the muffler,
- Electrical connection,
- Connection of inlet and discharge connection to the system.

5.1 Installation

Components for reducing noise on the pump-motor unit:

- **Mufflers** (included as standard equipment): On delivery the pump-motor units are equipped with attached mufflers as standard. The noise radiation is considerably reduced by the mufflers. See Fig. 2 to Fig. 4, Pg. 18 ff.
- **Additional mufflers** (available as an option): The additional mufflers enable a further noise reduction. They may only be used with free entry and exit of gases, i.e. with direct intake out of or direct feeding into the atmosphere **without piping**.
- **Noise protection hoods** (available as an option): Noise protection hoods are suitable for installation in rooms and in the open. They reduce both the total sound pressure level and tonal components that are perceived as particularly annoying.

Installation variants/axis position:

Basically, when installing the pump-motor unit, the following variants are possible with a different axis position (horizontal or vertical):

- Horizontal installation
- Vertical installation on the vacuum pump/compressor cover ("cover installation")
- Vertical mounting on the wall.

Basically, all variants are possible with all models.

However, a distinction must be made between a design with and a design without a **condensed water opening** for the axis position:

- The pump-motor units without a condensed water opening can be installed and secured in any axis position.
- The pump-motor unit with a condensed water opening may only be installed and secured horizontally with the base at the bottom.

Horizontal installation

Screw the base of the pump-motor unit to the surface with suitable mounting elements.

Proceed as follows:

- Provide the base of the pump-motor unit with mounting holes.
- Select the suitable screw type.
- Screw the base of the pump-motor unit to the surface with the screws.
  When doing so, be sure to provide **all** mounting holes with screws!

Vertical installation on the vacuum pump/compressor cover ("cover installation")

With vertical installation of the pump-motor unit with the vacuum pump/compressor cover facing downward, rubber feet must be used.

Proceed as follows:

- The rubber feet are available as accessories. They are delivered in a set of 3.
  On the upper section they are provided with stud bolts and on the lower section with a threaded hole.
- Mount the rubber feet on the pump-motor unit: Screw the stud bolts of the rubber feed into the holes on the face of the vacuum pump/compressor cover and tighten them.
- Mount the pump-motor unit together with the rubber feet on the installation surface:
  Select suitable mounting elements for the threaded hole.
  Screw the rubber feet to the surface or foundation via the threaded hole.

Vertical mounting on the wall

With vertical mounting of the pump-motor unit on the wall, the pump-motor unit is mounted via the holes in the base.

Proceed as follows:

- Position the pump-motor unit as close to the wall as possible on a stable supporting plate with sufficient load-bearing capacity.
  The pump-motor unit must be positioned with the base toward the wall.
- Provide the base of the pump-motor unit with mounting holes.
- Select the suitable screw type.
- Screw the base of the pump-motor unit to the wall with the screws.
  When doing so, be sure to provide **all** mounting holes with screws!
- Remove the supporting plate.

Eye bolt:

Following installation, the eye bolt must be either firmly tightened or removed.

5.2 Electrical connection (motor)

- For the tightening torques for terminal board connections (except terminal strips), see Chapter 3.1, "Mechanical data", Section "Tightening torques for screw connections", Pg. 10.
- For terminals with clamping straps (e.g. as per DIN 46282), the conductors must be inserted so that approximately the same clamping height results on both sides of the bar. Individual conductors must therefore be bent into a U-shape or connected with a cable lug (DIN 46234).

This also applies to:

- the protective conductor,
- the outer ground conductor.

Both conductors can be recognized from their color (green/yellow).

5.3 Connecting pipes/hoses (vacuum pump/compressor)

Mufflers:

The pump-motor units are delivered with mufflers (indicated with arrows in the following illustrations) for the inlet and discharge connections as standard equipment.

With **single-impeller pump-motor units**, the mufflers are already mounted on delivery.

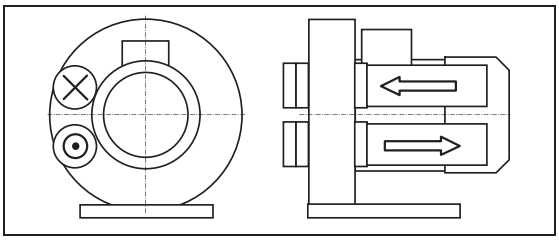

Fig. 2: 2BH721 ... 2BH761 (single-impeller pump-motor units)

With **two-impeller and three-impeller pump-motor units**, the inlet-side muffler is included loose for packaging-related reasons and must be mounted by the operator.

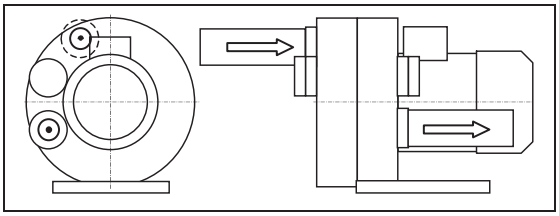

Fig. 3: 2BH722 ... 2BH762 (two-impeller pump-motor units with two-stage design)

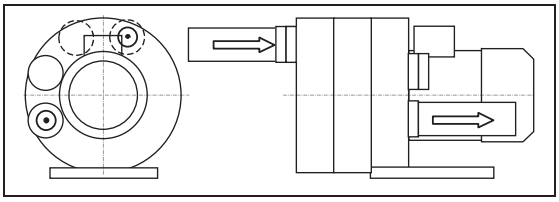

Fig. 4: 2BH723 ... 2BH763 (three-impeller pump-motor units with three-stage design)

6 Commissioning

6.2 Start-up and shut-down

Start-up

- Open shut-off device in intake/discharge pipe.
- Switch on power supply for drive motor.

Shut-down:

- Switch off power supply for drive motor.
- Close shut-off device in intake/discharge pipe.

7 Operation

- Provide mufflers on inlet and discharge side with sealing plugs.

8.2 Storage conditions

To prevent standstill damage during storage, the environment must provide the following conditions:

- dry,
- dust-free,
- low-vibration (effective value of vibration speed $v_{eff} \leq 2.8$ mm/s).
- Ambient temperature: max. **+40°C** [+104°F].

9.1 Repairs/troubleshooting

Fault	Cause	Remedy	Carried out by
Motor does not start; no motor noise.	At least two power supply leads interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
Motor does not start; humming noise.	One power supply lead interrupted.	Eliminate interruption by fuses, terminals or power supply cables.	Electrician
	Impeller is jammed.	Open vacuum pump/compressor cover, remove foreign body, clean.	Service*)
		Check or correct impeller gap setting if necessary.	Service
	Impeller defective.	Replace impeller.	Service*)
	Rolling bearing on drive motor side or vacuum pump/compressor side defective.	Replace motor bearing or vacuum pump/compressor bearing.	Service*)
Protective motor switch trips when motor is switched on. Power consumption too high.	Winding short-circuit.	Have winding checked.	Electrician
	Motor overloaded. Throttling does not match specification on rating plate.	Reduce throttling.	Service*)
		Clean filters, mufflers and connection pipes if necessary.	Service*)
	Compressor is jammed.	See fault: "Motor does not start; humming noise" with cause: "Impeller is jammed.".	Service*)
Pump-motor unit does not generate any or generates insufficient pressure difference.	Leak in system.	Seal leak in the system.	Operator
	Wrong direction of rotation.	Reverse direction of rotation by interchanging two connecting leads.	Electrician
	Incorrect frequency (on pump-motor units with frequency converter).	Correct frequency.	Electrician
	Shaft seal defective.	Replace shaft seal.	Service*)
	Different density of pumped gas.	Take conversion of pressure values into account. Inquire with Service Department.	Service
	Change in blade profile due to soiling.	Clean impeller, check for wear and replace if necessary.	Service*)
Abnormal flow noises.	Flow speed too high.	Clean pipes. Use pipe with larger cross-section if necessary.	Operator
	Muffler soiled.	Clean muffler inserts, check condition and replace if necessary.	Service*)
Abnormal running noise.	Ball bearing lacking grease or defective.	Regrease or replace ball bearing.	Service*)
Compressor leaky.	Seals on muffler defective.	Check muffler seals and replace if necessary.	Service*)
	Seals in motor area defective.	Check motor seals and replace if necessary.	Service

*) Only when the maintenance manual is at hand: rectification by the operator.

9.2 Service/After-sales service

Our Service is available for work (in particular the installation of spare parts, as well as maintenance and repair work), not described in these operating instruction.

A list of spare parts with an exploded drawing is available on the Internet at www.gd-elmorietschle.com.

Observe the following when **returning** pump-motor unit:

- The pump-motor unit must be delivered complete, i.e. not dismantled.
- The pump-motor unit may not present a danger to the workshop personnel.
  If the pump-motor unit has come into contact with dangerous substances, then the procedure described in Chapter 9.3, "Decontamination and Declaration of Clearance", Pg. 25, must be used.
- The original rating plate of the pump-motor unit must be properly mounted, intact and legible.
  All warranty claims are voided for pump-motor units delivered for a damage expertise without the original rating plate or with a destroyed original rating plate.
- In case of warranty claims, the manufacturer must be informed of the operating conditions, operating duration etc. and additional detailed information provided on request if necessary.

9.3 Decontamination and Declaration of Clearance

EU declaration of conformity

Manufacturer:	Gardner Denver Deutschland GmbH Industriestraße 26 97616 Bad Neustadt • Germany
Representative for the compilation of technical documents:	Holger Krause Industriestraße 26 97616 Bad Neustadt • Germany
Description and identification of the machine:	Vacuum pumps/Compressors (Side channel blower) Series G-BH7 Types 2BH72..-.....-. 2BH73..-.....-. 2BH74..-.....-. 2BH75..-.....-. 2BH76..-.....-.

The machine described above meets the following applicable Community harmonisation legislation:

2006/42/EC	European Parliament and Council Directive 2006/42/EC from 17th May 2006 on machinery and amending Directive 95/16/EC.
2004/108/EC*)	Directive 2004/108/EC of the European Parliament and Council from 15th December 2004 for the application of the legal regulations of the EU member states concerning electrical devices and repealing Directive 89/336/EEC

Harmonised standards applied:

EN 1012-1:2010	Compressors and vacuum pumps - Safety requirements - Part 1: Compressors
EN 1012-2:1996 +A1:2009	Compressors and vacuum pumps - Safety requirements - Part 2: Vacuum pumps
EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)
EN 60204-1:2006	Safety of machinery - Electrical equipment of machines Part 1: General requirements IEC 60204-1:2005 (amended)
EN 60034-1:2010/ AC:2010	Rotating electrical machines - Part 1: Rating and performance IEC 60034-1:2010 (amended)

Bad Neustadt, 18.04.2012
(Place and date of issue)

Andreas Bernklau, product management/attorney
(Name and function)

Dr. Rudi Dittmar, development
(Name and function)

*) Only applicable for version with frequency converter 2FC

664.44436.40.000

Statement on health safety and on the protection of the environment

- For the safety of our employees and to comply with statutory requirements on handling substances harmful to the health and the environment, this statement must be enclosed, fully completed, with **each** unit/system sent.
- **Without the fully completed statement, repair/disposal is not possible and delays are unavoidable!**
- The statement is to be completed and signed by suitably qualified, authorised personnel at the operating organisation.
- In the case of shipment to Germany, the statement is to be completed in German or English.
- The statement is to be attached to the outside of the packing on shipment.
- If necessary, the carrier is to be informed.

1. **Product designation (type):** .....
2. **Serial number (no. BN):** .....
3. **Reason for sending:** .....
4. **The unit/system**
   has **not** come into contact with hazardous substances. There will be **no** hazards for personnel or the environment during repair/disposal. Continue with "6. Legally binding statement“
   has come into contact with hazardous substances. Continue with "5. Information on the contamination“
5. **Information on the contamination** (if necessary provide more information on an additional sheet)
   The unit/system was used in the following application:

   .....
   and has come into contact with the following classifiable substances or substances presenting a hazard to health/environment:

Trade name:	Chemical designation:	Hazardous substance class:	Properties (e.g. toxic, inflammable, caustic, radioactive):

   The unit/system has been emptied in accordance with the operating instructions, flushed and cleaned externally.

   Safety data sheets in accordance with the applicable regulations are enclosed (sheet).

   The following safety precautions are necessary for handling (e.g. personal protective equipment):

   .....

   .....
6. **Legally binding statement**
   I herewith guarantee that the details specified are true and complete and that I, as signatory, am in a position to judge that this is so.
   We are aware that we are liable to the contractor for any damages arising from incomplete or incorrect specifications. We are obliged to indemnify the contractor against claims for damages by third parties arising from incomplete or incorrect specifications. We are aware that, irrespective of this statement, we are directly liable to third parties - in particular including the contractor's employees tasked with repair/disposal.

Company/institute: .....

Name, position: ..... Phone: .....

Street: ..... Fax: .....

Post code, city: .....

Country: ..... Stamp:

Date, signature: .....

P.O. box 1510
97605 Bad Neustadt
Phone: +49 7622 392 0
Fax: +49 7622 392 300
E-mail: er.de@gardnerdenver.com
Internet: www.gd-elmorietschle.com
610.44436.40.000
Edition: 04.2012
English

AIRCOM TECHNOLOGIES inc.

16781, Hymus, Kirkland (Québec) H9H 3L4
T.: 514 695-4740 F.: 514 695-0581
www.aircom.ca info@aircom.ca

Pression & Vide • Pressure & Vacuum

B-501/2 - Blower, Sutorbilt, Model 4L-RHC, Orientation: Horizontal (Flow Down) Driven Shaft Position: RHC (Right Hand Central) Flow Requirement: 487 scfm

OPERATION & MAINTENANCE MANUAL

AIRCOM PACKAGE

WITH

SUTORBILT

POSITIVE DISPLACEMENT BLOWER

YOUR REFERENCE: PO # 1704432-0008 (Blower) & 1704432-0009 (Package)

OUR REFERENCE: 222850 & 222851

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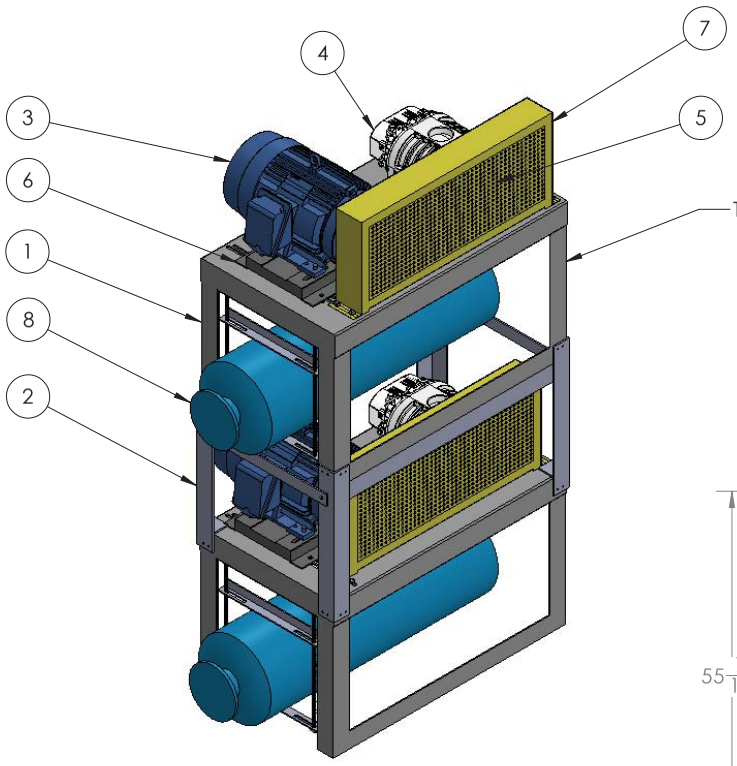
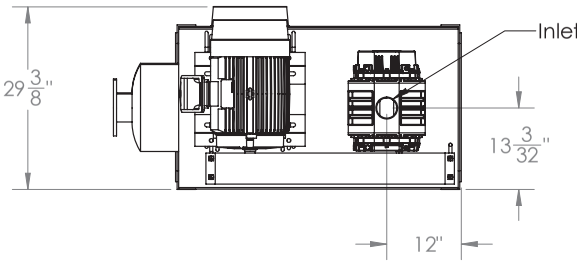
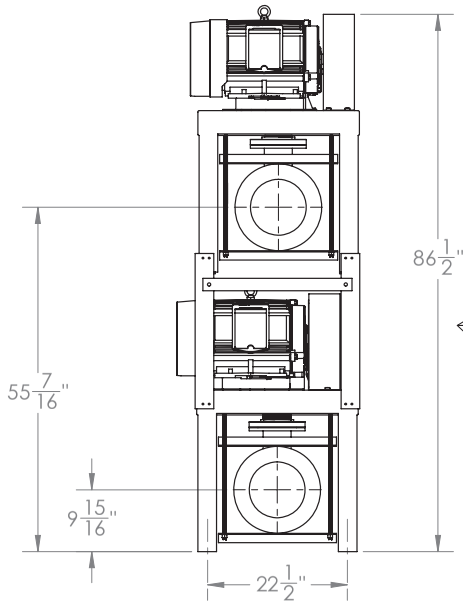
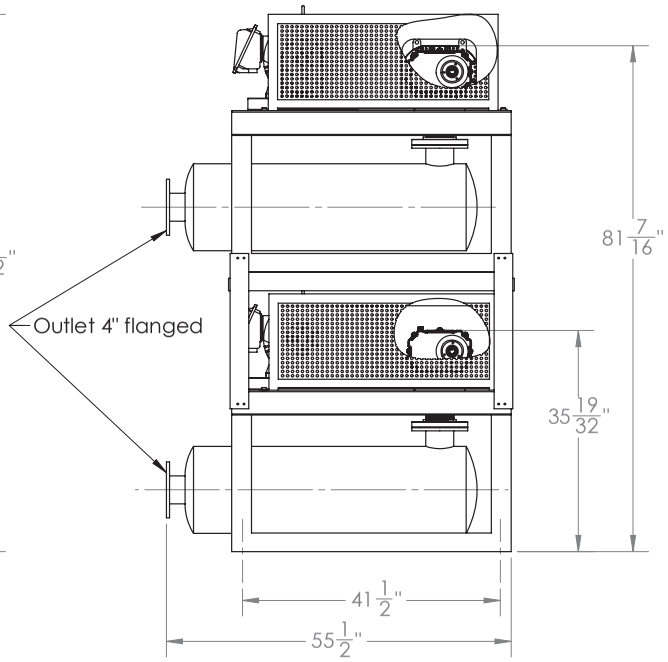








ITEM NO.	DESCRIPTION	QTY.
1	Elevated base, Steel	2
2	Extension base, Steel	1
3	Motor,15HP (supplied by Newterra)	2
4	Blower, Sutorbilt, Model 4L	2
5	Belt Drive 15HP	2
6	Motor slide base	2
7	Guard for belt drive, Steel	2
8	Silencer, URBY4 4in flanged	2

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION | DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	Alex C.	01/06/2017
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

AIRCOM TECHNOLOGIES

TITLE:
Blower Package
Sutorbilt 4L Stacked

SIZE	DWG. NO.	REV
B	0960	1

SCALE: 1:20 | WEIGHT: | SHEET 1 OF 1

E-75

Maska Pulleys Inc.
180, Boul. Gagnon, Ste-Claire
Qc, Canada G0R 2V0
Tel:(418)883-4322 Fax:(418)883-5015
www.maskapulleys.com

Selection Parameters

Family: Classic & Narrow belts drives

Shaft diameter Driver: 1-5/8 Inch
Shaft diameter Driven: 7/8 Inch
Service Factor: 1.4
Driver power: 13.3 hp
Rpm Driver: 3525
Rpm Driven: 3364 **Tolerance:** -0% +3%
Center distance : Minimum: 23.5 Inch
Maximum: 24.5 Inch
Belts: A,AX,B,BX,C,CX,3V,3VX,5V,5VX,8V

Max. Hub Load: 9999
Rim Speed min.: 900 FPM
Rim Speed max.: 6500 FPM
Nbr of Grooves min.: 1
Nbr of Grooves max.: 15

Pitch Diameter (Inch)

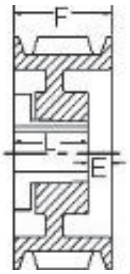
	Min.	Max.
Driver	0.50	71.00
Driven	0.50	71.00

Actual Drive Values

Maximum number of results: 20

Rpm: 3417
Service Factor: 1.55
BeltSpeed (fpm): 5859
List Price: 194.90
Center distance (Inch): 23.6
Power/Belt (hp): 10.3
Deflection (inch): 0.37
Deflection Force (lbs): 3.1
Hub Loads (lbs): 130

Driver Sheave: 2B64

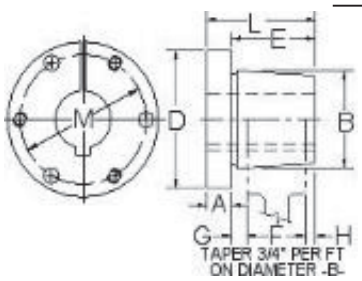


List Price: 68.00
Weight: 7.35 lbs

D.D. A or 4L Belt: 6.00"
D.D. B or 5L Belt: 6.40"
E: 7/16"
F: 1 3/4"
L: 1 5/16"
O.D.: 6.75"

Constuction type: Web

Driver Bushing: SDSX1-5/8

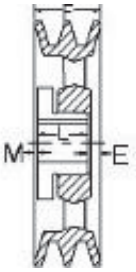


List Price: 17.30
Weight: 1.10 lbs

A: 7/16"
B: 2 3/16"
D: 3 3/16"
E: 7/8"
F: 3/4"
G: 1/4"
H: -1/8"
Keyseat: 3/8 x 3/16"
L: 1 5/16"
M: 2 11/16"

Set screw - Dimensions: 1/4-20 UNC x 1/4
Product specifications: Standard with set screw over keyway.
Hex bolt: 3=1/4-20 UNC x 1-3/8

Driven Sheave: 2MBL69



List Price: 64.60
Weight: 6.55 lbs

D.D. A or 4L Belt: 6.2"
D.D. B or 5L Belt: 6.6"
E: 1/16"
F: 1 3/4"
L: 1 11/32"
M: 11/32"
O.D.: 6.95"

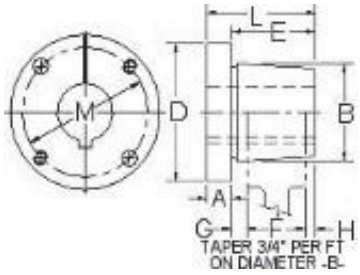
Constuction type: Arms

Driven Bushing: LX7/8

List Price: 9.00
Weight: 0.90 lbs

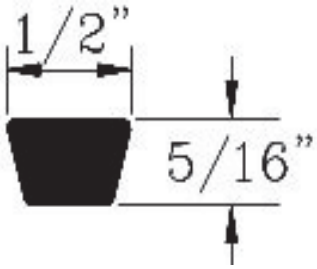
Set screw - Dimensions: 1-8UNCx1-1/2
Hex bolt: 2 = 1/4-20UNC X 7/8

A: 11/32"
B: 1 5/8"
D: 2 1/2"
E: 1"
F: 29/32"
G: 3/16"
H: -3/32"
Keyseat: 3/16 x 3/32"
L: 1 11/32"
M: 2"



Belts: VBA65 (Qty:2)

List Price: 18.00
Weight: 0.30 lbs



QuickPik™

Sutorbilt Legend - 4L

Product Information

CORRECTED VALUES	ORIGINAL UNITS	ENGLISH UNITS	METRIC UNITS
Ambient Pressure	100 ALTI-FT	14.642 PSIA	1.01 bar a
Elevation	100 ALTI-FT	100 ALTI-FT	30 alti-m
Inlet Pressure	14.642 PSIA	0.000 PSIG	0 bar g
Inlet Pressure Loss	0.3 PSIG	0.300 PSIG	0.021 bar g
Inlet Temp	68 F	68 °F	20 °C
Inlet Flow	487 SCFM	499 ICFM	848 m³/h
Discharge Pressure	4.4 PSIG	4.400 PSIG	0.303 bar g
Discharge Pressure Loss	0.2 PSIG	0.200 PSIG	0.014 bar g
MEASURED VALUES	**ORIGINAL UNITS**	**ENGLISH UNITS**	**METRIC UNITS**
Speed	3364 RPM	3364 RPM	3364 RPM
RPM % Of Max	93	93	93
Power	13.3 HP	13.3 HP	9.9 kW
Discharge Temp	126 °F	126 °F	52 °C
Temp % of Max	48	48	48
Noise	88 dBa	88 dBa	88 dBa
Pressure % of Max	70	70	70

PHYSICAL	
Weight	155 lbs.
Gear Diameter / Center Distance	4 in.
Connection Size	3i/3d in.
Case Length	8 in.
WR^2	0.924 lb-ft^2
Orientation	horizontal
PERFORMANCE	
Max Delta P	7 PSI
Max Temp	260 °F
Max Speed	3600 RPM
Min Speed	955 RPM
Max Case Pressure	25 PSIG
Max Delta T	160 °F

QuickPik™

AMBIENT GAS PARAMETERS	ENGLISH UNITS	METRIC UNITS
Molecular Weight	28.866 lbm/lbmol	28.866 kg/kgmol
R Value	53.523 ft.lbf/lbm.R	0.288 kJ/kg.K
Density	0.075 lbm/ft ^{3}	1.196 kg/m^3

GAS MIX:	VOL
Air	100%

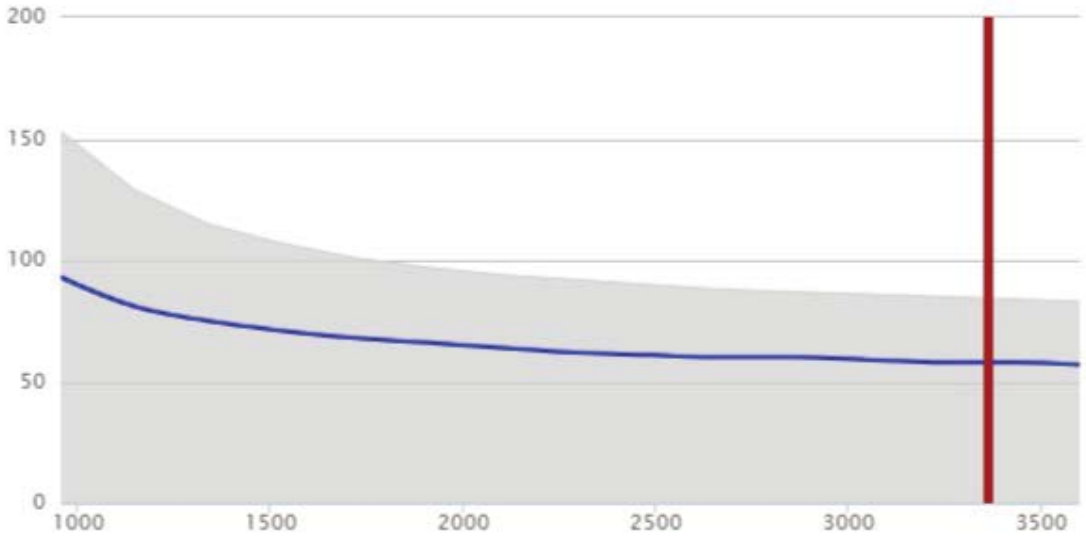
Performance Curves

Temperature Rise

DEFINED CONDITIONS
58 F

RPM
3364

Published Data
Defined Conditions

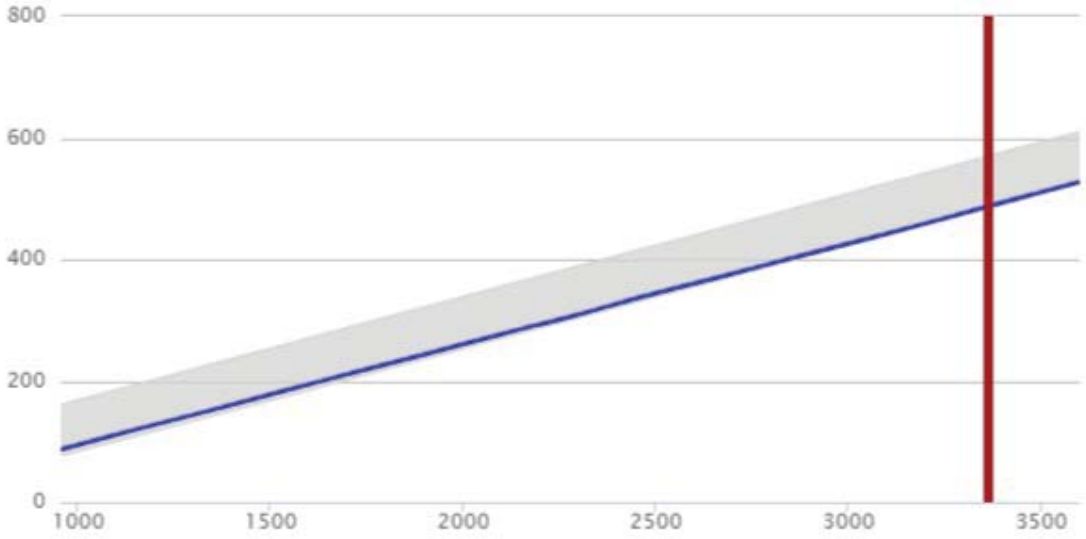


Flow

DEFINED CONDITIONS
487 SCFM

RPM
3364

Published Data
Defined Conditions



QuickPik™

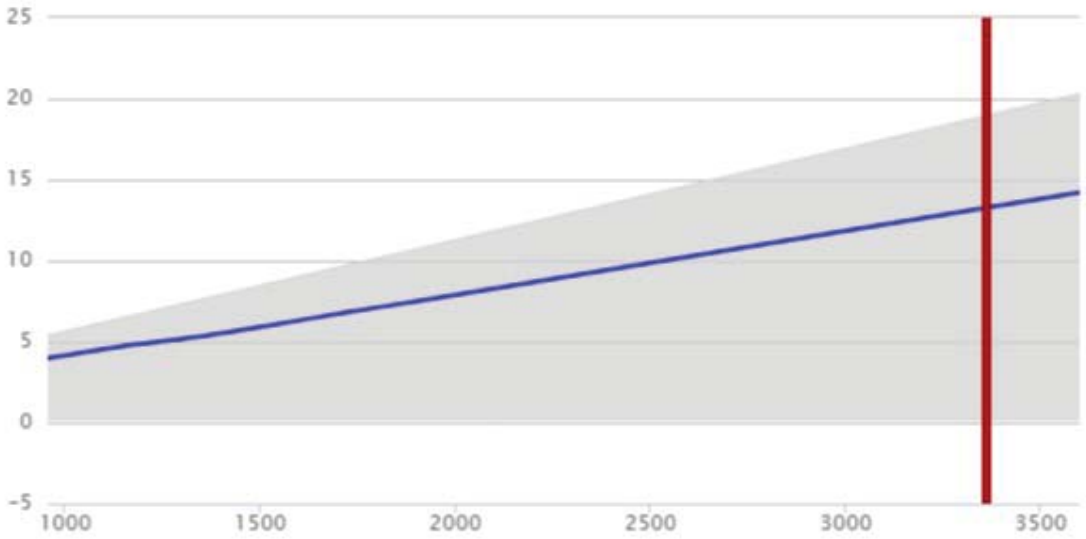
Performance Curves

Power

DEFINED CONDITIONS
13.3 HP

RPM
3364

Published Data
Defined Conditions

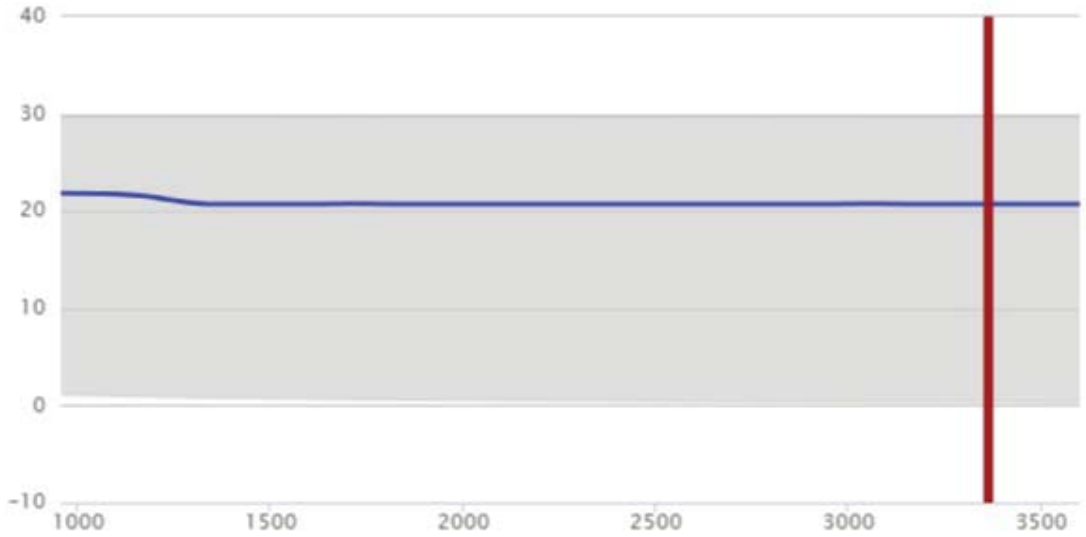


Torque

DEFINED CONDITIONS
20.8 ft-lb

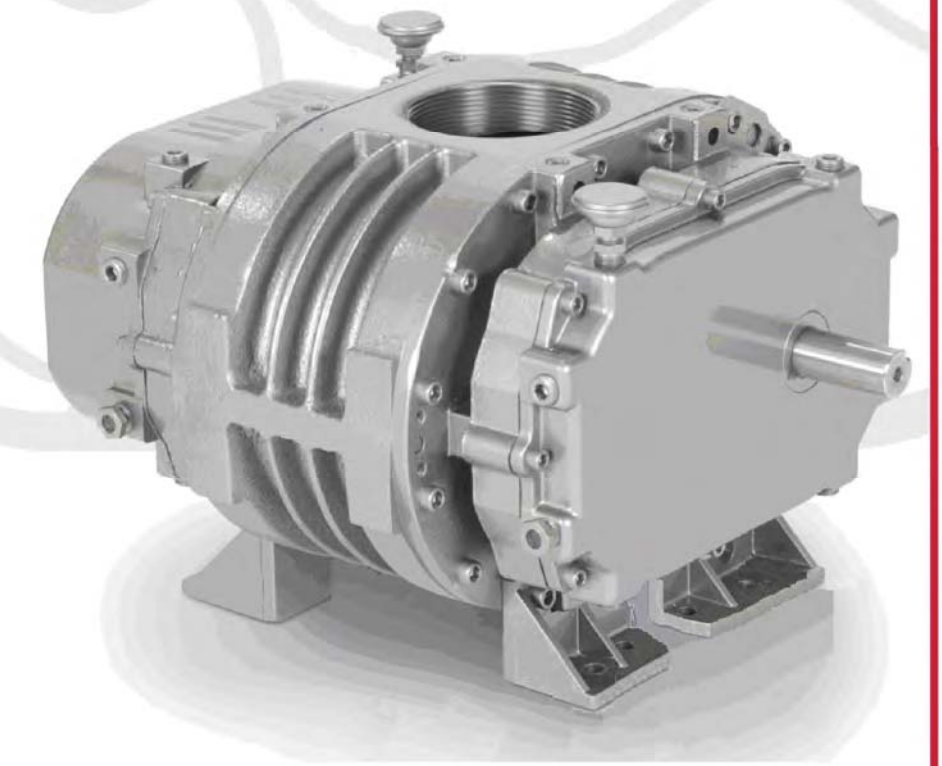
RPM
3364

Published Data
Defined Conditions



Gardner Denver

PARTS LIST OPERATING AND SERVICE MANUAL



LEGEND
"R" SERIES BLOWERS

3" – 5" GEAR DIAMETER

Models
GAB_ _ R _
GAC_ _ R _
GAE_ _ R _

ENERGY STAR PARTNER

SB-7-632
Version 05
July 8, 2015

MAINTAIN BLOWER RELIABILITY AND PERFORMANCE
WITH GENUINE GARDNER DENVER
PARTS AND SUPPORT SERVICES

Factory genuine parts, manufactured to design tolerances, are developed for optimum dependability - - - specifically for your blower. Design and material innovations are born from years of experience with hundreds of different blower applications. When you specify factory genuine parts you are assured of receiving parts that incorporate the most current design advancements manufactured in our state-of-the-art blower factory under exacting quality standards.

Your AUTHORIZED DISTRIBUTOR offers all the backup you require. A worldwide network of authorized distributors provides the finest product support in the blower industry.

1. Trained technical representatives to assist you in selecting the correct replacement parts.

2. Complete inventory of new machines and new, genuine factory parts.

3. A full line of factory tested AEON® PD blower lubricants, specifically formulated for optimum performance in all blowers.

4. Authorized distributor service technicians are factory-trained and skilled in blower maintenance and repair. They are ready to respond and assist you by providing fast, expert maintenance and repair service.

INSTRUCTIONS FOR DETERMINING BLOWER CONFIGURATION

1. Face the blower drive shaft.
2. In a **VERTICAL** configuration, air flow is horizontal.
3. In a **HORIZONTAL** configuration, air flow is vertical.
4. In a vertical configuration, a **BOTTOM HAND** exists when the drive shaft is below the horizontal center line of the blower. A **TOP HAND** exits when the drive shaft is above the horizontal center line of the blower.
5. In a horizontal configuration, a **RIGHT HAND** exists when the drive shaft is to the right of the vertical center line of the blower. A **LEFT HAND** exists when the drive shaft is to the left of the vertical center line of the blower.

INSTRUCTIONS FOR ORDERING REPAIR PARTS

For pricing, and ordering information contact your nearest AUTHORIZED FACTORY DISTRIBUTOR. When ordering parts, specify Blower **MODEL** and **SERIAL NUMBER** (see nameplate on unit).

Rely upon the knowledge and experience of your AUTHORIZED DISTRIBUTOR and let them assist you in making the proper parts selection for your blower.

To Contact Gardner Denver or locate your local distributor:
Visit: www.contactgd.com/mobile

Or

Call: (217)222-5400

GARDNER DENVER LUBRICANT ORDER INFORMATION

Re-order Part Numbers for Factory Recommended Lubricants.

Gear and Drive End

AEON PD Synthetic Lubricant, AEON PD-XP—Extreme Duty Synthetic Lubricant or AEON PD-FG—Food Grade Synthetic Lubricant

AEON PD Synthetic Lubricant

Description	Part Number
1 Quart	28G23
Case/12Quarts	28G24
1 Gallon Container	28G40
Case/6 Gallons	28G41
5 Gallon Pail	28G25
55 Gallon Drum	28G28

AEON PD-XD – Extreme Duty Synthetic Lubricant

Description	Part Number
1 Quart	28G46
Case/12Quarts	28G47
1 Gallon Container	28G42
Case/6 Gallons	28G43
5 Gallon Pail	28G44
55 Gallon Drum	28G45

AEON PD-FG – Food Grade Synthetic Lubricant

Description	Part Number
1 Quart	28H97
Case/12Quarts	28H98
1 Gallon Container	28H333
Case/6 Gallons	28H334
5 Gallon Pail	28H99
55 Gallon Drum	28H100

Drive End

AEON PD Grease

Description	Part Number
Case/10 Tubes (14oz/Tube	28H283

Call your local Gardner Denver Distributor to place your order for Gardner Denver lubricants. Your Authorized Gardner Denver Distributor is:

FOREWORD

Sutorbilt® blowers are the result of advanced engineering and skilled manufacturing. To be assured of receiving maximum service from this machine, the owner must exercise care in its operation and maintenance. This manual is written to give the operator and maintenance department essential information for day-to-day operation, maintenance and adjustment. Careful adherence to these instructions will result in economical operation and minimum downtime.

⚠ DANGER
Danger is used to indicate the presence of a hazard which will cause severe personal injury, death, or substantial property damage if the warning is ignored.

⚠ WARNING
Warning is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if the warning is ignored.

⚠ CAUTION
Caution is used to indicate the presence of a hazard which will or can cause minor personal injury or property damage if the warning is ignored.

NOTICE
Notice is used to notify people of installation, operation or maintenance information which is important but not hazard-related.

SAFETY PRECAUTIONS

Safety is everybody's business and is based on your use of good common sense. All situations or circumstances cannot always be predicted and covered by established rules. Therefore, use your past experience, watch out for safety hazards and be cautious. Some general safety precautions are given below:

⚠ DANGER

Failure to observe these notices could result in injury to or death of personnel.

- **Keep fingers and clothing away from revolving fan, drive coupling, etc.**
- **Do not use the air discharge from this unit for breathing – not suitable for human consumption.**
- **Do not loosen or remove the oil filler plug, drain plugs, covers or break any connections, etc., in the blower air or oil system until the unit is shut down and the air pressure has been relieved.**
- **Electrical shock can and may be fatal.**
- **Blower unit must be grounded in accordance with the National Electrical Code. A ground jumper equal to the size of the equipment ground conductor must be used to connect the blower motor base to the unit base.**
- **Open main disconnect switch, tag and lockout before working on the control.**
- **Disconnect the blower from its power source, tag and lockout before working on the unit – this machine may be automatically controlled and may start at any time.**

⚠ WARNING

Failure to observe these notices could result in damage to equipment.

- **Stop the unit if any repairs or adjustments on or around the blower are required.**
- **Disconnect the blower from its power source, tag and lockout before working on the unit – this machine maybe automatically controlled and may start at any time.**
- **Do not exceed the rated maximum speed shown on the nameplate.**
- **Do not operate unit if safety devices are not operating properly. Check periodically. Never bypass safety devices.**

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LIST OF ILLUSTRATIONS

SUTORBILT LEGEND SERIES BLOWERS
MATRIX/MENU

NOTICE TO CUSTOMER – To find the construction options for Your blower unit, FILL IN THE BALANCE OF LETTERS OR NUMBERS FROM YOUR UNIT NAMEPLATE

	G	A				R	
COLUMN NUMBER:	1	2	3	4	5	6	7

FOLLOW THE LINE DOWN AND OVER FROM EACH SPACE THUS FILLED IN TO FIND THE APPROPRICATE CONSTRUCTION OPTION WITH WHICH YOUR MACHINE IS EQUIPPED.

COLUMN 1 – BASIC DESIGNATOR

COLUMN 2 – PRODUCT FAMILY

COLUMN 3 – GEAR DIAMETER

B	3”	E	5”
C	4”		

COLUMN 4 – CASE LENGTH

- L - Low Pressure
- M - Medium Pressure
- H - High Pressure

COLUMN 5 – CONFIGURATION

- A Vertical-Top Hand -Central Timed
- B Vertical-Bottom Hand – Central Timed
- C Horizontal – Left Hand – Central Timed
- D Horizontal – Right Hand – Central Timed

COLUMN 6 – DESIGN VERSION

COLUMN 7 – ADDITIONAL DESCRIPTION

	SEALS	CLEARANCES	LUBRICATION
A.	Lip	Standard	Grease-Splash
B.	Mechanical	Standard	Grease-Splash
C.	Lip	High Temperature	Grease-Splash
D.	Lip	Standard	Dual-Splash
E.	Mechanical	Standard	Dual-Splash
F.	Lip	High Temperature	Dual-Splash
G.	Mechanical	High Temperature	Dual-Splash

INTRODUCTION
YOUR KEY TO TROUBLE FREE SERVICE

Thank you for investing in Gardner Denver quality. The Gardner Denver reputation for rugged dependability has been earned by over 50 years of service in demanding, industrial operations where downtime cannot be tolerated and efficient blower performance is expected.

Your Gardner Denver Sutorbilt blower is a precision engineered blower that has been carefully manufactured and thoroughly tested at the state-of the art Gardner Denver Blower Factory in Sedalia, Missouri.

As with other precision machinery, there are several relatively simple installation, operation and maintenance procedures that you must observe to assure optimum blower performance. There is no guesswork in the manufacture of your highly advanced Sutorbilt blower and there must be none in preparing the blower to get the job done in the field.

The purpose of this manual is to help you properly install, operate and maintain your Sutorbilt blower. It is essential that you review all sections of this manual in preparation for installing your blower. Follow the instructions for installing your blower. Follow the instructions carefully and you will be rewarded with trouble-free Gardner Denver Sutorbilt service year in and year out.

SECTION 1
EQUIPMENT CHECK

Before uncrating, check the packing slip carefully to be sure all the parts have been received. All accessories are listed as separate items on the packing slip, and small important accessories such as relief valves can be overlooked or lost. After every item on the packing slip has been checked off, uncrate carefully.

NOTICE
Register a claim with the carrier for lost or damaged equipment.

⚠WARNING
Customers are cautioned to provide adequate protection, warning and safety equipment necessary to protect personnel against hazards involved in installation and operation of this equipment in the system or facility.

STORAGE

Your Gardner Denver Blower was packaged at the factory with adequate protection to permit normal storage for up to six (6) months.

If the unit is to be stored under adverse conditions or for extended periods of time, the following additional measures should be taken to prevent damage.

1. Store the blower in a clean, dry, heated (if possible) area.
2. Make certain inlet and discharge air ports are tightly covered to prevent foreign material from entering the air box.
3. All exposed, non-painted surfaces should be protected against rust and corrosion.
4. Provide adequate protection to avoid accidental mechanical damage.
5. In high humidity or corrosive environments, additional measures may be required to prevent rusting of the blower internal surfaces.
6. To prevent rusting of gears, bearings, etc., the oil reservoirs may be filled with normal operating oil.

⚠CAUTION
Before running the blower, drain the oil and replace to the proper operating level with clean, fresh lubricant.

7. Rotate the blower shaft (10 to 25 turns) weekly during storage. Inspect the blower shaft (near the shaft seal area) monthly and spray with rust inhibitor if needed.
8. For long term storage (over six (6) months), contact Gardner Denver Compressor Division Customer Service for recommendations.

REMOVING PROTECTIVE MATERIALS

The shaft extension is protected with rust inhibitor which can be removed with any standard solvent.

⚠CAUTION
Follow the safety directions of the solvent manufacturer.

Blower inlet and outlet are temporarily capped to keep out dirt and other contaminants during shipment. These covers must be removed before start-up.

The internal surfaces of all Sutorbilt units are mist sprayed with a rust preventative to protect the machine during shipment. Remove this film upon initial startup, using any commercial safety solvent. Position the blower so that the inlet and discharge connections are in the vertical position (vertical airflow). On vertically mounted units, it will be necessary to lay the unit on its side supporting the ends of the unit so as not to restrict the port on the bottom side. Place a shallow pan on the under side of the unit. With the blower disconnected from power, spray the solvent in the top port, rotating the impellers by spinning the shaft manually. Continue this procedure until the unit is visibly clean.

⚠WARNING
Rotating components will cause severe injury in case of personal contact. Keep hands and loose clothing away from blower inlet and discharge ports.

SECTION 2
INSTALLATION

LOCATION

Install the blower in a well lit, clean dry place with plenty of room for inspection and maintenance.

FOUNDATIONS

For permanent installation we recommend concrete foundations be provided, and the equipment should be grouted to the concrete. It is necessary that a suitable base be used, such as a steel combination base under blower and motor, or a separate sole plate under each. Before grouting, equipment must be leveled, free of all strains, and anchored so no movement will occur during setting of grout. After grout has completely hardened, a recheck is necessary to compensate for shrinkage, etc. If required, add shims under blower feet after final tightening of foundation anchor bolts to remove strain from the blower housing.

Where jack screws or wedges are used during grouting, they must be backed off and wedges removed before final tightening of anchor bolts. Refer to grouting instructions.

Where a concrete foundation is not feasible, care must be taken to insure that equipment is firmly anchored to adequate structural members, restricting movement and vibration.

MOUNTING CONFIGURATIONS

The blower flex-mount design enables horizontal and vertical mounting configurations with top or bottom hand, right or left hand shaft positioning. The units are center timed allowing rotation in either direction (refer to Figure 2-1).

REPOSITIONING THE MOUNTING FEET.

1. Position the mounting feet to the desired location and snug the capscrew.
2. Place the blower on its feet on a flat surface.
3. Loosen mounting feet capscrews and level unit up. The bench or blower base flatness should be within .002 of an inch.

NOTICE
If the unit is not flat within .002 of an inch, it will be necessary to shim the blower feet at installation.

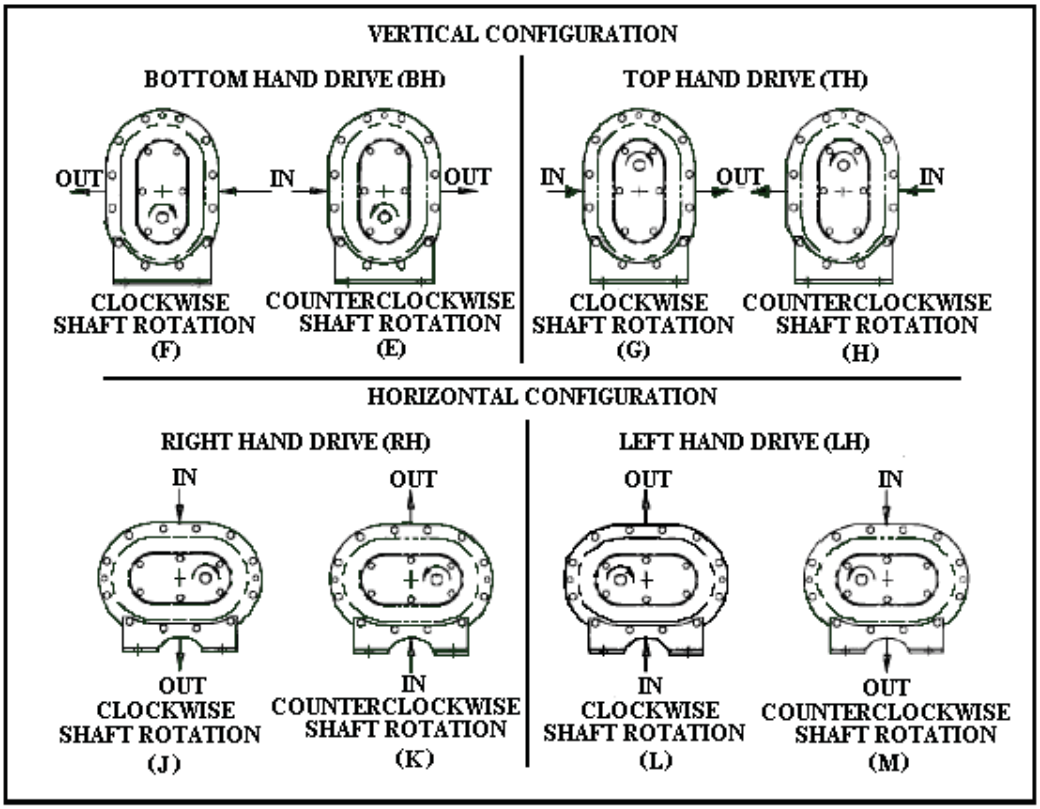


FIGURE 2-1 – BLOWER MOUNTING CONFIGURATIONS

4. Secure the mounting feet capscrews to the torque value in Figure 7-9, page 38.

NOTICE
When changing mounting configuration, it may be necessary to reposition breather/oil fill (B), oil level gauge (H) and drain plug (A). Refer to Figure 3-1, page 17, for correct location.

DRIVE INSTALLATION

When selecting a V-belt drive, check to be sure the shaft overhung load limitation is not exceeded. Refer to FIGURE 2-2, page 15, for overhung load calculations and limitations.

Belt drives must be carefully aligned. Motor and blower pulleys must be parallel to each other and in the same plane within 1/32 inch. Belt tension should be carefully adjusted to the belt manufacturer's recommendation using a belt tension gauge. Check tension frequently during the first day of operation.

⚠WARNING
Over tightening belts leads to heavy bearing loads and premature failure.

On the direct connected units, alignment and lubrication of couplings to specifications of the coupling manufacturer is very important. When mounted drives are supplied from the factory proper alignment has been established before shipment. However, during shipping, handling and installation, it is likely that the alignment has been disturbed and final adjustment must be made before startup.

⚠WARNING

Exceeding overhung load limitations leads to unwarrantable premature bearing failure and shaft breakage.

The location of the sheave on the blower shaft greatly affects the stress in the shaft. The optimum blower sheave positioning is as close as possible to the blower drive cover, not to exceed dimension "C" in Drive Shaft Illustration, FIGURE 2-2, page 15

The calculated shaft moment must not exceed the maximum allowable moment listed in Maximum Allowable Moment Chart, FIGURE 2-2 page 15. If the calculated shaft moment exceed the maximum allowable moment:

- Increase Sheave Diameters to Reduce Belt Pull
- Use Jackshaft Drive
- Use Direct Coupled or Gearbox Drive

To calculate shaft moment for a given V-Belt Drive Arrangement:

1. Use the formula for Calculation of Belt Pull, FIGURE 2-2, page 15, to calculate belt pull. Refer to Arc of Contact Factor Chart, Figure 2-2, page 15.
2. Insert the calculated belt pull into the formula for Calculation of Shaft Moment, FIGURE 2-2, page 15 to arrive at the calculated shaft moment.

PIPING

Inlet and discharge connections on all blowers are large enough to handle maximum volume with minimum friction loss. Reducing the pipe diameter on either inlet or discharge will only create additional line loss and increase the overall pressure differential. Excessive weight of piping and fittings will cause internal misalignment and premature wear. Never allow the blower to carry the weight of the pipe. If possible, a spool or sleeve-type expansion joint should be installed between the unit and the piping. Where a flexible connection is not practical, the weight of the rigid connection must be separately supported.

All system piping must be cleaned internally before connecting to the blower.

⚠WARNING

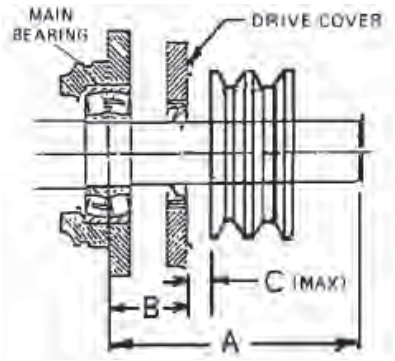
Sutorbilt blowers are shipped dry from the factory. Do not attempt to operate the blower before following proper lubrication instructions. Permanent damage to the gears, bearings and seals will occur.

Gear Diameter (Inches)	GREASE SPLASH Dimensions (Inches)			Maximum Allowable Moment (LB-IN)
	A	B	C (Max)	
3	2.88	.85	.38	385
4	3.49	1.10	.38	490
5	3.90	1.40	.38	1245

MAXIMUM ALLOWABLE MOMENT

Gear Diameter (Inches)	DUAL SPLASH LUBE Dimensions (Inches)			Maximum Allowable Moment (LB-IN)
	A	B	C (Max)	
3	3.07	1.18	.25	385
4	3.62	1.27	.25	650
5	3.85	1.39	.25	1370

MAXIMUM ALLOWABLE MOMENT



Z	Ac	Z	Ac	Z	Ac	Z	Ac	Z	Ac	Z	Ac
0.000	1.000	0.250	0.966	0.500	0.926	0.750	0.879	1.000	0.823	1.250	0.751
0.025	0.997	0.275	0.962	0.525	0.922	0.775	0.874	1.025	0.816	1.275	0.742
0.050	0.994	0.300	0.958	0.550	0.917	0.800	0.869	1.050	0.810	1.300	0.734
0.075	0.990	0.325	0.954	0.575	0.913	0.825	0.864	1.075	0.803	1.325	0.725
0.100	0.987	0.350	0.951	0.600	0.908	0.850	0.858	1.100	0.796	1.350	0.716
0.125	0.983	0.375	0.947	0.625	0.904	0.875	0.852	1.125	0.789	1.375	0.706
0.150	0.980	0.400	0.943	0.650	0.899	0.900	0.847	1.150	0.782	1.400	0.697
0.175	0.977	0.425	0.939	0.675	0.894	0.925	0.841	1.175	0.774	1.425	0.687
0.200	0.973	0.450	0.935	0.700	0.889	0.950	0.835	1.200	0.767		
0.225	0.969	0.475	0.930	0.725	0.884	0.975	0.829	1.225	0.759		

ARC OF CONTACT FACTORS

$$\text{Belt Pull} = \left[\frac{2.5 - Ac}{Ac}\right] \times \left[\frac{125954 \times Hp \times S.F.}{D \times RPM}\right]$$

Key:
- Ac = Arc of Contact Factor (Refer to Arc of Contact Factor Chart above)
- Hp = Blower Horsepower for Operating Conditions
- S.F. = Actual Drive Service Factor
- D = Blower Sheave Pitch Diameter in Inches
- RPM = Blower Sheave Speed
- Z = $\left[\frac{\text{Large Sheave Pitch Diameter (in)} - \text{Small Sheave Pitch Diameter (in)}}{\text{Sheave Center Distance (in)}}\right]$

CALCULATION OF BELT PULL

$$\text{Shaft Moment (LB-IN)} = \text{Belt Pull} \times \left[B + C + \left(\frac{\text{Sheave Width}}{2}\right)\right]$$

CALCULATION OF SHAFT MOMENT

FIGURE 2-2 – BELT DRIVE OVERHUNG LOAD CALCULATIONS

AIR FILTERS AND FILTER SILENCERS

⚠WARNING

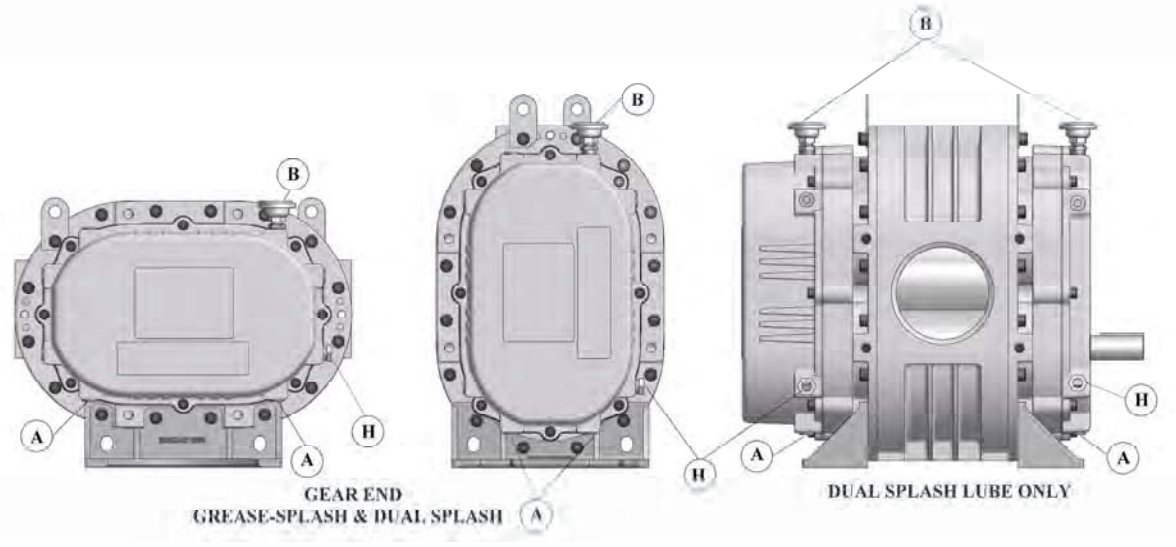
Servicing the air filters is one of the most important maintenance operations to be performed to insure long blower life.

Servicing frequency of filter elements is not time predictable. A differential pressure indicator, with a continuous gauge reading, should be installed across the inlet filter. It will tell how much of the service life of the filter element has been used. It will also eliminate both premature filter servicing and premature blower failure due to a plugged filter when the filter pressure drop is used to establish maintenance points. In all cases refer to the filter manufacturer's service instructions. Due to the many types of filters, it is not practical to give specific instructions covering all models.

NOTICE

No matter what type of filter is used, always make sure all seats, gaskets, clamps and hose connections on the filter and inlet line are absolutely air tight. Each time the filter is serviced, inspect interior of the blower for dirt.

SECTION 3
LUBRICATION



A. OIL DRAIN PLUG
B. BREATHER/OIL FILL
C. GREASE FITTING
E. GREASE VENTS
H. OIL LEVEL GAUGE

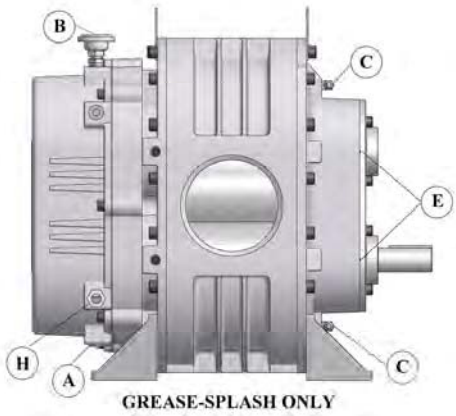


FIGURE 3-1 - LUBRICATION

DRIVE END LUBRICATION (For Grease – Splash Lube Blowers)

Drive end bearings are grease lubricated at the factory with Lithium Complex based grease. **For relubrication, use Gardner Denver AEON PD Grease, Part Number 28H283.** AEON PD Grease is a high temperature, high performance grease that is formulated with antiwear additives to provide superior service under the severe operating conditions of positive displacement blowers. It contains rust inhibitors which provide excellent protection against rust and corrosion.
If you choose not to use AEON PD Grease, select compatible base grease. The grease should be NLGI Grade 2 EP, contain rust inhibitors, and be suitable for blower discharge temperatures up to 350° F (177° C). Completely clean or purge the factory--filled grease from the blower. **Do not mix different types of grease as they may not be compatible. Substitutions may cause early bearing failure.**

Re-grease bearings every 500 hours of operation. Lubricate each bearing through the grease fittings located at C in FIGURE 3-1 (2 places). When re-greasing, the old grease will be forced out of the vents (E in FIGURE 3-1). To prevent damage to seals, these vents must be open at all times.

⚠ WARNING
Do not over--grease bearings as this could cause premature bearing failure.

DRIVE END LUBRICATION (For Dual Splash Lube Blowers)

At the drive end, the bearings are lubricated by the slinger, which must be on the lowest rotor when in a vertical configuration.

Approximate oil sump capacities are listed in Figure 3-2.

NOTICE
Machines are shipped without oil in the sump. Do not operate before adding lubricant.

Lubrication Instructions

Filling procedure
Refer to Figure 3-1, page 17. Remove the breather (B) from the drive cover. Add oil to the drive sump until oil reaches the center of the oil level gauge (H). Secure breather (B) in the drive cover.

Add fresh oil as required to maintain proper level. The oil level should be at the middle of the sight glass when the machine is not operating. Refer to Figure 3-2, for approximate oil capacities.

Legend "R" Series, Grease-Splash Lube Blower Oil Capacities

		Approximate Sump capacity in pints or ounces					
		Vertical Configuration			Horizontal Configuration		
Series	**Gear Diameter (in)**	**Gear End**	**Drive End**	**Total**	**Gear End**	**Drive End**	**Total**
3	3.5	0.6 PT (9 oz.)	grease	0.6 PT (9 oz.)	1.1 PT (18 oz.)	grease	1.1 PT (18 oz.)
4	4	0.9 PT (14 oz.)	grease	0.9 PT (14 oz.)	1.5 PT (24 oz.)	grease	1.5 PT (24 oz.)
5	5	1.1 PT (18 oz.)	grease	1.1 PT (18 oz.)	2.5 PT (40 oz.)	grease	2.5 PT (40 oz.)

Note: Quantities are for purchase estimates only.

Legend "R" Series, Dual Splash Lube Blower Oil Capacities

		Approximate Sump capacity in pints or ounces					
		Vertical Configuration			Horizontal Configuration		
Series	**Gear Diameter (in)**	**Gear End**	**Drive End**	**Total**	**Gear End**	**Drive End**	**Total**
3	3.5	0.6 PT (9 oz.)	0.3 PT (5 oz.)	0.9 PT (14 oz.)	1.1 PT (18 oz.)	0.6 PT (9 oz.)	1.7 PT (27 oz.)
4	4	0.9 PT (14 oz.)	0.4 PT (6 oz.)	1.3 PT (20 oz.)	1.5 PT (24 oz.)	0.7 PT (11 oz.)	2.2 PT (35 oz.)
5	5	1.1 PT (18 oz.)	0.6 PT (9 oz.)	1.7 PT (27 oz.)	2.5 PT (40 oz.)	1.2 PT (19.1 oz)	3.7 PT (59.1 oz.)

Note: Quantities are for purchase estimates only.

FIGURE 3-2 – APPROXIMATE OIL CAPACITIES

GEAR END LUBRICATION (For Grease – Splash Lube and Dual Splash Lube Blowers)
At the gear end, the timing gear teeth are lubricated by being partially submerged in oil. The gear teeth serve as oil slingers for gear end bearings.

Approximate oil sump capacities are listed in Figure 3-2.

⚠WARNING

Do not overfill as this will tend to cause excessive heating of the gears and may damage the unit.

NOTICE

Machines are shipped without oil in the sump. Do not operate before adding lubricant.

LUBRICATION INSTRUCTIONS

Filling procedure Refer to FIGURE 3-1, page 17. Remove the breather (B) from the gear cover. Add oil to the gear case until oil reaches the center of the oil level gauge (H). Secure breather (B) in the gear cover.

Add fresh oil as required to maintain proper level. The oil level should be at the middle of the sight glass when the machine is not operating. Refer to Figure 3-2, page 18, for approximate oil capacities.

RECOMMENDED LUBRICANT

AEON PD Synthetic Blower Lubricant is recommended. Refer to FIGURE 3-3, for AEON PD, AEON PD-FG (Food Grade) and AEON PD-XD (Extreme Duty) part numbers. Order AEON PD from your Gardner Denver Distributor or call Gardner Denver directly.

Convenient Package Sizes	AEON PD Part No.	AEON PD-FG Part No.	AEON PD-XD Part No.
1 quart	28G23	28H97	28G46
Case 12 quarts	28G24	28H98	28G47
1 gallon	28G40	28H333	28G42
Case 6 gallons	28G41	28H334	28G43
5 gallon pail	28G25	28H99	28G44
55 gallon drum	28G28	28H100	28G45

FIGURE 3-3 – AEON PD SYNTHETIC LUBRICANT

AEON PD is formulated especially for positive displacement blower service to provide maximum blower protection at any temperature. One fill of AEON PD will last a minimum of 4 times longer than a premium mineral oil. Refer to FIGURE 3-4.

		Ambient Temperatures			
		Less than 10° F	10°F to 32°F	32°F to 90°F	Greater than 90°F
Blower Discharge Temperature	Less than 32°F	AEON PD AEON PD-FG	AEON PD AEON PD-FG		
	32° F to 100° F	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG	
	100° F to 225°F	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG
	225° F to 300° F	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD AEON PD-FG	AEON PD XD
	Greater than 300°F			AEON PD XD	AEON PD XD

FIGURE 3-4 – SYNTHETIC LUBRICANT CHART

AEON PD Synthetic Lubricant should be drained after 6000 hours of operation. Re-fill with fresh AEON PD oil. If mineral oil is used, perform the above oil change maintenance every 1500 hours. Recommended service intervals are for normal blower operating conditions. Severe operating conditions may warrant more frequent oil changes. Laboratory analysis of lubricant should be used to help determine the optimum oil change interval.

For best performance and equipment protection, use AEON PD Synthetic Lubricant, which has been specifically formulated for positive displacement blowers. If you choose not to use AEON PD Synthetic Blower Lubricant, select an oil with rust and oxidation inhibitors, anti-foam additives, and the viscosities listed in FIGURE 3-5. Do not use an oil that contains EP additives.

NOTICE
Flush the oil whenever a change is made from one type of oil to another.

Drain the current lubricant as thoroughly as possible. Refill with the new lubricant. Fill to normal level of the blower, which is at the middle of the sight glass when the machine is not operating. Run the blower for one hour. Shut off the blower and drain the lubricant completely. Refill the blower again with the new lubricant.

Blower Discharge Temperature	Ambient Temperature			
	Less than 10° F*	10° F to 32° F**	32° F to 90° F	Greater than 90° F
Less than 32° F (0° C)	ISO 100	ISO 100		
32° F to 100° F (0° C to 38° C)	ISO 100	ISO 100	ISO 150	
100° F to 225° F (38° C to 105° C)	ISO 100	ISO 100	ISO 150	ISO 220
225° F to 300° F (105° C to 149° C)	ISO 150	ISO 150	ISO 220	ISO 220
Greater than 300° F (149° C)			***	***

* For ambient temperatures less than 10° F, but not less than –20° F, the use of oil sump heaters, heated enclosures or synthetic lubricant is required.

** For ambient temperatures 10° F to 32° F, the use of oil sump heaters, heated enclosures or synthetic lubricant is recommended.

*** The lubricant viscosity must be 70 SUS minimum at the lubricant operating temperature.

The pour point of the lubricant should be at least 5° to 10° F below the minimum expected ambient temperature.

For continuous operation, where the lubricant temperature exceeds 200° F, synthetic lubricant is recommended.

FIGURE 3-5 – LUBRICATION RECOMMENDATION

SECTION 4
OPERATION

Future operating problems can be avoided if proper precautions are observed when the equipment is first put into service.

Before starting under power, the blower should be turned over by hand to make certain there is no binding or internal contact.

Each size blower has limits on pressure differential, running speed and discharge temperature which must not be exceeded. These limits are shown in "Maximum Operating Limitations", FIGURE 4-1, below.

⚠WARNING

Operating beyond the specified operating limitations will result in damage to the unit.

It is important that the pressures and temperatures are measured directly at the ports of the blower to avoid error that may be caused by intervening pipe runs, fittings, etc.

Relief valves must be used to protect against excessive pressure or vacuum conditions. These valves should be tested at initial startup to be sure they are adjusted to relieve at or below the maximum pressure differential rating of the blower.

NOTICE

Relief valves should be placed as close as possible to the blower inlet or discharge.

In some instances, pressure may be relieved at a lower point than the blower maximum in order to protect the motor or the equipment served by the blower.

Discharge temperature switches are recommended to protect against excessive inlet restriction or inlet temperatures. Check valves in the discharge line on pressure blowers and in the inlet line on vacuum blowers are recommended to protect the blower from motoring backwards when shut down under load.

LIMITATIONS

For information regarding limitations, refer to FIGURE 4-1, below.

MAXIMUM / MINIMUM OPERATING LIMITATIONS

SIZE	MAX. RPM	MIN. RPM VERT.	MIN RPM HORIZ.	MAX. PRESSURE PSI	MAX VAC IN HG	MAX. TEMPERATURE RISE ° F	MAX. DISCHARGE TEMPERATURE ° F
3LR	3600	1528	1091	7	14	160	260
3MR	3600	1528	1091	12	15	180	280
3HR	3600	1528	1091	15	16	220	320
4LR	3600	1337	955	7	14	160	260
4MR	3600	1337	955	10	16	185	285
4HR	3600	1337	955	15	16	210	310
5LR	2850	1070	764	7	14	160	260
5MR	2850	1070	764	13	16	180	280
5HR	2850	1070	764	15	16	200	300

DO NOT EXCEED THESE LIMITS

NOTICE

Blower speed, line losses, elevation, and increased inlet temperatures will affect the maximum operating limitations. The minimum RPM for the blowers is based on lubrication only. The blowers may only be operated down to the minimum RPM, when the temperature rise and discharge temperature are below the maximum limitations as shown.

FIGURE 4-1 – MAXIMUM / MINIMUM OPERATING LIMITATIONS

BLOWER STARTUP CHECKLIST

This startup procedure should be followed during the initial installation and after any shutdown periods or after the blower has been worked on or moved to new location. It is suggested that the steps be followed in sequence and checked off (√) in the boxes provided.

- ☐ 1. Check the unit and all piping for foreign material and clean if required.
- ☐ 2. Check the flatness of the feet and the alignment of the drive. Feet that are bolted down in a bind can cause housing distortion and internal rubbing. Misaligned V-drives can cause the rotors to rub against the headplates and cause a reduction in the volumetric efficiency of the unit. Misaligned couplings can ruin bearings.
- ☐ 3. If the blower is V-belt driven, check the belt tension and alignment. Over-tensioned belts create heavy bearing/shaft loads which lead to premature failure.
- ☐ 4. Be sure adequate drive guards are in place to protect the operator from severe personal injury and incidental contact.
- ☐ 5. Check the unit for proper lubrication. Proper oil level cannot be over-emphasized. Too little oil will ruin bearings and gears. Too much oil will cause overheating and can ruin gears and cause other damage. Insure that grease lubricated bearings are properly lubricated.
- ☐ 6. With motor electrical power locked out and disconnected, turn the drive shaft by hand to be certain the impellers do not bind.
- ☐ 7. “Jog” the unit with the motor a few times to check that rotation is in the proper direction, and to be certain it turns freely and smoothly.
- ☐ 8. The internal surfaces of all Sutorbilt units are mist sprayed with a rust preventive to protect the machine during the shipping and installation period. This film should be removed upon initial startup.
- ☐ 9. Start the unit and operate 15 minutes at no load. During this time, check for hot spots and other indications of interference.
- ☐ 10. Apply the load and observe the operation of the unit for one hour. Check frequently during the first day of operation.
- ☐ 11. If malfunctions occur, do not continue to operate. Problems such as knocking rotors can cause serious damage if the unit is operated without correction.

SAFETY PRECAUTIONS

1. Do not operate blower with open inlet or outlet port.
2. Do not exceed specified vacuum or pressure limitations.
3. Do not operate above or below recommended blower speed range.
4. Blower is not to be used where non-sparking equipment is specified.
5. Do not operate without belt guard or coupling shield.

Do not exceed sheave or coupling manufacturer's rim speed limit.

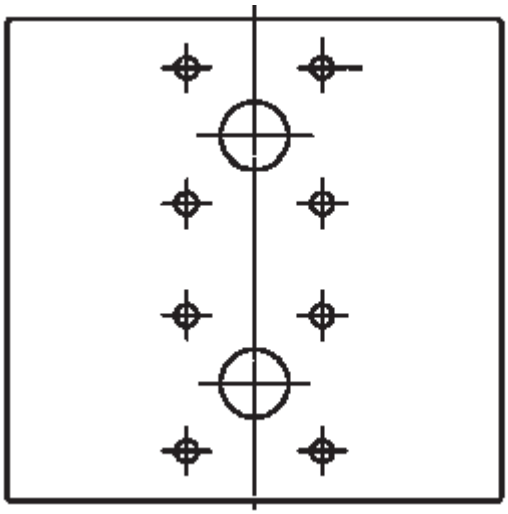
6. The blower and blower discharge piping may be extremely hot and cause skin burns on contact.

TROUBLE SHOOTING

No matter how well the equipment is designed and manufactured, there may be times when servicing will be required due to normal wear, the need for adjustment, or various external causes. Whenever equipment needs attention, the operator or repairman should be able to locate the cause and correct the trouble quickly. The Trouble Shooting Chart below is provided to assist the mechanic in those respects.

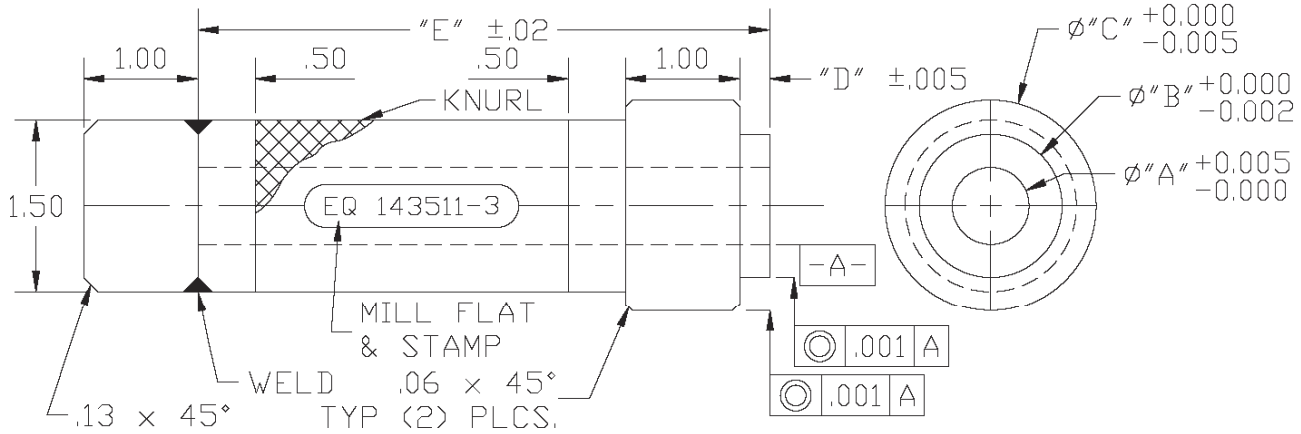
PROBLEM	POSSIBLE CAUSES	SOLUTION
Knocking	1. Unit out of time. 2. Distortion due to improper mounting or pipe strains. 3. Excessive pressure differential. 4. Worn gears. 5. Worn bearings.	1. Re-time impellers 2. Check mounting alignment and relieve pipe strains. 3. Reduce to manufacturer's recommended pressure. Examine relief valve, re-set if necessary. 4. Replace timing gears. 5. Replace bearings..
Excessive blower temperature.	1. Too much oil in gear case. 2. Too low operating speed. 3. Dirty air Filter. 4. Clogged filter or muffler. 5. Excessive pressure differential. 6. Worn impeller clearances. 7. Internal contact.	1. Reduce oil level. 2. Increase blower speed. 3. Clean or replace air filter 4. Remove cause of obstruction. 5. Reduce pressure differential across the blower. 6. Replace impeller. 7. Correct clearances.
Impeller end or tip drag.	1. Insufficient assembled clearances. 2. Case or frame distortion. 3. Excessive operating pressure. 4. Excessive operating temperature.	1. Correct clearances. 2. Check mounting and pipe strain. 3. Remove cause. 4. Remove cause
Lack of volume.	1. Slipping belts. 2. Worn clearances. 3. Dirty air filter	1. Tighten belts. 2. Re-establish proper clearances. 3. Clean or replace air filter.
Excessive bearing or gear wear.	1. Improper lubrication.	1. Correct lubrication level. Replace dirty oil.
Loss of oil.	1. Headplate, gear case or drive cover vents plugged. 2. Worn Seal.	1. Clean vents. 2. Replace seals.

ORDER SPECIAL TOOLS BY PART NUMBER. SEE PAGE 2 FOR ORDERING INSTRUCTIONS.



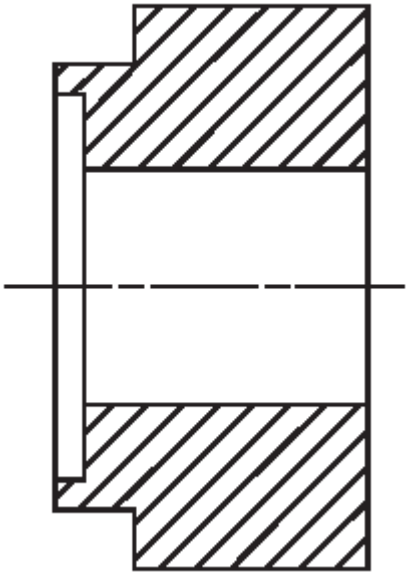
Unit Size	Part Number
3”	201GAA340
4”	202GAA340
5”	203GAA340

FIGURE 5-1 – PULLER PLATE



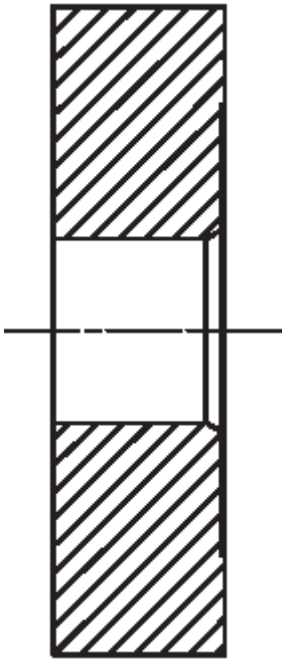
PART NO.	SIZE	"A"	"B"	"C"	"D"	"E"
EQ 143511-3	3"	.790	1.435	2.044	.335	5.50
EQ 143511-4	4"	1.000	1.624	2.436	.395	6.25
EQ 143511-5	5"	1.184	2.247	2.829	.695	7.00

FIGURE 5-2 – SEAL DRIVE



Unit Size	Part Number
3”	205GAA074
4”	206GAA074
5”	207GAA074

FIGURE 5-3 – MECHANICAL SEAL INSTALLATION TOOL



Unit Size	Part Number
3”	201GAA074
4”	202GAA074
5”	203GAA074

FIGURE 5-4 – BEARING PRESS TOOL – MECHANICAL SEAL UNITS

SECTION 6
DISASSEMBLY INSTRUCTIONS

NOTICE
Numbers in parentheses ( ) refer to key numbers in assembly drawings on pages 39 and 43.

1. Drain oil from gear case by removing drain plug (2).
2. Remove the socket head bolts (5) from the gear cover (3).
3. Remove the gear cover from the gear headplate.

NOTICE
The cover and gear headplate gasket tends to bond tightly to both surfaces. After socket head bolt removal, it is sometimes necessary to take a ball peen hammer and a blunt chisel and drive off the cover.

IMPORTANT:

MARK ALL PARTS WITH A CENTER PUNCH SO THEY CAN BE REASSEMBLED IN THE SAME POSITION (IMPELLERS, HEADPLATES, AND GEARS).

4. If the timing gears appear undamaged, the gear backlash must be checked to see if the gears can be salvaged.
   - A. Mount a magnetic base dial indicator on the gear headplate (see FIGURE 6-1).
   - B. Lock one impeller stationary by wedging a feeler gauge between the impeller and the headplate.
   - C. The tip of the indicator should be placed at the center of the contact surface on a tooth of the gear on the free shaft.
   - D. Rock the impeller back and forth by hand and read the total rotational movement to the nearest .0005 inches. Do this at four gear mesh positions 90 degrees apart.
   - E. Permissible gear backlash is shown below.

GEAR DIA.	GEAR BACKLASH
3”	.0015 - .0025
4”	.0015 - .0025
5”	.002 - .003

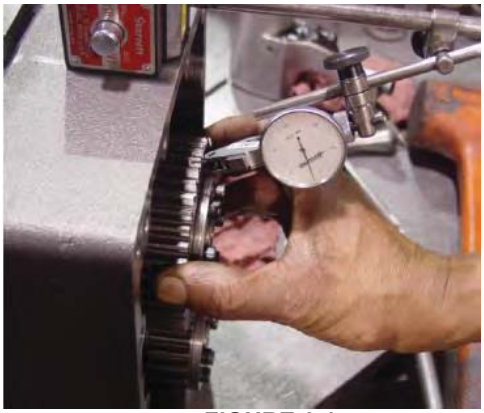


FIGURE 6-1

FIGURE 6-2

FIGURE 6-3

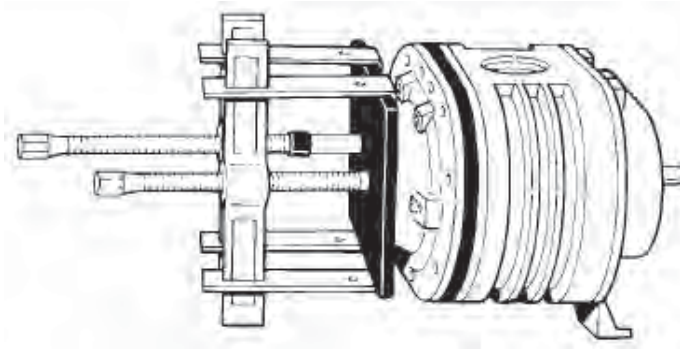


FIGURE 6-4

NOTICE
If backlash is above the specified limit, the gears are not necessarily unusable. Excessive play could be caused by worn bearings.

5. If timing gears appear to be reusable, match marktiming gear toothmesh by making small punch marks on the ends of meshing gear teeth with a pin punch and hammer (see FIGURE 6-2, page 27). The impeller tip to valley (throat) and the case to headplates should also be matchmarked to facilitate blower reassembly.
6. Remove all cap screws from both gear locking assemblies (see FIGURE 6-3). Thread 3 of these cap screws into the threaded holes in the outer ring of each locking assembly. Tighten the screws evenly to remove the locking assembly from each gear. Remove the gears (9) from both rotor shafts.

NOTICE
Blowers with mechanical seals have two wavy washers (28) located between the bearings and the cover on the drive end.

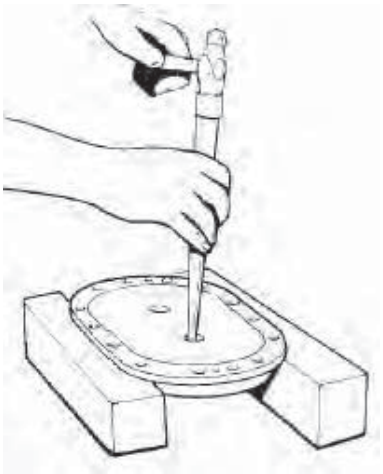


FIGURE 6-5

7. Remove the socket head cap screws (30) from the drive end bearing cover (29) and remove the cover. Support the external surface of the drive end cover near the oil seal with blocks of wood. Drive the oil seal from the cover using a hammer and punch. Discard the seal as it will not be reused. Replace oil seals each time the drive end cover is removed.

   For Dual Splash Version
   Remove the socket cap screws (84) from each slinger and remove slingers.

   For Dual Splash Version with Mechanical Seal
   Remove the socked cap screws (84) from each slinger and remover slingers. Remove flat head cap screws (86) from wavy spring retainer plates and remove retainer plate and wavy spring.

8. Remove mounting foot (17) from the drive headplate (24) by removing the capscrews (16).
9. Remove the capscrews (21) which secure the drive headplate (24) to the impeller case (22).
10. Using the puller plate shown on page 25, bolt to the drive headplate using the tapped holes on used to secure the drive cover.
11. Install a gear puller to each shaft and attach puller arms to the plate. Turn each puller only half a revolution at a time keeping the advance of the shafts as uniform as possible (see Figure 6-4). After the headplate has been removed, detach the puller plate.
12. Remove the two drive end bearings (35 and 80 for dual splash lube) or (14 and 35 for grease) from the drive headplate (24) using a ball peen hammer and punch (see Figure 6-5, page 28).

⚠ CAUTION
Exercise care not to damage the headplate bearing bores when removing bearings.

13. The oil seals can now be driven out of the drive headplate with hammer and punch (see Figure 6-5, page 28). Discard the seals as they will not be reused. Replace oil seals each time the headplate is removed.

   For Mechanical Seal Version
   Remove mechanical seal from the drive headplate.

NOTICE
Seals and bearings should be replaced during overhaul as a matter of service policy.

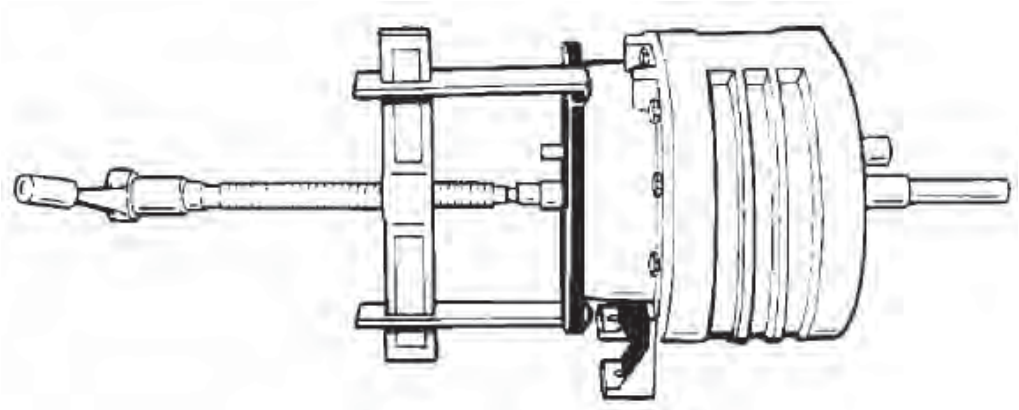


FIGURE 6-6

14. Remove the four bearing retaining screws (10), and washers (12) from the gear headplate.

    For Mechanical Seal Version
    Remove bearing retainer plate by removing 8 screws.

15. Attach puller plate to the gear headplate using the tapped holes on the bearing housing.

16. Install a gear puller to one of the shafts and attach puller arms to the plate (see Figure 6-6).

17. Remove mounting foot (17) from the gear headplate by removing 4 capscrews (16).

18. Push the impeller shaft through the gear headplate and remove the impeller assembly(23) (see Figure 6-6). Remove the other impeller assembly following the same procedure.

19. Remove the cap screws (21) securing the gear headplate to the impeller case. Located near each dowel pin on the headplate is a threaded hole. Insert a 5/16-18 UNC capscrew into each of the threaded holes. Tighten the screws evenly until the headplate separates from the impeller case.

20. Remove the two gear and bearings (14) from the gear headplate (18) as done in step 12.

21. Remove the oil seals (15) from gear headplate (19) as done in step 13.

SECTION 7
ASSEMBLY INSTRUCTIONS

NOTICE
Numbers in parentheses ( ) refer to key numbers in assembly drawings on pages 39 and 43.

1. Make sure all metallic parts are clean and free of any nicks or burrs.
2. Lubricate the outside diameter of the lip seal (15) with a light oil or grease. Install seals in both the drive headplate (24) and gear headplate (18). Use the seal driver (Figure 5-2). The seal lip should always face towards the bearing or lubricant. New seals should be installed each time the headplate is removed.

NOTICE
Make sure seals are fully seated. Use extreme care when installing.

MECHANICAL SEALS ONLY

A. Lightly coat the headplate bores with assembly lubricant.

B. Refer to Figure 7-1. Install mechanical seal (A) into the headplate bore (C) using a press and the correct driver shown on page 26. Drive the seal securely on to its seat.

⚠ CAUTION
Use extreme care when installing seals in the headplate bores. Do not attempt to install the mechanical seals without the use of a press. Blows from a hammer or mallet can damage the fragile seal surface. Too much force can crush the seal casing. Make certain the seal is properly seated and undamaged before proceeding.

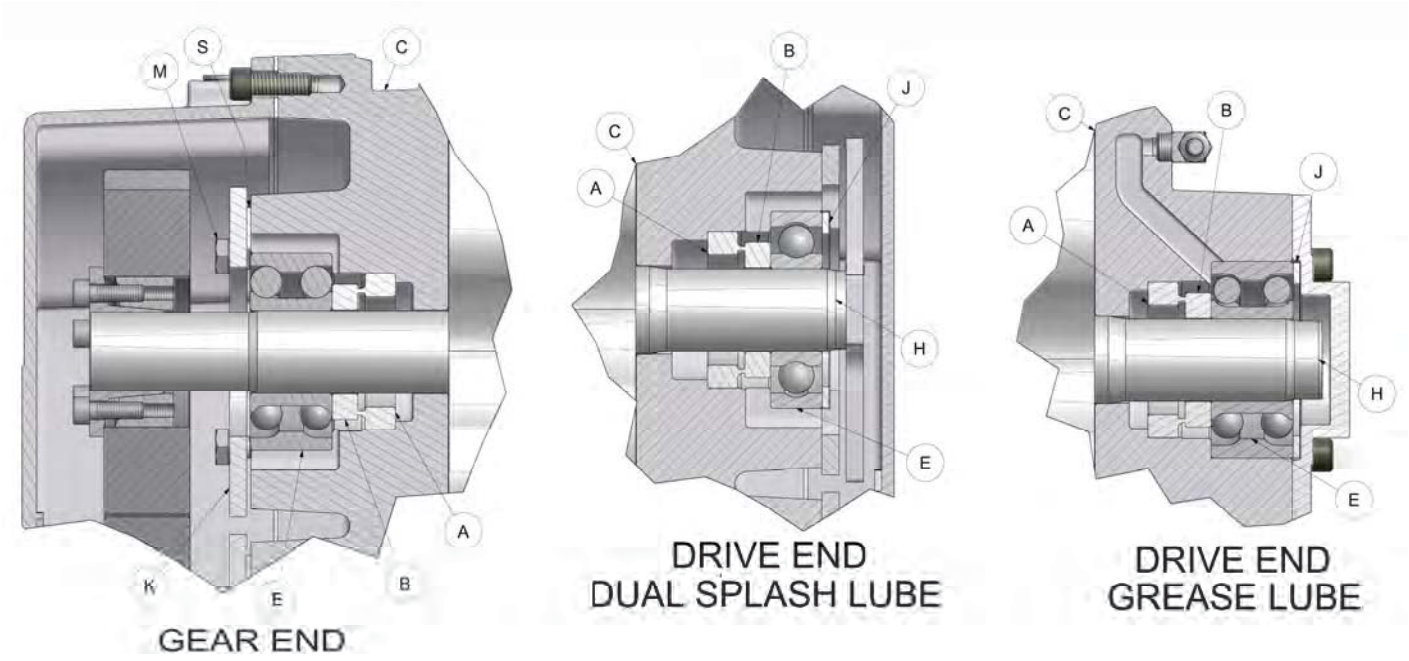


FIGURE 7-1

FIGURE 7-2

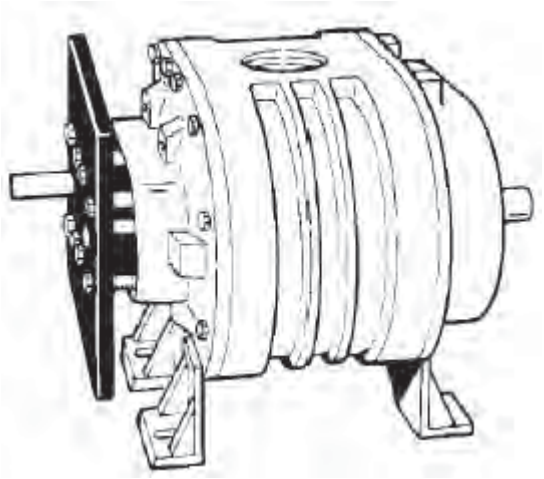


FIGURE 7-3

3. Assemble gear headplate (18) and mounting foot (17) to the impeller case with cap screws (21) and where the mounting foot is secured to the headplate use capscrews (16). The two positioning dowel pins (19) will ensure proper alignment of the headplate and impeller case. Also secure lifting lugs using capscrews (21) (see exploded assembly drawing on page 39. Refer to Figure 7-9, page 38, for torque specifications.

⚠ CAUTION
Seals are delicate; use extreme care when installing impeller shafts in the headplate bores. A piece of light shim stock wrapped around the shaft keyway will prevent cutting the seal lip.

4. Apply a light oil or grease on the shaft seal areas and the bearing areas. Insert impellers into the gear headplate using the same headplate bores as used in the original assembly.
5. Position blower so that impellers are vertical, with the drive end on top. It will be necessary to use blocks in order for the unit to set level. Measure the total end clearance using a depth micrometer (see Figure 7-2).

NOTICE
If more than .007" shim is required, put .007" on the drive end and the remaining on the gear end.

If total clearance is not within the limits specified in Figure 7-4, page 33, it may be necessary to shim the case to obtain the proper total end clearance. The shim should be placed between the drive headplate and impeller case.

6. Assemble drive headplate (24) to impeller case as in step 3 with the gear headplate. If shims were required, place shims between drive headplate and impeller case.

MECHANICAL SEALS ONLY

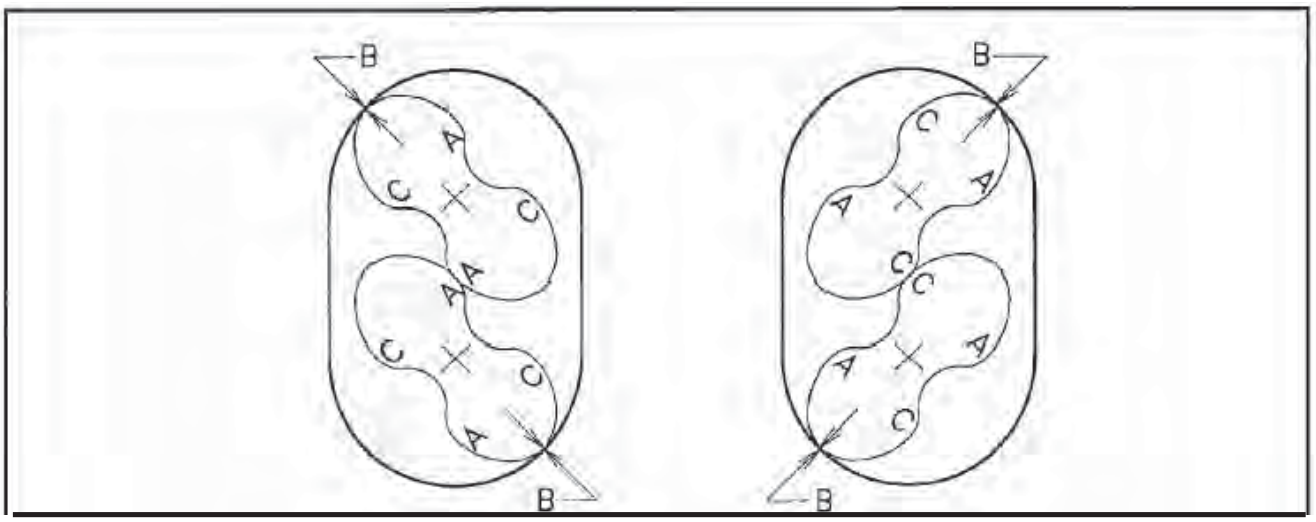
A. Refer to Figure 7-1, page 31. Lightly coat the impeller shaft (H) and the inside diameter of the mating ring (B) with assembly lubricant.

B. Install the mating ring (B) on the shaft only far enough to get the bearing (E) started on the shaft.

⚠ CAUTION
Do not drive the mating ring down to the mechanical seal, as this can damage the seal.

C. Lightly lubricate the bearing inner race (E) with a light oil or grease.

D. Using a press, install the bearing on the shaft with the bearing driver shown on page 24.



INTERNAL CLEARANCES FOR STANDARD UNITS ONLY

	3H	3M	3L	4H	4M	4L	5H	5M	5L
TOTAL END CLEARANCE	0.007-0.011			0.007-0.011			0.007-0.011		
IMPELLER TO GEAR HEADPLATE	0.003-0.005			0.003-0.005			0.003-0.005		
IMPELLER TIMING (A-A) (C-C)	0.005-0.007	.006-.008		0.006-0.008	.007-.010		.007-.010	.008-.010	
TIP TO CASE CLEARANCE (B-B)	0.002 min.			0.002 min.			0.002 min.		

FIGURE 7-4

The bearing driver will position the mating ring (B) to the correct depth with respect to the mechanical seal (A).

7. Apply a light oil to the drive headplate bearing bore, bearing inside diameter, and shaft seat. Install the drive end bearings (14and 35 for grease) or (80 and 35 for dual splash lube) as far as possible without force.
8. Attach the puller plate shown on page 25, to the drive headplate using the tapped holes used on the drive headplate (see FIGURE 7-3, page 32). Tighten the bolts so that the advance of the bearings stay as uniform as possible. Bearings should be pressed until flush with the drive headplate.
9. Lubricate the gear end bearing fits with a light oil as described previously. Install gear end bearings (14) as far as possible without force. Use the plate, used to install the drive end bearings, to press the bearings on the shafts as described in Step 8. Press bearings into the gear headplate until completely seated in the bearing bore.

NOTICE
Bearings will not be flush with gear headplate bores when completely seated.

10. Impellers should now be checked for free axial movement by hitting the ends of the impeller shafts with the palm of your hand.
11. Push the impellers against the gear headplate and recheck the total end clearance between the drive headplate and the impellers (see FIGURE 7-4).
    A. If total end clearance is insufficient, loosen impeller case to headplate bolts on either headplate, and move the headplate away from the case far enough to insert a paper shim in the amount equal to the insufficient clearance. Retighten case bolts and again check the total end clearance. Refer to FIGURE 7-4 for correct clearance.
    B. Excessive end clearances normally will require new impeller assemblies, but in some circumstances the impeller case can be removed and reduced in width by machining off the amount of excess clearance.
    C. Apply Loctite 246 on the 4 bearing retaining screws. Install 4 bearing screws and washers into the gear end headplate. Tighten screws evenly to the torque value given in FIGURE 7-9.

For Mechanical Seal Version

Install 8 bearing retaining screws and washers into the gear bearing retainer plates. Tighten screws evenly.

12.

A. Dual Splash Version

Install slingers on both shafts. Hold .31" +/_.01" gap between face of the bearing and back of the slingers. Rotate slingers approximately 90 degree apart, apply Loctite 246 on the socket cup screw and tight. Recommended torque is 3-3.5 FT-LBS. (See FIGURE 7-5).

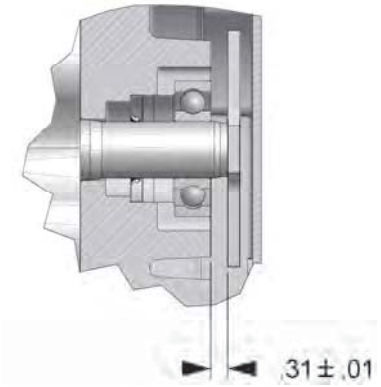


Figure 7-5

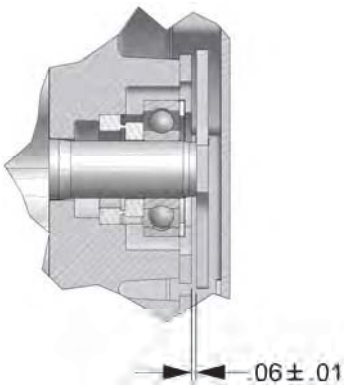


Figure 7-6

B. For Dual Splash Version with Mechanical Seal

Install slingers on both shafts. Hold .06"+_.01" gap between wavy spring retainer plates and back of the slingers. Rotate slingers approximately 90 degree apart, apply Loctite 246 on the socket cup screw and tight. Recommended torque is 3-3.5 FT-LBS. (See FIGURE 7-6).

13. **SETTING IMPELLER END CLEARANCES**

Refer to FIGURE 7-7, page 34. The outer races of the gear end bearings are clamped against the headplate (F) by the bearing retaining screws or by bearing retainer plate (mechanical seal version) (B).

This is referred to as the "fixed end". The interference fit between the shaft and the bearing inner race (H) keeps the shaft from moving axially. Adjustment is by movement of the shaft through the gear end bearing inner race (H).

A. Check the total end clearance by adding the clearance between the impellers and the drive headplate to the clearance between the impellers and the gear headplate.

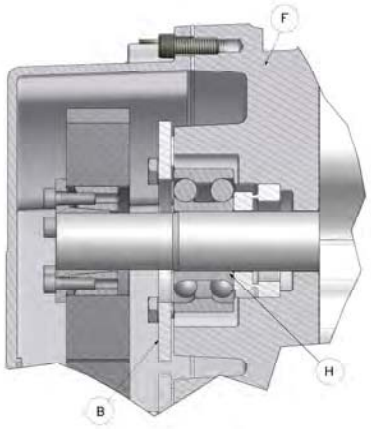


Figure 7-7

NOTICE
Check the clearance over the entire width of the impeller and consider the tightest spot.

B. Divide the end clearance by 3 and distribute approximately 1/3 on the gear end and the remaining 2/3 on the drive end.
C. To move the impeller assembly toward the drive end, lightly tap the shaft at the gear end with a soft face mallet.

D. To move the impeller assembly toward the gear end, lightly tap the shaft at the drive end with a soft face mallet.

E. To set the fixed end, insert the feeler gauge in the amount specified in FIGURE 7-4, page 33, between the headplate and the impeller at the gear end.

F. Tap lightly until the feeler gauge is snug. Adjust both impellers using the same procedure. Rotate the impellers checking for clearance through a complete revolution.

SETTING IMPELLER END CLEARANCE WITH MECHANICAL SEALS

Refer to FIGURE 7-1, page 31. The gear end bearings are held in position by the force created by the wavy spring (J) on the drive end and the bearing retainer (K) on the gear end. This is referred to as the fixed end. The interference fit between the shaft (H) and the bearing inner race (E) keeps the shaft from moving axially.

End clearance adjustment is by movement of the bearing retainer (K). Tightening the bearing retainer screws (M) moves the bearing to load the wavy spring (J), and the impeller is forced toward the drive end. Relaxing the screws allows the wavy spring to return the impeller toward the gear end.

A. Assemble drive cover to drive headplate. Refer to Step 15 with the exception of the use of wavy springs (J) installed between the drive end bearings and the wavy spring retainer plates.

B. Back out retainer screws (M) until both impellers are tight against the gear headplate.

C. With feeler gauge, measure the clearance between each impeller and the drive headplate. This value is the total end clearance.

D. Measure the clearance between the gear headplate and bearing retainer (K) at point (S).

E. Subtract 1/3 of the total end clearance from the clearance measured at point (S). This value is the amount of shim (13) that should be placed between the retainer and the headplate at point (S).

F. Tighten the bearing retainer screws (M) to the torque value given in FIGURE 7-9, page 38. With the retainer screws secure, approximately 1/3 of the total end clearance should be on the gear end and the remaining 2/3 on the drive end.

1. INSTALLING THE TIMING GEARS

If reusing the timing gears, the gears should be returned to their original positions.

A. Obtain 2 gear locking assemblies. Clean the inside and outside diameters of both locking assemblies. Clean the inside diameter of 2 gears. Clean the outside diameter of the both rotor shafts. Lightly oil the surfaces that have been cleaned. Note: DO NOT USE MOLYBDENUM DISULFIDE, MOLYKOTOE, OR ANY OTHER SIMILAR LUBRICANTS.

B. Slide a locking assembly into a gear. Install the gear and locking ring assembly onto the idler rotor shaft. Push the locking assembly firmly until flush with the end of the idler rotor shaft and hand tighten the 7 cap screws. Align and adjust the connections.

C. Use a torque wrench to tighten the screws to 75 in. lbs. in a diametrically opposite sequence. Ensure that none of the screws will turn when 75 in. lbs. is applied to them a second time.

D. Tighten the screws further to 150 in. lbs. in a diametrically opposite sequence. Ensure that none of the screws will turn when 150 in. lbs. is applied to them a second time.

E. Slide the second locking assembly into a gear. Install the gear and locking ring assembly onto the drive rotor shaft. Note the circular mark on each gear indicates the position of the largest runout. These marks must be 180 degrees apart when the gears are installed.

F. Push the locking assembly firmly until flush with the end of drive rotor shaft and hand tighten all cap screws but leave them loose enough that the gear can be rotated on the shaft.

G. The first step in setting the interlobe clearance is to measure the total clearance between two meshing lobes. This is accomplished by determining the maximum feeler gauge thickness that will fit between the rotor lobes near the pitch diameter. The clearance should be measured along the entire length of the meshing lobes. This measurement should be taken for each of the 2 interlobe meshes. The location of the smallest total interlobe clearance should be marked on the rotor lobes. Refer to diagram in FIGURE 7-4, page 33. Use feeler gauges to check clearances between impeller lobes at positions A—A and C—C. Add the clearances, and divide the total clearance evenly between A—A and C—C.

H. Rotate the rotors until the two lobes that have the smallest total interlobe clearance (as determined in step G) are visible through the discharge port. Lock the idler rotor from turning by wedging a shop rag between the tip of a lobe and the air cylinder. Insert feeler gauges with a thickness equal to the half clearance (determined in step G) between the drive rotor and the idler rotor lobe. Pull the drive rotor tight against the feeler gauges (drive rotor, feeler gauges, and idler rotor must be tight against each other). While holding the drive rotor tight against the feeler gages rotate (in the direction that the rotor turns) the gear on the drive rotor until a tooth on it contacts a tooth on the gear on the idler rotor. Hand tighten the 7 capscrews in the drive gear locking assembly. Align and adjust the connection.

I. Use a torque wrench to tighten the screws to 75 in. lbs in a diametrically opposite sequence. Ensure that none of the screws will turn when 75 in. lbs is applied to them a second time.

J. Tighten the screws further to 150 in. lbs in a diametrically opposite sequence. Ensure that none of the screws will turn when 150 in. lbs is applied to them a second time.

K. Check gear backlash four places at 90 degree intervals as described in the disassembly procedure (Item 4).

⚠ CAUTION

These impeller-to-impeller and impeller-to-case clearances are extremely critical. Even though the blower may turn freely by hand when cold, under operating conditions, the parts expand, and the rotors are subject to slight defection.

If the clearances are not sufficient, the impellers may contact each other or the housing with destructive results. If the clearances are too great, the blower may not develop the pressure or airflow that is required to perform its function.

14. Impeller tip to case clearance should be checked at this time by inserting the correct thickness feeler gauge between the tip and the case and rotating the impeller (see FIGURE 7-4, page 34). Repeat the procedure on both impellers.

NOTICE

When checking the tip to case clearance, move the feeler gauge over the entire length of the impeller to ensure that the tips do not bind along their length.

FIGURE 7-8

NOTICE

Replacement gears have minimum backlash marks on the outside diameter of the gear face. These marks should be located 180 degrees from each other (see FIGURE 7-8).

NOTICE

The gear used for adjustment should be flush with its mate on completion of the timing.

NOTICE

If any of the four gear backlash readings are not within the specified limits, the gears must be replaced.

15. Replace drive shaft oil seal (31) in the drive end cover (29). The seal lip should always face towards the bearing or lubricant.

Grease Units

Pack bearing cavities with recommended grease and secure drive cover with socket head cap screws (30) to drive headplate.

Dual Splash Units

Install drive end gasket (7). Gently slide the drive end cover (29) over the drive shaft and tap cover down over dowel pins until flush. Install and tighten drive cover bolts (30).

Refer to FIGURE 7-9, for torque specifications.

⚠ CAUTION
Exercise care not to damage the seal lip as it passes over the shaft keyway.

16. Assemble the gear cover (3) and gasket (7) to the gear headplate (18) using socket head screw (5). Tighten the capscrews alternately and evenly. Refer to FIGURE 7-9 for torque specifications.

17. Place the blower on its feet on a flat surface. Loosen cap screws (16) and level the unit up. The bench or blower base flatness should be within .002 of an inch. Re-tighten cap screws (16) to the specification in FIGURE 7-9.

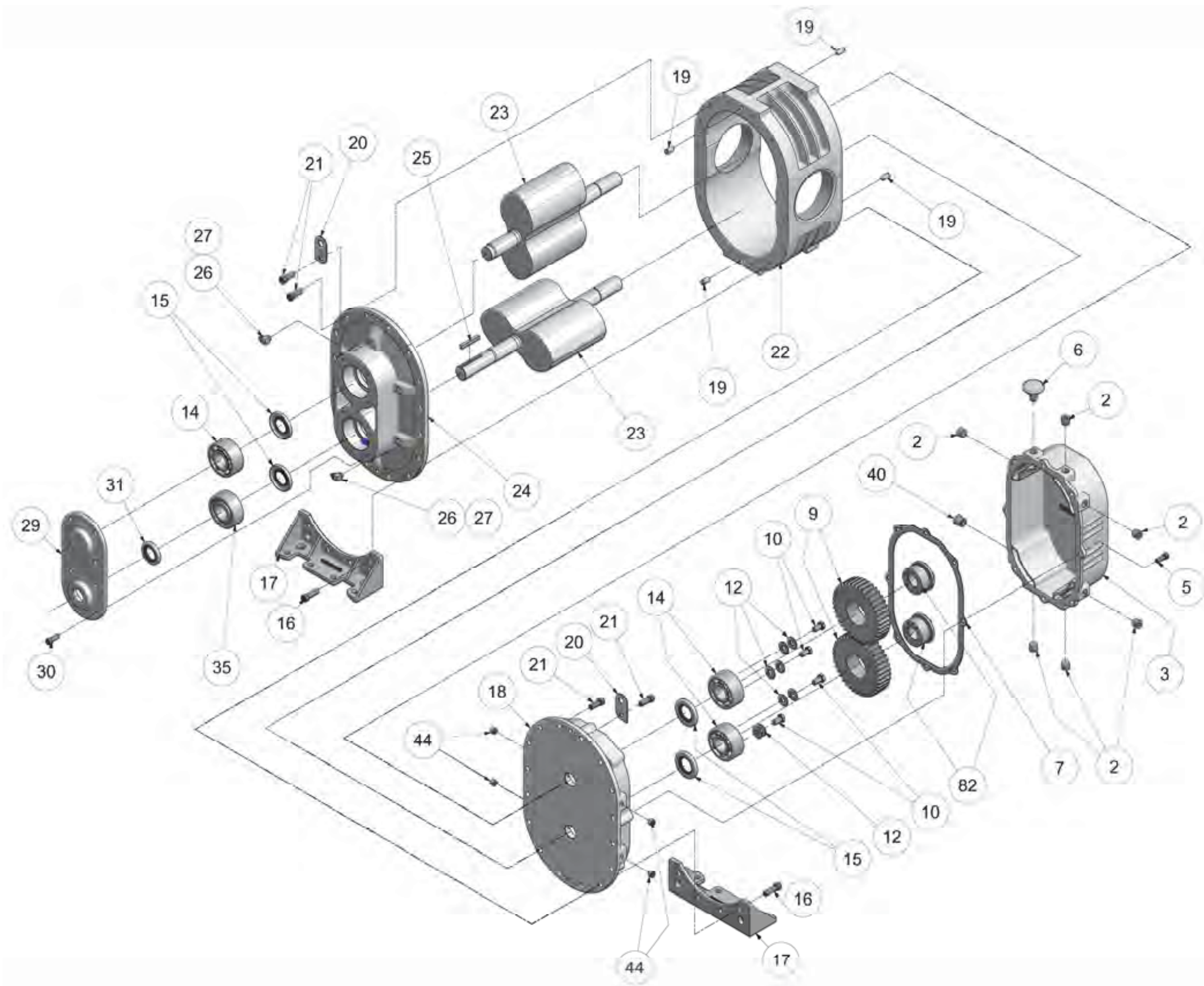
NOTICE
If the unit is not flat within .002 of an inch, it will be necessary to shim the blower feet at installation.

	GEAR DIAMETER		
FASTENERS	**3**	**4**	**5**
CAPSCREW (21)	23 – 30	42 – 45	42 – 45
CAPSCREW (16)	23 – 30	42 – 45	42 – 45
SOCKET HD CAPSCREW (5)	6 – 8	16 – 18	11 – 13
SOCKET HD CAPSCREW (30)	6 – 8	16 – 18	11 – 13
CAPSCREW (10)	6 – 8	38 – 42	38 – 42

NOTE: ( ) DENOTES ITEMS IN EXPLODED VIEW DRAWINGS ON PAGES 39 AND 43.

FIGURE 7-9 – TORQUE (FT-LBS)

SECTION 8
PARTS LIST

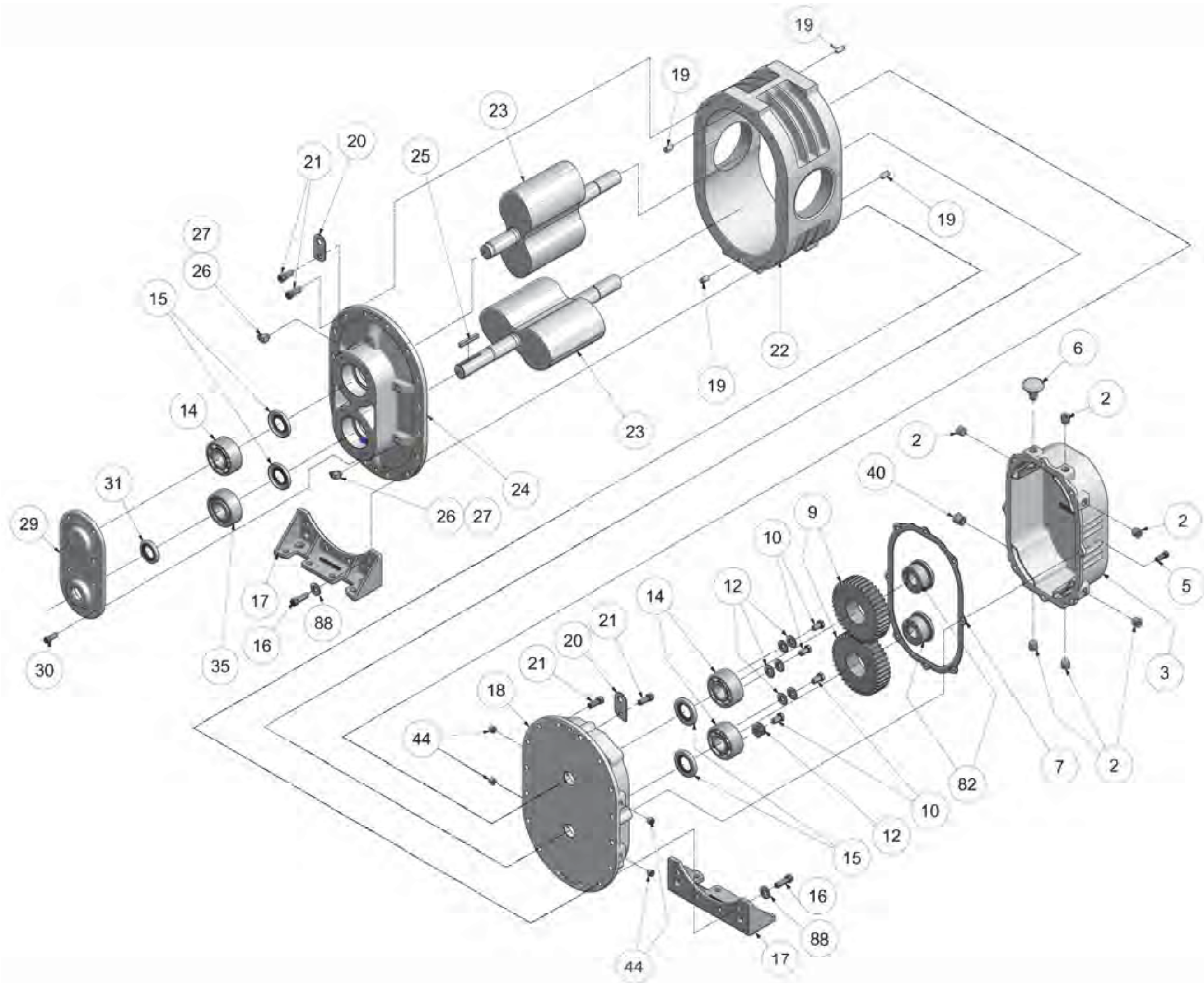


Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAB Lip Seal — Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 3H GABH_R Δ Δ= (A or C)	Size – 3M GABM_R Δ Δ= (A or C)	Size -- 3L GABL_R Δ Δ= (A or C)
2	Plug	6	64AC2	64AC2	64AC2
3	Gear Case	1	303GAB602	303GAB602	303GAB602
5	Screw	8	75P7	75P7	75P7
6	Breather	1	5L358	5L358	5L358
* 7	Gasket	1	300GAB715	300GAB715	300GAB715
9	Gear Kit	1	300GAB6008	300GAB6008	300GAB6008
* 10	Screws	4	75A33P	75A33P	75A33P
12	Washer	4	95A2	95A2	95A2
* 14	Ball Bearing	3	12BA143	12BA143	12BA143
* 15	Oil Seal	4	900891030601	900891030601	900891030601
16	Screw	4	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	303GAB166	303GAB166	303GAB166
18	Bearing Housing Gear End	1	302GAB006	302GAB006	302GAB006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	20	75P55	75P55	75P55
22	Impeller Case	1	900873034301	900873033801	900873034201
23	Rotor Group				
	3" Standard Clearances	1	307GAB4028	309GAB4028	308GAB4028
	3" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	900873033501	900873033501	900873033501
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
29	Drive Cover	1	900873033701	900873033701	900873033701
30	Screw	6	75P22	75P22	75P22
* 31	Oil Seal	1	60DD725	60DD725	60DD725
* 35	Bearing – Roller	1	12BA153	12BA153	12BA153
40	Oil Level Gauge	1	40P82	40P82	40P82
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAB732	200GAB732	200GAB732
** 55	Shim Case .010"	1	201GAB732	201GAB732	201GAB732
** 56	Shim Case .0015/.002"	1	202GAB732	202GAB732	202GAB732
82	Locking Assembly	2	22G45	22G45	22G45
** 105	Overhaul Kit 3" R VERS Lip Seal, Grease Splash Lube	1	302GAB6010	302GAB6010	302GAB6010
** 900	Group-Indent & Instruction Legend Series 3" R VERS	1	303GAB4011	303GAB4011	303GAB4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION.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82
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16
88
44
17

Order by Part Number and Description. Reference Numbers are for your convenience only.

Model GAC Lip Seal — Grease Splash Lube

Ref. No.	Description	No. Req'd	Size – 4H GACH_R Δ Δ= (A or C)	Size – 4M GACM_R Δ Δ= (A or C)	Size -- 4L GACL_R Δ Δ= (A or C)
2	Plug	6	64AC3	64AC3	64AC3
3	Gear Case	1	304GAC602	304GAC602	304GAC602
5	Screw	8	75P40	75P40	75P40
6	Breather	1	5L359	5L359	5L359
* 7	Gasket	1	301GAC715	301GAC715	301GAC715
9	Gear Kit	1	300GAC6008	300GAC6008	300GAC6008
* 10	Screws	4	655ED03P	655ED03P	655ED03P
12	Washer	8	95A3	95A3	95A3
* 14	Ball Bearing	3	12BA144	12BA144	12BA144
* 15	Oil Seal	4	60DD630	60DD630	60DD630
16	Screw	8	75P56	75P56	75P56
17	Foot – Vert. & Horiz.	2	300GAC166	300GAC166	300GAC166
18	Bearing Housing Gear End	1	302GAC006	302GAC006	302GAC006
19	Dowel Pin	4	62M48	62M48	62M48
20	Lifting Lug	2	200GAA451	200GAA451	200GAA451
21	Screw	16	75P55	75P55	75P55
22	Impeller Case	1	900883042201	900883041801	900883042001
23	Rotor Group				
	4" Standard Clearances	1	307GAC4028	306GAC4028	305GAC4028
	4" High Temperature Clearances	1	To be assigned	To be assigned	To be assigned
24	Bearing Housing Drive End	1	300GAC006	300GAC006	300GAC006
25	Key-Square	1	900639910304	900639910304	900639910304
26	Pipe Fitting	2	40E9	40E9	40E9
27	Cap	2	40P58	40P58	40P58
29	Drive Cover	1	900883040301	900883040301	900883040301
30	Screw	8	75P189	75P189	75P189
* 31	Oil Seal	1	60DD716	60DD716	60DD716
* 35	Bearing – Roller	1	12BA154	12BA154	12BA154
40	Oil Level Gauge	1	40P34	40P34	40P34
44	Screw	4	76F1	76F1	76F1
** 45	Paint, Bulk, GDP188, Aluminum	0.125	28H284	28H284	28H284
** 54	Shim Case .0025/.0035"	1	200GAC732	200GAC732	200GAC732
** 55	Shim Case .010"	1	201GAC732	201GAC732	201GAC732
** 56	Shim Case .0015/.002"	1	202GAC732	202GAC732	202GAC732
82	Locking Assembly	2	22G44	22G44	22G44
88	Washer	4	95A3	95A3	95A3
** 105	Overhaul Kit 4" R VERS Lip Seal, Grease Splash Lube	1	300GAC6010	300GAC6010	300GAC6010
** 900	Group-Indent & Instruction Legend Series 4" R VERS	1	201GAC4011	201GAC4011	201GAC4011

* INCLUDED IN OVERHAUL KIT.
** NOT SHOWN ON ILLUSTRATION.