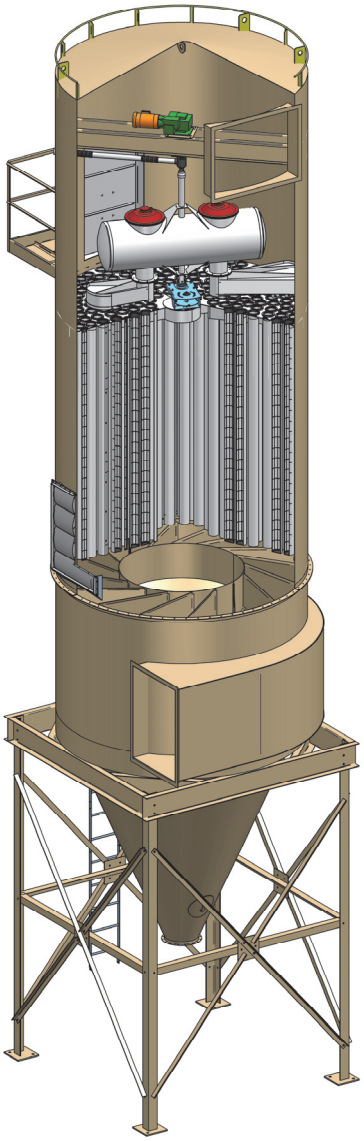
HONEYVILLE MPC SERIES

Medium Pressure Compressed / Reverse Air
Continuous Cleaning Baghouse Filter

Models

MPC-117-8
MPC-117-10
MPC-117-12
MPC-153-8
MPC-153-10
MPC-153-12



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HONEYVILLE MPC SERIES

Customer Name	
Model Number	
Serial Number	
Date of Purchase	

HONEYVILLE MPC SERIES

Contents

HONEYVILLE MPC SERIES

FILTER DESCRIPTION

HONEYVILLE MPC CYCLONIC FILTERS are recommended for medium to heavy dust load applications utilizing cyclone separation and bag filtration. This design includes a 110° involute inlet with an inner cyclone baffle and vortex breakers to insure minimal air swirl in the bag chamber. The primary material separation takes place in the 67° cone section. The involute inlet allows for better material separation by providing an extended transition as the dust laden air enters the cyclone. By increasing the material separation in the cyclone section, the dust load on the bags is significantly decreased allowing for better air flow and extended bag life.

THE MPC BAGHOUSE FILTER will effectively filter such materials as grain, feed, flour, minerals, cement products, plastics, and all types of wood waste. The filter utilizes high volume, medium pressure cleaning of the bags. The NO-TOOL top bag removal allows for easy inspection or service.

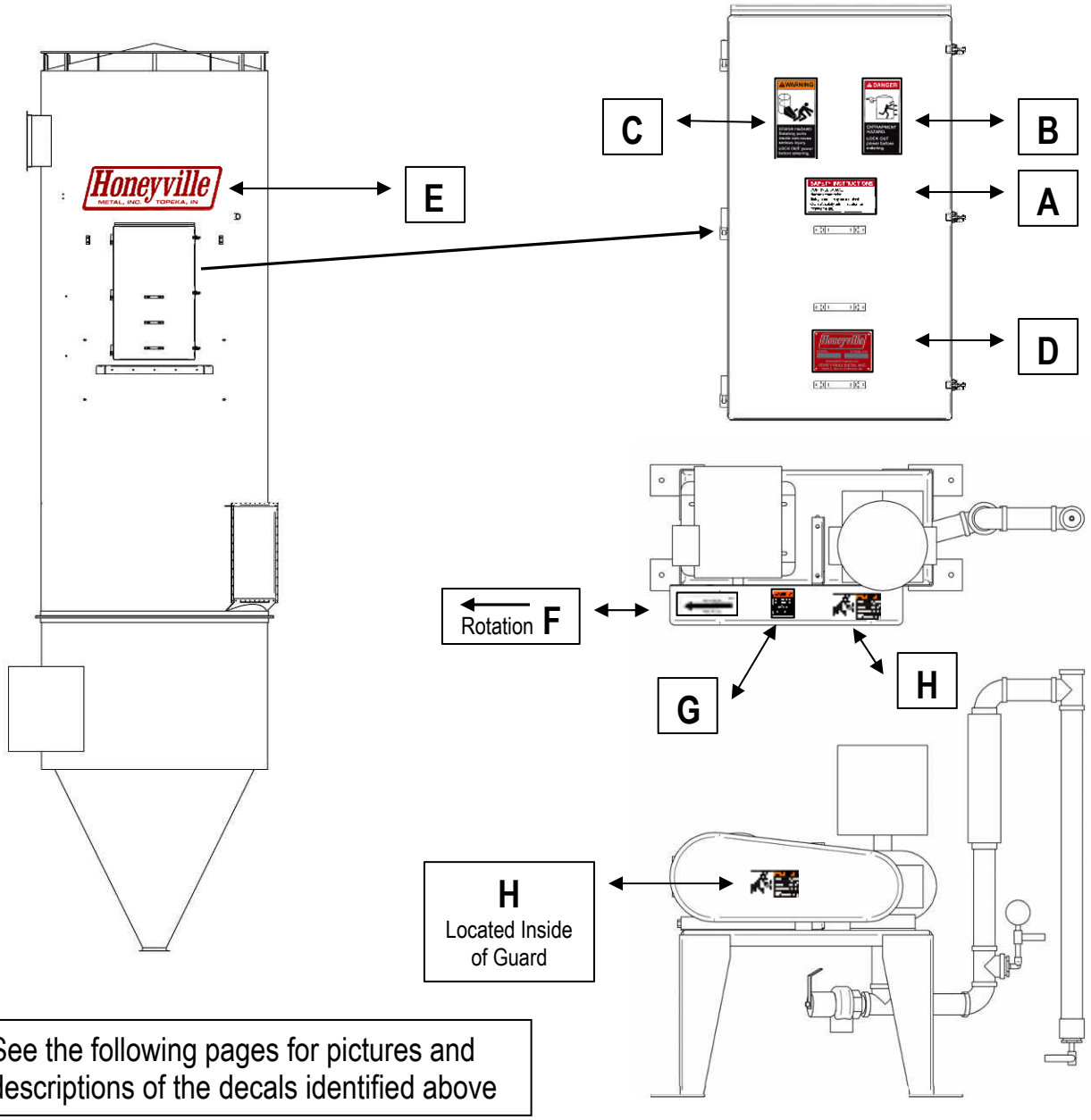
THE MPC FILTER OPERATES AS FOLLOWS: Dust laden air enters the involute inlet directly above the cone section. Large particles enter the cone section, separate, and exit out the bottom while smaller particles flow upward into the bag chamber and are retained on the exterior of the filter bags. The clean air flows upward through the bags and exits via the open top of the bags into the clean air plenum. This clean air may be vented outside or inside a building.

THE MPC BAG CLEANING PROCESS is an innovative hybrid of traditional high pressure pulse jet and reverse air cleaning of the bags. The cleaning mechanism is comprised of a large compressed air tank mounted on a rotating assembly with diaphragm valves connected to manifolds with air discharge nozzles. A mechanical timing control with precision adjustment directs a high volume, medium pressure burst of air through the nozzles and into the bags. As the burst of air enters the bags, filtration is momentarily stopped. As the compressed air bubble travels down the bags, it is moving the fabric outward to its elastic limit. The bag movement is stopped while the dust continues to move away from the bag surface because of the large volume of air that is following the initial pulse action. The released dust cake is discharged into the cone of the filter and is blended with larger particulate that is being separated.

SAFETY INFORMATION & DECALS

Lockout-Tagout Requirements: **WARNING!** - Before inspecting or servicing this equipment perform an approved lockout-tagout procedure on the electrical service.

Read and Understand Safety Decals: Several safety labels are located on this piece of equipment in different locations to warn the operator(s) of potentially hazardous situations. The following figure shows typical locations for safety decals on the MPC Filter. The locations of decals for your particular filter may vary from those indicated. Inspect your filter for locations of all decals.



See the following pages for pictures and descriptions of the decals identified above

SAFETY DECALS

Safety decals (and other information labels) may include, but are not necessarily limited to, the examples shown below. Locate all of the safety decals on your equipment and know their meaning prior to operating this dust filter. It is the owner/operator's responsibility to maintain the integrity of these decals and to ensure that all operators of the equipment are aware of them and understand their meaning. Free replacement decals are available if required.

A

End User MUST determine hazard level for entry permit requirements

B

Equipment can start without warning. The exhaust fan can create enough force to close and hold the service door closed.

HONEYVILLE MPC SERIES

SAFETY DECALS

C

Equipment can start without warning. Cleaning mechanism rotation can cause entrapment under cleaning arm, which will induce serious injury.

D

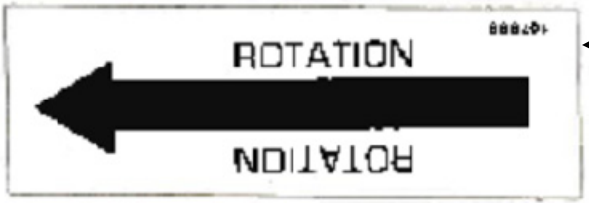
Typical Honeyville Metal, Inc. nameplate

E

45” x 16”

SAFETY DECALS

F



Equipment must rotate in the direction indicated by the rotation arrow.

G

Equipment may be remotely controlled.

H

Moving drive components can cause injury. Do not operate equipment with guards removed.

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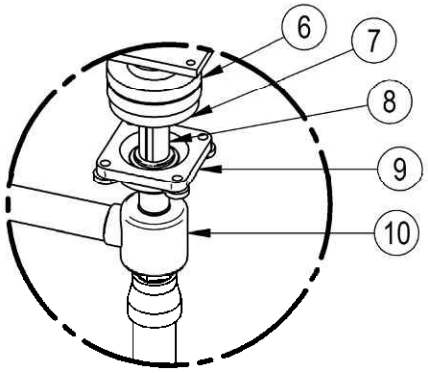
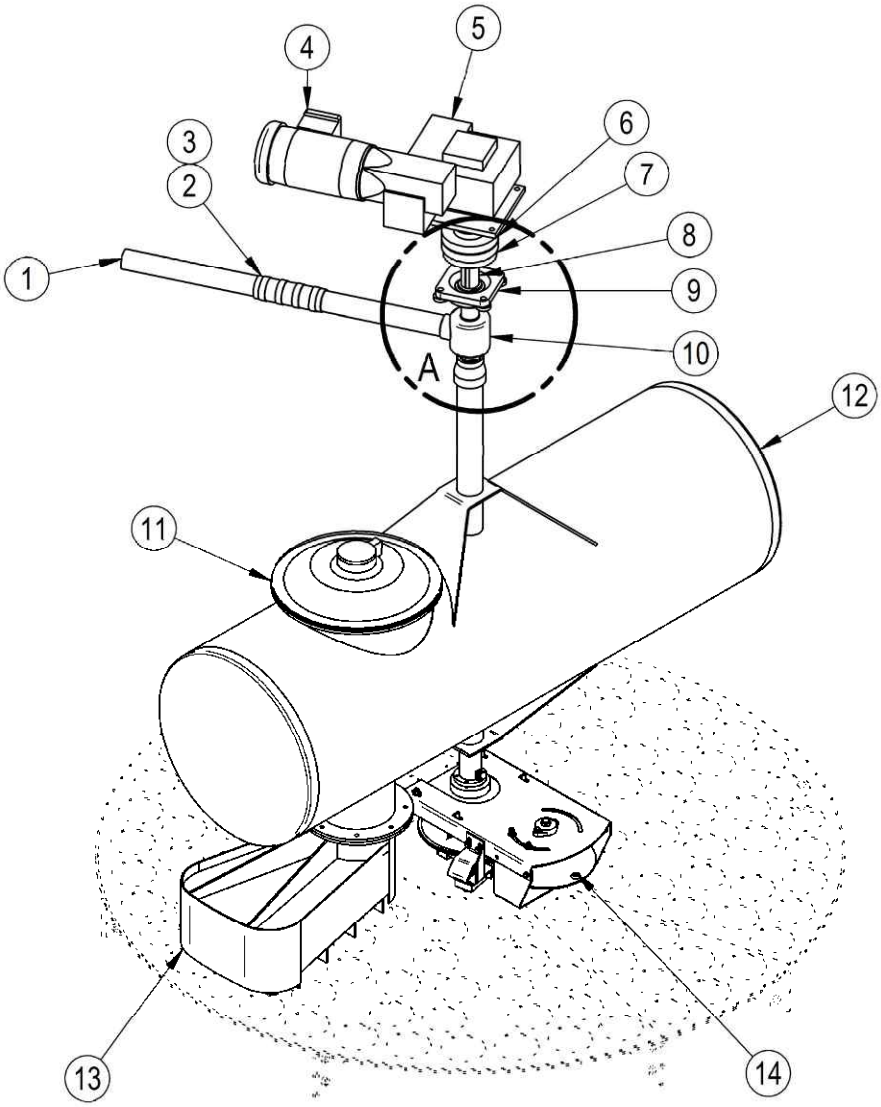
FILTER WORKS



DETAIL A

Item	Part Number	Qty	Description
1	See Chart	2	2" Galv. Pipe Sch. 40
2	PDHS0206	1	2⅜" ID Black Rubber Hose w/spiral wire
3	HWHC0300	4	3" Dia. Hose Clamp
4	PTEM3001012BX	1	Baldor VM7032 1HP 1200 RPM Motor
5	PTGR1201	1	Peerless-Winsmith 943MDVD 750:1 Gear Reducer
6	FLHW1203	2	9S x 2" Sure-Flex Flange
7	FLHW1202S	1	9JES Sure-Flex Split Sleeve
8	FLMPUS01	1	2" Rotary Union Shaft for MPC Filters
9	PTFB1008	2	Peer UCF211-32E 2" Four-bolt Flange Bearing
10	FLMPRU01	1	Rotary Union
11	FLPG1027	1	8" Low Pressure Valve
12	FLMPTA01	1	Single Valve Tank Assembly
13	See Chart	1	Manifold
14	FLMP5001	1	Timing Mechanism Assembly **
** See separate drawings for breakdown of Timing Mechanism Assembly			



Item	Model	Part Number
1	MPC-117	PPGP020403800
	MPC-153	PPGP020404400
13	MPC-117	FLMPMA07A
	MPC-153	FLMPMA08A

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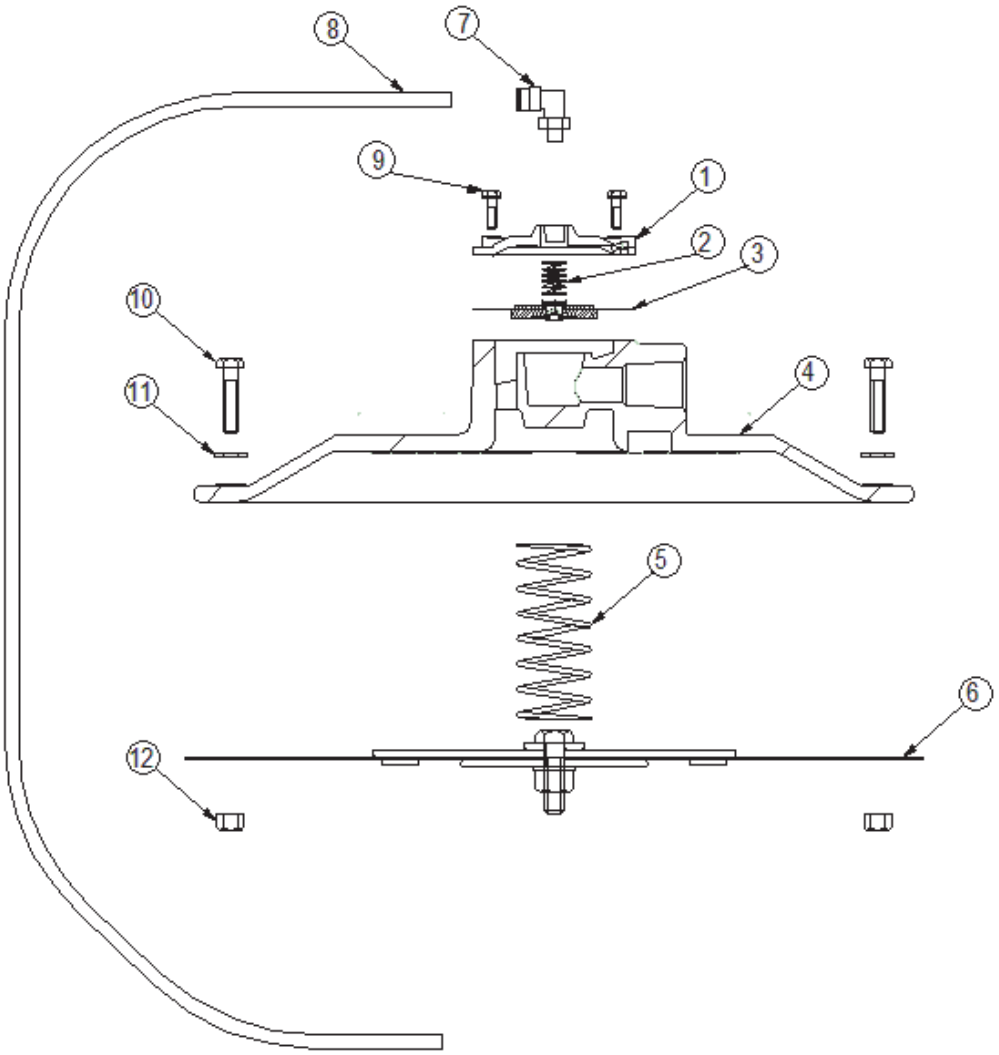
8” LOW PRESSURE VALVE

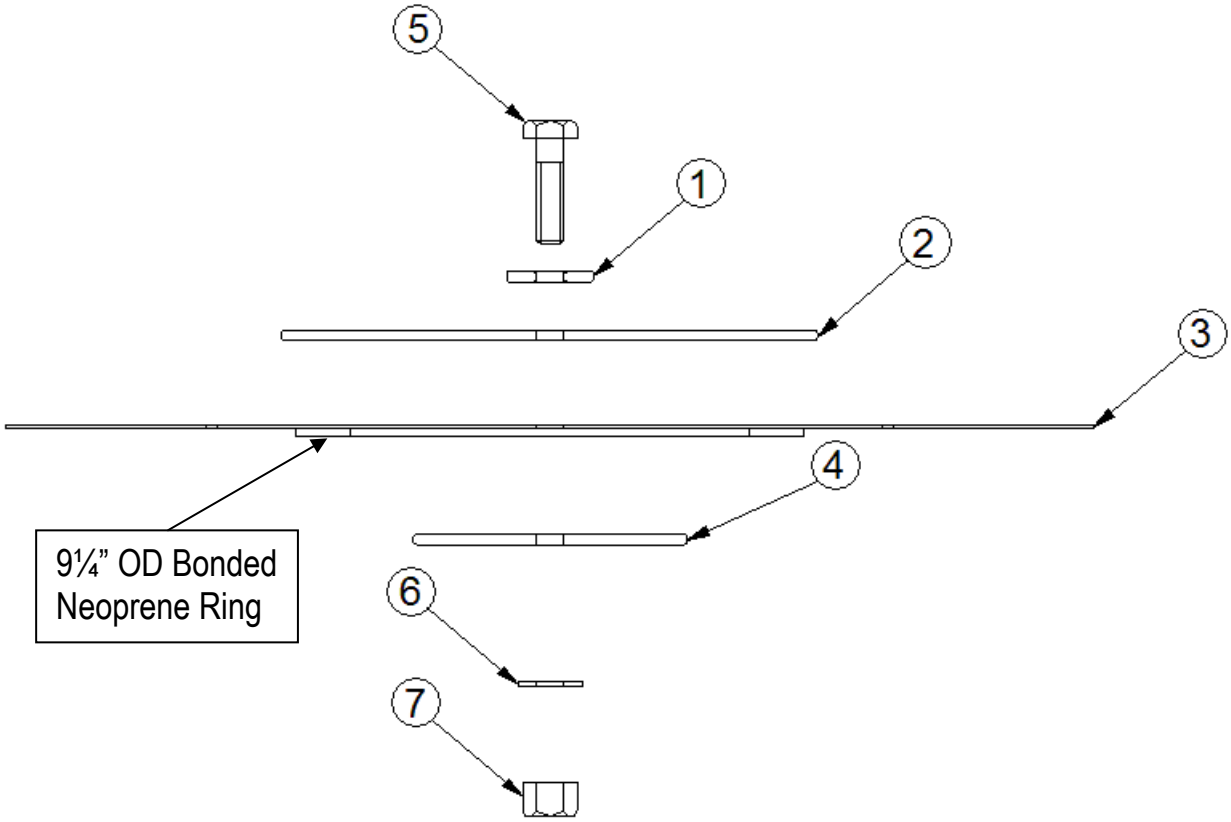
Item	Part Number	Qty	Description
1	FLGP1034	1	Secondary (Small) Cover
2	FLGP1033	1	Secondary (Small) Spring
3	FLGP1036	1	Secondary (Small) Diaphragm
4	N/A	1	Main Cover
	FLGP1037		Main Cover Assembly (Includes Items 1, 2, 3, 4, & 9)
5	FLGP1032LSS	1	Main (Large) Spring, Stainless Steel
6	FLGP1035H *	1	Main (Large) Diaphragm Assembly
7	HWHF1008	1	⅛" NPT x 3/8"OD Hose 90° Swivel Elbow
8	CSTB1006	6'	⅜" Black Poly Flo Tubing
9	HWMBM625	6	M6 x 1.0 x 25 S.S. Hex Washer Head Machine Screw
10	HWMB506014	12	⅜"-16 x 1¾" Hex Grade 5 Machine Bolt
11	HWFW1006	12	⅜" Flat Washer
12	HWNN1006	12	⅜"-16 Nylock Nut
* See parts breakdown on the following page.			



HONEYVILLE MPC SERIES

MAIN (LARGE) DIAPHRAGM ASSEMBLY

Item	Part Number	Qty	Description
1	FLGP1035DK3	1	Spring Retainer Disk for Main (Large) Diaphragm Assembly
2	FLGP1035DK1	1	Large Disk for Main (Large) Diaphragm Assembly
3	FLGP1035D3	1	Main (Large) Diaphragm for Main (Large) Diaphragm Assembly
4	FLGP1035DK2	1	Small Disk for Main (Large) Diaphragm Assembly
5	HWMB508012	1	½"-13 x 1½" Hex Grade 5 Machine Bolt
6	HWFW1008	1	½" Flat Washer
7	HWNN1008	1	½"-13 Nylock Nut



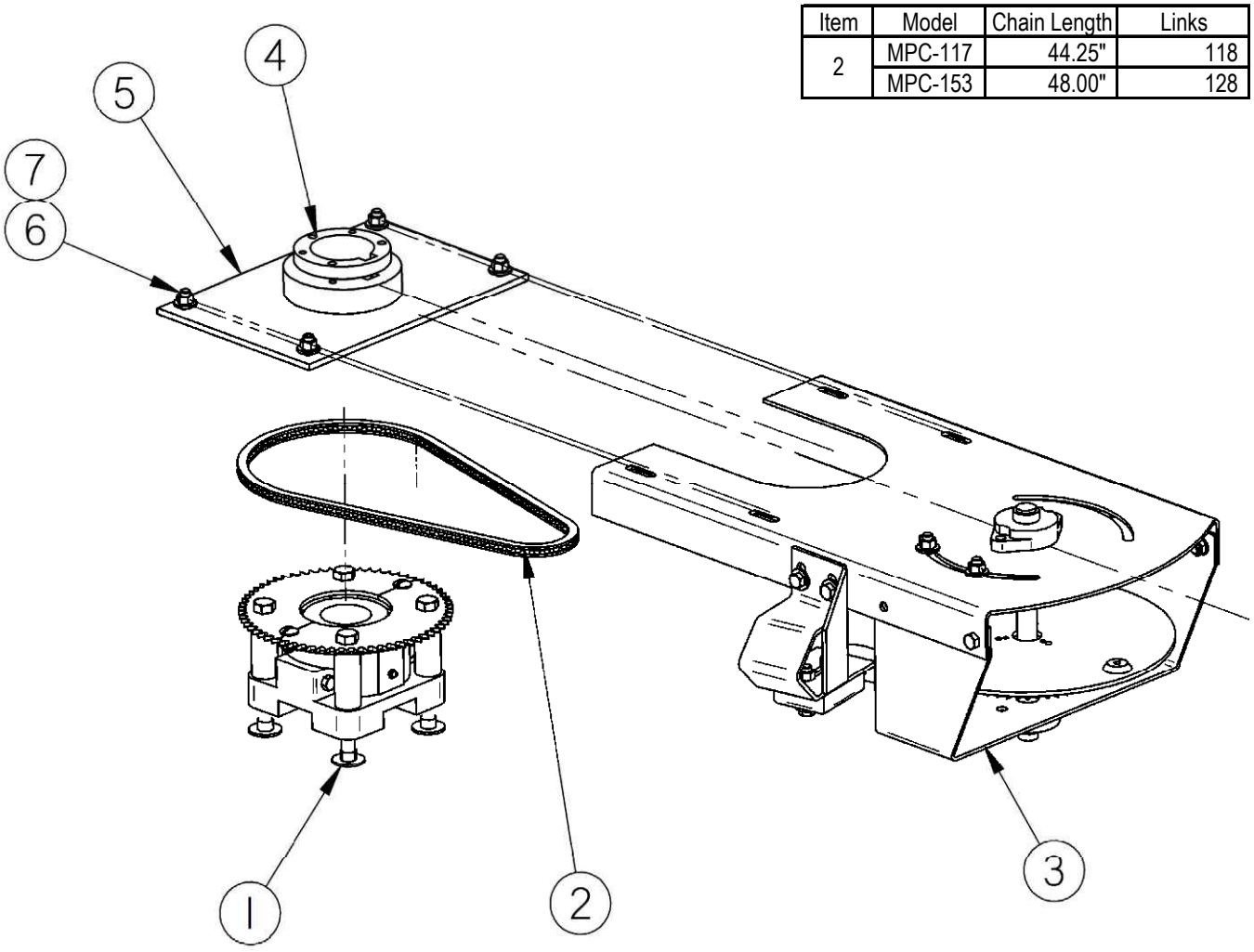
Note: Item 3 must be installed with the 9¼" OD Bonded Neoprene Ring on the bottom (tank side) of the diaphragm as shown in the drawing above.

HONEYVILLE MPC SERIES

TIMING MECHANISM ASSEMBLY

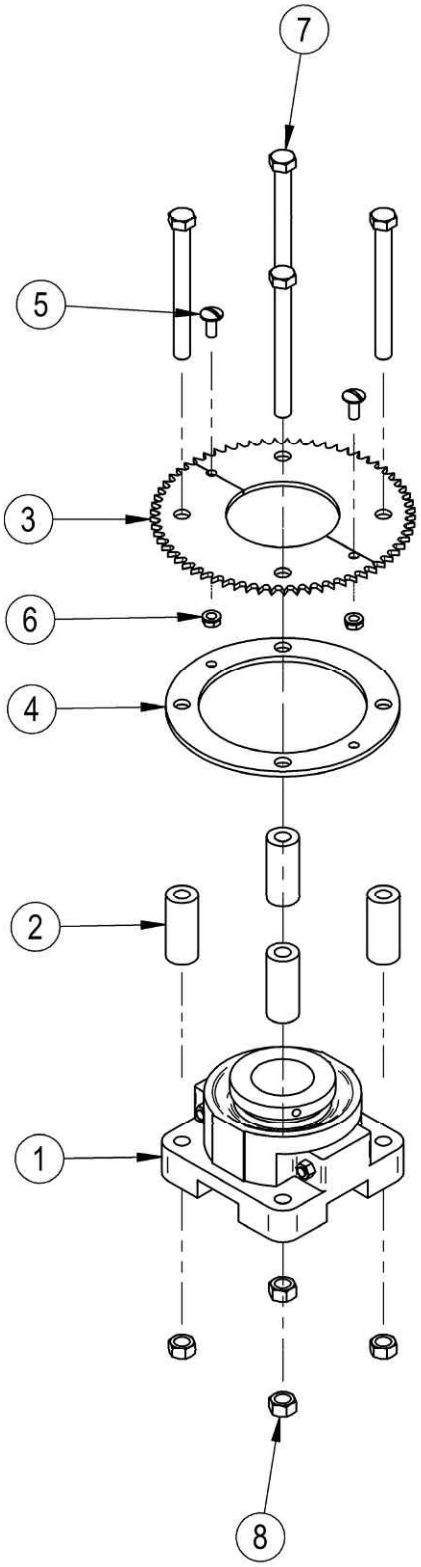
Item	Part Number	Qty	Description
1	FLMP5002 **	1	MPC Fixed Sprocket Assembly
2	PTRC35HC	1	#35 Roller Chain (See chart for length)
3	FLMP5004S1 **	1	MPC Timing Mechanism Arm Assembly - Single Tank
4	PTSBB039	1	B 2-7/16" Bushing
5	FLMP5003	1	MPC Arm Mount Assembly
6	HWNT0206	4	⅜"-16 Nut
7	HWFW1006	4	⅜" USS Flat Washer
** See separate drawings for breakdown of parts.			

Item	Model	Chain Length	Links
2	MPC-117	44.25"	118
	MPC-153	48.00"	128



HONEYVILLE MPC SERIES

FIXED SPROCKET ASSEMBLY

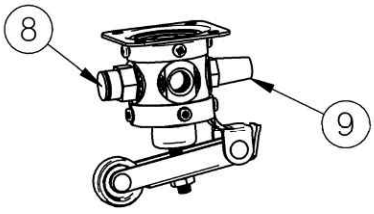


Item	Part Number	Qty	Description
1	PTFB5011	1	Dodge S2000 1-15/16" Flange Bearing
2	FLMP5006	4	Timing Mechanism Spacer
3	See Chart	1	Split Sprocket
4	FLMP5002R	1	Sprocket Ring
5	HWTH0506	2	5/16"-18 x ¾" Truss Head Plated Bolt
6	HWWN1005	2	5/16"-18 Whiz Nut
7	HWMB508040	4	½"-13 x 5" Hex Grade 5 Machine Bolt
8	HWNT0208	4	½"-13 x 5" Nut

Item	Model	Part Number
3	MPC-117	FLMP5008
	MPC-153	FLMP5007

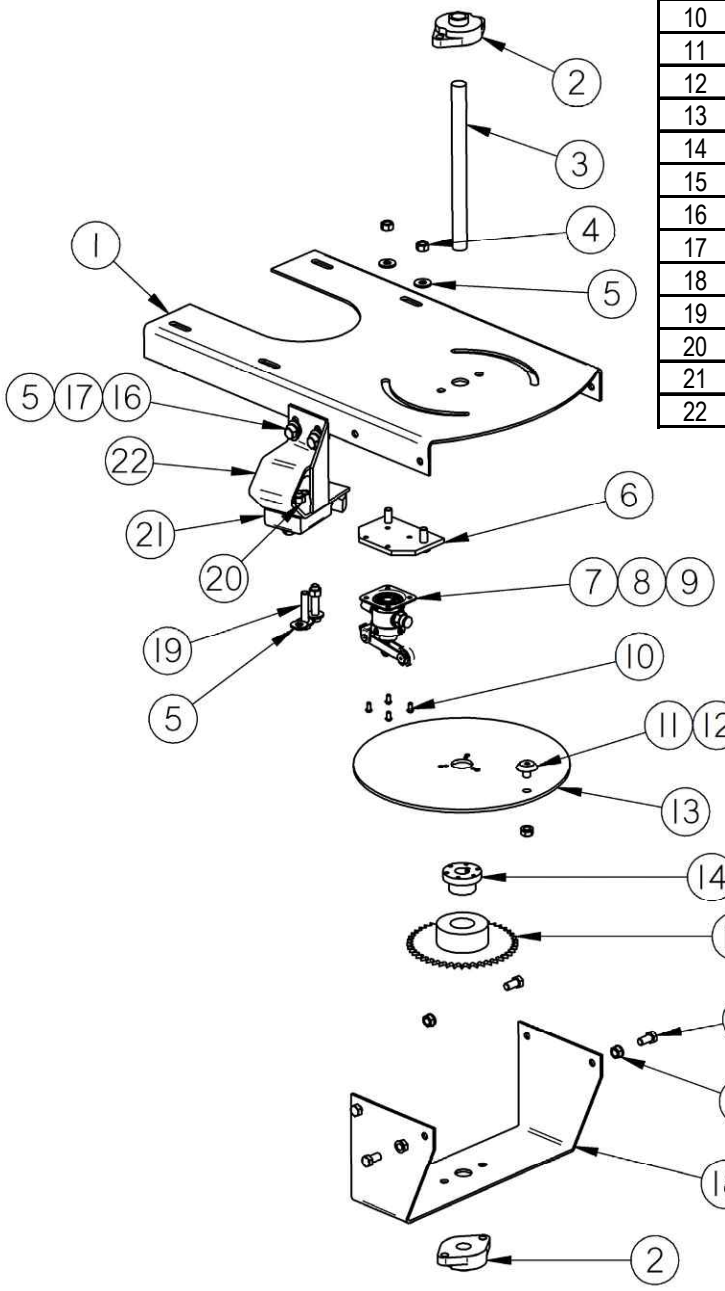
HONEYVILLE MPC SERIES

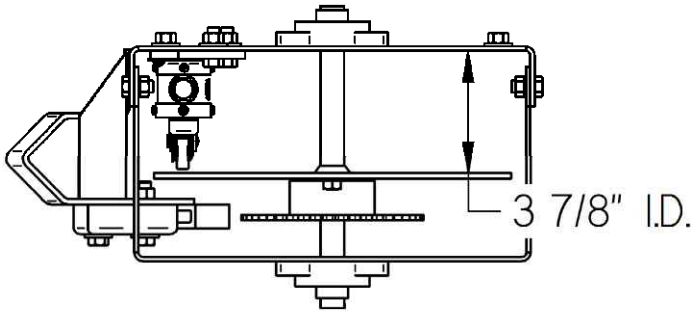
TIMING MECHANISM ARM ASSEMBLY

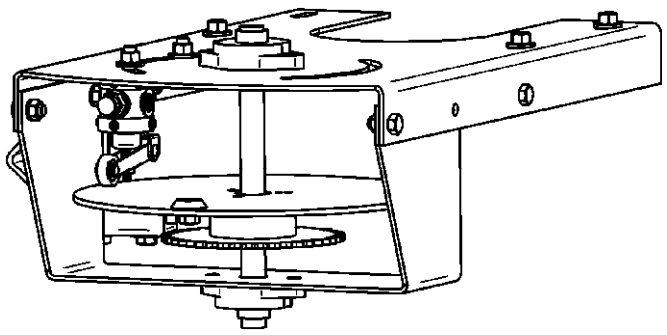


Items 7, 8, & 9 Assembly

Item	Part Number	Qty	Description
1	FLMP5004-1	1	Timing Mechanism Arm
2	PTFB1018	2	Peer FHSLF204-12G ¾" Two-bolt Flange Bearing
3	FLMP5004-4	1	Timing Mechanism Shaft
4	HWNT0206	2	⅜"-16 Nut
5	HWFW1006	6	⅜" USS Flat Washer
6	FLMP5005	1	Timing Mechanism Valve Mount
7	FLMP5021	1	250C210-21BRB Humphrey Valve
8	HWHF1004	1	¼" NPT x ⅜" OD Hose Straight Adapter
9	FLHW1081	1	¼" Sintered Bronze Muffler Filter
10	HWMSPP103203	4	10-32 x ⅜" Machine Screw
11	FLHW1227	1	⅜"-16 x ¾" Flat Head Socket Cap Screw
12	FLHW1228	1	⅜" Brass Countersunk Washer
13	FLMP5004-3	1	Index Disk
14	PTSBQDSH12	1	¾" QDSH Bushing
15	PTSP35SH45	1	35SH45 Traveling Sprocket
16	HWMB506006	6	⅜"-16 x ¾" Hex Grade 5 Machine Bolt
17	HWWN1006	7	⅜"-16 Whiz Nut
18	FLMP5004-2	1	Timing Mechanism Arm Bearing Mount
19	HWMB506012	2	⅜"-16 x 1½" Hex Grade 5 Machine Bolt
20	HWNN1006	2	⅜"-16 Nylock Nut
21	FLMP5011	1	CT1201-L Chain Tensioner Sm Arc Head #35 SG
22	FLMP5004-5	1	Chain Tensioner Mount Weldment

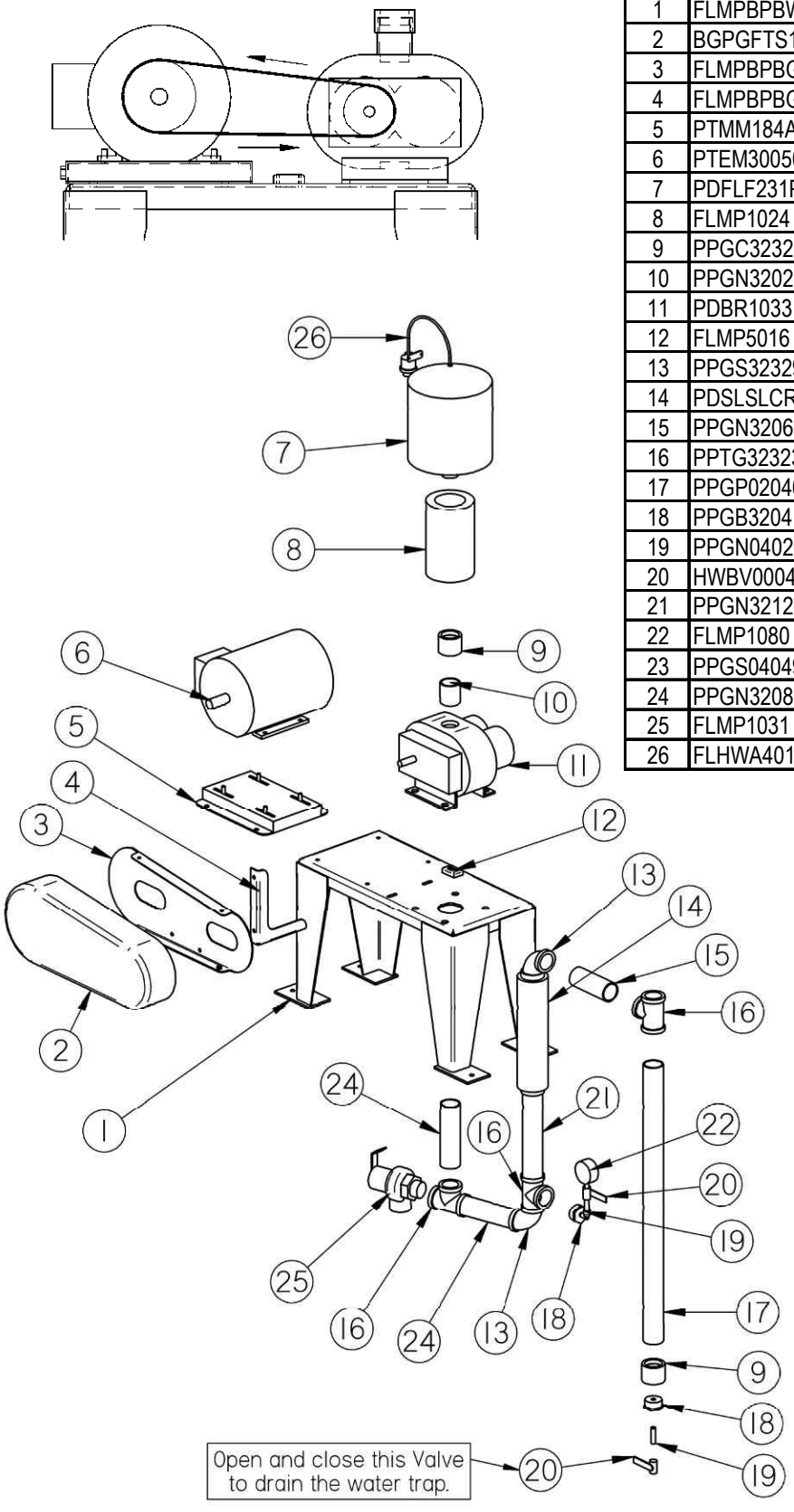






HONEYVILLE MPC SERIES

BLOWER PACKAGE

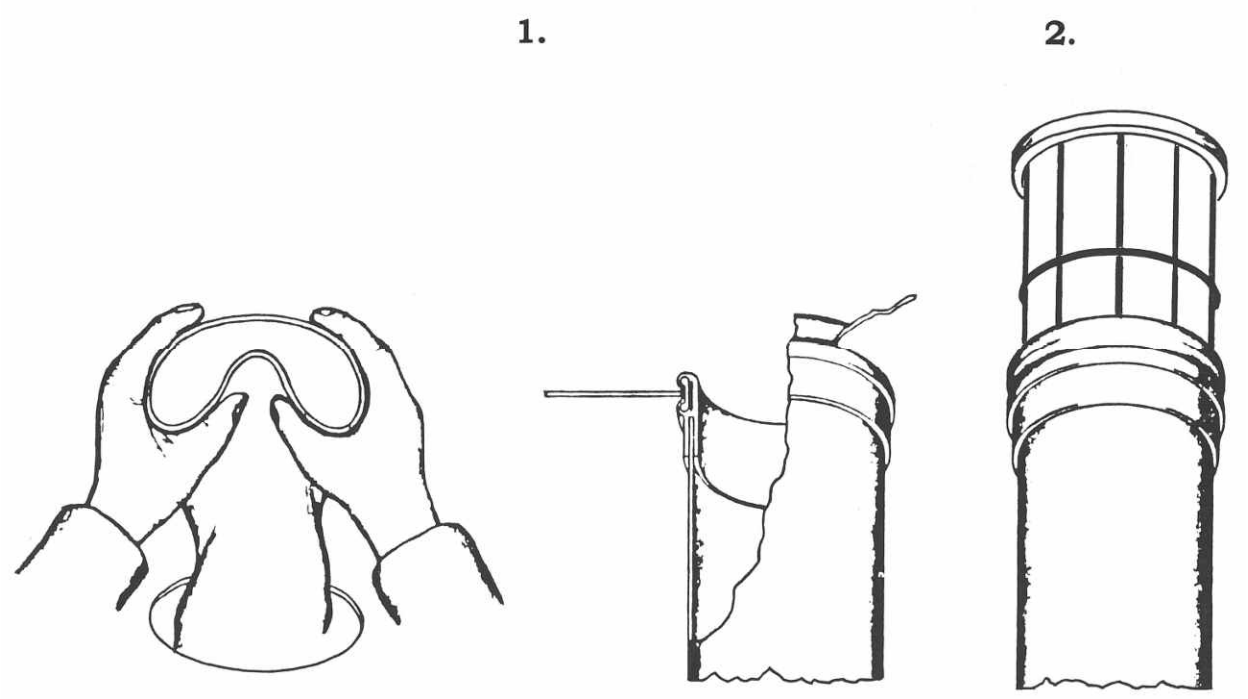


Item	Part Number	Qty	Description
1	FLMPBPBW	1	Base Weldment
2	BGPGFTS1024	1	TS1024 Plastic Yellow Belt Guard Front
3	FLMPBPBGB	1	Belt Guard Back
4	FLMPBPBGM	1	Belt Guard Mount
5	PTMM184A2	1	184A2 Double Adj. Motor Mount
6	PTEM3005018BE	1	Baldor EM3615T 5HP Motor
7	PDFLF231P200	1	Compact Filter, 2" NPT Outlet
8	FLMP1024	1	231P Solberg Filter (Included w/Item #7)
9	PPGC3232	2	2" Standard Galv. Coupling
10	PPGN320250	1	2" x 2½" Long Standard Galv. Nipple
11	PDBR1033	1	33 URAI-DSL Roots Blower
12	FLMP5016	1	ENM T56F1 Vibration Activated Hour Meter
13	PPGS323290	2	2" 90° Galv. Street Elbow
14	PDSLSLCR200	1	SLCR200 Solberg Silencer
15	PPGN320600	1	2" x 6" Long Standard Galv. Nipple
16	PPTG323232	3	2" Galv. Tee
17	PPGP020403600	1	2" Sch. 40 Galv. Pipe 36" Long TBE
18	PPGB3204	2	2" x ¼" Galvanized Hex Bushing
19	PPGN040200	2	¼" x 2" Long Standard Galv. Nipple
20	HWBV0004	2	6GD11 ¼" Brass Ball Valve
21	PPGN321200	1	2" x 12" Long Standard Galv. Nipple
22	FLMP1080	1	Noshok 25-901-15 Pressure Gauge
23	PPGS040490	1	¼" 90° Galv. Street Elbow
24	PPGN320800	2	2" x 8" Long Standard Galv. Nipple
25	FLMP1031	1	10 PSI Safety Relief Valve
26	FLHWA40108	1	Pressure Drop Indicator

Item	Model	Part Number
Motor Sheave	MPC-117	PTSH00BK045H
	MPC-153	PTSH00BK045H
Motor Bushing	MPC-117	PTSBH018
	MPC-153	PTSBH018
Blower Sheave	MPC-117	PTSH00BK080H
	MPC-153	PTSH00BK072H
Blower Bushing	MPC-117	PTSBH012
	MPC-153	PTSBH012
Belt	MPC-117	PTBLB44
	MPC-153	PTBLB44
Note: Items not shown.		

HONEYVILLE MPC SERIES

FILTER BAG INSTALLATION



Before entering the filter, be sure to perform the appropriate lockout-tagout procedures. To install the filter bags and wire cages, enter the clean air chamber through the door and stand on the cell plate. There will be sufficient room to install the bags and wire cages.

1) Insert the lower (closed) end of the bag through the cell plate. The best method for inserting the bag cuff into the cell plate is to form the bag cuff into a "U" shape. Center the cuff groove in the cell plate, and carefully snap the bag cuff into its sealed position. Caution must be exercised and each bag checked carefully to insure that the filter bag cuff groove is properly seated in the cell plate.
2) Insert the wire frame into each bag by sliding each cage downward until the bottom edge of the upper lip is fully covering the bag cuff and resting firmly on the filter cell plate.

MPC Filter Bags & Cages	
Part Number	Description
FLBG1005	4⅝" x 8' 16oz PE Felt Mirror Finish Microseal Bag
FLBG1006	4⅝" x 10' 16oz PE Felt Mirror Finish Microseal Bag
FLBG1007	4⅝" x 12' 16oz PE Felt Mirror Finish Microseal Bag
FLWC1002	96" Wire Cage
FLWC1003	120" Wire Cage
FLWC1004	144" Wire Cage

HONEYVILLE MPC SERIES

MAGNEHELIC DIFFERENTIAL GAUGE PARTS LIST

Quantity	Unit of Measure	Part Number	Description
1	Each	FLHW1003	2010 Magnehelic Gauge
1	Each	FLBR1001	Magnehelic Gauge Bracket
80	Feet	CSTB1002	1/4" Black Poly Flo Tubing
5	Each	FLGB1000	Grommet Bracket for 1/4" Hose
9	Each	FLHW1022	230 Rubber Grommet
2	Each	HWHF1002	1169X4S 1/8" NPT x 1/4"OD Hose 90° Swivel Elbow
2	Each	HWHF1001	1168X4 1/8" NPT x 1/4"OD Hose Straight Adapter
1	Each	FLHW1080	75048496 1/8" Polyethylene Exhaust Muffler

MAINTENANCE

Daily/Weekly Procedures

- Check the magnehelic gauge and record the pressure level. The normal operating range is 0.25" to 6.00". Note, your system will perform best if pressure is below 3.00". If the pressure changes significantly over a short period of time, investigate to determine the cause of the change.
    - If the pressure has increased, you should check the operation of the bag cleaning mechanism and check *if baghouse is plugged.*
    - If the pressure has decreased, you should check for torn filter bags, verify that the fan is producing the proper CFM, and verify that the magnehelic gauge is working properly.
- Check the pressure gauge on the blower package (Item #22 on page 13). The pressure should reach between 6 and 9 psi before pulsing, then the pressure should drop to zero and begin building back up.
    - You will need to open the valve directly below the pressure gauge before you can get a reading. After you are done, close the valve to prevent excessive wear on the pressure gauge.
    - Ensure that the relief disc on the top of the gauge is in the raised position.
- Empty the water trap on the blower package by opening the valve at the bottom of the trap (Item #20 on page 13).
- Check fan and motor bearings for excessive heat or vibration.

Quarterly Procedures

- In the clean air chamber of the filter (perform lockout-tagout procedures before entering the filter):
    - Tension the chain in the timing mechanism assembly (Item #2 on page 10). See page 17 for further instructions.
    - Ensure that the nuts (Item #4 on page 12) on the timing mechanism valve mount are tight. See page 17 for instructions on adjusting the timing of the cleaning pulse.
    - Check the split sprocket (Item #3 on page 11) and traveling sprocket (Item #15 on page 12) for signs of wear. Signs of wear may indicate that the chain is not tight enough.
    - Check for visible dust.
        - If dust is visible, check the bags in the areas where dust is present for tears.
        - Leaks that are difficult to detect may require the use of ultraviolet dye and a black light. Contact Honeyville Metal for further information.

MAINTENANCE (continued)

Semi-Annual Procedures

- Check the belt tension on all V-belt drives.
- Check the oil levels in the Peerless-Winsmith Gear Reducer (Item #5 on page 7). Note that the double reduction gear reducer has two oil housings. The Peerless-Winsmith Installation, Operation, and Lubrication Instructions have been included with this manual. Please consult their manual for further instructions specific to the gear reducer.

Annual Procedures

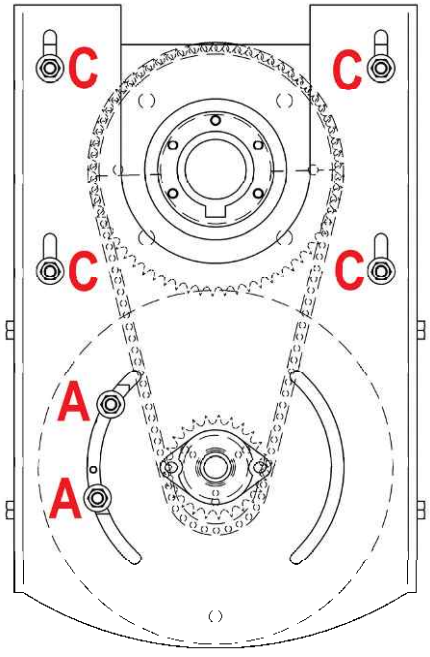
- Remove the Main Cover on the 8" Low Pressure Valve (Item #4 on page 8) and inspect the Main Spring (Item #5 on page 8) and the Main Diaphragm (Item #3 on page 9). Please contact Honeyville Metal if these items appear to have significant signs of wear.

Tensioning the Timing Mechanism Chain

- To tension the chain, loosen the four nuts labeled "C" in the image below, slide the Timing Mechanism Arm Assembly away from the Fixed Sprocket Assembly until the chain is tight, and then retighten the nuts.

Adjusting the Timing of the Cleaning "Pulse"

- For the bag cleaning process to function properly, the filter must "pulse" when the air discharge nozzles are passing over the centerline of the individual filter bags. The "pulse" is triggered when the Humphrey Valve passes over the Cap Screw and Countersunk Washer on the Index Disk (see Page 12).
- You can adjust the timing of the "pulse" by shifting the Timing Mechanism Valve Mount (Item #6 on page 12). Loosen the two nuts labeled "A" in the image to the right to shift the valve mount and retighten the nuts when finished.
    - If the valve pulses *BEFORE* the air discharge nozzles are centered on the bags, move the valve mount *counter clockwise.*
    - If the valve pulses *AFTER* the air discharge nozzles are centered on the bags, move the valve mount *clockwise.*



MAINTENANCE (continued)

- The following manufacturer's manuals have been included with this MPC Series manual. Please consult these manuals for maintenance instructions specific to their products that have been included in the filter.
    - Baldor AC & DC Motor Installation & Maintenance
        - Item #4 on page 7
        - Item #6 on page 13
    - Dodge S-2000 Spherical Roller Bearings
        - Item #1 on page 11
    - Peer Bearings Engineering Data
        - Item #9 on page 7
        - Item #2 on page 12
    - Peerless-Winsmith Installation, Operation, and Lubrication Instructions
        - Item #5 on page 7
    - Rotary Systems Dis-Assembly / Assembly Instructions
        - Item #10 on page 7
    - TB Wood's Sure-Flex Couplings Installation Instructions
        - Items #6 & 7 on page 7
    - Roots Blower Installation Operation & Maintenance Manual
        - Item #11 on page 13
    - V-Belts Operation & Maintenance
        - Blower Package Belt on page 13

Fike®

INSTALLATION AND MAINTENANCE INSTRUCTIONS

Explosion Vents

06-308-1

WARNING

- Read these instructions carefully and completely before attempting to unpack, install or service the explosion vent.
- Handle the explosion vent with extreme care. DO NOT bend, poke, or in any way distort the explosion vent.
- Do not locate vent assembly where personnel are exposed to the vent or the area above or in front of the vent, as they may be injured by the release of pressure, flame, noise, particles, and/or process material.
- Locate the explosion vent so that the discharge does not ignite other combustibles, resulting in an ensuing fire or secondary explosion.
- Interfacing equipment and/or machinery must also be protected.
- Flow arrows on round explosion vent tags, or explosion vent tag for square and rectangular vents must be directed to the atmospheric side of the process. Provisions shall be made to prevent personnel from standing or walking on vents, as they risk falling through.
- The vent opening is to be left free and clear. Nothing, i.e. goods or products, is allowed to obstruct the vent area as this will decrease vent efficiency.
- Install the enclosed DANGER sign in a conspicuous location near the zone of potential danger.

GENERAL

An explosion vent is a pressure relief device, designed to give an instantaneous opening at a predetermined pressure. Its purpose is to protect the equipment from excessive pressures caused by dust or gas deflagrations.

INSPECTION/PREPARATION

WARNING: Always handle the explosion vent with extreme caution. Handle the explosion vent by its edges only. Damage to the functional area (center) or seat area of the explosion vent may adversely affect the performance of the explosion vent. Read the explosion vent tag completely before installing to confirm that the size and type are correct for your system.

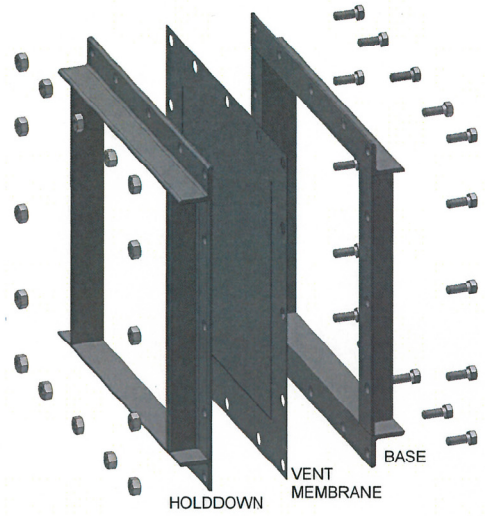
1. Carefully remove the explosion vent from its packaging container.
2. Inspect the explosion vent for damage.
3. If foreign material is present, carefully clean the explosion vent with a solvent that is compatible with your media.
4. Two personnel are recommended for handling of all vents larger than 24" x 30" (600 x 1000 mm) (rectangular) and 30" (800 mm) (round) or larger.
5. CV-SF vents require vent frames with back-up bars to properly function (consult Fike for design requirements).

INSTALLATION - OPEN DISCHARGE

WARNING: The vent opening should be left free and clear. Do not insulate any part of the explosion vent or frame without consulting Fike.

IMPORTANT: When explosion vents are installed horizontally, the use of drainage/weep holes in the holddown frame is required.

1. Use base/inlet of explosion vent frame as a template to indicate placement of explosion vent on the vessel or duct to be protected.



2. Cut the vessel or duct opening to the marked size. The marked size should match the size identified on the vent tag.
3. Weld or bolt the inlet angle frame to the vessel or duct.

IMPORTANT: The explosion vent frame must be installed such that the seat area is flat and bolt holes remain perpendicular (square and rectangular vent frames) or circular (round vent frames).

4. If sealing is a particular concern due to the nature of the process, apply a process compatible silicone sealant or gasket to provide seal between explosion vent and inlet frame.
5. If using a gasket, select a gasket material that is compatible with the process, with a suggested thickness of 1/8" (3.2 mm) maximum. The gasket is to have the same inside diameter and outside diameter as the explosion vent frame.
6. Install the explosion vent and outlet flange aligning the bolt holes. DO NOT force the explosion vent hole alignment.
7. Apply light oil to the threads and install the nuts and bolts hand tight.
8. Torque each bolt to the value identified on the explosion vent tag.

CAUTION: The torque values should not be exceeded as this may cause failure of the bolt and/or damage to the vent.

INSTALLATION – WITH FLAMQUENCH II SQ (FQIISQ)

For additional information, refer to FQIISQ installation instructions, E06-085.

WARNING: The vent opening should be left free and clear. Do not insulate any part of the explosion vent or frame without consulting Fike.

1. Use base/inlet of explosion vent frame as a template to indicate placement of explosion vent on the vessel or duct to be protected.

2. Cut the vessel or duct opening to the marked size. The marked size should match the size identified on the vent tag.

IMPORTANT: The FQIISQ uses an alignment hole feature to ensure proper orientation of the hinge of the explosion vent. The alignment hole must be included on the mounting frame so the explosion vent and FQIISQ can be mounted in only the prescribed orientation. Consult factory for FQIISQ bolting pattern.

3. Weld or bolt the inlet angle frame to the vessel or duct.

IMPORTANT: The explosion vent frame must be installed such that the seat area is flat and bolt holes remain perpendicular (square and rectangular vent frames).

4. Install gaskets on both sides of the explosion vent. Select a gasket material that is compatible with the process, with a suggested thickness of 1/16" (1.5 mm) maximum. The gasket is to have the same inside diameter and outside diameter as the explosion vent frame.
5. Install the explosion vent and outlet flange aligning the bolt holes. DO NOT force the explosion vent hole alignment.
6. Apply light oil to the threads and install the nuts and bolts hand tight.
7. Torque each bolt to the value identified on the explosion vent tag.

CAUTION: The torque values should not be exceeded as this may cause failure of the bolt and/or damage to the vent.

BURST INDICATOR
The explosion vents can have as an option an integrated electric burst indicator designed for intrinsically safe service. Refer to Burst Indicator Instructions / Drawing for electrical and dimensional specifications.

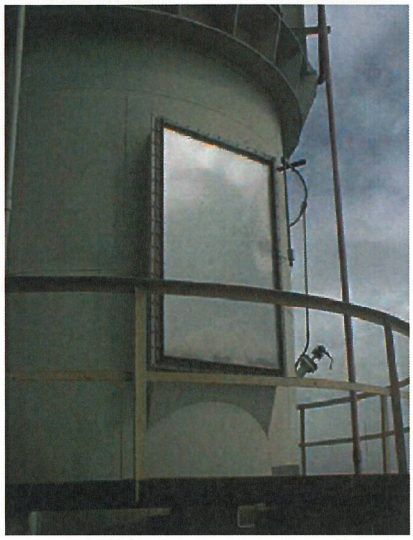
CAUTION: Unacceptably high voltage or currents will permanently damage the electrical system and the use of a non approved intrinsically safe power supply may even be the eventual ignition source of a dust or gas explosion. All burst indicators must be installed in an intrinsically safe circuit which conforms to the applicable national standard.

WARNING: Do not bend the electrical cable at any angle at a distance of less than 8 inch (20cm) from the mechanical bracing part and do not lift the explosion vent by the electrical cable, as this may damage the electrical circuit.

WARNING: The maximum torque values as mentioned on the nameplate must not be exceeded as this will permanently damage the electrical circuit.

MAINTENANCE
The explosion vent is maintenance-free due to its basic design and concept. Periodic visual inspections should be performed in accordance to the operating parameters and severity of service. All operational system parameters should be observed as a standard maintenance practice. The explosion vent must be replaced if they appear damaged, corroded, or leaking.

NOTE: Severe service is defined as rapid changes in pressure, high pressure, high temperature, or corrosive process.



P/N 06-308-1-6 October, 2011 Specifications are subject to change without notice.

FIKE WARRANTY INFORMATION

LIMITED WARRANTY

1. Because of the many and varied circumstances and extreme conditions under which Fike's products are used, and because Fike has no control over this actual use, Fike makes no warranties which extend beyond the express provisions herein. FIKE MAKES NO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS. Fike makes no express warranties beyond the following provisions, which only apply to the original purchaser.
2. Fike only warrants to the original purchaser as follows: When the products and their component parts are properly installed and maintained, and if the product has not been modified or tampered with, then only the products actually manufactured by Fike shall be free from defects in material and workmanship only for a period of one year from shipment by Fike for all products except certain qualified Fike Fire Suppression Systems which shall be free of said defects for a period of sixty (60) months (see additional details for qualifications). The original manufacturers' warranties apply to products and components not manufactured by Fike.

NON-ASSIGNABILITY OF WARRANTY

3. The warranty as set forth in these terms and conditions may not be assigned, transferred, sold, or alienated in any other way and extends only to the original purchaser.

PURCHASER'S EXCLUSIVE REMEDY

4. The original purchaser's sole and exclusive remedy, unless varied by written agreement with Fike, is that Fike will, at Fike's option, repair or replace any defective part which is returned to Fike within ninety (90) days of discovery of the defect.

DISCLAIMER OF CONSEQUENTIAL DAMAGES

5. In no event shall Fike be liable for consequential damages, including but not limited to damages for loss of use, damages for lost profits, and damages for resulting harm other than the Fike assemblies and their component parts.

704 S.W. 10th Street · P.O. Box 610 · Blue Springs, Missouri 64013-0610 U.S.A. · (816) 229-3405 · www.fike.com

HONEYVILLE MPC SERIES

HONEYVILLE METAL WARRANTY

The full extent of the warranty supplied by Honeyville Metal, Inc. (“HMI”) is to correct any defects in material and/or workmanship on the products manufactured only by HMI. Any unauthorized modification to the equipment voids this warranty. This warranty period extends for **one year** from the date the product arrives on the site where installation will take place. HMI retains the right to review and/or adjust the time period for those products that may be held in inventory at a dealer's warehouse. HMI retains the final authority on determining if a product is within the warranty period and if full replacement of that product is required to retain the integrity of our products reputation and meet the customer's expectations. HMI will not furnish labor for replacement of any defective product or components of a product. Any product that is determined defective by both HMI and the end user who purchased the product may not be returned to HMI without the receipt of a Return Merchandise Authorization (“RMA”) from our office. Returned merchandise must be shipped prepaid, unless instructed otherwise, and clearly marked with the RMA number provided by HMI. This warranty supplied by HMI excludes damage to products while in transit to the destination on all public forms of transportation except the trucking equipment owned and operated by HMI. This warranty does not cover performance guarantees on products, only defects in material and/or workmanship as prior statement. HMI does honor vendor warranties that extend beyond the one year period and will pass warranty coverage on to the purchaser of that vendor product.

HMI will provide replacement Main (Large) Diaphragms, Item #3 on page 9, and Main (Large) Springs, Item #5 on page 8, free of charge for the life of the filter to the original owner. HMI will not furnish the labor to replace these parts.

HONEYVILLE MPC SERIES

HONEYVILLE CERTIFICATE OF QUALITY

Every effort has been made to make this equipment the best value you can obtain for your money. All the components have been inspected and assembled. The complete system has been tested to insure proper operation. We sincerely hope this equipment and our efforts meet with your approval. The full extent of the Honeyville Metal, Inc. warranty is to correct any defects in material or workmanship in those products manufactured by Honeyville Metal, Inc. Motors and drives, and all electrical and air control parts carry a one-year warranty.

READ INSTRUCTIONS CAREFULLY BEFORE OPERATING!

THIS UNIT WAS FINAL INSPECTED AND PACKED BY _____

Honeyville Metal, Inc.
4200 S 900 W
Topeka, IN 46571
P (800) 593-8377
F (260) 593-2486
www.honeyvillemetal.com
dustinfo@honeyvillemetal.com

AC & DC Motor Installation & Maintenance

Safety Notice Be sure to read and understand all of the Safety Notice statements in MN408. A copy is available at:
http://www.baldor.com/support/literature_load.asp?ManNumber=MN408

ACCEPTANCE
Thoroughly inspect this equipment before accepting shipment from the transportation company. If any damage or shortage is discovered do not accept until noted on the freight bill. Report all damage to the freight carrier.

SAFETY
Eye bolts, lifting lugs or lifting openings, if provided, are intended only for lifting the motor and motor mounted standard accessories not exceeding, in total 30% of the motor weight. These lifting provisions should never be used when lifting or handling the motor and driven equipment. Eye bolt lifting capacity rating is based on a lifting alignment coincident with eye bolt center line. Eye bolt capacity reduces as deviation from this alignment is increased. Be sure eye bolts are tight and prevented from turning before lifting.

INSTALLATION OUTSIDE THE USA:
Refer to MN408 and MN1383 for Compliance with European Directives. Copies are available at:
http://www.baldor.com/support/literature_load.asp

MOTOR ENCLOSURE
ODP, **Open drip proof** motors are intended for use in clean, dry locations with adequate supply of cooling air. These motors should not be used in the presence of flammable or combustible materials. Open motors can emit flame and/or molten metal in the event of insulation failure.
TEFC, **totally enclosed** motors are intended for use where moisture, dirt and/or corrosive materials are present in indoor and outdoor locations.
Explosion protected motors, as indicated by a Nationally Recognized Testing Laboratory Certification mark and marking with Class, Division and Temperature Code are intended for installation in hazardous locations as described in Article 500 of the NEC. Refer to MN408 for more details.

MOUNTING
Foot mounted machines should be mounted to a rigid foundation to prevent excessive vibration. Shims may be used if location is uneven.
Flange mounted machines should be properly seated and aligned. Note: If improper rotation direction is detrimental to the load, check rotation direction prior to coupling the load to the motor shaft.
For **V-belt drive,** mount the sheave pulley close to the motor housing. Allow clearance for end to end movement of the motor shaft. Do not overtighten belts as this may cause premature bearing failure or shaft breakage.
Direct coupled machines should be carefully aligned and the shaft should rotate freely without binding.

GENERAL
The user must select a motor starter and overcurrent protection suitable for this motor and its application. Consult motor starter application data as well as the National Electric Code and/or applicable local codes. Special motors for use by United States Government including special specifications, master plans, etc. refer to the applicable master plans and specifications involved.
On motors received from the factory with the shaft blocked, remove blocking before operating the motor. If motor is to be reshipped alone or installed to another piece of equipment, the shaft block must be installed to prevent axial movement and prevent brinelling of the bearings during shipment.

TESTING
If the motor has been in storage for an extensive period or has been subjected to adverse moisture conditions, check the motor insulation resistance with a meg ohm meter. Depending on storage conditions it may be necessary to regrease or change rusted bearings. Contact Baldor District Office if resistance is less than 5 meg ohms.

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury.

WARNING: Be sure the system is properly grounded before applying power. Electrical shock can cause serious or fatal injury.

INSTALLATION
This motor must be installed in accordance with National Electric Code, NEMA MG-2, IEC standards and local codes.

WIRING
Connect the motor as shown in the connection diagrams. If this motor is installed as part of a motor control drive system, connect and protect the motor according to the control manufacturers diagrams. Refer to MN408 for additional details on lead marking. The wiring, fusing and grounding must comply with the National Electrical Code or IEC and local codes. When the motor is connected to the load for proper direction of rotation and started, it should start quickly and run smoothly. If not, stop the motor immediately and determine the cause. Possible causes are: low voltage at the motor, motor connections are not correct or the load is too heavy. Check the motor current after a few minutes of operation and compare the measured current with the nameplate rating.

GROUNDING
Ground the motor according to NEC and local codes. In the USA consult the National Electrical Code, Article 430 for information on grounding of motors and generators, and Article 250 for general information on grounding. In making the ground connection, the installer should make certain that there is a solid and permanent metallic connection between the ground point, the motor or generator terminal housing, and the motor or generator frame. In non-USA locations consult the appropriate national or local code applicable.

ADJUSTMENT
The neutral is adjustable on some DC motors. AC motors have no adjustable parts.

Noise
For specific sound power or pressure level information, contact your local Baldor representative.

VIBRATION
This motor is balanced to NEMA MG1, Part 7 standard.

BRUSHES (DC Motors)
Periodically, the brushes should be inspected and all brush dust blown out of the motor. If a brush is worn $^{1}/_{2}$, (length specified in renewal parts data), replace the brushes. Reassemble and seat the new brushes using a brush seating stone. Be sure the rocker arm is set on the neutral mark.

WARNING: Guards must be installed for rotating parts such as couplings, pulleys, external fans, and unused shaft extensions, should be permanently guarded to prevent accidental contact by personnel. Accidental contact with body parts or clothing can cause serious or fatal injury.

INSPECTION
Before connecting the motor to an electrical supply, inspect for any damage resulting from shipment. Turn the shaft by hand to ensure free rotation. Motor leads must be isolated before the shaft will turn freely on permanent magnet motors.

DRAIN PLUGS
Condensation drain plugs are provided at four points on each endplate for various motor mounting configurations. For Washdown and totally enclosed, fan cooled or non-ventilated motors, the plugs in the lowest portion of the ends shields should be removed for operation (unless the motor has special stainless steel drains). All drains are located in the lowest portion of the ends shields.

MOUNTING
Mount the motor on a foundation sufficiently rigid to prevent excessive vibration. Grease lubricated ball bearing motors may be mounted with the feet at any angle. After careful alignment, bolt motor securely in place. Use shim to fill any unevenness in the foundation. Motor feet should sit solidly on the foundation before mounting bolts are tightened.

IP (Ingress Protection)
IP designations include two numerals, the first characteristic numeral is for ingress solid bodies and from dust.
The second for ingress protection from liquid - water.
Motors marked less than IP23 require additional protection from water.

GUARDING
After motor installation is complete, a guard of suitable dimensions must be constructed and installed around the motor/gearmotor. This guard must prevent personnel from coming in contact with any moving parts of the motor or drive assembly but must allow sufficient cooling air to pass over the motor.
If a motor mounted brake is installed, provide proper safeguards for personnel in case of brake failure.
Brush inspection plates and electrical connection cover plates or lids, must be installed before operating the motor.

STARTING

Before starting motor remove all unused shaft keys and loose rotating parts to prevent them from flying off.
Check direction of rotation before coupling motor to load. The motor should start quickly and run smoothly and with little noise. If the motor should fail to start the load may be too great for the motor, the voltage is low or the motor has been miswired. In any case immediately shut motor off and investigate the cause.

ROTATION
To reverse the direction of rotation, disconnect and lockout power and interchange any two of the three AC power leads for three phase motors. For two-phase four wire, disconnect and lockout power and interchange the AC line leads on any one phase. For two phase three wire, disconnect and lockout power and interchange phase one and phase two AC line leads.

Maintenance Procedures

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury.

WARNING: Surface temperatures of motor enclosures may reach temperatures which can cause discomfort or injury to personnel accidentally coming into contact with hot surfaces. Protection should be provided by the user to protect against accidental contact with hot surfaces. Failure to observe this precaution could result in bodily injury.

Lubrication Information

This is a ball or roller bearing motor. The bearings have been lubricated at the factory. Motors that do not have regrease capability are factory lubricated for the normal life of the bearings. **Washdown motors can not be lubricated**.

Lubricant
Baldor motors are pregreased, normally with Mobil Polyrex EM unless stated on nameplate. Do not mix lubricants due to possible incompatibility. Look for signs of lubricant incompatibility, such as extreme soupiness visible from the grease relief area. If other greases are preferred, check with local Baldor representative for recommendations.

Relubrication Intervals (For motors with regrease capability)
New motors that have been stored for a year or more should be relubricated. Lubrication is also recommended at these intervals.

LUBRICATION INSTRUCTIONS

Cleanliness is important in lubrication. Any grease used to lubricate anti friction bearings should be fresh and free from contamination. Properly clean the grease inlet area of the motor to prevent grease contamination.
1. Select service condition from Table 1.
2. Select lubrication frequency from Table 2.

LUBRICATION PROCEDURE
Bearings should be lubricated while stationary and the motor is warm.
1. Locate the grease inlet, clean the area, and replace the pipe plug with a grease fitting.
2. Locate and remove the grease drain plug, if provided.
3. Add the recommended volume of recommended lubricant until clean grease appears at the grease drain, at the grease relief, or along the shaft opening.
4. Replace the grease inlet plug and run the motor for two hours.
5. Replace the grease drain plug.

SPECIAL APPLICATIONS
For special temperature applications, consult your Baldor District Office.

Table 1 Service Conditions

Severity of Service	Ambient Temperature Maximum	Atmospheric Contamination	Type of Bearing
Standard	40° C	Clean, Little Corrosion	Deep Groove Ball Bearing
Severe	50° C	Moderate dirt, Corrosion	Ball Thrust, Roller
Extreme	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion	All Bearings
Low Temperature	<-30 ° C **		

* Special high temperature grease is recommended. ** Special low temperature grease is recommended.

Table 2 Lubrication Frequency (Ball Bearings)

NEMA / (IEC) Frame Size	Rated Speed @ RPM					
	10000	6000	3600	1800	1200	900
Up to 210 incl. (132)	**	2700 Hrs.	5500 Hrs.	12000 Hrs.	18000 Hrs.	22000 Hrs.
Over 210 to 280 incl. (180)		**	3600 Hrs.	9500 Hrs.	15000 Hrs.	18000 Hrs.
Over 280 to 360 incl. (225)		**	* 2200 Hrs.	7400 Hrs.	12000 Hrs.	15000 Hrs.
Over 360 to 5000 incl. (300)		**	*2200 Hrs.	3500 Hrs.	7400 Hrs.	10500 Hrs.

* Relubrication intervals are for ball bearings. For vertically mounted motors and roller bearings, divide the relubrication interval by 2.

** For motors operating at speeds greater than 3600 RPM, contact Baldor for relubrication recommendations.

Table 3 Lubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Table 4 Amount of Grease to Add

Frame Size NEMA (IEC)	Bearing Description (Largest bearing in each frame size)					
	Bearing	OD D mm	Width B mm	Weight of grease to add ounce (gram)	Volume of grease to add	
					inches^3	teaspoon
Up to 210 incl. (132)	6307	80	21	0.30 (8.4)	0.6	2.0
Over 210 to 280 incl. (180)	6311	120	29	0.61 (17.4)	1.2	3.9
Over 280 to 360 incl. (200)	6313	140	33	0.81 (23.1)	1.5	5.2
Over 360 to 5000 incl. (300)	NU322	240	50	2.12 (60.0)	4.1	13.4

Weight in grams = 0.005 DB

Shaker Duty Motors only

Caution: Shaker Duty motors must be properly lubricated prior to Start Up to prevent damage. See Table 5.
Lubrication should be performed before Start Up and at regular maintenance intervals. Follow these recommendations to ensure proper lubrication.

Recommended Lubricant

For ambient temperatures between -15°F to 120°F the following lubricants are recommended:
Mobil PolyrexEM, Texaco Premium RB, Exxon Unirex N-2.
Do not mix greases unless compatibility has been checked and verified.

Table 5 Lubrication Volume

NEMA Frame Size	Volume in Cubic Inches					
	Normal Duty		Severe Duty		Extreme Duty	
	Start Up	Relub	Start Up	Relub	Start Up	Relub
184TY	1.4	0.5	1.4	0.5	2.7	0.5
215TY	1.6	0.5	1.6	0.5	4.5	1
256TY	7	1			11	2
286TY	9	1			15	3

Lubrication Frequency
Normal Duty 8 hours per day (16 hours per day in a clean environment). Lubricate every 2 months.
Severe Duty 16 hours per day or more in a dirty environment (corrosive atmosphere, chemical fumes, acids, alkalies or extreme high humidity). Lubricate every month or 700 hours of operation.
Extreme Duty operation in extremely dirty or dusty environments and high ambient temperatures exceeding 104°F (40°C). Lubricate twice a month or 350 hours of operation.

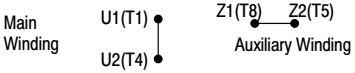
Lubrication Procedure
1. Locate the grease inlet and outlet. Clean the areas.
2. Remove the plug(s) and install a grease fitting in the inlet if grease fitting is not already installed.
3. Add the recommended amount of lubricant.
4. Run the motor for two hours with the outlet plug removed.
5. Install outlet plug.

Note: To loosen hardened grease it may be necessary to insert a rod or wire into the grease inlet and outlet holes.

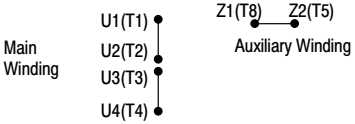
Typical IEC vs NEMA Lead Marking

Single Phase Non-Reversible
Refer to the connection diagram provided on the Baldor motor.

Single Phase Reversible



Dual Voltage Reversible

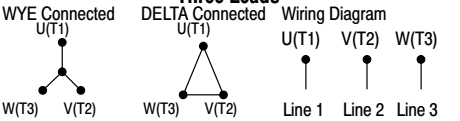


Three Phase
For single winding 3 phase motors, lead markings can be directly translated between IEC and NEMA designations. For these motors, the lead markings are:

U1=T1	U2=T4	U3=T7	U4=T10
V1=T2	V2=T5	V3=T8	V4=T11
W1=T3	W2=T6	W3=T9	W4=T12

Refer to the connection diagram provided on the Baldor motor. Some examples are as follows:

Three Leads

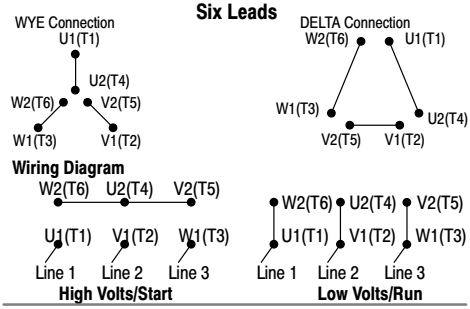


DC Motors
Lead markings can be translated between IEC and NEMA designations as follows:

	NEMA	IEC
Armature	A1, A2	A1, A2
Series Field	S2, S2	D1, D2
Shunt Field	F1, F2	E1, E2

Refer to the connection diagram provided on the Baldor motor.

Six Leads



* 4 1 6 - 0 8 1 2 *

P.O. Box 2400 Fort Smith, AR 72902-2400 USA Ph: (1) 479.646.4711, Fax: (1) 479.648.5792
www.baldor.com

MN416 8/12

INSTRUCTION MANUAL FOR DODGE®S-2000 SPHERICAL ROLLER BEARINGS

These instructions must be read thoroughly before installing or operating this product.

WARNING
TO ENSURE THAT DRIVE IS NOT UNEXPECTEDLY STARTED, TURN OFF AND LOCK OUT OR TAG POWER SOURCE BEFORE PROCEEDING. FAILURE TO OBSERVE THESE PRECAUTIONS MAY RESULT IN BODILY INJURY.

INSTALLATION:

GENERAL INFORMATION

DODGE S-2000 Spherical Roller Bearing mounted units incorporate a unique way of sealing the internal components of the bearing while still allowing a full + or - 1 degree of misalignment. The patented sealing system (Pat. #5,908,249) has proven effective, due to its constant contact pressure, in protecting the internal bearing components under maximum allowable misaligned conditions.

NON-EXPANSION BEARING

1. Clean shaft and bore of bearing. The shaft should be straight, free of burrs and nicks, and correct size (see shaft tolerance table). If used shafting is utilized, then the bearing should be mounted on unworn section of shafting.
2. Lubricate shaft and bearing bore with grease or oil to facilitate assembly. Slip bearing into position. When light press fit is required, press against the end of the inner ring of bearing. Do not strike or exert pressure on the housing or seals.
3. Bolt bearing to support, using shims where necessary to align bearing so inner ring does not rub on seal carrier. Use full shims which extend across the entire housing base.
4. Determine final shaft position and tighten setscrews in the locking collar(s) of non-expansion bearing to recommended torque while the other bearings remain free. Rotate the shaft slowly under load, if possible, to properly center the rolling elements with respect to the raceways. Then tighten setscrews into the locking collar of the remaining bearings to the recommended torque.
5. Check rotation. If there is any strain, irregular rotational torque or vibration, it could be due to incorrect alignment, bent shaft or bent supports. Installation should be rechecked and correction made where necessary.

WARNING: Because of the possible danger to persons(s) or property from accidents which may result from the improper use of products, it is important that correct procedures be followed: Products must be used in accordance with the engineering information specified in the catalog. Proper installation, maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure safe operation under prevailing conditions. Proper guards and other suitable safety devices or procedures as may be desirable or as may be specified in safety codes should be provided, and are neither provided by Baldor Electric Company nor are the responsibility of Baldor Electric Company. This unit and its associated equipment must be installed, adjusted and maintained by qualified personnel who are familiar with the construction and operation of all equipment in the system and the potential hazards involved. When risk to persons or property may be involved, a holding device must be an integral part of the driven equipment beyond the speed reducer output shaft.

EXPANSION BEARING

Steps (1, 2, 3) Same as Non-Expansion Bearing.

4. Position expansion bearing in the housing. For normal expansion conditions, the bearing insert should be positioned in the center of the housing. To center bearing insert in housing, move bearing insert to extreme position and mark shaft. Then using bearing maximum total expansion table, move bearing insert in opposite direction one-half the total expansion to center bearing in the housing. If maximum expansion is required, move bearing insert to the extreme position in the housing to permit full movement in direction of expansion. After expansion bearing has been positioned in the housing, tighten the setscrews in the locking collar to the recommended torque.
5. Same as Non-Expansion Bearing.

FIELD CONVERSION (RE-OP) OF A NON-EXPANSION BEARING INTO AN EXPANSION BEARING

All non-expansion bearing sizes can be re-oped to become expansion bearings. To re-op a non-expansion to an expansion bearing follow these steps:

1. Move the snap ring, opposite from the collar side of bearing, to the outermost snap ring groove.
2. Install bearing per Expansion Bearing instructions listed above.

NOTE: Bearing nameplate has a non-expansion Part Number. When bearing is re-oped the bearing should be marked as expansion for future reference.

BEARING MAXIMUM TOTAL EXPANSION TABLE

Shaft Size	Total Expansion
in.	in.
1 3/8 – 1 1/2	3/16
1 11/16 – 3 7/16	1/14
3 15/16	5/16
4 7/16 – 4 15/16	3/8

LUBRICATION INSTRUCTIONS

OPERATION IN PRESENCE OF DUST, WATER OR CORROSION VAPORS

This bearing is factory lubricated with No. 2 consistency lithium complex base grease which is suitable for most applications. However, extra protection is necessary if bearing is subjected to excessive moisture, dust, or corrosive vapor. In these cases, bearing should contain as much grease as speed will permit (a full bearing with consequent slight leakage through the seal is the best protection against contaminant entry).

In extremely dirty environments, the bearing should be purged daily to flush out contaminants. For added protection, it is advisable to shroud the bearing from falling material.

HIGH SPEED OPERATION

At higher operation speeds, too much grease may cause overheating. In these cases, the amount of lubrication can only be determined by experience. If excess grease causes overheating, remove grease fittings and run for ten minutes. This will allow excess grease to escape. Then wipe off excess grease and replace grease fittings.

In higher speed applications, a small amount of grease at frequent intervals is preferable to a large amount at infrequent intervals. However, the proper volume and interval of lubrication can best be determined by experience.

AVERAGE OPERATIONS

The following table is a general guide for normal operating conditions. However, some situations may require a change in lubricating periods as dictated by experience. If the bearing is exposed to unusual operating conditions, consult a reputable grease manufacturer.

LUBRICATION GUIDE

READ PRECEDING PARAGRAPHS BEFORE ESTABLISHING LUBRICATION SCHEDULE

Suggested Lubrication Period in Weeks

Hours run per day	1 to 250 rpm	251 to 500 rpm	501 to 750 rpm	751 to 1500 rpm	1001 to 2000 rpm	1501 to 2000 rpm	2001 to 2500 rpm	2501 to 3000 rpm
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	2	1
24	10	5	3	2	1	1	1	1

OPERATING TEMPERATURE

Abnormal bearing temperatures may indicate insufficient lubrication. If the housing is too hot to touch for more than a few seconds, check the temperature by applying a thermometer at the top of the pillow block with the thermometer tip surrounded by putty.

Because the thermometer reading will be approximately 10°F lower than the actual bearing temperature, add ten degrees to the reading and compare to the temperature rating of your grease. If the bearing temperature reading is consistent and operating within the recommended limits of your grease, the bearing is operating satisfactorily. The recommended maximum operating temperature for S-2000 Spherical Roller Bearings is 200 °F.

STORAGE OR SPECIAL SHUT DOWN

If equipment will be idle for some time, before shutting down, add grease to the bearing until grease purges from the seals. This will ensure protection of the bearing, particularly when exposed to severe environmental conditions. After storage or idle period, add fresh grease to the bearing before starting.

Set Screw Torque Table

Shaft Size	Socket Set Screw Size	Tightening Torque
1-3/8 – 1-3/4 in.	5/16 in.	165 Inch Pounds
11-15/16 – 2-7/16 in.	3/8 in.	290 Inch Pounds
12-11/16 – 3-7/16 in.	1/2 in.	620 Inch Pounds
13-15/16 – 4-15/16 in.	5/8 in.	1325 Inch Pounds

Recommended Shaft Tolerance Table

Normal Shaft Size	Low to Normal Equlvalent Load and Catalog Speed*	
Up to 1-1/2 in.	+.000 in.	–.0005 in.
Over 1-1/2 to 2-1/2 in.	+.000 in.	–.001 in.
Over 2-1/2 to 4 in.	+.000 in.	–.001 in.
Over 4 to 5 in.	+.000 in	–.0015 in.

On severe applications and where dynamic balance and minimum runout are important, a snug to light press fit may be required to obtain optimum bearing performance. Consult factory.

*Normal equivalent load .08C to .18C.

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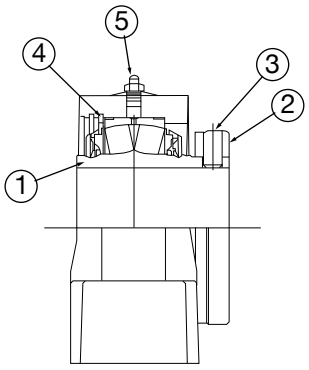
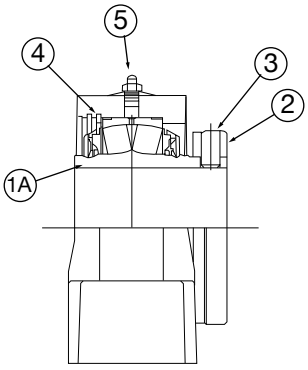
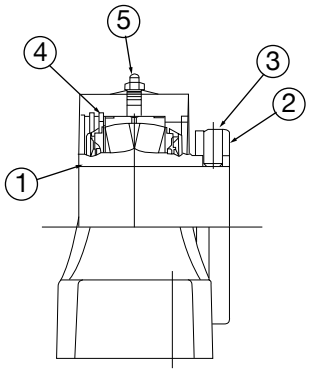


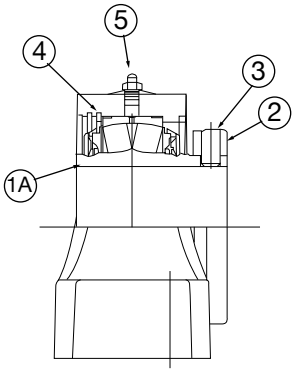
2 BOLT PILLOW
BLOCK S2000-R



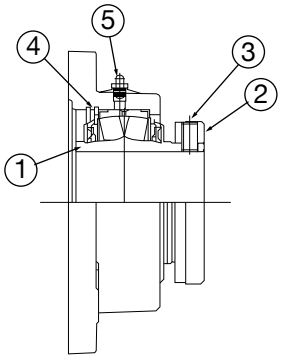
2 BOLT PILLOW
BLOCK S2000-L



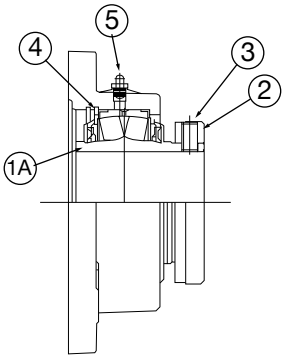
4 BOLT PILLOW
BLOCK S2000-R



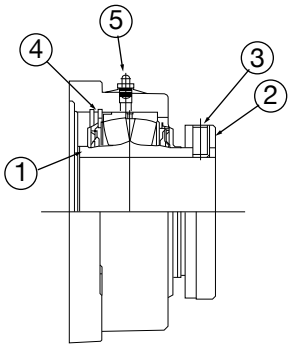
4 BOLT PILLOW
BLOCK S2000-L



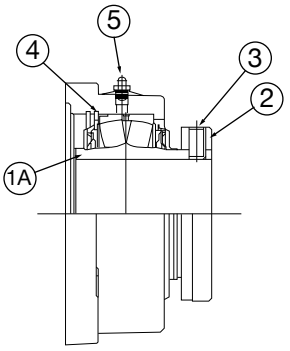
3 & 4 BOLT ROUND
FLANGE S2000-R



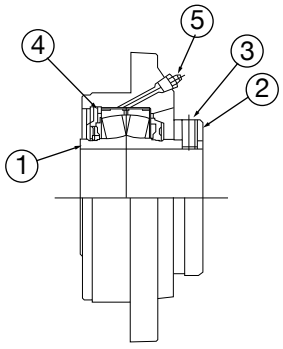
3 & 4 BOLT ROUND
FLANGE S2000-L



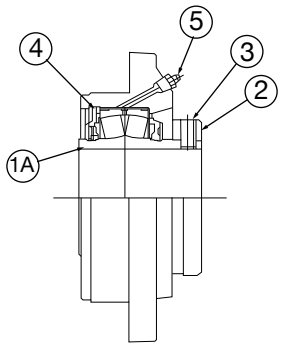
4 BOLT SQUARE
FLANGE S2000-R



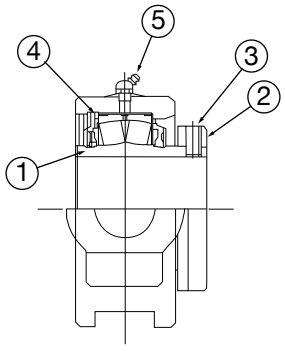
4 BOLT SQUARE
FLANGE S2000-L



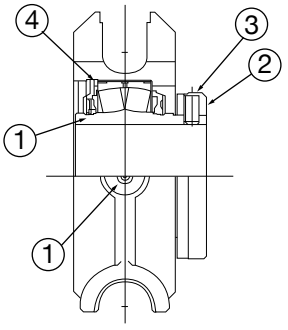
PILOTED FLANGE
S2000-R



PILOTED FLANGE
S2000-L



WIDE SLOT TAKE-UP
S2000-R



TPHU TAKE-UP
S2000-R

DODGE®

COMPONENT PART NUMBERS (1 3/8” - 4 15/16”)

ITEM	1	1A	2	3	4	5
Shaft Size	**Bearing Insert Assembly (R) Seal**	**Bearing Inert Assembly (L) Seal**	***Collar**	***Set Screw**	**Snap Ring**	****Grease Fitting**
1 3/8	070000	070016	040050	400058	069276	405015
1 7/16	070001	070017	040050	400058	069276	405015
1 1/2	070002	070018	040050	400058	069276	405015
1 11/16	070003	070019	040051	400058	069277	405015
1 3/4	070004	070020	040051	400058	069277	405015
1 15/16	070005	070021	070587	400094	069278	405015
2	070006	070022	070587	400094	069278	405015
2 3/16	070007	070023	070588	400094	069279	405015
2 7/16	070008	070024	040054	400094	069280	405015
2 11/16	070009	070025	070589	400150	069281	405015
2 15/16	070010	070026	070589	400150	069281	405015
3	070011	070027	070589	400150	069281	405015
3 7/16	070012	070028	040056	400154	069282	405015
3 15/16	070013	070029	060946	400186	069283	405015
4 7/16	070014	070030	* 060947	* 400186	069284	405015
4 15/16	070015	070031	* 040059	* 400190	069285	405015
QTY/PER	1	1	1	2	1	1

*Shaft sizes 4 7/16” - 4 15/16” have two collars a

** WSTU and TPHU TU take a 405016 grease fitting.

World Headquarters

P.O. Box 2400, Fort Smith, AR 72902-2400 U.S.A., Ph: (1) 479.646.4711, Fax (1) 479.648.5792, International Fax (1) 479.648.5895

Dodge Product Support

6040 Ponders Court, Greenville, SC 29615-4617 U.S.A., Ph: (1) 864.297.4800, Fax: (1) 864.281.2433

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D. Mounting
Locking to the shaft.

Cylindrical bore bearings- Set screw locking.
For normal operating conditions, ball bearings are fixed to the shaft with socket head set screws as illustrated in figures 4 and 5. It is recommended that the shaft have flats or recesses in the areas where the set screws will contact it. This eliminates the formation of burrs on the shafting

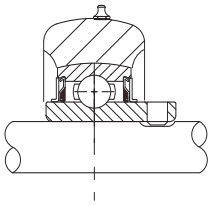


Figure 4

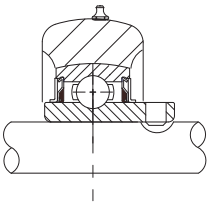


Figure 5

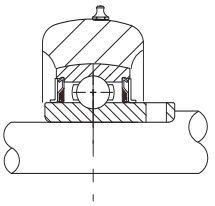


Figure 6

Where vibration, shock and or thrust loads are anticipated, it is recommended that the shaft have a machined shoulder or auxiliary locking collar against which the bearing inner ring can be mounted. See figure 6. Set screws on cylindrical bore bearings should be tightened incrementally and firmly to prevent rotation of the shaft in the bearing bore. Tighten one set screw to sufficiently contact the shaft, then tighten the second set screw to the full torque requirement, and then tighten the first set screw to the full torque requirement. It is also recommended the set screws be re-tightened after 24 hours of operation. Tightening torque values are shown in table 16. Caution should be taken to not over tighten the set screws as this can cause inner ring distortion instigating an eccentric rotation and out of balance situation.

It is important to mention that PEER high frequency anneals the inner ring in the areas around the set screws. In addition to preventing cracking of the inner ring during set screw tightening, this allows the use of larger diameter set screws increasing the holding power. Set screw sizes and hex sizes are shown in table 16. PEER also uses a special set screw spacing to increase holding power of the set screws during operation.

Table 16: Tightening torque of set screws in set screw locking bearings.

Bearing No.			Size	Hex width	Tightening torque In-Lbs.
UC/SER	UCX	FHS			
201-205	X05	201-206	1/4-28x1/4	1/8	77.9
201-205(mm)		201-206(mm)	M6xP1.0		77.9
206-209	X06-X08	207-209	5/16-24x5/16	5/32	156
206-209(mm)		207-209(mm)	M8xP1.0		156
210-213	X10-X12	210-213(mm)	3/8-24x3/8	3/16	273
210-213(mm)			M10xP1.25		273
214-217	X13-X16		7/16-20x7/16	7/32	428
214-217(mm)			M12xP1.5		428
218	X17		1/2-20x1/2	1/4	615
218(mm)			M12xp1.5		428

Note: based on class 3A, alloy steel, knurled cup point set screws, cold forged with black oxide finish. Hardness value of 45-53 used in annealed inner rings with class 3B set screw holes. Other set screw styles and types are available upon request.

Table 16:a Stainless Steel Set Screw Tightening Torque Requirements

Size	Set Screw	Torque (in-lbs)
201-206	1/4-28	54
207-209	5/16-24	110
210-212	3/8-24	205

5 Greasing:
5.1 greasing intervals.
PEER mounted unit insert bearings are pre-lubricated at the factory and are ready for operation. Under normal operating conditions it is normal for a small amount of grease to purge from the seals during initial start up. This condition will stop once optimum grease fill has been obtained. Re-lubrication of PEER insert bearings is determined by operating conditions and environment. Greases used in re-lubricating PEER bearings should be NLGI # 2 compatible with a lithium thickener, mineral base oil and a temperature range of -10 to +260 degrees F. General greasing intervals based on RPM and operating conditions are shown in table 19. However, experience is the preferred method of determining greasing intervals and fill amounts.

Table 19: Greasing intervals.

Type of unit	dn value	Environmental conditions	Operating temperature F	Relubrication Frequency	
				Hours	Period
Standard	40,000 and below	Ordinary	5 to 176	1500 to 3000	6 to 12 months
Standard	70,000 and below	Ordinary	5 to 176	1000 to 2000	3 to 6 months
Standard	70,000 and below	Ordinary	176 to 212	500 to 700	1 month
Heat-resistant	70,000 and below	Ordinary	212 to 284	300 to 700	1 month
Heat-resistant	70,000 and below	Ordinary	284 to 338	300 to 700	1 month
Heat-resistant	70,000 and below	Ordinary	338 to 392	100	1 week
Cold-resistant	70,000 and below	Ordinary	76 to 176	1000 to 2000	3 to 6 months
Standard	70,000 and below	Very Dusty	5 to 212	100 to 500	1 week to 1 month
Standard	70,000 and below	Exposed to water	5 to 212	30 to 100	Daily to weekly

d = inner diameter of bearing (mm)
n = speed in RPM

5.2 Grease fill amounts

Care should be taken when re-greasing bearings to avoid overfilling. Overfilling can lead to excessive heat and or unseating of the seals. Grease should be introduced in small increments and under light pressure. The use of pneumatic greasing equipment is not recommended unless low pressure is assured. Whenever possible, the shaft should be rotated during relubrication to insure proper grease distribution throughout the raceways.

The grease fill shown in table 20 provides a general rule for re-greasing amounts. However, it is preferred that experience dictates fill amounts due to wide variances in applications and operating environments.

Table 20: Grease fill amounts.

Series	Fill Amount
201-205	2 grams
206-208	3 grams
209-212	5 grams
213-218	8 grams

5.3 Grease fittings.

PEER offers many styles and types of grease fittings. Figure 7 illustrates some of the many styles and sizes PEER units can be equipped with. Optional fitting materials, thread designs and additional styles are available by special order. Table 21 shows the standard fitting sizes used on PEER units.

Table 21: Grease fitting equipped in PEER ball bearing mounted units.

Bearing Number	Fitting Name	Thread Size
203-209	Zerk-1/4-28	1/4-28 UNF
210-218	Zerk-PS-18	1/8-27 NPT

Note: Optional 90˚ and 45˚ fittings available.

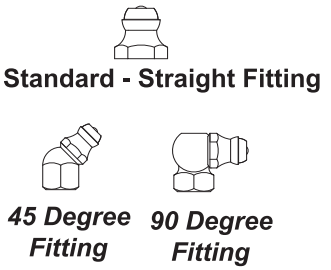


Figure 7

Location of zerk hole on pillow block units.

PEER has the ability to locate the zerk hole in a wide variety of locations on the pillow block housings. Table 22 shows our standard location. See figure 8 and figure 9. Special locations are available by request.

Table 22: Location of zerk fitting on pillow block units.

Unit no.	Location
203-209	Angle - Figure 8
210-218	Top - Figure 9

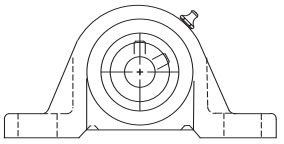


Figure 8

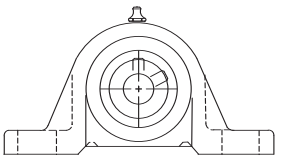


Figure 9

5.4 Grease types.

PEER bearings are pre-lubricated with standard grease suitable for a wide variety of applications, speeds, temperatures and environments. Special greases are readily available. Shown in table 23 is a small sampling of standard and special greases offered.

Table 23: Greases and operating temperatures.

Manufacturer trade name.	Recommended operating temperature range F	Properties				
		Thickener	Base oil	Water resistant	Viscosity CST @ 40C	Viscosity CST @ 100C
Shell Alvania RL2	-10 to +260	Lithium	Mineral	Yes	98	9.4
Shell Alvania RL3	0 to +230	Lithium	Mineral	Yes	98	9.4
Exxon Polyrex EM	-40 to +350	Polyurea	Mineral	Yes	115	12.2
Chevron SRI #2	-20 to +350	Polyurea	Mineral	Yes	110	11
Chevron FM NLGI #2	-40 to +300	Polyurea	Mineral	Yes	220	18
Krytox 240AC / GPL	-30 to +550	Synthetic	Synthetic	Yes	270	26

Note: Operating temperature, environment, RPM and load all play a role in selecting the appropriate grease for each application. Experience and field data are the best method of selecting the correct grease.

6. Internal radial clearance.

Internal clearance between the balls and ball raceways in insert ball bearings permits interference fits on the bearing rings without preloading the bearings. In addition, the internal clearance is designed to allow for slight thermal expansion of the shafting in the inner ring and slight misalignment of the inner and outer rings. Proper internal clearance is particularly important for bearings operating at high speeds or under high temperatures and or loads.

Radial clearance can be defined as the average diameter of the outer ring raceway, minus the average diameter of the inner ring raceway, minus twice the ball diameter. The result is the amount of radial internal clearance. Generally, radial clearance is measured on assembled bearings by displacing the outer ring radially with respect to the inner ring under a reversing light gauge load. Table 24 shows the most common internal clearance classifications.

Table 24: Internal radial clearance for cylindrical bore insert bearings

Unit: 0.001mm / 0.0001 in.

Nominal bore diameter d				Radial internal clearance																			
				C2				C0				Standard / C3				C4				C5			
Over		Incl.		min.		max.		min.		max.		min.		max.		min.		max.		min,		max.	
mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	In
10	0.3937	18	0.7087	0	0	9	4	3	1	18	7	11	4	25	10	18	7	33	13	25	10	45	18
18	0.7087	24	0.9449	0	0	10	4	5	2	20	8	13	5	28	11	20	8	36	14	28	11	48	19
24	0.9449	30	1.1811	1	0	11	4	5	2	20	8	13	5	28	11	23	9	41	16	30	12	53	21
30	1.1811	40	1.5748	1	0	11	4	6	2	20	8	15	6	33	13	28	11	46	18	40	16	64	25
40	1.5748	50	1.9685	1	0	11	4	6	2	23	9	18	7	36	14	30	12	51	20	45	18	73	29
50	1.9685	65	2.5591	1	0	15	6	8	3	28	11	23	9	43	17	38	15	61	24	55	22	90	35
65	2.5591	80	3.1496	1	0	15	6	10	4	30	12	25	10	51	20	46	18	71	28	65	26	105	41
80	3.1496	100	3.9370	1	0	18	7	12	5	36	14	30	12	58	23	53	21	84	33	75	30	120	47
100	3.9370	120	4.7244	2	1	20	8	15	6	41	16	36	14	66	26	61	24	97	38	90	35	140	55
120	4.7244	140	5.5118	2	1	23	9	18	7	48	19	41	16	81	32	71	28	114	45	105	41	160	63

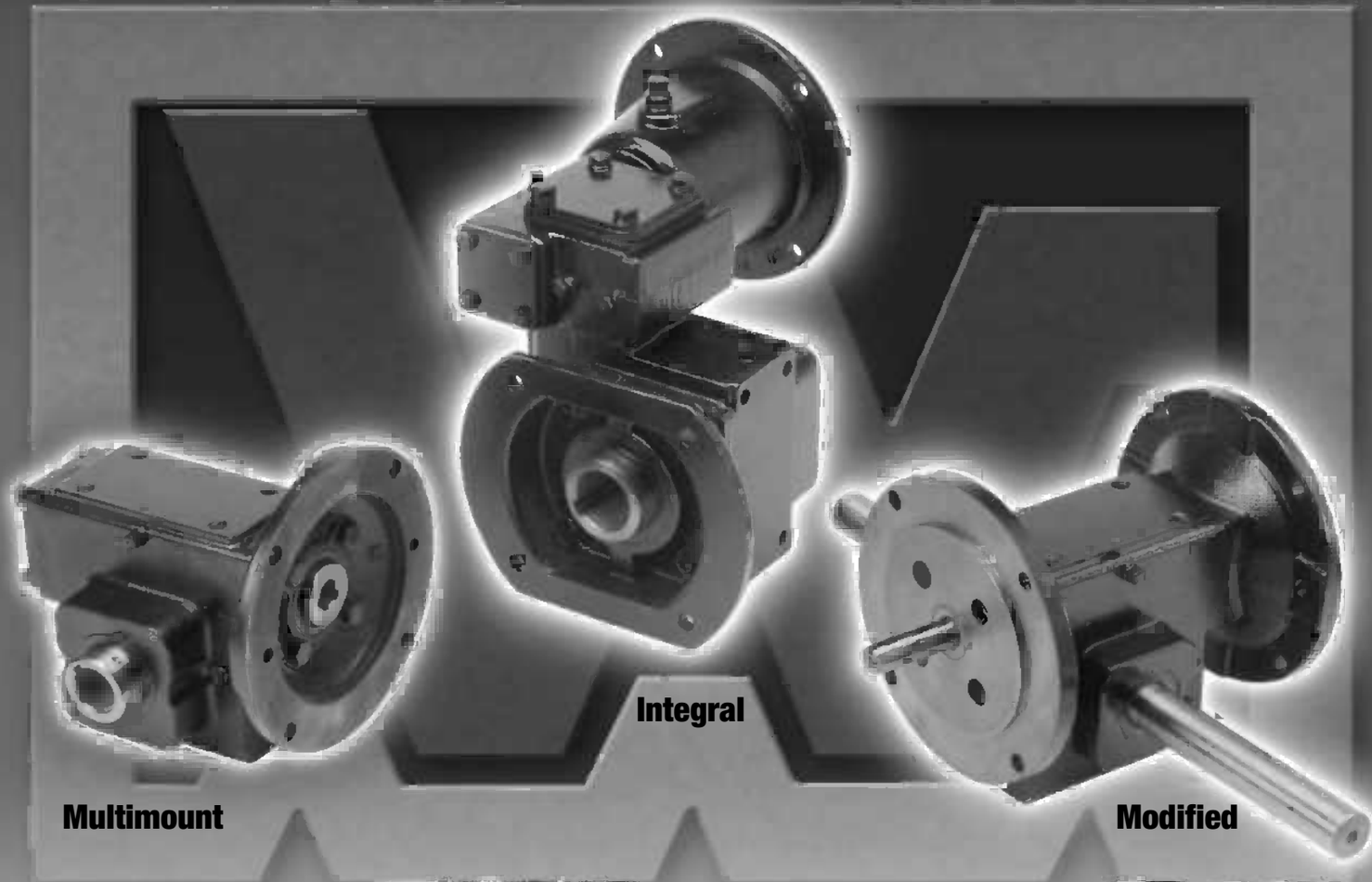
Note: Peer standard is C3 clearance for all ball bearing units except SER series, which utilizes C4 internal clearance.

WINSMITH

PEERLESS-WINSMITH, INC.

ENGINEERING
SERVICE BULLETIN

ILE-08



Installation, Operation, and Lubrication Instructions

SE ENCORE
Unique, Powerful Performance

WORM GEAR SPEED REDUCERS

I. SELECTION

The selection of the appropriate speed reducer for a given application requires that all factors affecting the operation of the reducer be given careful consideration. Service factors must be applied to catalog ratings depending on the type of prime mover used, the severity of the application, and duration of daily service. Many application and SE Encore worm gear speed reducer selection criteria are discussed in the SE Encore catalog that is available at www.WINSMITH.com. For personal assistance, please speak with a local Winsmith sales representative whose contact information is also available on the website.

II. INSTALLATION

1. Shaft Alignment and Loading

A. Guard against unusual stresses and overloads by accurately aligning the various drive members (motor, speed reducer, coupling, sprocket, sheave, gear, etc.).

B. Flexible couplings are recommended if a prime mover shaft is to be directly connected to the input shaft or if the output shaft is directly connected to the driven shaft. **Note:** Flexible couplings have a limited capacity for misalignment. Ensure that shaft alignments are within the limits recommended by the coupling manufacturer at installation. Even slight misalignments in a rigid mounting system may bring about binding, large vibration forces, or excessive overhung loading; each in itself promoting premature bearing, shaft, or speed reducer failure. Do not excessively force couplings or other connection devices onto either input or output shafts; the result may be permanent bearing damage. Ensure all shaft keys are captive and secured before operation.

C. A common base plate supporting the motor and reducer will help preserve the original alignment between the reducer and the motor shaft. If a structural steel base is used, the plate should be at least equal in thickness to the diameter of the base plated fastening bolts. In addition, the structure supporting the base plate must be sufficiently rigid that it prevents excessive flexing during normal operation.

D. Vibration tends to loosen fasteners even if they are initially tight. After the first week or two of operation, all fasteners within the drive assembly should be retightened. Doweling the motor and speed reducer to the base plate will help maintain alignment.

E. Excessive thrust or overhung loads on the input or output shafts of a gear reducer may cause premature failures of the bearings and/or shafts. Mount gears, pulleys and sprockets as close to the housing as possible to minimize such loads. Do not exceed catalog loads.

2. Mounting Positions

A. Single Reduction Speed Reducers and Helical Gear Ratio Multipliers

All SE Encore single reduction speed reducers and all helical gear ratio multipliers are filled with lubricant at Winsmith and can be mounted in any of the positions identified in Figure 3. Grease fittings (not shown in Figure 3) are used to lubricate bearings when the motor speed is below 1160 RPM. Please reference Section III of this document, “Lubrication & Maintenance,” for details related to proper lubrication levels.

B. Double Reduction Speed Reducers

Worm/Worm and Helical/Worm Double Reduction

The SE Encore double reduction speed reducers are designed to be mounted in any of the “Standard” positions shown in Figure 4. These units are factory filled with lubricant to a level that is appropriate for these standard mounting positions. Standard models have an oil level that is common to both housings. Grease fittings (not shown in Figure 4) are used to lubricate bearings when the motor speed is below 1160 RPM. If an additional mounting position not shown in Figure 4 is required, please speak with a local Winsmith sales representative whose contact information is available on the website, www.WINSMITH.com.

3. Mounting Considerations

The recommended mounting for a hollow shaft reducer incorporates a torque arm. The recommended mounting of a reducer with a flange/bracket mounting on a conveyor head shaft uses a pillow block or flange bearing on the opposite side of the conveyor from the speed reducer as a support bearing. This provides three bearings for alignment purposes. It is difficult to maintain and align a system with a rigidly mounted bearing close to a rigidly mounted speed reducer. It is extremely important to “custom align” and “custom shim” all components prior to tightening mounting bolts when using a rigid mounting approach. This minimizes misalignment that is caused by excessive loads. Select an appropriate key when using a bushing in the output bore of any hollow output shaft speed reducer.

4. C Face Motor Mounting Procedures

A. C Face/Quill Motor Mounting

1. Check the motor and reducer mounting registers for nicks that could interfere with assembly; remove if necessary.
2. Remove protective plastic from the reducer input shaft. The bore has been coated with an anti-seize compound.
3. Align the motor shaft and key with keyway in bore and slide motor up input adaptor.
4. Position the motor conduit box as desired.
5. Secure the motor to the reducer using the supplied fasteners. Ensure proper motor seating before tightening the fasteners. If the motor does not readily seat itself, check for axial movement of the motor shaft key as this can cause interference. Staking the keyway adjacent to the motor key will help prevent axial movement of the key during the mounting procedure. Draw down evenly on the fasteners to avoid bending the motor shaft and tighten to 200 lbf-in maximum.

B. C Face Coupling Motor Mounting

1. Check the motor and reducer mounting registers for nicks that could interfere with assembly. Remove if necessary.
2. When assembling the motor and coupling, the coupling halves should be evenly spaced on each shaft to obtain proper engagement. The following describes a method for doing this:
3. Determine the assembled shaft clearance by measuring the distance from the C Face to the reducer shaft end and subtracting the motor shaft length. Mount and secure the motor shaft side of the coupling such that the spider-end of the coupling is located one half of the clearance distance beyond the motor shaft. Mount the reducer coupling half and coupling spider onto the reducer shaft in its approximate position, but do not secure.
4. Locate the motor conduit box in the desired position and secure the motor to the reducer input adaptor using the fasteners provided. Tighten to 200 lbf-in.
5. Using the access hole in the input adaptor, slide the coupling together and tighten the set screw.

5. Speed Reducer Assembly/Disassembly Instructions

Contact Winsmith or a local sales representative for detailed assembly/disassembly instructions.

6. Sealed vs. Vented Speed Reducer Operation

All SE Encore series speed reducers are designed to operate sealed or vented. Deciding whether a speed reducer should operate sealed or vented requires an understanding of the application, the environment, the operation of radial shaft seals, and a review of the fundamentals of thermodynamics that govern the temperature and pressure relationship in the speed reducer.

Any significant increase in pressure in a sealed speed reducer decreases the operational service life of the radial lip seals. A pressure change of only 5 psi may reduce the seal life by as much as one third. There are two important phenomena that cause an increase in the internal pressure of a sealed speed reducer. First, the change of internal pressure during operation is proportional to the change of internal temperature that occurs during normal operation. The relationship follows the combined gas law expressed as

$$P_1V_1 / T_1 = P_2V_2 / T_2$$

Secondly, radial lip seals can ingest or “pump” air into a speed reducer regardless of whether it is operating sealed or vented. While the rate of ingestion is highly variable and dependant on running time and speed, under continuous operating conditions the net effect of “pumped” air to the total pressure increase is significant. Venting, or the use of a breather vent, is the only absolute method of eliminating the pressure increase in a speed reducer caused by both pumping and thermal expansion.

In some applications, the duty cycle of the speed reducer is intermittent, the run times short, and the temperature increase modest. While sealing the reducer during operation subsequently increases the pressure in these applications, the increase may be very small and therefore have minimal impact on the seal service life. Additionally, operating a sealed speed reducer may be the best choice in applications where external airborne contamination causes a greater reduction in overall speed reducer service life than the negative impact of the internal pressure increase. The machine builder or the end equipment user should determine whether sealing or venting the speed reducer is the best choice for a specific application as this decision has a direct impact on the seal service life. A more detailed discussion of the factors influencing seal wear and seal service life follows.

Internal Temperature and Pressure Increase in a Sealed Speed Reducer

A speed reducer experiences a significant internal temperature increase due to operating loads. The change in temperature of an operating speed reducer (from static ambient temperature to maximum operating temperature) often exceeds 130° Fahrenheit. In a sealed speed reducer, the increasing temperature

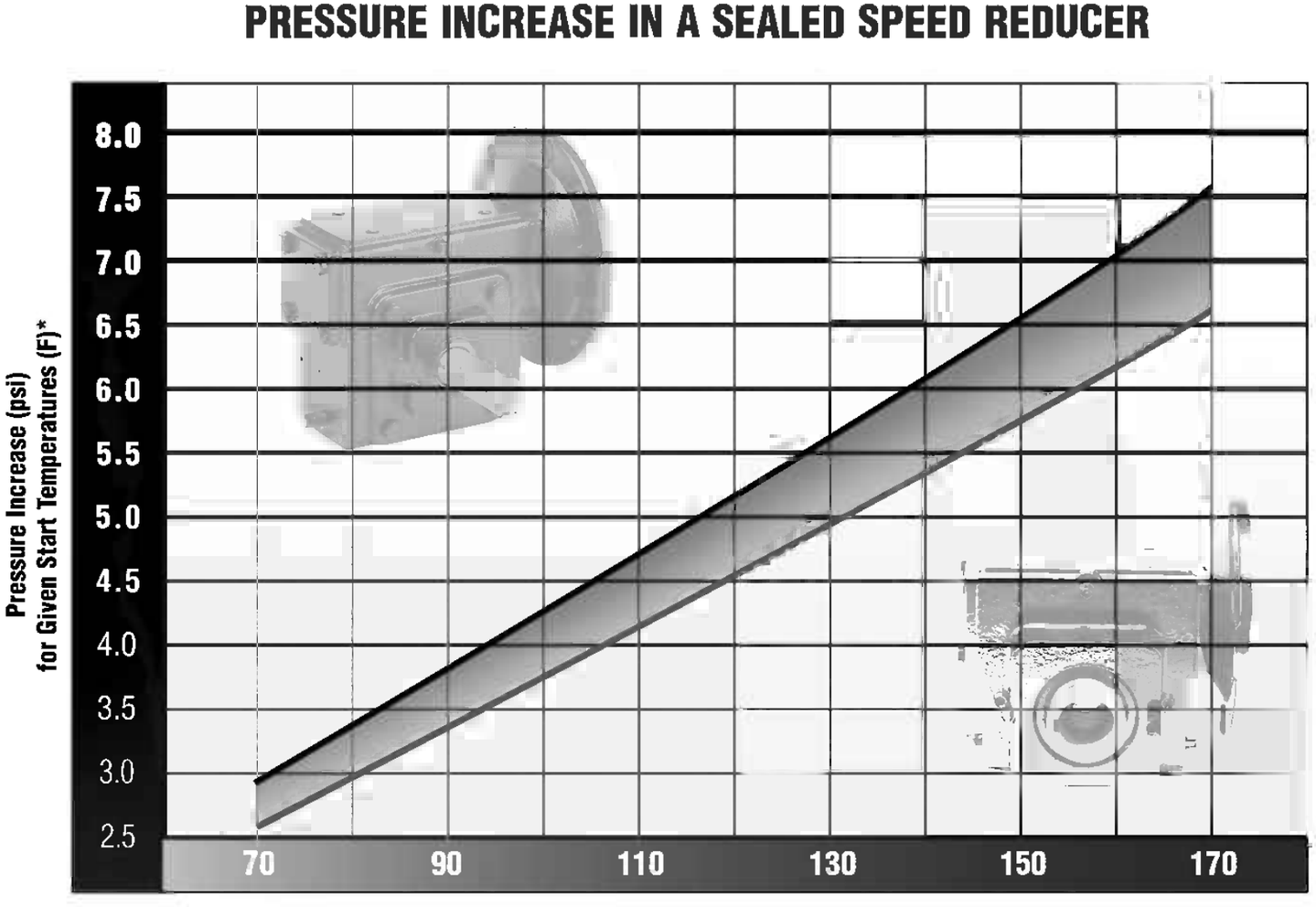


FIGURE 1. Change in Speed Reducer Operating Temperature (F)

* Assumes 60% lubricant and 40% air fill
* Assumes reducer starting pressure of 14.7psi at each starting temperature
* Uses coefficient of thermal expansion for Mobil Glygoyle 460 lubricant

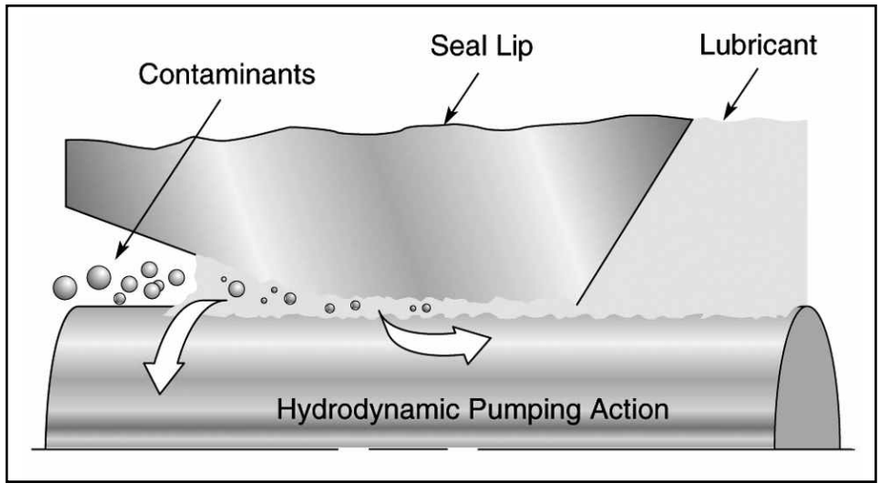


FIGURE 2. Ingestion of Air and Contaminant by a Radial Seal

Courtesy of Parker Hannifin Corporation

results in a corresponding pressure increase as described by the combined gas law:

$$P_1V_1 / T_1 = P_2V_2 / T_2$$

In a closed system (e.g. sealed reducer), any change in temperature from one state of equilibrium to the next state of equilibrium results in a corresponding change in both oil volume and internal pressure. Moreover, the thermal expansion of the lubricant in the reducer can have a considerable effect on the pressure, temperature, and volume relationship. The influence of the lubricant's thermal expansion depends on the percent volume occupied by the lubricant compared to that of the air. Typically, the volume inside the reducer is about 60% lubricant and 40% air. The thermal expansion of the lubricant alone increases the internal pressure in the reducer by approximately 1.5 psi when the change in temperature is 130 ºF.

Figure 1 (*see page 4*) shows the total impact of the internal temperature and associated pressure increase at different ambient starting temperatures in a sealed speed reducer. Pressure increases greater than 5 psi can result from the combined effect of the lubricant's thermal expansion and the internal temperature change.

Seal "Pumping" Effects on Increased Pressure in an Operating Speed Reducer

Correctly operating radial shaft lip seals are dynamic and require the presence of a microscopically thin film of lubricant directly under the sealing lip. The seal lip imposes shear forces on the film as the shaft rotates beneath it. This creates a seal "pumping action" that circulates the lubricant residing closest to the seal back inside the speed reducer and away from the external environment. The pumping action of the seal prevents the lubricant from seeping out and is necessary for proper operation. Unfortunately, a correctly functioning radial shaft seal also causes an unintended and unavoidable side effect. Tests confirm that microscopic air bubbles and contaminants from the external environment are entrained in the lubricant. The actively pumping seal sweeps them inward with the induced lubricant flow and once inside, they escape into the speed reducer. With continuous operation, the air bubbles accumulate inside the reducer cavity. The seal is acting as an air pump, causing air ingestion that increases the internal pressure of a sealed speed reducer. Winsmith's extensive testing has verified that the increased internal pressure of the speed reducer and the rate of pressurization are dependent on many variables including operating time, linear velocity of the shaft under the seal, temperature, seal material, and seal and shaft manufacturing tolerances.

In summary, a significantly large percentage of sealed speed reducers develop an internal pressure of 5 psi or more when operated on a continuous duty cycle. This phenomenon can occur even when there is no change in temperature because the radial lip seals ingest air into the reducer (see **Figure 2 - *see top of page 5***). Conversely, testing indicates that when a reducer operates in an intermittent manner (e.g. 5 minutes of run time every 30 minutes of dwell); the internal pressure build-up is very small.

The Effects of Temperature and Pressure on Seal Operating Life

The specific failure mechanisms of seals vary depending on the seal material. However, the normal "wear out" failure mode of an NBR rubber (Acrylonitrile-butadiene or "nitrile") dynamic radial shaft seal is related to time and temperature and often termed "embrittlement." Over time under some relative elevation of temperature, nitrile seals loose elasticity, develop micro cracks that cause an abraded sealing surface that can no longer properly contain the speed reducer lubricant. The embrittlement rate of NBR materials begins to accelerate at lip operating temperatures between 180ºF and 200ºF.

The impact of increasing temperature and pressure in a sealed speed reducer on the service life of an NBR seal has been assessed by numerous seal manufacturers. While the results of these tests vary depending on variables such as the actual seal lip temperature, they indicate that a change in pressure as small as 5 psi can reduce the expected seal service life by one third. This is because a positive internal pressure differential in a speed reducer causes the shaft lip seals to exert a higher radial force on the shaft. Under dynamic conditions, this force increases the lip seal contact area on the shaft, increasing the friction, and thereby creating a correspondingly higher temperature between the shaft and the lip seal. This increase is directly proportional to the amount of radial force on the seal and to the speed of the shaft at the seal interface and causes a decrease in the seal life.

All SE Encore speed reducers with a quill input adaptor use special HNBR (hydrogenated nitrile butadiene rubber) or fluoroelastomer (aka Viton®) materials on all input shafts because these materials are tolerant of higher lip operating temperatures. The typical failure mode of HNBR material is blistering at the seal surface.

Performance Issues with Bladders and Expansion Chambers

Various speed reducer design approaches aimed at eliminating the internal pressure increase have incorporated internal collapsible diaphragms or bladders. Eliminating the pressure increase requires that the bladder or diaphragm collapse at very low pressures and have a volume that sufficiently accommodates the expansion of the air and the lubricant. In a reducer with a two inch center distance, the internal volume is between 30 in^3 and 40 in^3. Assuming the volume is 60% lubricant and 40% air and applying the previously discussed combined gas law over a temperature change of 130°F (70°F start, 200°F final), the size of an internal diaphragm or bladder required to prevent a pressure increase must be between 3.9 in^3 and 5.2 in^3. In most typical speed reducers, there is insufficient internal space for such a large bladder. Moreover, while some internal expansion chambers are effective in limiting or reducing internal pressure rise due to temperature changes, none are completely effective in avoiding the pressure build up related to seal air pumping action associated with continuous duty cycle applications.

Applications Determine When Sealing a Speed Reducer is Preferred to Venting

As covered in the preceding discussion, sealing a reducer can increase the internal pressure which results in decreased seal service life. This is especially prevalent when operating under continuous duty conditions. However, there are certain applications where the speed reducer duty cycle is highly intermittent, and run times are short with light average duty loads. Testing and field experience indicate that small internal pressure increases (1 – 2 psi) have a minimal effect on the seal service life.

Another application dependent situation where sealed reducer operation is preferred occurs when the external air environment is extremely contaminated with material that, if drawn into the reducer through a vent, can rapidly reduce seal, bearing, or worm gear life. In these applications, the increased pressure resulting from operating a sealed reducer can still have a significantly negative effect on seal life and, in these cases, require more frequent seal replacement. However, the reducer life may be lengthened by operating sealed rather than operating with an open vent in these types of harsh environments. Further, the machine builder or equipment operator might determine that the convenience of operating a sealed speed reducer outweighs the negative result of reduced seal service life.

The Winsmith two (2) year warranty on defects in parts and workmanship remains unaffected whether an SE Encore worm gear speed reducer operates with or without a vent since the vent/sealed decision only affects the service life of the speed reducer wear components.

In conclusion, there are three fundamental factors that govern the speed reducer seal/vent decision. First, as the temperature increases in a sealed reducer, so will the pressure. Second, the radial shaft seals are designed to “pump” lubricant back into the speed reducer. This pumping action also causes an ingestion of air that increases the internal pressure. Any increase of pressure causes decreased dynamic radial seal life. Venting is the most cost effective method of eliminating the pressure. Finally, when extreme environmental conditions cause component or seal wear in excess of that caused by an increased internal pressure, sealing

a speed reducer is the best likely alternative. However, under these conditions, seal wear is apt to take place at higher than predicted rates.

SE Encore Venting Solution is a Standard Feature

The SE Encore worm gear speed reducer series can satisfactorily operate sealed or vented. Each reducer is supplied with an optional "open-closed vent" that can be installed by the equipment builder or the equipment user. This exclusive Winsmith vent is made from black DuPont™ Zytel® Nylon with UV protection. The vent's design incorporates a labyrinth with a dust/splash cap that minimizes contaminate and water incursion from the external environment created by general, harsh, and outdoor applications. The reducer housing offers multiple locations for vent installation depending on the final reducer mounting position on the equipment Turning the top cap to the closed position ensures that no oil drains while the equipment is in transit to the operating location. Turning the top cap counter clockwise, by hand, opens the vent prior to running the speed reducer A special screw driver slot molded into the cap allows easy actuation when access is limited. The vent should be installed in the highest pipe plug location available based on the actual mounting orientation of the speed reducer on the operating equipment. Additionally, a bright yellow plastic tag is provided with the vent that reads:

"IMPORTANT - VENT REQUIRES ACTIVATION

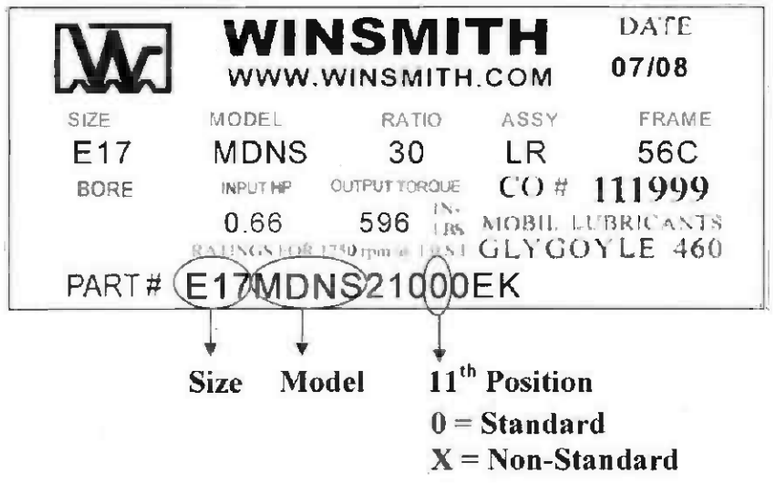
THIS UNIT HAS BEEN SHIPPED TO YOU WITH THE VENT IN THE CLOSED POSITION – IT IS IMPORTANT TO OPEN THE VENT BY MAKING A ONE QUARTER TURN COUNTER CLOCKWISE"

III. LUBRICATION & MAINTENANCE

NOTE: SE Encore worm gear speed reducers are factory filled with Mobil Glygoyle 460 (PAG) lubricant. The use of other lubricants may result in substantially lower torque capacity and is not recommended by Winsmith. If other lubricants are used, a thorough flushing procedure is required.

NOTE: Helical Gear Ratio Multipliers are factory filled with Mobilgear 600 XP 220 lubricant. The use of other lubricants may result in substantially lower torque capacity and is not recommended by Winsmith. If other lubricants are used, a thorough flushing procedure is required.

1. Factory Filling and Universal Mounting



NOTE: All SE Encore MDNS and MDSS standard models are filled with lubricant by Winsmith. The lubricant level in these reducers may be slightly above the appropriate level plug in some orientations. This small amount of additional lubrication is normal and acceptable.

All SE Encore MDNS and MDSS non-standard models are filled with lubricant by Winsmith to a level dictated by the specified orientation. These fill levels are shown in **Figure 3**.

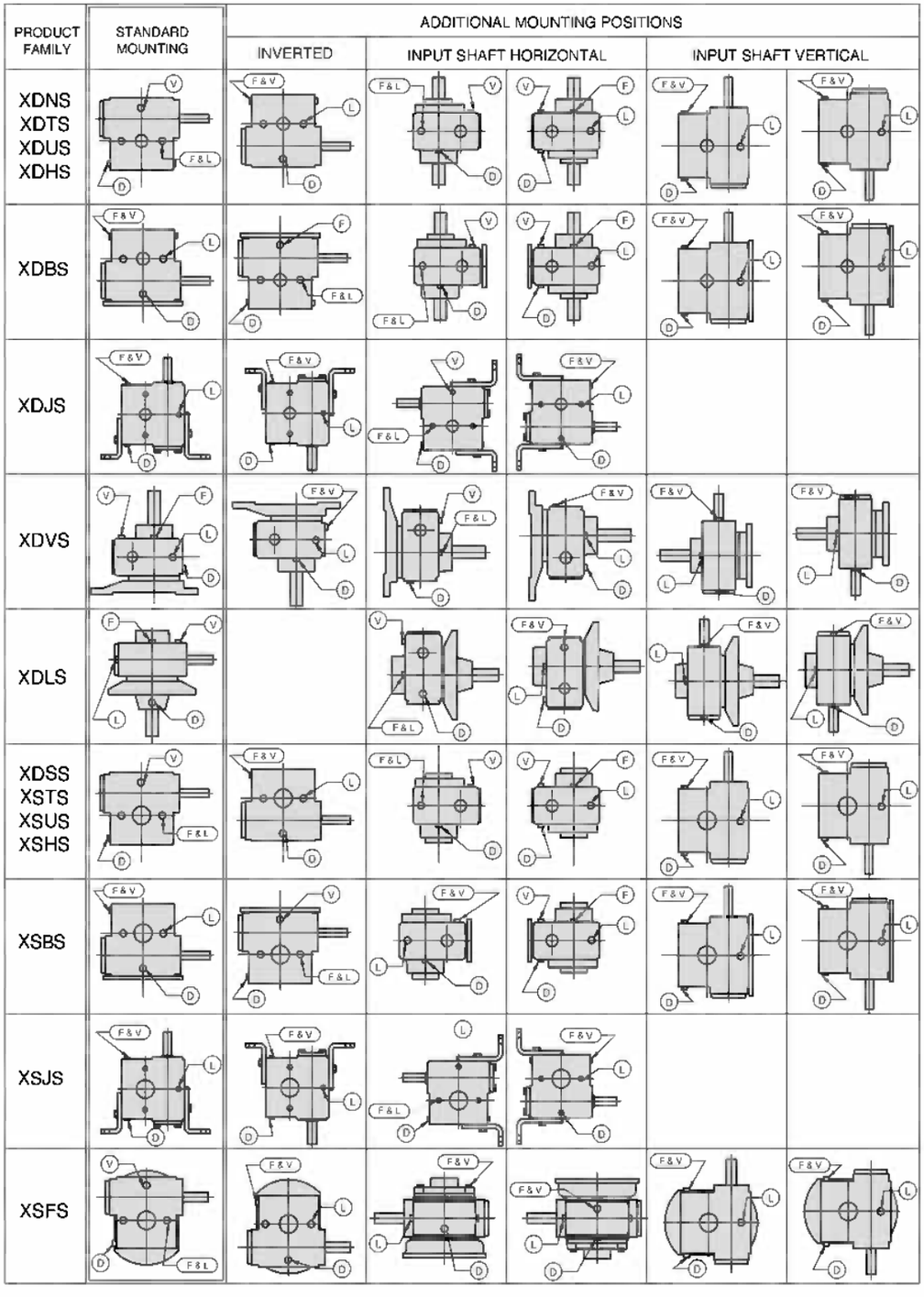
The 11th character in the part number on the reducer name plate designates a standard or non-standard reducer. A "0" in the 11th position indicates "Standard" and an "X" in the 11th position indicates "Non-Standard."

2. Ambient Temperature

If the ambient temperature during operation is outside of -18 to 130 degrees F, please contact Winsmith.

3. Initial Start-Up

FIGURE 3 ▲



Prior to start-up, the lubricant level should always be checked. The proper lubricant fill level is dependent on the speed reducer orientation during operation. The appropriate fill, drain, and level plug locations for a variety of models and orientations are shown in **Figures 3 & 4**. Grease fittings, not shown in **Figures 3 & 4**, are used to lubricate bearings when the motor speed is below 1160 rpm. If an alternate mounting position, not shown in **Figures 3 & 4**, is required, please contact a local sales representative or Winsmith for assistance.

The oil level should be checked, and adjusted if necessary, prior to operation using the oil level plug provided and while the reducer is oriented in its operating position. Only Mobil Glygoyle 460 or compatible lubricant should be used for reducers containing worm gears. The Helical Gear Ratio Multipliers should use Mobilgear 600 XP220 lubricant.

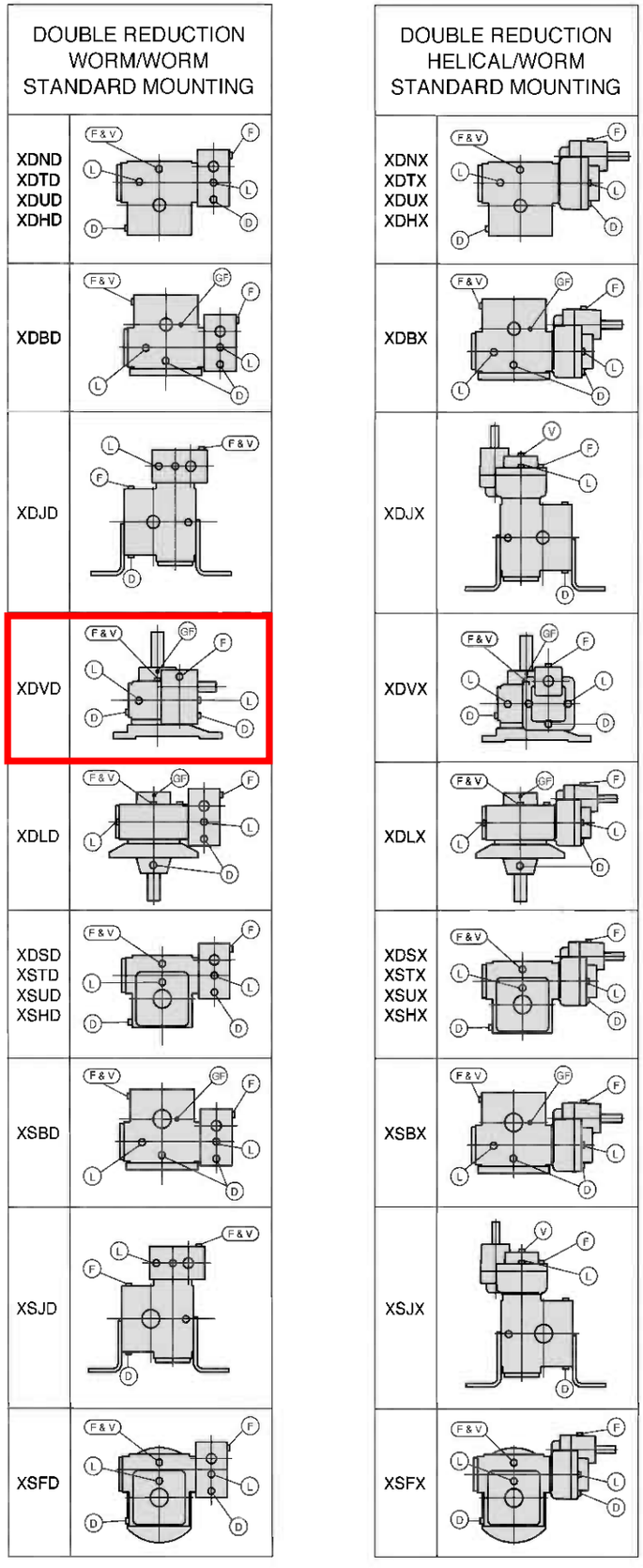
During the initial start-up operation, a break-in period is necessary before the reducer reaches maximum operating efficiency. Winsmith recommends a gradual application of load during the first several hours after start-up. The reducer may run hot during this initial break-in period. This is normal. A few drops of oil may weep from the lip seals during the break-in stage. After a short period of operation, clean off any excess oil around the shaft seals and recheck the oil level; adjust if necessary.

4. Oil Change Instructions

When changing the oil for any reason, use only Mobil Glygoyle 460 or other compatible PAG (Polyalkylene glycol) synthetic lubricants. If another oil type is used (PAO, Mineral Oil, etc.), the housing(s) must be drained and thoroughly flushed with a light flushing oil prior to refilling. Do not mix different lubricants in the reducer. Lubricant incompatibility many result in premature failure. **Note:** When changing oil, carefully inspect used oil to be sure there are no metal shavings, fragments and other signs of excessive wear.

The oil level should be checked after a short period of operation and adjusted if necessary. Each housing of a

FIGURE 4 ▲



1. Fill, vent, level and drain locations are the same for quill and coupled models.
2. Double reduction size E35 and E43 models are supplied with grease fittings on the input shaft to ensure bearing lubrication for all mounting positions.
3. Contact Winsmith when input speeds are less than 1160 rpm to ensure proper lubrication.

▲ FIGURE 3 & 4 CHART KEY

(F) REFILL PLUG (V) VENT PLUG (L) LEVEL PLUG (D) DRAIN PLUG

double reduction model should be drained and filled independently when changing the oil. Visit our website, www.WINSMITH.com, for a detailed flushing procedure.

In many light duty, relatively clean ambient conditions, the life of Mobil Glygoyle 460 is extended to the point where a reducer can operate for the AGMA specified “Normal” reducer life of 25,000 hours without ever changing the lubricant.

Note: The “Normal” reducer life of 25,000 hours specified in AGMA 6034-B92 is highly application dependent. In Winsmith’s 100 years of experience, we have found that the actual service life of many of our reducers exceeds 25,000 hours by several multiples.

Under severe conditions (rapid temperature changes, moist, dirty, or corrosive environments) it may be necessary to change the oil at intervals of 1-3 months. Periodic examination of oil samples taken from the reducer will help establish the appropriate interval.

The oil change procedure for all SE Encore speed reducers is similar. The appropriate oil fill, drain, and level plugs are identified in **Figures 3 & 4**. Please note that these locations are unique for each operating position shown. After draining the old lubricant, new lubricant should be added to the appropriate level plug shown.

Mounting Position and Lubricant Levels for Single and Double Reduction Models

Optimal lubricant level information for single and double reduction models is shown in **Figures 3 and 4.** Lubricant levels are critical to the proper operation of all speed reducers. If a speed reducer was ordered and supplied for a specific mounting position, it should not be changed without contacting Winsmith. Altering the mounting position from that which was specified may result in inadequate lubrication. Contact Winsmith or a local sales representative with questions regarding proper lubricant selection and level.

5. Long Term Storage or Infrequent Operation

If a speed reducer is to stand idle for an extended period of time, either prior to installation or during use, the housing should be completely filled with oil. This will protect the interior components from corrosion due to internal condensation. Be sure to drain the oil to the proper level prior to placing the reducer into service. Contact Winsmith or a local sales representative with questions on long term storage.

6. Grease Fittings

Some speed reducer models are equipped with grease fittings to lubricate bearings that are not adequately lubricated by the oil splash. These fittings must be lubricated every 3-6 months depending on the operating conditions. Winsmith uses Mobilith SHC 220 or equivalent (NLGI #2). Caution should be used when greasing because excessive grease may reduce the performance of the lubricant inside the speed reducer.

7. Low Input Speeds (Under 1160 RPM)

When input speeds are less than 1160 RPM, grease fittings will be required to lubricate any bearings not partially covered by the normal oil level. If a low speed operating condition exists and the reducers are without the appropriate grease fittings, please contact Winsmith or a local Sales Representative.

8. Oil Temperature

Speed reducers in normal operation can generate temperatures of up to 200 degrees F depending on the type of the reducer and the severity of the application (loading, duration of service, ambient temperatures). Excessive oil temperatures may be the result of one or more of the following factors:

A. Overloads

Overloads may be due to the original model being too small for the application. Overloads can also occur if the speed reducer is properly sized for the application and higher than anticipated loads are experienced. Always check the reducer rating when increasing driven loads or when increasing the horsepower rating of the motor or other prime mover.

B. Overfilling or Underfilling

If a speed reducer is overfilled with oil, the energy used in churning the excessive oil can result in overheating. If overfilling occurs, shut down the drive, remove the oil level plug, and allow oil to drain from the level hole until it stops. Reinstall the level plug and restart the drive.

If the speed reducer is under filled, the resultant friction can cause overheating and possible damage. If this occurs, the reducer should be disassembled and inspected for excessive wear. Replace damaged components, reassemble the reducer, and fill with lubricant to the appropriate level fill hole.

C. Inadequate Cooling

In order to dissipate internally generated heat, the speed reducer must be installed in such a way that air can circulate freely. Tightly confined areas, (inside cabinets, etc.) should be avoided. If this is not possible, use a separate blower to provide forced air cooling.

9. Oil Seals and Wear Components

Various normal wear components such as seals, bearings and gears may need more frequent replacement in severe applications.

Gear reducer shaft lip seals are all subject to wear. Experience indicates that their useful life is extremely variable, and based primarily on the operating temperature. Other operating factors that influence seal life are high input shaft speeds and environmental factors such as air-born abrasive particulates. Inspecting the gear reducer regularly and replacing the shaft seals at the first sign that they are beyond their useful life is the only method of ensuring no lubricant leakage. This might be as frequently as 2 years or less in some applications; in others it can be as long as 10 years or more.

Winsmith uses high quality oil seals and precision ground shafts. However, it is possible that damage during shipment or installation can cause oil seal leakage. When replacing a shaft oil seal, the following suggestions will help ensure leak free operation and long seal life:

A. When installing a new seal, cover the keyway and any other shaft surface discontinuities with smooth tape to protect the seal lip from being damaged.

B. Use a sealant between the OD of the seal and the ID of the bore into which the seal is being installed. The seal bore should also be free of any burrs, nicks, or scratches.

C. Be sure that the seal is not cocked in the seal bore. The outer face of the seal should be flush with the outer surface of the reducer.

WARNINGS AND CAUTIONS:

Winsmith products, and associated equipment and machinery, are intended for selection and use by trained and skilled persons capable of determining their suitability for the specific application or use. Proper selection, installation, operation and maintenance, including implementation of adequate safety precautions, are the responsibility of the purchaser or user. The following safety precautions, as well as additional safety precautions that may be required for the specific application or use, are the responsibility of the purchaser or user. FAILURE TO OBSERVE REQUIRED SAFETY PRECAUTIONS COULD RESULT IN SERIOUS INJURY TO PERSONS OR PROPERTY OR OTHER LOSS.

Lock-out/Tag-out. It is EXTREMELY IMPORTANT that equipment or machinery does not unexpectedly start. To prevent this possibility, all electrical or other input power sources must be turned off, and properly locked out. Tag out procedures must be followed before working on or near the reducer or any associated equipment. Loads on the input and output shafts should be disconnected prior to working on any reducer. Failure to observe these precautions may result in serious bodily injury and/or property damage.

Grounding. Be sure the unit and associated equipment are properly grounded and otherwise installed in accordance with all electrical code requirements.

Protective Guarding / Loose Clothing, etc. Always insure there is proper protective guarding over all rotating or moving parts. Never allow loose clothing, hair, jewelry and the like to be worn in the vicinity of rotating or moving parts or machinery. The purchaser or user is responsible for complying with all applicable safety codes. Failure to do so may result in serious bodily injury and/or damage to property or other loss.

Selection & Installation. This reducer and associated equipment must be selected, installed, adjusted and maintained by qualified personnel who are knowledgeable regarding all equipment in the system and the potential hazards involved.

Consult Catalog Ratings. Load, torque and other requirements must not exceed the published ratings in the current catalog and/or on the speed reducer nameplate, and the reducer selected must be consistent with all service factors for the application. See Winsmith catalogs and www.WINSMITH.com.

Brake Torque Loads. Whenever a brake or any other stopping force is involved in an application, braking torque loads imposed on the gear reducer must not exceed the allowable load ratings.

Not a Brake. Speed reducers should never be used to provide the function of a fail safe brake or an assured self locking device. Speed reducers must never be used to replace a brake or a critical braking application function.

Excess Overhung Loads. Excessive overhung loads on the input or output shafts of a gear reducer may cause premature fatigue failures of the bearings and/or shafts. Mount gears, pulleys and sprockets as close to the housing as possible to minimize such loads. Do not exceed catalog ratings.

Excess Thrust Loads. Excessive thrust loads on the input or output shafts of a gear reducer may cause premature failure of bearings. Do not exceed catalog ratings.

Alignment. Properly align any input and output power transfer elements connected to the speed reducer. Even slight misalignments in a rigid mounting system may cause binding, large vibration forces or excessive overhung loads, leading to premature bearing, shaft, or speed reducer failure. Use of flexible couplings that allow the reducer and connected transfer elements to self-align during operation will compensate for minor misalignments.

Not a Support Structure. A speed reducer must never be used as an integral component of a machine superstructure or support frame that would subject it to additional loads other than properly rated loads transmitted through the shafts.

Mounting Position. Your Winsmith gear reducer should be mounted in one of the mounting positions shown in the catalog. Different mounting positions should not be used without contacting Winsmith as this may result in improper lubrication.

Overhead Mounting. Mounting of a speed reducer in overhead positions may be hazardous. Use of external support rails or structure is strongly recommended for any overhead mounting.

Lifting Eyebolts. Any lifting supports or eyebolts provided on the gear reducer are supplied with the purpose to vertically lift the gear reducer only, without any other attachments or motors. Inspect such supports and bolts before each use.

Properly Secure Mounting Bolts. Proper mounting bolts and proper torques must be applied and maintained to insure the gear reducer is securely mounted to the desired machinery. Inspect regularly as machine vibration may loosen fasteners.

Thread Locking Compound. Proper thread locking compound should be appropriately applied to the cleaned threads of all mounting bolts connecting or securing the speed reducer to equipment and any drive, accessories, or brake components attached to the speed reducer. If at any time after installation a factory supplied assembly or construction bolt is removed, care must be taken to thoroughly clean off the old thread locking compound and a new appropriate thread locking compound must be applied. Failure to properly apply new thread locking compound on all mounting or reducer construction bolts may result in serious injury or death from falling mechanical components.

Reducer Surface Is Hot. Operating gear reducers generate heat. Surface temperatures may become hot enough to cause severe burns. Proper personal protective equipment should be used.

Noise. Operating gear reducers may generate high noise levels. Use appropriate hearing protection and avoid extended exposure to high noise levels.

Lubricants Hot and Under Pressure. The temperature of lubricants inside a gear reducer may be very high. The reducer should be allowed to cool to ambient temperature before removal of any vent, drain, level, or fill plugs, and before removing seals or bearing covers. Gear reducers without a pressure vent may also be under great internal pressure. Slowly loosen the lubricant fill plug above the lubricant level to vent any internal pressure before further disassembly.

Lubricant Contact. Contact with lubricants can present safety concerns. Proper personal protective equipment should be used whenever handling speed reducer lubricants. Consult the lubricant MSDS sheet which is often available on the lubrication manufacturer's website.

FDA, USDA, and NSF Applications. Factory supplied lubricants may not be suitable or safe for applications involving food, drugs and similar products. This includes applications subject to FDA, USDA, NSF or other regulatory jurisdiction. Consult the lubricant supplier or Winsmith for acceptable lubricants.

Inspection and Lubrication. Regularly inspect the gear reducer to ensure it is properly operating, and follow all maintenance, operation and lubrication guidelines provided.

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PWS-19792-January 11/08–20M
Printed in U.S.A.

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DIS-ASSEMBLY / ASSEMBLY INSTRUCTIONS FOR 10058-0301-000 (FORMERLY 003-18210)

Dis-assembly

1. Remove snap ring from back of union.
2. Support housing and press shaft through housing with a hydraulic press. Make sure that the shaft is supported as it is pressed out of the housing.
3. Use a split ring puller to remove the large bearing from the shaft and remove the small bearing from the back of the housing.
4. Remove Teflon seals with an O-ring pick.
5. Remove O-ring backer from glands.
6. Degrease the housing and clean the seal glands with a Q-tip soaked in alcohol.
7. Clean shaft and examine seal area for damage.

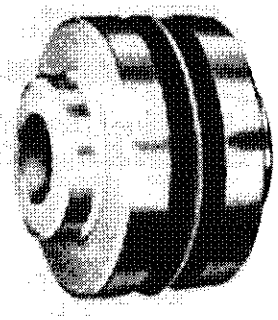
Assembly

1. Install O-rings in the seal glands.
2. Install Teflon seal over O-ring, seal to be concentric with bore of housing after installed.
3. To install Teflon seal: form seal into a kidney shape
4. Lightly lubricate Teflon seals and o-rings after installation with grease that is appropriate for the expected media
5. Install large and small bearing into housing.
6. Lightly lubricate shaft with same/similar grease as used in step 4.
7. Carefully press shaft into housing by hand to ensure that new seals don't get damaged.
8. Use hydraulic or manual press to press the shaft the rest of the way into the housing by bearing.
9. Install snap ring.
10. Rotate the union at 50 RPM for approx. 15 minutes without media to break in the new seals to the shaft.
11. Unit is ready for installation

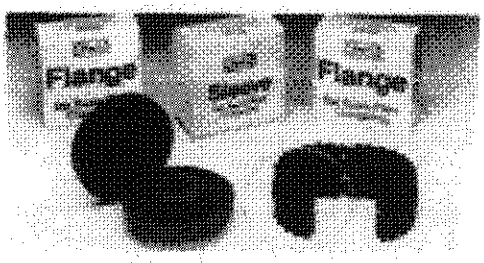
TB Wood's

Sure-Flex® Couplings

Installation Instructions



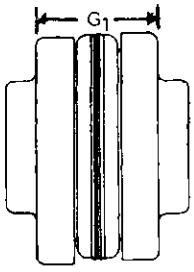
Sure-Flex flanges (outer metallic parts) and sleeves (inner elastomeric members) come in many sizes and types. First, determine the size and type of components being used. Remove all components from their boxes, and loosely assemble the coupling on any convenient surface. (Do not attempt to install the wire ring on the two-piece E or N sleeve at this time.) Also check maximum RPM values in Table 2 against operating speed. All rubber sleeves (EPDM and Neoprene) have the same ratings for a given size and may be used interchangeably. However, because rubber and Hytrel sleeves have completely different ratings, they never should be used interchangeably.

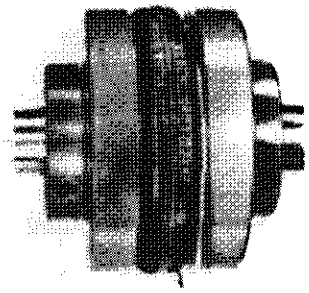


1 Inspect all coupling components and remove any protective coatings or lubricants from bores, mating surfaces and fasteners. Remove any existing burrs, etc. from the shafts.

2 Slide one coupling flange onto each shaft, using snug-fitting keys where required. With the Type B flange, it may be necessary to expand the bore by wedging a screwdriver into the saw cut of the bushing.

3 Position the flanges on the shafts to approximately achieve the G_1 dimension shown in Table 2. It is usually best to have an equal length of shaft extending into each flange. Tighten one flange in its final position. Refer to Table 1 for fastener torque values. Slide the other far enough away to install the sleeve. With a two-piece sleeve, do not move the wire ring to its final position; allow it to hang loosely in the groove adjacent to the teeth, as shown.





4 Slide the loose flange on the shaft until the sleeve is completely seated in the teeth of each flange, (The "G_1" dimension is for reference and not critical.) Secure the flange to the shaft using the torque values from Table 1.

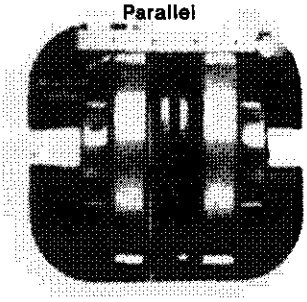
TABLE 1 — FASTENER TORQUE VALUES (ft.-lbs.)

Coupling Size	TYPE J	TYPE S	TYPE B	TYPE SC*		TYPE C	
	2 Setscrews at 90°	2 Setscrews at 90°	3 Hex Head Cap Screws	4 Hex Head Cap Screws Flange to Hub	1 Setscrew over Keyway in Hub	Clamping Screws	1 Setscrew over Keyway
3	3	...	...	...	...	...	...
4	3	...	...	5½**	13	...	...
5	7	13	...	4	13	...	...
6	13	13	5	9	13	15	13
7	13	13	5	9	13	30	13
8	23	23	9	18	23	55	13
9	...	23	9	31	23	55	13
10	...	23	15	50	50	130	13
11	...	23	30	75	50	130	13
12	...	50	60	150	100	250	13
13	...	100	75	150	165	...	...
14	...	100	75	150	165	...	...
16	...	100	135	150	165	...	...

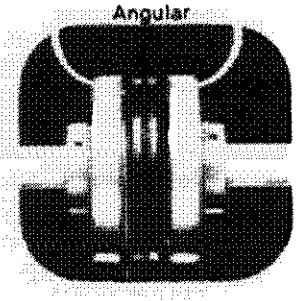
*Torque values apply to hub size when different than flange size.
**Value for socket head clamping screw.

Sure-Flex *Installation Instructions (continued)*

Different coupling sleeves require different degrees of alignment precision. Locate the alignment values for your sleeve size and type in Table 2 below.



5 Check parallel alignment by placing a straightedge across the two coupling flanges and measuring the maximum offset at various points around the periphery of the coupling **without** rotating the coupling. If the maximum offset exceeds the figure shown under "Parallel" in Table 2, realign the shafts.



6 Check angular alignment with a micrometer or caliper. Measure from the outside of one flange to the outside of the other at intervals around the periphery of the coupling. Determine the maximum and minimum dimensions **without rotating** the coupling. The difference between the maximum and minimum must not exceed the figure given under "Angular" in Table 2. If a correction is necessary, be sure to recheck the parallel alignment.

TABLE 2 – MAXIMUM RPM AND ALLOWABLE MISALIGNMENT
(Dimensions in inches)

Sleeve Size	Maximum RPM	Types JE, JN, JES, JNS, E & N			*Type H & HS		
		Parallel	Angular	G_1	Parallel	Angular	G_1
3	9200	.010	.035	1.188	....	....	....
4	7600	.010	.043	1.500	....	....	....
5	7600	.015	.056	1.938	....	....	....
6	6000	.015	.070	2.375(1)	.010	.016	2.375
7	5250	.020	.081	2.563	.012	.020	2.563
8	4500	.020	.094	2.938	.015	.025	2.938
9	3750	.025	.109	3.500	.017	.028	3.500
10	3600	.025	.128	4.063	.020	.032	4.063
11	3600	.032	.151	4.875	.022	.037	4.875
12	2800	.032	.175	5.688	.025	.042	5.688
13	2400	.040	.195	6.625	.030	.050	6.625
14	2200	.045	.242	7.750	.035	.060	7.750
16	1500	.062	.330	10.250	....	....	....

Note: Values shown above apply if the actual torque transmitted is more than 1/4 the coupling rating. For lesser torque, reduce the above values by 1/2.

* Type H and HS sleeves **should not** be used as direct replacements for EPDM or Neoprene sleeves.

(1) Value when using 6J flanges is 2.125.

7 If the coupling employs the two-piece sleeve with the wire ring, force the ring into its groove in the center of the sleeve. It may be necessary to pry the ring into position with a blunt screwdriver.

8 Install coupling guards per OSHA requirements.

CAUTION: **Coupling sleeves may be thrown from the coupling assembly with substantial force when the coupling is subjected to a severe shock load or abuse.**

TB WOOD'S INCORPORATED • Chambersburg, PA 17201
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FORM 741E 6-96

Printed in U.S.A.

GE Oil & Gas

Roots* Universal RAI*, URAI-DSL, URAI-G* & Metric Series

Installation Operation & Maintenance Manual

imagination at work

Contents

Do these things to get the most from your Roots* Blower

- ❏ Check shipment for damage. If found, file claim with carrier and notify GE.
- ❏ Unpack shipment carefully, and check contents against Packing List. Notify GE if a shortage appears.
- ❏ Store in a clean, dry location until ready for installation. Lift by methods discussed under INSTALLATION to avoid straining or distorting the equipment. Keep covers on all openings. Protect against weather and corrosion if outdoor storage is necessary.
- ❏ Read OPERATING LIMITATIONS and INSTALLATION sections in this manual and plan the complete installation.
- ❏ Provide for adequate safeguards against accidents to persons working on or near the equipment during both installation and operation. See SAFETY PRECAUTIONS.
- ❏ Install all equipment correctly. Foundation design must be adequate and piping carefully done. Use recommended accessories for operating protection.
- ❏ **Make sure both driving and driven equipment is correctly lubricated before start-up. See LUBRICATION.**
- ❏ Read starting check points under OPERATION. Run equipment briefly to check for installation errors and make corrections. Follow with a trial run under normal operating conditions.
- ❏ In event of trouble during installation or operation, do not attempt repairs of GE furnished equipment. Notify GE, giving all nameplate information plus an outline of operating conditions and a description of the trouble. Unauthorized attempts at equipment repair may void GE warranty.
- ❏ Units out of warranty may be repaired or adjusted by the owner. Good inspection and maintenance practices should reduce the need for repairs.

NOTE: Information in this manual is correct as of the date of publication. GE reserves the right to make design or material changes without notice, and without obligation to make similar changes on equipment of prior manufacture.

For your nearest GE Office, dial our Customer Service Hot Line toll free; 1 877 363 7668 or direct +1 832 590 2600.

Roots products are sold subject to the current General Terms of Sale, ES104 and Warranty Policy WP-5020. Copies are available upon request.

Safety Precautions

It is important that all personnel observe safety precautions to minimize the chances of injury. Among many considerations, the following should be particularly noted:

- Blower casing and associated piping or accessories may become hot enough to cause major skin burns on contact.
- Internal and external rotating parts of the blower and driving equipment can produce serious physical injuries. Do not reach into any opening in the blower while it is operating, or while subject to accidental starting. Protect external moving parts with adequate guards.
- Disconnect power before doing any work, and avoid bypassing or rendering inoperative any safety or protective devices.
- If blower is operated with piping disconnected, place a strong coarse screen over the inlet and avoid standing in the discharge air stream.

CAUTION: Never cover the blower inlet with your hand or other part of body.

- Stay clear of the blast from pressure relief valves and the suction area of vacuum relief valves.
- Use proper care and good procedures in handling, lifting, installing, operating and maintaining the equipment.
- Casing pressure must not exceed 25 PSI (1725 mbar) gauge. Do not pressurize vented cavities from an external source, nor restrict the vents without first consulting Roots.
- Do not use air blowers on explosive or hazardous gases.
- Other potential hazards to safety may also be associated with operation of this equipment. All personnel working in or passing through the area should be trained to exercise adequate general safety precautions.

Operating Limitations

A Roots blower or exhauster must be operated within certain approved limiting conditions to enable continued satisfactory performance. Warranty is contingent on such operation.

Maximum limits for pressure, temperature and speed are specified in Table 1 for various models & sizes of blowers and exhausters. These limits apply to all units of normal construction, when operated under standard atmospheric conditions. Be sure to arrange connections or taps for instruments, thermometers and pressure or vacuum gauges at or near the inlet and discharge connections of the unit. These, along with a tachometer, will enable periodic checks of operating conditions.

PRESSURE – The pressure rise, between inlet and discharge, must not exceed the figure listed for the specific unit frame size concerned. Also, in any system where the unit inlet is at a positive pressure above atmosphere a maximum case rating of 25 PSI gauge (1725 mbar) should not be exceeded without first consulting Roots. Never should the maximum allowable differential pressure be exceeded.

On vacuum service, with the discharge to atmospheric pressure, the inlet suction or vacuum must not be greater than values listed for the specific frame size.

TEMPERATURE – Blower & exhauster frame sizes are approved only for installations where the following temperature limitations can be maintained in service:

- Measured temperature rise must not exceed listed values when the inlet is at ambient temperature. Ambient is considered as the general temperature of the space around the unit. This is not outdoor temperature unless the unit is installed outdoors.
- If inlet temperature is higher than ambient, the listed allowable temperature rise values must be reduced by 2/3 of the difference between the actual measured inlet temperature and the ambient temperature.
- The average of the inlet and discharge temperature must not exceed 250°F. (121°C).
- The ambient temperature of the space the blower/motor is installed in should not be higher than 120°F (48.8°C).

SPEED – These blowers & exhausters may be operated at speeds up to the maximum listed for the various frame sizes. They may be direct coupled to suitable constant speed drivers if pressure/temperature conditions are also within limits. At low speeds, excessive temperature rise may be a limiting factor.

Special Note: The listed maximum allowable temperature rise for any particular blower & exhauster may occur well before its maximum pressure or vacuum rating is reached. This may occur at high altitude, low vacuum or at very low speed. The units' operating limit is always determined by the maximum rating reached first. It can be any one of the three: Pressure, Temperature or Speed.

Installation

Roots blowers & exhausters are treated after factory assembly to protect against normal atmospheric corrosion. The maximum period of internal protection is considered to be one year under average conditions, if shipping plugs and seals are not removed. Protection against chemical or salt water atmosphere is not provided. Avoid opening the unit until ready to start installation, as corrosion protection will be quickly lost due to evaporation.

If there is to be an extended period between installation and start up, the following steps should be taken to ensure corrosion protection.

- ❏ Coat internals of cylinder, gearbox and drive end bearing reservoir with Nox-Rust VCI-10 or equivalent. Repeat once a year or as conditions may require. Nox-Rust VCI-10 is petroleum soluble and does not have to be removed before lubricating. It may be obtained from Daubert Chemical Co., 2000 Spring Rd., Oak Brook, Ill. 60521.
- ❏ Paint shaft extension, inlet and discharge flanges, and all other exposed surfaces with Nox-Rust X-110 or equivalent.
- ❏ Seal inlet, discharge, and vent openings. It is not recommended that the unit be set in place, piped to the system, and allowed to remain idle for extended periods. If any part is left open to the atmosphere, the Nox-Rust VCI-10 vapor will escape and lose its effectiveness.
- ❏ Protect units from excessive vibration during storage.
- ❏ Rotate shaft three or four revolutions every two weeks.
- ❏ Prior to start up, remove flange covers on both inlet and discharge and inspect internals to insure absence of rust. Check all internal clearances. Also, at this time, remove gearbox and drive end bearing cover and inspect gear teeth and bearings for rust.

Because of the completely enclosed unit design, location of the installation is generally not a critical matter. A clean, dry and protected indoor location is preferred. However, an outdoor location will normally give satisfactory service. Important requirements are that the correct grade of lubricating oil be provided for expected operating temperatures, and that the unit be located so that routine checking and servicing can be performed conveniently. Proper care in locating driver and accessory equipment must also be considered.

Supervision of the installation by a GE Service Engineer is not usually required for these units. Workmen with experience in installing light to medium weight machinery should be able to produce satisfactory results. Handling of the equipment needs to be accomplished with care, and in compliance with safe practices. Unit mounting must be solid, without strain or twist, and air piping must be clean, accurately aligned and properly connected.

Bare-shaft Units: Two methods are used to handle a unit without base. One is to use lifting lugs bolted into the top of the unit headplates. Test them first for tightness and fractures by tapping with a hammer. In lifting, keep the direction of cable pull on these bolts as nearly vertical as possible. If lifting lugs are not available, lifting slings may be passed under the cylinder adjacent to the headplates. Either method prevents strain on the extended drive shaft.

Packaged Units: When the unit is furnished mounted on a baseplate, with or without a driver, use of lifting slings passing under the base flanges is required. Arrange these slings so that no strains are placed on the unit casing or mounting feet, or on any mounted accessory equipment. DO NOT use the lifting lugs in the top of the unit headplates.

Before starting the installation, remove plugs, covers or seals from unit inlet and discharge connections and inspect the interior completely for foreign material. If cleaning is required, finish by washing the cylinder, headplates and impeller thoroughly with an appropriate solvent. Turn the drive shaft by hand to make sure that the impellers turn freely at all points. Anti-rust compound on the connection flanges and drive shaft extension may also be removed at this time with the same solvent. Cover the flanges until ready to connect piping.

Mounting

Care will pay dividends when arranging the unit mounting. This is especially true when the unit is a "bare-shaft" unit furnished without a baseplate. The convenient procedure may be to mount such a unit directly on a floor or small concrete pad, but this generally produces the least satisfactory results. It definitely causes the most problems in leveling and alignment and may result in a "Soft Foot" condition. Correct soft foot before operation to avoid unnecessary loading on the casing and bearings. Direct use of building structural framing members is not recommended.

For blowers without a base, it is recommended that a well anchored and carefully leveled steel or cast iron mounting plate be provided. The plate should be at least 1 inch (25 mm) thick, with its top surface machined flat, and large enough to provide leveling areas at one side and one end after the unit is mounted. It should have properly sized studs or tapped holes located to match the unit foot drilling. Proper use of a high quality machinist's level is necessary for adequate installation.

With the mounting plate in place and leveled, set the unit on it without bolting and check for rocking. If it is not solid, determine the total thickness of shims required under one foot to stop rocking. Place half of this under each of the diagonally-opposite short feet, and tighten the mounting studs or screws. Rotate the drive shaft to make sure the impellers turn freely. If the unit is to be direct coupled to a driving motor, consider the height of the motor shaft and the necessity for it to be aligned very accurately with the unit shaft. Best unit arrangement is directly bolted to the mounting plate while the driver is on shims of at least 1/8 inch (3mm) thickness. This allows adjustment of motor position in final shaft alignment by varying the shim thickness.

Aligning

When unit and driver are factory mounted on a common baseplate, the assembly will have been properly aligned and is to be treated as a unit for leveling purposes. Satisfactory installation can be obtained by setting the baseplate on a concrete slab that is rigid and free of vibration, and leveling the top of the base carefully in two directions so that it is free of twist. The slab must be provided with suitable anchor bolts. The use of grouting under and partly inside the leveled and shimmed base is recommended.

It is possible for a base-mounted assembly to become twisted during shipment, thus disturbing the original alignment. For this reason, make the following checks after the base has been leveled and bolted down. Disconnect the drive and rotate the unit shaft by hand. It should turn freely at all points. Loosen the unit foot hold-down screws and determine whether all feet are evenly in contact with the base. If not, insert shims as required and again check for free impeller rotation. Finally, if unit is direct coupled to the driver, check shaft and coupling alignment carefully and make any necessary corrections.

In planning the installation, and before setting the unit, consider how piping arrangements are dictated by the unit design and assembly. Drive shaft rotation must be established accordingly and is indicated by an arrow near the shaft.

Typical arrangement on vertical units has the drive shaft at the top with counterclockwise rotation and discharge to the left. Horizontal units are typically arranged with the drive shaft at the left with counterclockwise rotation and discharge down. See Figure 4 for other various unit arrangements and possible conversions.

When a unit is DIRECT COUPLED to its driver, the driver RPM must be selected or governed so as not to exceed the maximum speed rating of the unit. Refer to Table 1 for allowable speeds of various unit sizes.

A flexible type coupling should always be used to connect the driver and unit shafts.

When direct coupling a motor or engine to a blower you must insure there is sufficient gap between the coupling halves and the element to prevent thrust loading the blower bearings. When a motor, engine or blower is operated the shafts may expand axially. If the coupling is installed in such a manner that there is not enough room for expansion the blower shaft can be forced back into the blower and cause the impeller to contact the gear end headplate resulting in damage to the blower. The two shafts must be in as near perfect alignment in all directions as possible, and the gap must be established with the motor armature on its electrical center if end-play exists. Coupling manufacturer's recommendations for maximum misalignment, although acceptable for the coupling, are normally too large to achieve smooth operation and maximum life of the blower.

The following requirements of a good installation are recommended. When selecting a coupling to be fitted to the blower shaft GE recommends a taper lock style coupling to insure proper contact with the blower shaft. If the coupling must have a straight bore the coupling halves must be fitted to the two shafts with a line to line thru .001" interference fit. Coupling halves must be warmed up per coupling manufacturer's recommendations. Maximum deviation in offset alignment of the shafts should not exceed .005" (.13 mm) total indicator reading, taken on the two coupling hubs. Maximum deviation from parallel of the inside coupling faces should not exceed .001" (.03 mm) when checked at six points around the coupling.

When a unit is BELT DRIVEN, the proper selection of sheave diameters will result in the required unit speed. When selecting a sheave to be fitted to the blower shaft GE recommends a taper lock style sheave to insure proper contact with the blower shaft. This flexibility can lead to operating temperature problems caused by unit speed being too low. Make sure the drive speed selected is within the allowable range for the specific unit size, as specified under Table 1.

Belt drive arrangements usually employ two or more V-belts running in grooved sheaves. Installation of the driver is less critical than for direct coupling, but its shaft must be level and parallel with the unit shaft. **The driver should be mounted on the inlet side of a vertical unit (horizontal piping) and on the side nearest to the shaft on a horizontal unit. SEE PAGE 6 - Acceptable Blower Drive Arrangement Options.** The driver must also be mounted on an adjustable base to permit installing, adjusting and removing the V-belts. To position the driver correctly, both sheaves need to be mounted on their shafts and the nominal shaft center distance known for the belt lengths to be used.

CAUTION: Drive couplings and sheaves (pulleys) should have an interference fit to the shaft of the blower (set screw types of attachment generally do not provide reliable service.) It is recommended that the drive coupling or sheave used have a taper lock style bushing which is properly sized to provide the correct interference fit required. Drive couplings, that require heating to fit on the blower shaft, should be installed per coupling manufacturer recommendations. A drive coupling or sheave should not be forced on to the shaft of the blower as this could affect internal clearances resulting in damage to the blower.

Engine drive applications often require special consideration to drive coupling selection to avoid harmful torsional vibrations. These vibrations may lead to blower damage if not dampened adequately. It is often necessary to install a fly-wheel and/or a torsionally soft elastic element coupling based on the engine manufacturer recommendations.

The driver sheave should also be mounted as close to its bearing as possible, and again should fit the shaft correctly. Position the driver on its adjustable base so that 2/3 of the total movement is available in the direction away from the unit, and mount the assembly so that the face of the sheave is accurately in line with the unit sheave. This position minimizes belt wear, and allows sufficient adjustment for both installing and tightening the belts. After belts are installed, adjust their tension in accordance with the manufacturer's instructions. However, only enough tension should be applied to prevent slippage when the unit is operating under load. Excessive tightening can lead to early bearing concerns or shaft breakage.

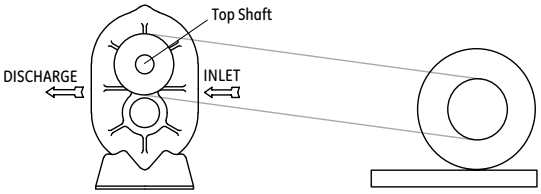
Before operating the drive under power to check initial belt tension, first remove covers from the unit connections. Make sure the interior is still clean, then rotate the shaft by hand. Place a coarse screen over the inlet connection to prevent anything being drawn into the unit while it is operating, and avoid standing in line with the discharge opening. Put oil in the sumps per instructions under **LUBRICATION**.

Piping

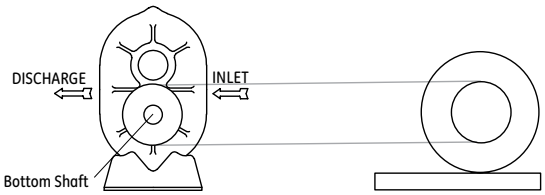
Before connecting piping, remove any remaining anti-rust compound from unit connections. Clean pipe should be no smaller than unit connections. In addition, make sure it is free of scale, cuttings, weld beads, or foreign material of any kind. To further guard against damage to the unit, especially when an inlet filter is not used, install a substantial screen of 16 mesh backed with hardware cloth at or near the inlet connections. Make provisions to clean this screen of collected debris after a few hours of operation. It should be removed when its usefulness has ended, as the wire will eventually deteriorate and small pieces going into the unit may cause serious damage.

Fig. 1 - Acceptable Blower Drive Arrangement Options

Acceptable

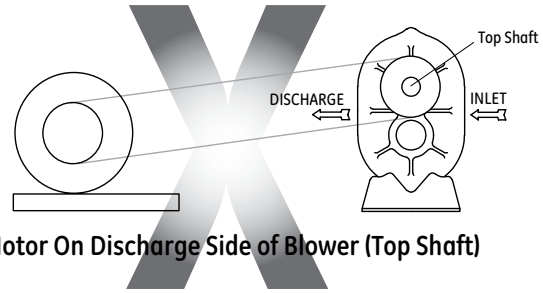


Motor On Inlet Side of Blower (Top Shaft)

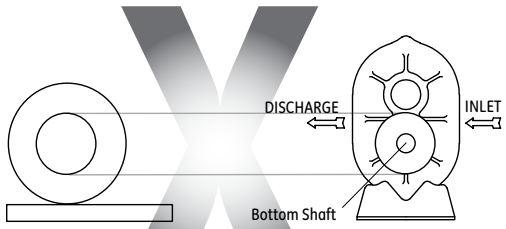


Motor On Inlet Side of Blower (Bottom Shaft)

Unacceptable



Motor On Discharge Side of Blower (Top Shaft)



Motor On Discharge Side of Blower (Bottom Shaft)

Above are suggested locations for available accessories.

Pipe flanges or male threads must meet the unit connections accurately and squarely. DO NOT attempt to correct misalignment by springing or cramping the pipe. In most cases this will distort the unit casing and cause impeller rubbing. In severe cases it can prevent operation or result in a broken drive shaft. For similar reasons, piping should be supported near the unit to eliminate dead weight strains. Also, if pipe expansion is likely to occur from temperature change, installation of flexible connectors or expansion joints is advisable.

Figure 3 represents an installation with all accessory items that might be required under various operating conditions. Inlet piping should be completely free of valves or other restrictions. When a shut-off valve can not be avoided, make sure a full size vacuum relief is installed nearest the unit inlet. This will protect against unit overload caused by accidental closing of the shut-off valve.

Need for an inlet silencer will depend on unit speed and pressure, as well as sound-level requirements in the general surroundings. An inlet filter is recommended, especially in dusty or sandy locations. A discharge silencer is also normally suggested, even though WHISPAIR® units operate at generally lower noise levels than conventional rotary blowers. Specific recommendations on silencing can be obtained from your local GE distributor.

Discharge piping requires a pressure relief valve, and should include a manual unloading valve to permit starting the unit under no-load conditions. Reliable pressure/vacuum gauges and good thermometers at both inlet and discharge are recommended to allow making the important checks on unit operating conditions. The back-pressure regulator shown in Figure 3 is useful mainly when volume demands vary while the unit operates at constant output. If demand is constant, but somewhat lower than the unit output, excess may be blown off through the manual unloading valve.

In multiple unit installations where two or more units operate with a common header, use of check valves is mandatory. These should be of a direct acting or free swinging type, with one valve located in each line between the unit and header. Properly installed, they will protect against damage from reverse rotation caused by air and material back-flow through an idle unit.

After piping is completed, and before applying power, rotate the drive shaft by hand again. If it does not move with uniform freedom, look for uneven mounting, piping strain, excessive belt tension or coupling misalignment.

DO NOT operate the unit at this time unless it has been lubricated per instructions.

Technical Supplement for URAI-G Gas Blowers

Technical Supplement for 32, 33, 36, 42, 45, 47, 53, 56, 59, 65, 68, 615 Universal RAI-G blowers

Precaution: URAI-G blowers: Care must be used when opening the head plate seal vent chamber plugs (43) as some gas will escape–if it is a pressure system, or the atmospheric air will leak into the blower if the system is under vacuum. There is a possibility of some gas leakage through the mechanical seals. This leakage on the gear end will escape through the gear box vent, and on the drive end, through the grease release fittings. If the gas leakage is undesirable, each seal chamber must be purged with an inert gas through one purge gas hole (43) per seal. There are two plugged purge gas holes (1/8 NPT) provided per seal. The purge gas pressure must be maintained one PSI above the discharge gas pressure. Also, there exists a possibility of gear end oil and drive end grease leakage into the gas stream.

Roots Universal RAI-G rotary positive gas blowers are a design extension of the basic Roots Universal RAI blower model. URAI-G blower uses (4) mechanical seals in place of the standard inboard lip seals to minimize gas leakage into the atmosphere.

These units are intended for gases which are compatible with cast iron case material, steel shafts, 300/400 series stainless steel and carbon seal components, viton o-rings and the oil/grease lubricants. If there are any questions regarding application or operation of this gas blower, please contact factory.

A simple but very effective lubrication system is employed on the drive shaft end bearings. Hydraulic pressure relief fittings are provided to vent any excess grease, preventing pressure build-up on the seals. A restriction plug and metering orifice prevent loss of lubricant from initial surges in lubricant pressure but permit venting excess lubricant under steadily rising pressures.

Using a pressure gun, slowly force new lubricant into each drive end bearing housing until traces of clean grease comes out of the relief fitting. The use of an electric or pneumatic grease gun could force the grease in too rapidly and thus invert the seals and should not be used.

Gear end bearings, gears and oil seals are lubricated by the action of the timing gears which dip into the main oil sumps causing oil to splash directly on gears and into bearings and seals. A drain port is provided below each bearing to prevent an excessive amount of oil in the bearings. Seals located inboard of the bearings in each headplate effectively retain oil within the sumps. Any small weepage that may occur should the seals wear passes into a cavity in each vented headplate and is drained downward.

Proper lubrication is usually the most important single consideration in obtaining maximum service life and satisfactory operation from the unit. Unless operating conditions are severe, a weekly check of oil level and necessary addition of lubricant should be sufficient.

During the first week of operation, check the oil levels in the oil sumps about once a day, and watch for leaks. Replenish as necessary. Thereafter, an occasional check should be sufficient.

More frequent oil service may be necessary if the blower is operated in a very dusty location.

Lubrication

Due to sludge build-up and seal leakage problems, GE recommendation is DO NOT USE Mobil SHC synthetic oils in Roots blowers.

Proper lubrication is usually the most important single consideration in obtaining maximum service life and satisfactory operation from the unit.

URAI Air and Gas gear end bearing lubrication/oil with splash lubrication on the gear end only (Drive end grease lubricated).

- The specified and recommended oil is Roots Synthetic Oil of correct viscosity per Table 2, page 16.
- To fill the gearbox, remove the breather plug (25) and the oil overflow plug (21) - see page 15. Fill the reservoir up to the overflow hole. **DO NOT OVERFILL**. Place the breather and the overflow plug back into their respective holes.
- The lubrication should be changed after initial 100 hours of operation.
- Proper service intervals of the oil thereafter are based on the discharge air temperature of the blower. Please refer to the information below to "How to properly determine the oil service intervals" shown on this page.
- Unless operating conditions are quite severe, a weekly check of the oil level and necessary addition of lubricant should be sufficient. During the first week of operation, check the oillevels in the oil sumps about once a day, and watch for leaks. Replenish as necessary.
- If you choose to use another oil other than the specified and recommended ROOTS Synthetic, use a good grade of industrial type non-detergent, rust inhibiting, anti-foaming oil and of correct viscosity per Table 2, page 16.
- GE does NOT recommend the use of automotive type lubricants, as they are not formulated with the properties mentioned above.

Roots URAI-DSL blowers with splash lubrication/oil on each end. No grease.

- The specified and recommended oil is Roots Synthetic Oil of correct viscosity per Table 2, page 16.
- The lubrication should be changed after initial 100 hours of operation.
- The proper oil level should be half way or middle of the sight gauge when the blower is not operating. **DO NOT OVERFILL OIL SUMP/S** as damage to the blower may occur.

- The oil level should not fall below the middle of the site gauge when the blower is idle.
- The lubrication/oil level may rise or fall in the gauge during operation to an extent depending somewhat on oil temperature and blower speed.Proper service intervals of the oil thereafter are based on the discharge air temperature of the blower. Please refer to the information below to "How to properly determine the oil service intervals" shown on this page.
- Unless operating conditions are quite severe, a weekly check of the oil level and necessary addition of lubricant should be sufficient. During the first week of operation, check the oil levels in the oil sumps about once a day, and watch for leaks. Replenish as necessary.
- If you choose to use another oil other than the specified and recommended Roots Synthetic Oil, use a good grade of **industrial type** non-detergent, rust inhibiting, anti-foaming oil and of correct viscosity per Table 2, page 16.
- Roots does **NOT** recommend the use of automotive type lubricants, as they are not formulated with the properties mentioned above.

How to properly determine the oil service intervals.

Normal life expectancy of the specified and recommended Roots Synthetic Oil is approximately 6000 hours with an oil temperature of 180°F (82°C) or less. As the oil temperature increases by increments of 15°F (8°C), the oil life is reduced by half for each 15°F (8°C) increase. Example: Oil temperatures of 195°F (90.5°C) will produce a life expectancy reduced by half or 3000 hours oil service life.

Normal life expectancy of petroleum based oils is about 2000 hours with an oil temperature of about 180°F (82°C). As the oil temperature increases by increments of 15°F (8°C), the life is reduced by half for each 15°F (8°C) increase. Example: Oil temperatures of 195°F (90.5°C) will produce life expectancy reduced by half or 1000 hours oil service life.

NOTE: To estimate oil temperature, multiply the discharge temperature of the blower by 0.80. Example: if the discharge air temperature of the blower is 200° F, it is estimated that the oil temperature is 160° F

For Units with grease lubricated drive end bearings.

URAI AIR (Non GAS) blower grease specifications.

- When servicing drive end bearings of a AIR (Non Gas) blower, use the specified and recommended Shell Darina SD 2 NLGI #2 product code 5067628.
- For grease lubricated drive end blowers see page 16, table 4, regarding specified greasing intervals.
- Lithium based greases are not compatible with the specified and recommended Shell Darina SD 2 grease used when assembling the blower. **Lithium based grease is not approved for any ROOTS blowers.**
- Table 4 page 16 has been prepared as a general greasing schedule guide based on average operating conditions. More frequent intervals may be necessary depending on the grease operating temperature and unusual circumstances.

URAI-G blower grease specifications.

- When servicing drive end bearings of a URAI-G blower, use the specified NLGI #2 premium grade aluminum complex† grease, GE P/N T20019001. Lithium based greases are not compatible with the specified and recommended Roots Synthetic Grease used when assembling a GAS blower. **Lithium based grease is not approved for any Roots blowers.**
- The lubricants selected must be compatible with the gas.

†Roots Synthetic Oil is superior in performance to petroleum based products. It has high oxidation stability, excellent corrosion protection, extremely high film strength and low coefficient of friction. Typical oil change intervals are increased 2-3 times over petroleum based lubricants. Also, Roots Synthetic Oil is 100% compatible with petroleum based oils. Simply drain the oil in the blower and refill the reservoirs with Roots Synthetic Oil to maintain optimum performance of your Roots blower.

Operation

Before operating a blower under power for the first time, recheck the unit and the installation thoroughly to reduce the likelihood of avoidable troubles. Use the following procedure check list as a guide, but consider any other special conditions in the installation.

- ❏ Be certain that no bolts, tools, rags, or debris have been left in the blower air chamber or piping.
- ❏ If an outdoor intake without filter is used, be sure the opening is located so it cannot pick up dirt and is protected by a strong screen or grille. Use of the temporary protective screen as described under INSTALLATION is strongly recommended.
- ❏ Recheck blower leveling, drive alignment and tightness of all mounting bolts if installation is not recent. If belt drive is used, adjust belt tension correctly.
- ❏ Turn drive shaft by hand to make sure impellers still rotate without bumping or rubbing at any point.
- ❏ Ensure oil levels in the main oil sumps are correct.
- ❏ Check lubrication of driver. If it is an electric motor, be sure that power is available and that electrical overload devices are installed and workable.
- ❏ Open the manual unloading valve in the discharge air line. If a valve is in the inlet piping, be sure it is open.
- ❏ Bump blower a few revolutions with driver to check that direction of rotation agrees with arrow near blower shaft, and that both coast freely to a stop.

After the preceding points are cleared, blower is ready for trial operation under "no-load" conditions. The following procedure is suggested to cover this initial operation test period.

a. Start blower, let it accelerate to full speed, then shut off. Listen for knocking sounds, both with power on and as speed slows down.

b. After blower comes to a complete stop, repeat above, but let blower run 2 or 3 minutes. Check for noises, such as knocking sounds.

c. After blower comes to a complete stop, operate blower for about 10 minutes unloaded. Check oil levels. Observe cylinder and headplate surfaces for development of hot spots such as burned paint, indicating impeller rubs. Be aware of any noticeable increase in vibration.

Assuming that all trials have been satisfactory, or that necessary corrections have been made, the blower should now have a final check run of at least one hour under normal operating conditions. After blower is restarted, gradually close the discharge unloading valve to apply working pressure. At this point it is recommended that a pressure gauge or manometer be connected into the discharge line if not already provided, and that thermometers be in both inlet and discharge lines. Readings from these instruments will show whether pressure or temperature ratings of the blower are being exceeded.

During the final run, check operating conditions frequently and observe the oil levels at reasonable intervals. If excessive noise or local heating develops, shut down immediately and determine the cause. If either pressure rise or temperature rise across the blower exceeds the limit specified in this manual, shut down and investigate conditions in the piping system. Refer to the TROUBLESHOOTING CHECKLIST for suggestions on various problems that may appear.

The blower should now be ready for continuous duty operation at full load. During the first few days make periodic checks to determine whether all conditions remain steady, or at least acceptable. This may be particularly important if the blower is supplying air to a process system where conditions can vary. At the first opportunity, stop the blower and clean the temporary inlet protective screen. If no appreciable amount of debris has collected, the screen may be removed. See comments under INSTALLATION. At this same time, verify leveling, coupling alignment or belt tension, and mounting bolt tightness.

Should operating experience prove that blower capacity is a little too high for the actual air requirements, a small excess may be blown off continuously through the manual unloading or vent valve. Never rely on the pressure relief valve as an automatic vent. Such use may cause the discharge pressure to become excessive, and can also result in unsafe operation of the valve itself. If blower capacity appears to be too low, refer to the TROUBLESHOOTING CHECKLIST.

Vibration Assessment Criteria

With measurements taken at the bearing locations on the housings, see chart below for an appropriate assessment guide for rotary lobe blowers rigidly mounted on stiff foundations.

In general, blower vibration levels should be monitored on a regular basis and the vibration trend observed for progressive or sudden change in level. If such a change occurs, the cause should be determined through spectral analysis.

As shown on the chart below, the level of all pass vibration will determine the need to measure discrete frequency vibration levels and the action required.

All Pass Vibrations (in/sec)	Discrete Frequency Vibration (in/sec)	Action
0.45 or less	N/R	Acceptable
Greater than 0.45 but 1.0 or less	0.45 or less @ any frequency	Acceptable
	Greater than 0.45 @ any frequency	Investigate
Greater than 1.0	Less than 1.0	Investigate
	Greater than 1.0	Investigate

Troubleshooting Checklist

Trouble	Item	Possible Cause	Remedy
No flow	1	Speed too low	Check by tachometer and compare with published performance.
	2	Wrong rotation	Compare actual rotation with Figure 1, change driver if wrong.
	3	Obstruction in piping	Check piping, valves, silencer to assure open flow path.
Low capacity	4	Speed too low	See item 1, if belt drive, check for slippage and re-adjust tension.
	5	Excessive pressure rise	Check inlet vacuum and discharge pressure and compare with published performance.
	6	Obstruction in piping	See item 3.
	7	Excessive slip	Check inside of casing for worn or eroded surfaces causing excessive clearances
Excessive power	8	Speed too high	Check speed and compare with published performance.
	9	Excessvie pressure rise	See item 5
	10	Impeller rubbing	Inspect outside of cylinder for high temperature areas, then check for impeller contact at these points. Correct blower mounting, drive alignment.
	11	Scale , sludge, rust or product build up	Clean blower appropriately
Damage to bearings or gears	12	Inadequate lubrication	Check oil sump levels in gear and drive end headplates
	13	Excessive lubrication	Check oil levels. If correct, drain and refill with clean oil of recommended grade.
	14	Excessive pressure rise	See item 5.
	15	Coupling misalignment	Check carefully. Re-align if questionable.
	16	Excessive belt tension	Re-adjust for correct tension.
Vibration	17	Misalignment	See item 15
	18	Impellers rubbing	See item 10
	19	Worn bearings/gears	Check gear backlash and conditions of bearings and replace as indicated.
	20	Unbalanced or rubbing impeller	Scale or process material may build up on casing and impellers, or inside impellers. Remove build-up to restore original clearances and impeller balance.
	21	Driver or blower loose	Tighten mounting bolts securely.
	22	Piping resonances	Determine whether standing wave pressure pulsations are present in the piping.
	23	Scale/sludge build-ups	Clean out interior of impeller lobes to restore dynamic balance.
Driver stops, or will not start	24	Casing strain	Re-work piping alignment to remove excess strain
	25	Impeller stuck	Check for excessive hot spot on headplate or cynlinder. See item 10. Look for defective shaft bearing and/or gear teeth.
	26	Scale, sludge, rust or product build-up	Clean blower appropiately
Excessive breather	27	Broken seal	Replace seals
Blow-by or excessive oil leakage to vent area	28	Defective O-ring	Replace seals and O-ring
Excessive oil leakage in vent area	29	Defective/plugged breather	Replace breather and monitor oil leakage
	30	Oil level too high	Check sump levels in gear and drive headplates
	31	Oil type or viscosity incorrect	Check oil to ensure it meets recommendations. Drain then fill with clean oil of recommended grade.
	32	Blower running hot	Check blower operating conditions to ensure they are within the operating limitations defined in this manual.

Inspection & Maintenance : Roots Universal RAI series blowers

A good program of consistent inspection and maintenance is the most reliable method of minimizing repairs to a blower. A simple record of services and dates will help keep this work on a regular schedule. Basic service needs are:

- Lubrication
- Checking for hot spots
- Checking for increases or changes in vibration and noise
- Recording of operating pressures and temperatures

Above all, a blower must be operated within its specified rating limits, to obtain satisfactory service life.

A newly installed blower should be checked often during the first month of full-time operation. Attention there after may be less frequent assuming satisfactory performance. Lubrication is normally the most important consideration and weekly checks of lubricant levels in the gearbox and bearing reservoirs should be customary. Complete oil change schedules are discussed under **LUBRICATION.**

Driver lubrication practices should be in accordance with the manufacturer's instructions. If direct connected to the blower through a lubricated type coupling, the coupling should be checked and greased each time blower oil is changed. This will help reduce wear and prevent unnecessary vibration. In a belted drive system, check belt tension periodically and inspect for frayed or cracked belts.

In a new, and properly installed, unit there is no contact between the two impellers, or between the impellers and cylinder or headplates. Wear is confined to the bearings (which support and locate the shafts) the oil seals, and the timing gears. All are lubricated and wear should be minimal if clean oil of the correct grade is always used. Seals are subject to deterioration as well as wear, and may require replacement at varying periods.

Shaft bearings are designed for optimum life under average conditions with proper lubrication and are critical to the service life of the blower. Gradual bearing wear may allow a shaft position to change slightly, until rubbing develops between impeller and casing. This will cause spot heating, which can be detected by observing these surfaces. Sudden bearing failure is usually more serious. Since the shaft and impeller are no longer supported and properly located, extensive general damage to the blower casing and gears is likely to occur.

Oil seals should be considered expendable items, to be replaced whenever drainage from the headplate vent cavity becomes excessive or when the blower is disassembled for any reason. Some oil seal leakage may occur since an oil film under the lip is required for proper operation. Periodically leaked oil should be wiped off from surfaces. Minor seal leakage should not be considered as indicating seal replacement.

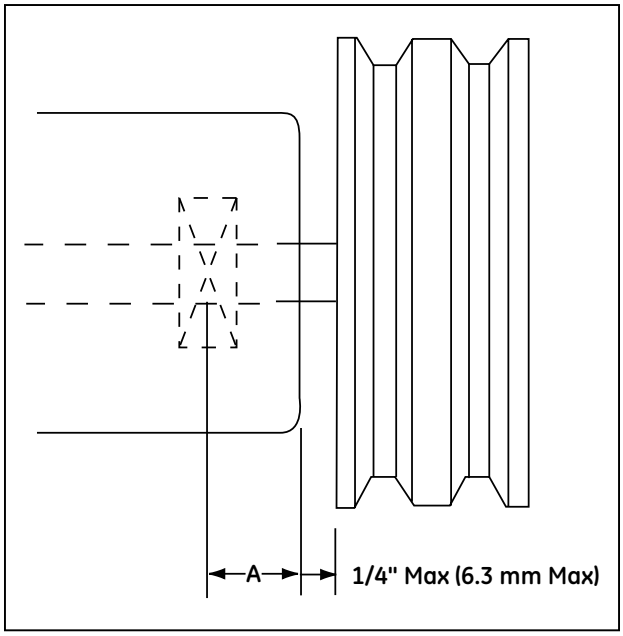
Timing gear wear, when correct lubrication is maintained, should be negligible. Gear teeth are cut to provide the correct amount of backlash, and gears correctly mounted on the shafts will accommodate a normal amount of tooth wear without permitting contact between lobes of the two impellers. However, too high an oil level will cause churning and excessive heating. This is indicated by unusually high temperature at the bottom of the gear housing. Consequent heating of the gears will result in loss of tooth-clearance , backlash and rapid wear of the gear teeth usually will develop. Continuation of this tooth wear will eventually produce impeller contacts (knocking), and from this point serious damage will be unavoidable if blower operation is continued. A similar situation can be produced suddenly by gear tooth fracture, which is usually brought on by sustained overloading or momentary shock loads.

Problems may also develop from causes other than internal parts failure. Operating clearances within a blower are only a few thousandths of an inch. This makes it possible for impeller interference or casing rubs to result from shifts in the blower mounting, or from changes in piping support. If this type of trouble is experienced, and the blower is found to be clean, try removing mounting strains. Loosen blower mounting bolts and reset the leveling and drive alignment. Then tighten mounting again, and make sure that all piping meets blower connections accurately and squarely Foreign materials in the blower will also cause trouble, which can only be cured by disconnecting the piping and thoroughly cleaning the blower interior.

A wide range of causes and solutions for operating troubles are covered in the **TROUBLE SHOOTING CHECKLIST.** The remedies suggested should be performed by qualified mechanics with a good background. Major repairs generally are to be considered beyond the scope of maintenance, and should be referred to an authorized GE distributor.

Warranty failures should not be repaired at all, unless specific approval has been obtained through GE before starting work. Unauthorized disassembly within the warranty period may void the warranty.

Figure 2 - Allowable Overhung Loads for V-belt Drives Roots Universal RAI/URAI-J Units



$$\text{†Belt Pull lbs} = \frac{252100 \bullet \text{Motor HP}}{\text{Blower RPM} \bullet \text{Sheave Diameter in Inches}}$$

$$\text{Shaft Load (lb.in)} = \text{Belt Pull} \bullet \left(\text{A"} + \tfrac{1}{4}\text{"} + \frac{\text{Sheave Width (")}}{2}\right)$$

†Based on SF = 1.4 for v-belt drives. If higher SF belt is used, belt load should be increased proportionally and may exceed limits of the blower.

Frame Size	Dim "A"	Max. Allow. Shaft Load (lb.in)	Min Sheave Diameter
22, 24	0.61	150	4.00
32, 33, 36	0.80	400	5.00
42, 45, 47	1.02	730	5.00
53, 56, 59	1.13	1,325	6.00
65, 68, 615	1.36	2,250	8.00
76, 711, 718	1.16	3000	9.50

NOTE:

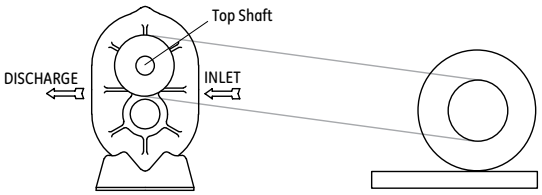
Arc of sheave belt contact on the smaller sheave not to be less than 170°.

Driver to be installed on the inlet side for vertical units, and on the drive shaft side for horizontal units.

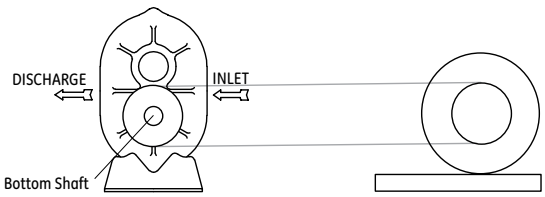
GE recommends the use of two or more 3VX, 5VX or 8VX belts and sheaves.

Acceptable Blower Drive Arrangement Options

Acceptable

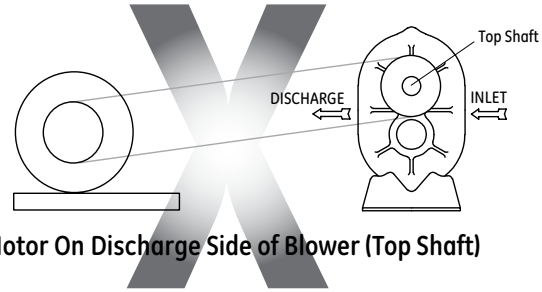


Motor On Inlet Side of Blower (Top Shaft)

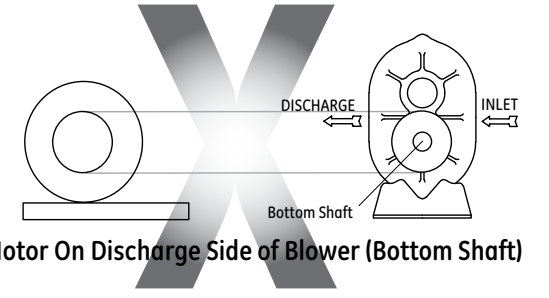


Motor On Inlet Side of Blower (Bottom Shaft)

Unacceptable



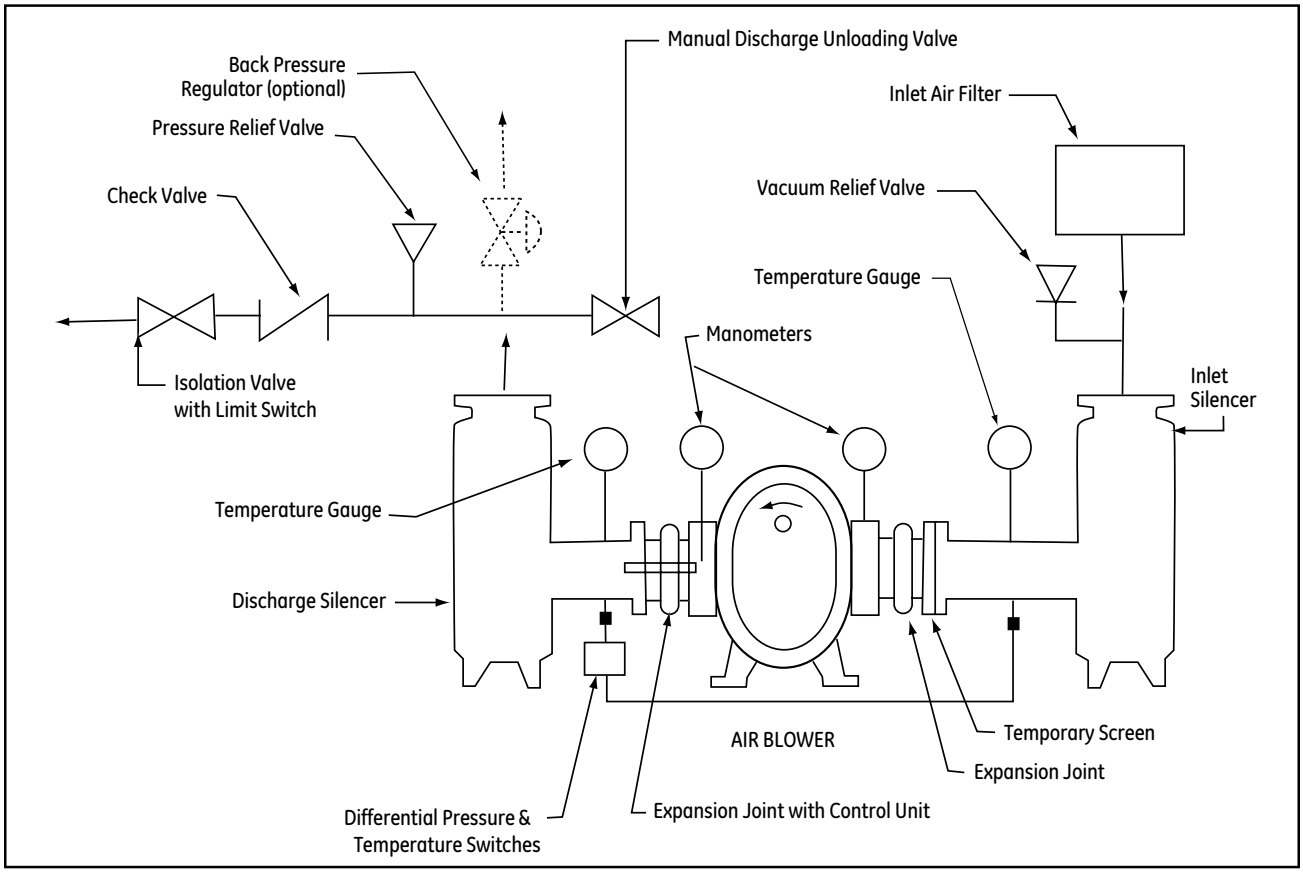
Motor On Discharge Side of Blower (Top Shaft)



Motor On Discharge Side of Blower (Bottom Shaft)

Above are suggested locations for available accessories.

Figure 3a - Air Blower Installations with Accessories



Above are suggested locations for available accessories.

Figure 3b - Gas Blower Installations with Accessories

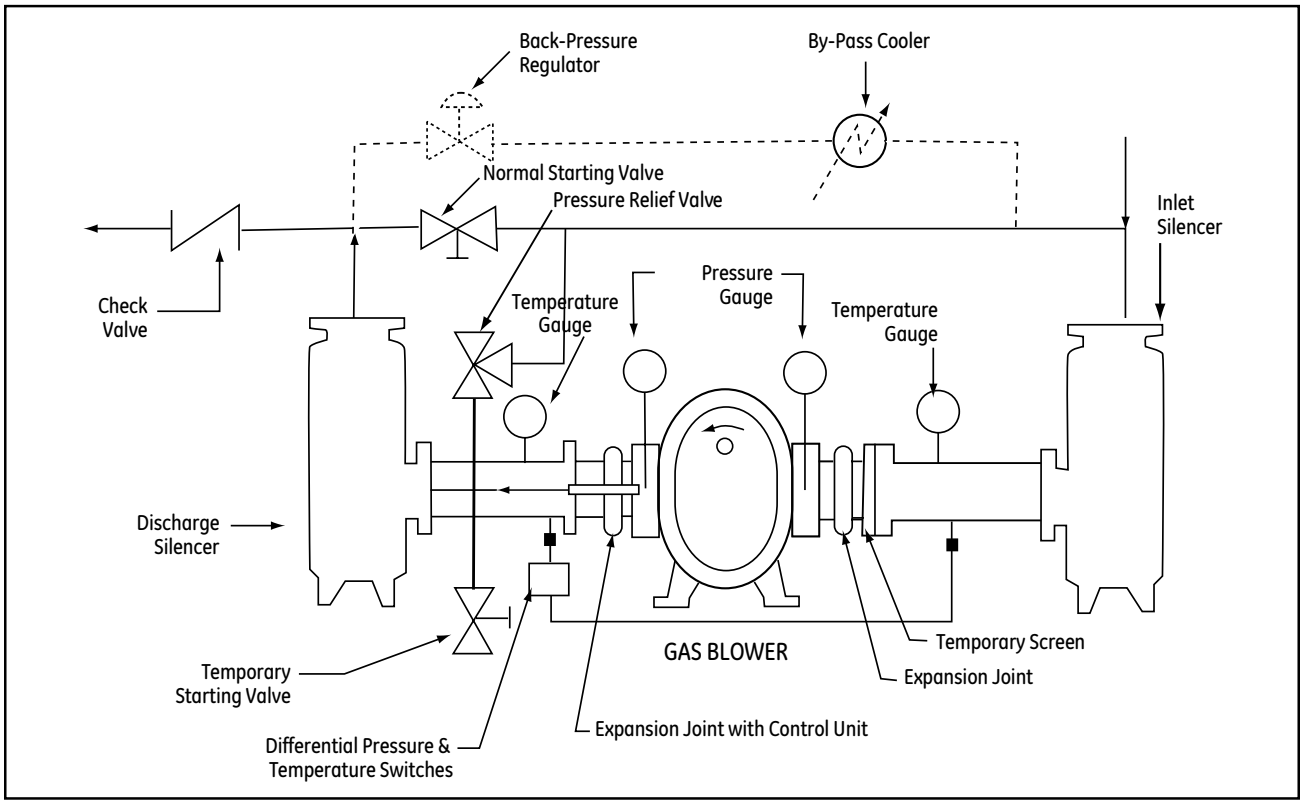


Figure 4 - Blower Orientation Conversion

Model	Reversible Rotation	WHISPAIR* Design
Roots Universal RAI	Yes	No
Roots URAI-J WHISPAIR	No	Yes
Roots URAI-G	Yes	No

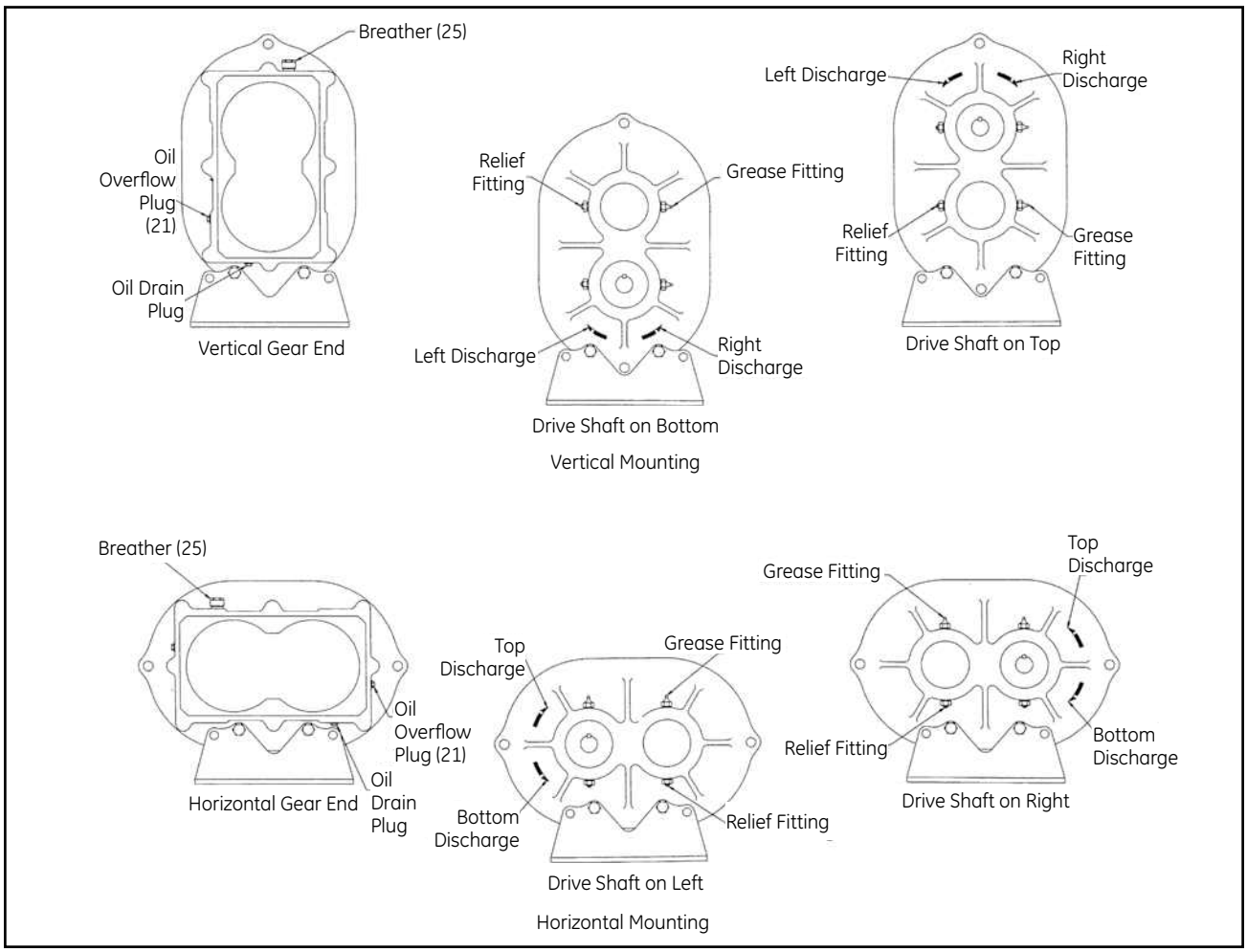
Special Note: WHISPAIR models are designed to operate with only one shaft rotation direction to take full advantage of the WHISPAIR feature. Therefore, a WHISPAIR blower may be operated in the following combinations.

- CCW Rotation: Bottom Shaft; Right side discharge or a Left Shaft; Bottom discharge
- CCW Rotation: Top Shaft; Left side discharge or a Right Shaft; Top discharge

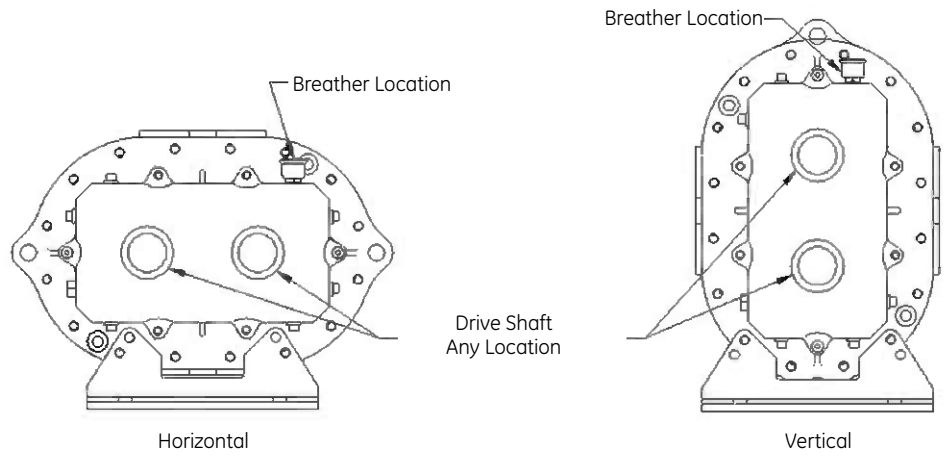
or

- CW Rotation: Bottom Shaft; Left side discharge or a Right Shaft Bottom discharge
- CW Rotation: Top Shaft; Right side discharge or a Left Shaft Top discharge

Blower Orientation and Lubrication Points: Grease Lubricated Drive End Roots Universal RAI series & URAI-G gas blowers



Drive End Breather Orientation for Roots Universal RAI Series - DSL with Oil Lube



Universal RAI DSL Breather Orientation

Revised Date: 1/11/05

Table 1 - Universal RAI series, Universal RAI-DSL & URAI-G gas blower, Maximum Allowable operating Conditions

Frame Size	Gear Dia. (inch)	Speed RPM	Temperature Rise		Delta Pressure		Inlet Vacuum	
			F°	C°	PSI	mbar	INHG	mbar
22	2.5	5275	225	125	12	827	15	500
24	2.5	5275	210	117	7	483	15	500
32	3.5	3600	240	133	15	1034	16	539
33	3.5	3,600	225	125	12	827	15	500
36	3.5	3,600	225	125	7	483	15	500
42	4.0	3,600	240	133	15	1034	16	539
45	4.0	3600	225	125	10	690	16	539
47	4.0	3600	225	125	7	483	15	500
53	5.0	2850	225	125	15	1034	16	539
56	5.0	2850	225	125	13	896	16	539
59	5.0	2850	225	125	7	483	15	500
65	6.0	2350	250	130	15	1034	16	539
68	6.0	2350	240	133	14	965	16	539
615	6.0	2350	130	72	7	483	14	472
76	7.0	2050	250	139	15	1034	16	539
711	7.0	2050	225	125	10	690	16	539
718	7.0	2050	130	72	6	414	12	405

Table 2 - Recommended Oil Grades

Ambient† Temperature °F (°C)	ISO Viscosity No.
Above 90° (32°)	320
32° to 90° (0° to 32°)	220
0° to 32° (-18° to 0°)	150
Below 0° (-18°)	100

†Ambient temperature is defined as the temperature of the space in which the blower and drive are located.

Roots URAI Gas Blower Oil and Grease Specifications

The specified oil should be Roots Synthetic Oil P/N 813-106-xxx of the proper viscosity.

Table 3 - Approximate Oil Sump Capacities

These capacities are provided to assist in stocking the correct amount of oil. Exact sump capacities may differ slightly. See "Lubrication" section for proper filing instructions.

Roots Universal RAI, URAI-J, URAI-G

Model No./Drive shaft location	Gear End Approx. Oil Sump Capacities	
	Fl. Oz	Liters
22, 24 (left or right)	6.1	0.18
22, 24 (top or bottom)	3.4	0.1
32, 33, 36 (left or right)	10.5	0.31
32, 33, 36 (top or bottom)	8.5	0.25
42, 45, 47 (left or right)	14.5	0.43
42, 45, 47 (top or bottom)	12.7	0.37
53, 56, 59 (left or right)	27.6	0.82
53, 56, 59 (top or bottom)	16	0.47
65, 68, 615 (left or right)	52.1	1.54
65, 68, 615 (top or bottom)	28.3	0.84
76, 711, 718 (left or right)	59.5	1.76
76, 711, 718 (top or bottom)	32.3	0.96

See page 14 and 15 for illustration of vertical and horizontal configurations

Roots Universal RAI series -DSL Splash Lubricated Drive End
Note that the gear and sump capacity is provided on the adjacent table.

Model No./Drive shaft location	Drive End Capacity	
	Fl. Oz	Liters
32, 33, 36 (left or right)	6.5	0.19
32, 33, 36(top or bottom)	4	0.12
42, 45, 47 (left or right)	10.8	0.32
42, 45, 47 (top or bottom)	5.5	0.16
53, 56, 59 (left or right)	14.8	0.44
53, 56, 59(top or bottom)	7.5	0.22
65, 68, 615 (left or right)	31	0.91
65, 68, 615 (top or bottom)	16	0.47

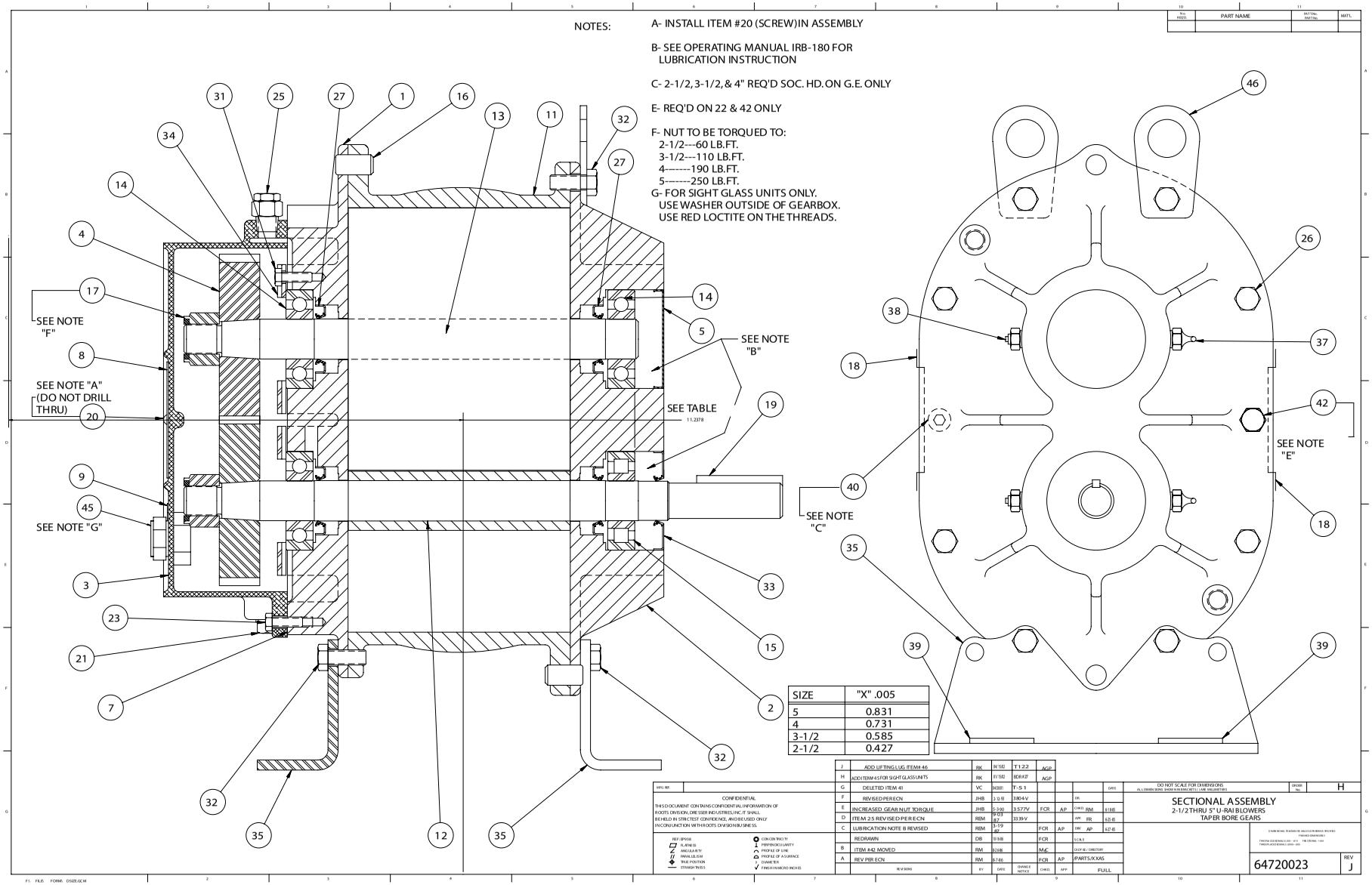
Table 4 - Roots Universal RAI series with Grease Lubricated Drive End: Specified Bearing Greasing Intervals

Speed in RPM	Operating Hours Per Day		
	8	16	24
	Greasing Interval in Weeks		
750-1000	7	4	2
1000-1500	5	2	1
1500-2000	4	2	1
2000-2500	3	1	1
2500-3000	2	1	1
3000 and up	1	1	1

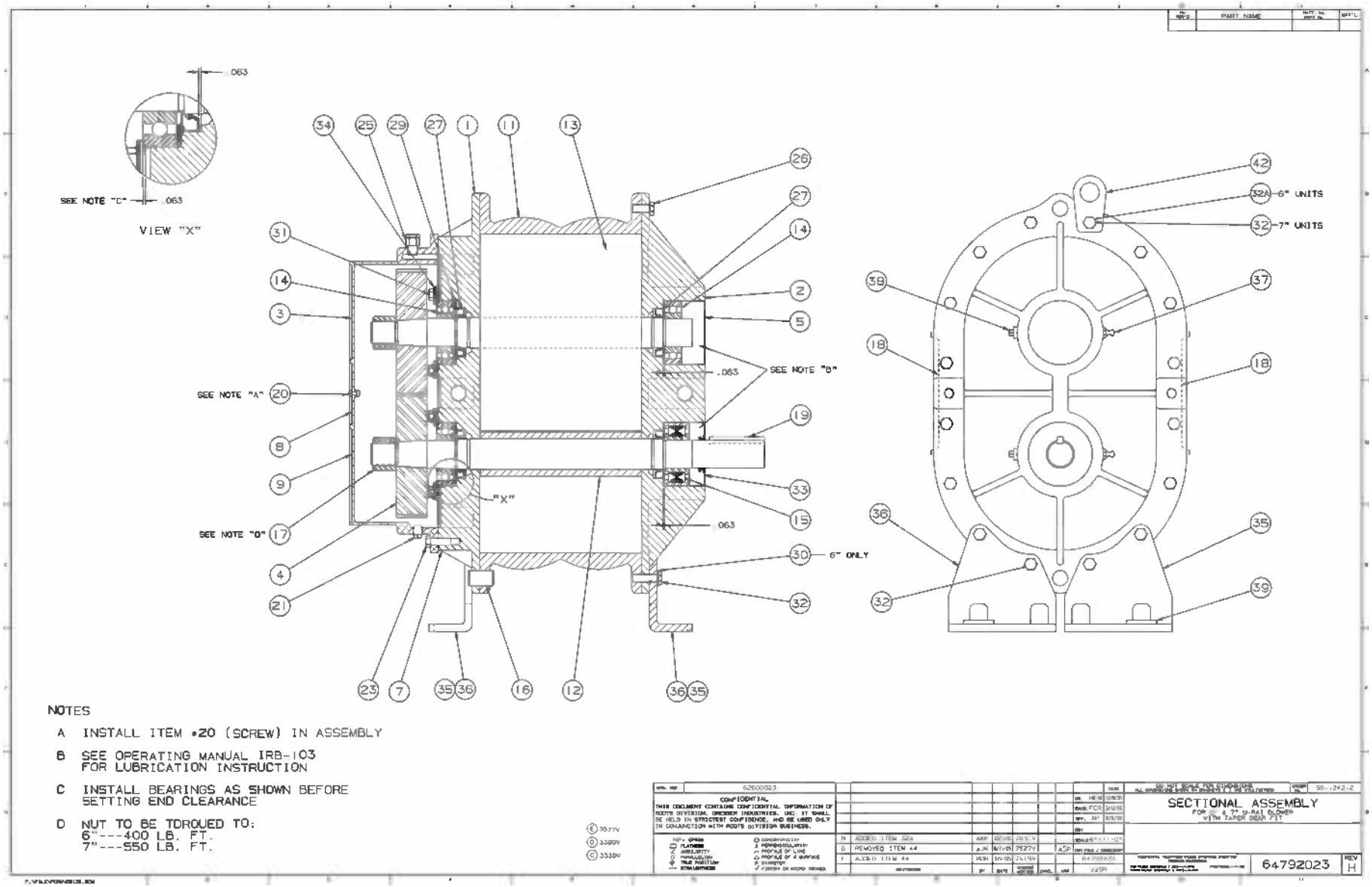
The specified grease for servicing drive end bearings of a gas blower, use a NLGI #2 premium grade aluminum complex* grease, GE P/N T20019001 with 300°F (149°C) service temperature and moisture resistance and good mechanical stability.

When servicing drive end bearings of non gas blower, use a NLGI #2 premium grade microgel grease with 250°F (121°C) service temperature and moisture resistance and good mechanical stability. GE specifies Shell Darina SD2 NLGI#2. Product Code 5067628.

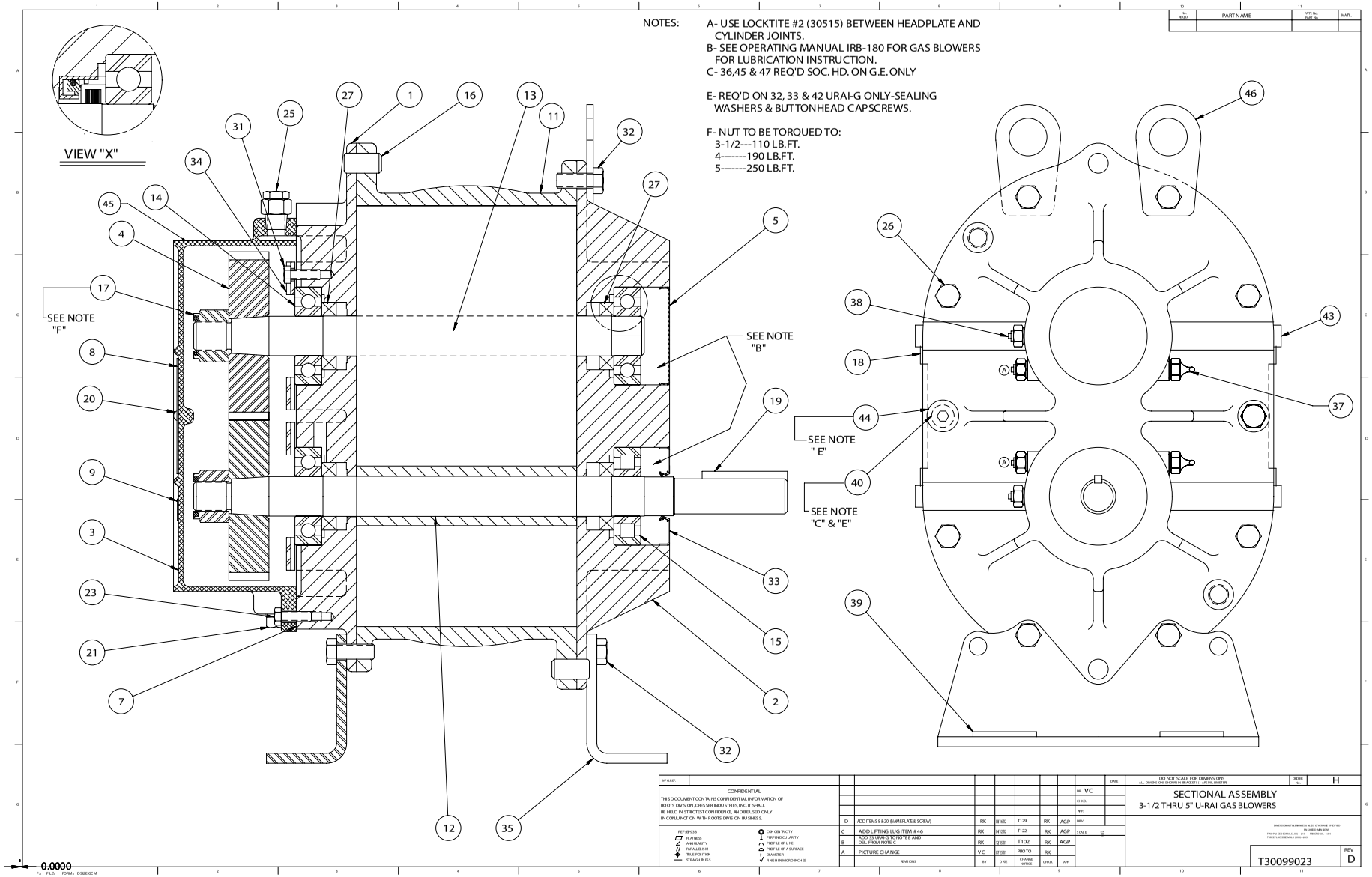
NOTE: Lithium based greases are not compatible with the Roots Synthetic Grease used when assembling a gas blower or the non-soap base grease used when assembling a standard Roots URAI blower. Lithium based grease is not approved for any Roots blowers.



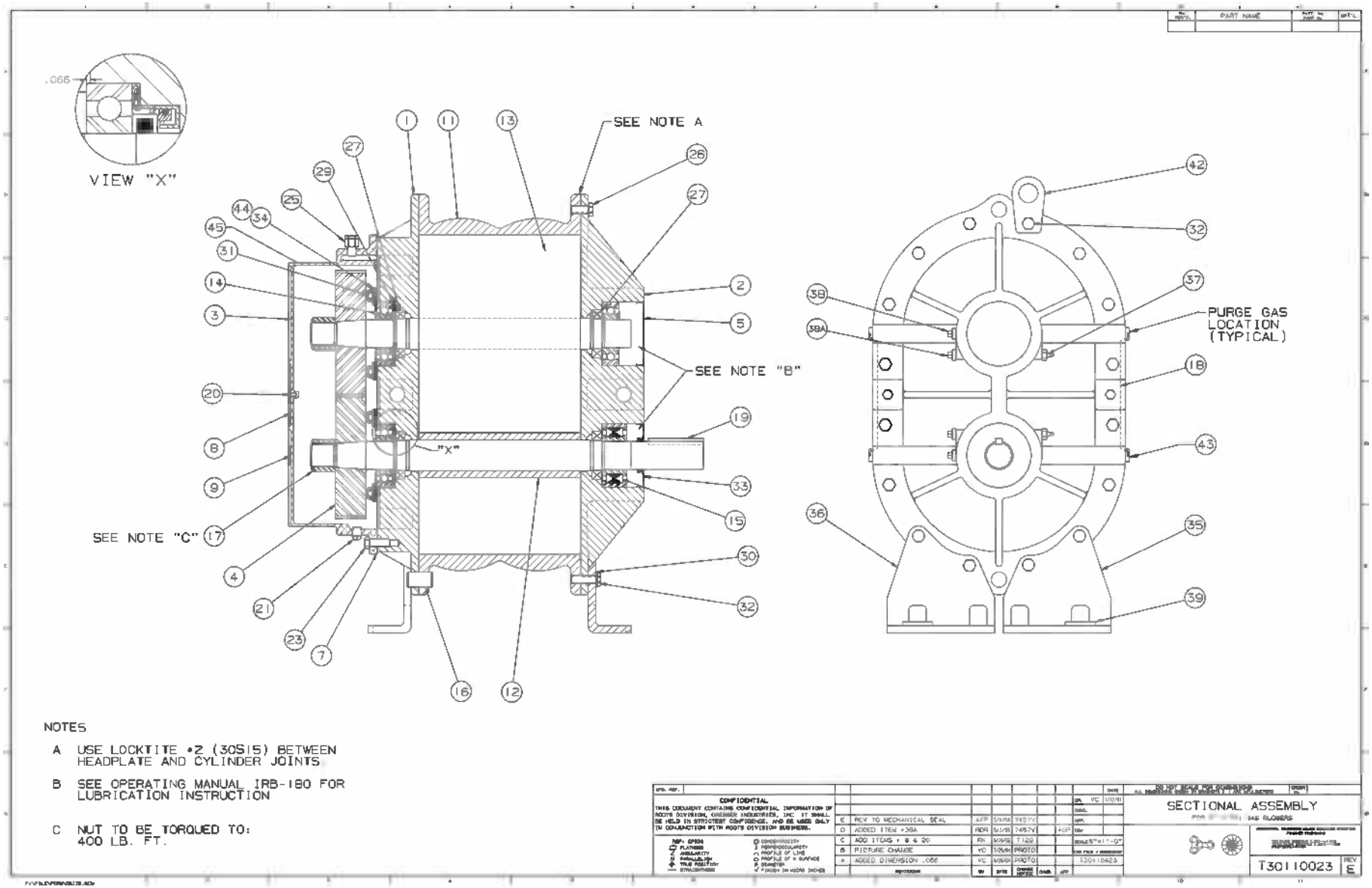
Assembly of Roots Universal RAI Series, Air Blowers, 2-1/2" Through 5" Gear Diameter



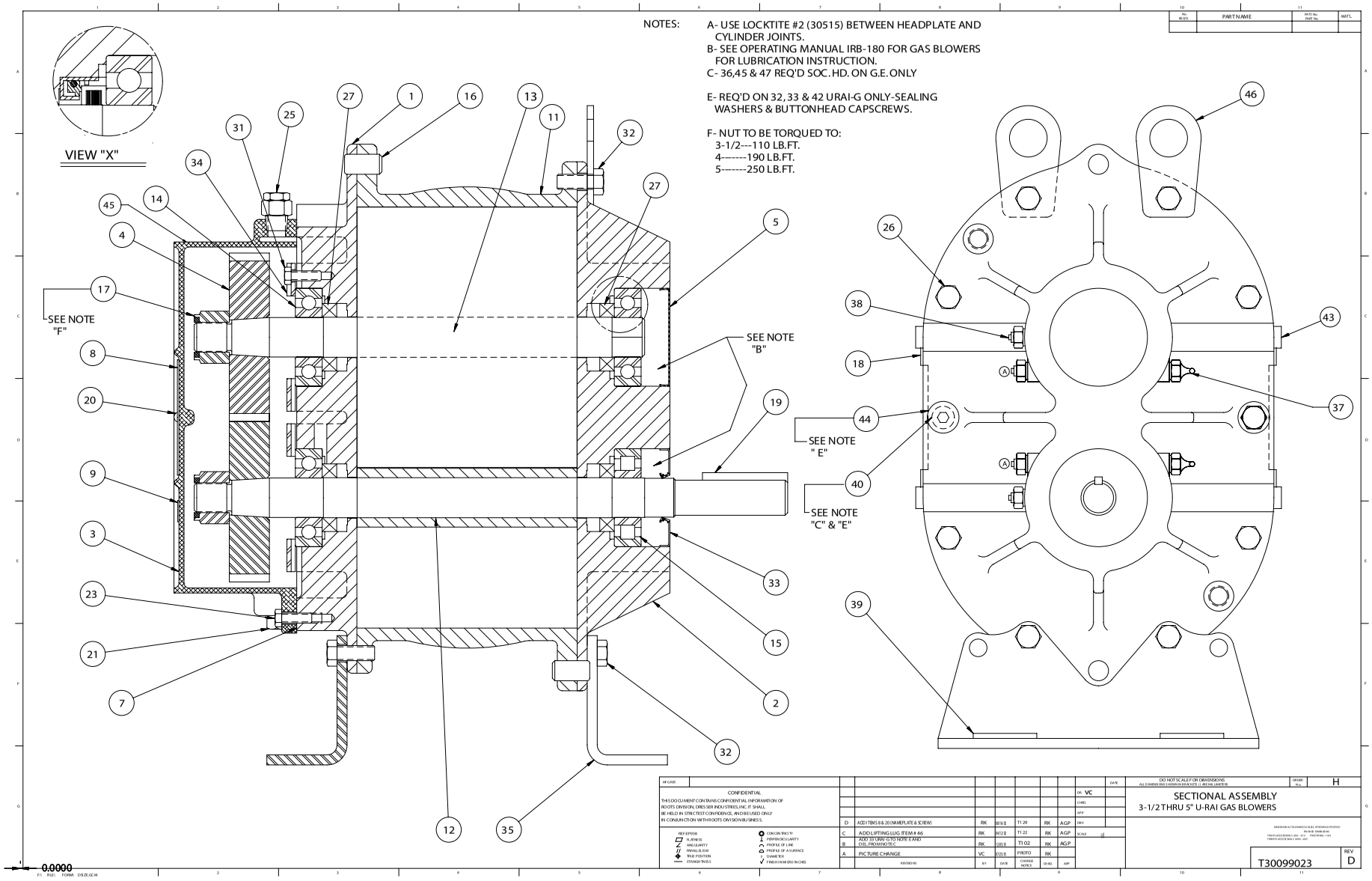
Assembly of Roots Universal RAI Blowers, 6" and 7" Diameter



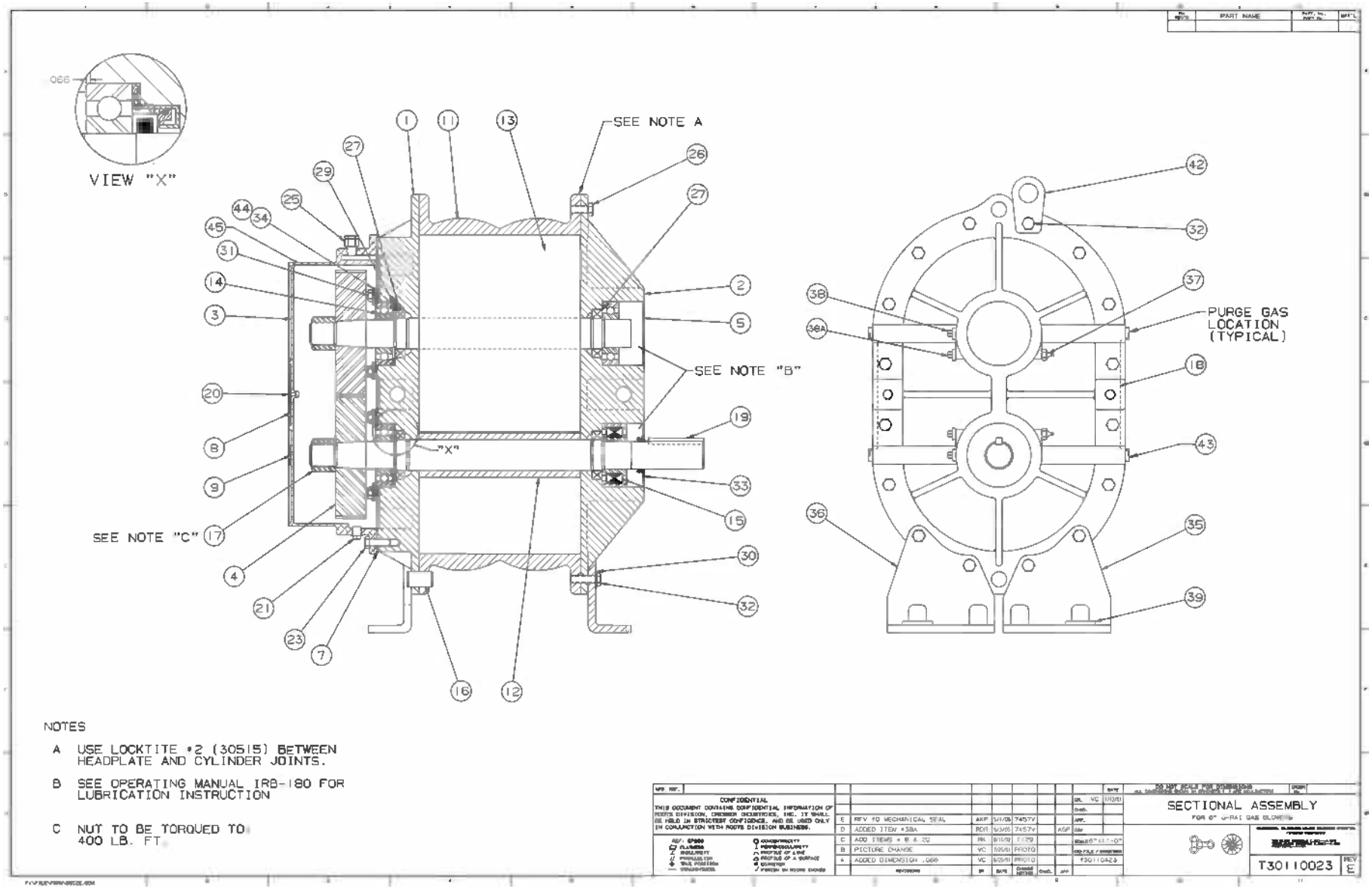
Assembly of Roots Universal RAI-G Series Gas Blowers, 3-1/2" through 5" Gear Diameter



Assembly of Roots Universal RAI Series Gas Blowers, 6" Gear Diameter



Assembly of Roots Universal RAI-G Series Gas Blowers, 3-1/2" through 5" Gear Diameter



Assembly of Roots Universal RAI Series Gas Blowers, 6" Gear Diameter

Roots Universal RAI Series Blowers
Parts List 2-1/2" – 5" Gear Diameter
(Refer to drawing #64720023)

Item #	Part Name	Qty.
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
5	Cover-Blind (Plug Opening)	1
7	Gasket, Gear Box	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3
23	Screw Hex	6
25	Breather (Plug Vent)	1
26	Screw, Hex	†
27	Seal, Lip Bearing	4
31	Screw, Hex, Nylock	4
32	Screw, Hex	6
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
37	Fitting, Grease	2
38	Fitting, Relief	2
39	Washer Mounting	4
40	Screw Socket	2
42	Screw Hex	2

†Quantities vary by blower.

Roots Universal RAI Series Blowers
Parts List 6" & 7" Gear Diameter
(Refer to drawing #64792023)

Item #	Part Name	Qty.
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
5	Cover-Blind (Plug Opening)	1
7	Gasket, Gear Box	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3
23	Screw Hex Nylock	8
25	Breather (Plug Vent)	1
26	Screw, Hex	†
27	Seal, Lip Bearing	4
29	Washer, Spring Wavy	2
31	Screw, Hex, Nylock	4
32	Screw, Hex	10
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
37	Fitting, Grease	2
38	Fitting, Relief	2
39	Washer Mounting	4

†Quantities vary by blower.

Roots Universal RAI-DSL Series Blowers
Parts List 3-1/2" – 5" Gear Diameter
(Refer to drawing #T30356023)

Item #	Part Name	Qty.
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
7	Gasket, Gear Box, DE Cover	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3
23	Screw Hex	6
25	Breather (Plug Vent)	1
26	Screw, Hex	†
27	Seal, Lip Bearing	4
31	Screw, Hex, Nylock	4
32	Screw, Hex	6
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
39	Washer Mounting	4
40	Screw Socket	2
42	Screw Hex	2
48	DE Oil Slinger Set Screw	4
50	Drive End Cover	1
52	Drive End Oil Slinger	2
53	Oil Sight Glass	2

†Quantities vary by blower.

Roots Universal RAI DSL Series Blowers Parts List 6" Gear Diameter
(Refer to drawing #T30382023)

Item #	Part Name	Qty.
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
7	Gasket, Gear Box	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3

Item #	Part Name	Qty.
23	Screw Hex Nylock	8
25	Breather (Plug Vent)	1
26	Screw, Hex	†
27	Seal, Lip Bearing	4
31	Screw, Hex, Nylock	4
32	Screw, Hex	10
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
39	Washer Mounting	4
48	DE Oil Slinger Set Screw	4
50	Drive End Cover	1
52	Drive End Oil Slinger	2
53	Oil Sight Glass	2

†Quantities vary by blower.

Roots Universal RAI Series Gas Blowers Parts List
3-1/2" & 5" Gear Diameter
(Refer to drawing #T30099023)

Item Number	Part Name	Quantity
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
5	Cover-Blind (Plug Opening)	1
7	Gasket, Gear Box	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3
23	Screw Hex	8
25	Breather (Plug Vent)	1
26	Screw, Hex	14†
27	Seal, Bearing	4
31	Screw, Hex	4
32	Screw, Hex	4
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
37	Fitting, Grease	2
38	Fitting, Relief	2
39	Washer Mounting	4
40	Screw Socket	2
42	Screw Hex	2

†Quantity varies by blower.

Specified Lubricants

Roots Synthetic Oil: ISO-VG-220 Grade	
	Part Number
Quart	813-106-001
Gallon	813-106-002
Case (12 qts)	813-106-008
Roots Synthetic Oil: ISO-VG-320 Grade	
	Part Number
Quart	813-106-004
Gallon	813-106-005
Case (12 qts)	813-106-007
Roots Synthetic Grease: NLGI #2	
	Part Number
14.5 oz. Tube	T200019-001
5 Gallon Pail	T200019-003
Case (30 tubes)	T200019-002

Roots Universal RAI Series Gas Blowers Parts List
6" Gear Diameter
(Refer to drawing #T3011023)

Item Number	Part Name	Quantity
1	Headplate Gear End	1
2	Headplate Drive End	1
3	Gearbox	1
4	Timing Gears	2
5	Cover-Blind (Plug Opening)	1
7	Gasket, Gear Box	1
7†	Gasket DE Cover	1
11	Cylinder	1
12	Impeller & Shaft Drive	1
13	Impeller & Shaft Driven	1
14	Bearing, Ball	3
15	Bearing, Roller	1
16	Pin, Dowel	4
17	Gear Nut	2
19	Key	1
21	Plug, Pipe	3
23	Screw Hex Nylock	8
25	Breather (Plug Vent)	1
26	Screw, Hex	14††
27	Seal, Bearing	4
31	Screw, Hex	4
32	Screw, Hex	10
33	Seal Lip-Drive	1
34	Clamp Plate	2
35	Foot	2
37	Fitting, Grease	2
38	Fitting, Relief	2
39	Washer Mounting	4
40	Screw Socket	2
42	Screw Hex	2
43	Plug	8
51	Shoulder Bolt	2
53	Oil Sight Glass	2

†DE cover gasket is not the same as the gasket used on the GE model. You must specify the gasket required when ordering.
††Quantities vary by blower.

Basic Connection & Drive Shaft Information

Roots Universal RAI (URAI) Air Blowers with Grease Lubricated Drive End

BOM#*	Frame Size	Inlet/Disch Connection	Shaft Diameter (in.)	Bare Weight
65102020	22	1" NPT	0.625	32
65103020	24	2" NPT	0.625	43
71048020	32	1.25" NPT	0.750	69
65105020	33	2" NPT	0.750	74
65106020	36	2.5" NPT	0.750	102
65108020	42	1.5" NPT	0.875	88
65109020	45	2.5" NPT	0.875	109
65110020	47	3" NPT	0.875	128
65112020	53	2.5" NPT	1.125	143
65113020	56	4" NPT	1.125	170
65114020	59	4" NPT	1.125	204
65116020	65	3" NPT	1.375	245
65117020	68	5" NPT	1.375	285
65118020	615	6" Flange	1.375	425
65120020	76	4" NPT	1.562	400
65121020	711	6" Flange	1.562	530
65122020	718	8" Flange	1.562	650

Refer to Specification Sheet S-12K84

Roots URAI DSL Air Blowers with Dual Splash Lubrication

BOM#*	Frame Size	Inlet/Disch Connection	Shaft Diameter (in.)	Bare Weight
T30378020	32	1.25" NPT	0.750	72
T30379020	33	2" NPT	0.750	77
T30380020	36	2.5" NPT	0.750	105
T30352020	42	1.5" NPT	0.875	92
T30353020	45	2.5" NPT	0.875	113
T30354020	47	3" NPT	0.875	132
T30359020	53	2.5" NPT	1.125	148
T30360020	56	4" NPT	1.125	175
T30361020	59	4" NPT	1.125	209
T30384020	65	3" NPT	1.375	250
T30385020	68	5" NPT	1.375	290
T30386020	615	6" Flange	1.375	430

Refer to Specification Sheet S-27S03

Roots Universal RAI air blowers include detachable mounting feet which permit vertical or horizontal installation. The units are center timed for rotation in either direction. The bearings on the URAI are grease lubricated on the drive end and splash lubricated on the gear end. The URAI-DSL is splash lubricated on BOTH ends.

Roots Universal RAI-G Gas Blowers with Grease Lubricated Drive End

BOM#*	Frame Size	Inlet/Disch Connection	Shaft Diameter (in.)	Bare Weight
710480G0	32	1.25" NPT	0.750	69
651050G0	33	2" NPT	0.750	74
651060G0	36	2.5" NPT	0.750	102
651080G0	42	1.5" NPT	0.875	88
651090G0	45	2.5" NPT	0.875	109
651100G0	47	3" NPT	0.875	128
651120G0	53	2.5" NPT	1.125	143
651130G0	56	4" NPT	1.125	170
651140G0	59	4" NPT	1.125	204
651160G0	65	3" NPT	1.375	245
651170G0	68	5" NPT	1.375	285
651180G0	615	6" NPT	1.375	425

Refer to Specification Sheet S-60A01

Roots Universal RAI-G gas blowers include detachable mounting feet which permit vertical or horizontal installation. **Feet are different for vertical and horizontal mounting.** The units are center timed for rotation in either direction. The bearings on the Universal RAI-G are grease lubricated on the drive end and splash lubricated on the gear end. Roots Synthetic Lubricant is recommended.

Basic Connections and Drive Shaft Information

Roots Universal RAI (URAI-J) WHISPAIR Air Blowers

Roots Universal RAI-J WHISPAIR Air Blowers with Grease Lubricated Drive End

BOM#*	Frame Size	Inlet/Disch Connection	Shaft Diameter (in.)	Bare Weight
74065020	33J	2" NPT	0.750	84
74086020	36J	2.5" NPT	0.750	112
74066020	45J	2.5" NPT	0.875	119
74087020	47J	3" NPT	0.875	138
74067020	56J	4" NPT	1.125	180

Refer to Specification Sheet S-33A93

Roots URAI-J-DSL WHISPAIR Air Blowers with Dual Splash Lubrication

BOM#*	Frame Size	Inlet/Disch Connection	Shaft Diameter (in.)	Bare Weight
T30417020	33J	2" NPT	0.750	87
T30418020	36J	2.5" NPT	0.750	115
T30410020	45J	2.5" NPT	0.875	122
T30412020	47J	3" NPT	0.875	141
T30415020	56J	4" NPT	1.125	185

Refer to Specification Sheet S-33A93

Roots URAI-J Metric WHISPAIR Air Blowers with Grease Lubricated Drive End

BOM#*	Frame Size	Inlet/Disch Connection	Shaft Diameter (mm)	Bare Weight
TBD	33J	2" BSP	19	84
740860M0	36J	2.5" BSP	19	112
TBD	45J	2.5" BSP	24	119
TBD	47J	3" BSP	24	138
TBD	56J	4" BSP	28	180

Roots URAI-J-DSL Metric WHISPAIR Air Blowers with Dual Splash Lubrication

BOM#*	Frame Size	Inlet/Disch Connection	Shaft Diameter (mm)	Bare Weight
TBD	33J	2" BSP	19	87
T304660M0	36J	2.5" BSP	19	115
TBD	45J	2.5" BSP	24	122
T304550M0	47J	3" BSP	24	141
TBD	56J	4" BSP	28	185

Roots Universal RAI-J air blowers incorporate the patented WHISPAIR® design in addition to the same features as the original URAI blowers. Roots URAI-J's are centered timed, however the WHISPAIR benefits can only be realized when the jet is located in the discharge position.

Basic Connections and Drive Shaft Information

Roots Universal RAI Metric (URAI-M) Air Blowers with Grease Lubricated Drive End
NOTE: Metric URAI product has metric shaft diameter and connection sizes.

BOM#*	Frame Size	Inlet/Disch Connection	Shaft Diameter (mm)	Bare Weight
651020M0	22	1" BSP	16	32
651030M0	24	2" BSP	16	43
710480M0	32	1.25" BSP	19	69
651050M0	33	2" BSP	19	74
651060M0	36	2.5" BSP	19	102
651080M0	42	1.5" BSP	24	88
651090M0	45	2.5" BSP	24	109
651100M0	47	3" BSP	24	128
651120M0	53	2.5" BSP	28	143
651130M0	56	4" BSP	28	170
651140M0	59	4" BSP	28	204
T30392060	65	3" BSP	32	245
T30394060	68	5" BSP	32	285
T30390060	615	150 NP10	32	425
T30396060	76	4" BSP	38	400
T30398060	711	150 NP10	38	530
T30340060	718	200 NP10	38	650

Roots URAI-DSL Metric Air Blowers with Dual Splash Lubrication

BOM#*	Frame Size	Inlet/Disch Connection	Shaft Diameter (mm)	Bare Weight
T30463060	32	1.25" BSP	19	72
T30464060	33	2" BSP	19	77
T30465060	36	2.5" BSP	19	105
T30451060	42	1.5" BSP	24	92
T30452060	45	2.5" BSP	24	113
T30453060	47	3" BSP	24	132
T30459060	53	2.5" BSP	28	148
T30460060	56	4" BSP	28	175
T30461060	59	4" BSP	28	209
T30467260	65	3" BSP	32	250
T30467360	68	5" BSP	32	290
T30467460	615	150 NP 10	32	430

Roots Universal RAI air blowers include detachable mounting feet which permit vertical or horizontal installation. The units are center timed for rotation in either direction. The bearings on the URAI are grease lubricated on the drive end and splash lubricated on the gear end. The Roots URAI-DSL is splash lubricated on BOTH ends.

GE Oil & Gas

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V-Belts
Operation & Maintenance

V-belts run longer and perform better if they are given the proper care and attention during the following 48-hour running-in period. This is a most critical time for V-belts, especially if they are to last for a few years. During this run-in period, the initial stretch is taken out of the belt. Also, the soft rubber surface of the belt's outer envelope is abraded away, and the belt settles deeper in the groove of the sheave. This causes the belt to run slack. At this point, the slack on the new belts must be taken up to avoid considerable slippage, frictional burning, and other irreparable damage. **It is very important that the belts are checked often over the first few days of operation and are adjusted according to the correct tension until all signs of stretching have been eliminated. This practice will eliminate early damage and promote longer belt lives.** Following are general guidelines for the operation and maintenance of V-belt drives:

Step 1
Follow your company's safety work practices during the installation of the V-belts, including personal protective equipment policies and lockout and tag-out policies.

Step 2
Remove the safety guard from the V-belt drive area.

Step 3
Adjust the moveable plate toward the fixed component by using the adjusting screws to reduce the center-to-center distance of the driver-to driven sheaves. This reduces the tension on the belt and allows slack in the belt between the sheaves.

Step 4
Remove the old belts from the sheaves. Examine the operational surfaces to determine if any damage had forced the belts into an early demise. Look specifically for fabric wear on the sidewalls, reinforcing nylon cords, cracking caused by dry out, and oily surfaces.

Note: If any of the above symptoms are apparent, do not install any new V-belts until the root cause of the problem has been identified and corrected.

Step 5
Clean the sheaves of all foreign matter with a stiff brush that has bristles softer than the sheave surface material. Heavy-duty wire brushes can scratch the surface of the groove walls. These scratches can, in turn, tear up the V-belt's outer skin and systematically destroy the belt.

Step 6
Using the "go-no-go" slip gauges that can be obtained from a belt manufacturer, determine the condition of the V-groove in the sheave. This will accurately determine if the walls of the V-groove have been subjected to excessive forces caused by improper tension causing slippage and poor alignment between the driver and the driven shafting.

Step 7
If the sheaves do not meet these criteria or are damaged in other ways (chipped or cracked sidewalls), discard these defective parts and install new ones.

Step 8
Verify that the replacement belts are the correct size. Check with the "go-no-go" gauge to ensure the cross-section of the V-belt is compatible with the V section in the groove. The belt must ride in the groove with its top flat surface level with the outer periphery of the sheave.

Note: Never mix new and old belts regardless of the "new" look of the old one. Belts should always be installed in matched sets. This ensures that all of the replacement belts are exactly alike in all respects. Never mix belts from different manufacturers because they have different stretch characteristics, coefficients of friction, and cross-sectional areas. If the V-belts are not the same length, they will not carry the same amount of load. This will cause some of the belts to become overloaded and wear rapidly, shortening the life of the belt drive.

Step 9
Before installing the new belts, the following checks must be made:

Check the TIR (Total Indicated Run-out) of both the driver and driven shafts. These should be within +/- 0.003". If the run-out reading exceeds this value, the shaft(s) must be straightened. This check must also be carried out on the outer rim of each sheave, as it is quite common to find the shaft hole in the hub drilled off-center causing damaging eccentricity. This eccentricity causes the belts to slacken off at the 3 o'clock position and to snap into tension at the 9 o'clock position during shaft rotation. This continual snapping action creates rapid belt and bearing deterioration.

Check all of the hold-down bolts around the bedplate to determine if any soft-foot conditions exist. This reading should not be greater than 0.002".

Check sheave alignment by placing a straightedge or a tightly drawn cord across the sheave faces so that it touches all four points of contact.

Note: This method of alignment is only effective when the sheaves are a matched pair. If the sheaves are mismatched, there may be differences in the sidewalls' thickness, which will aggravate the misalignment. When this is the case, align the Vs with each other, as this is the perfect way to line up the belts. Misalignment causes uneven wear on one side of the belt, which causes it to roll over in the sheave, or it can throw the entire load on one side of the belt, stretching or breaking the cords. Therefore:

Parallel the position of the sheave shafts.

Correctly align the grooves in the sheave.

Step 10
Install the new belts on the sheaves so that the slack sides of all belts are on the same side, either top or bottom, of the drive.

Caution: Under no circumstances install the belts by prying them onto the sheaves with a screwdriver or any other forcible method. This will damage the internal cords of the belts and possibly break off the rim of the sheave's sidewalls, which would cause unbalance of the rotating components. The motor must always be detensioned enough to allow the belts to be removed or installed without forcing them.

Step 11
Adjust the tensioning screws to pull the motor away from the driven unit until the belts are correctly in tension. The following formula is used for determining the correct tension of the belts:

Tension load = The distance in inches between the axes of the driver and driven shafts x 1/64"

For example, if the distance between the centers of the driver shaft and the driven shaft is 64 inches, the belt deflection load will be:

Deflection Load = 64 inches x 1/64 inch = 1 inch of deflection

Step 12
When the belts are correctly in tension, paint a thin, narrow line across the belts' top surfaces at 90 degrees to the length. (After the unit is started, a strobe light flashing on the belts at the operating frequency of the belts will show the painted line appearing as if it was stopped. Should there be any slippage, the belts that are slipping will be moving away from the line at various speeds according to their degree of looseness. This can be expected during the initial run-in period, but the belts must again be retensioned to allow the correct deflection. This may have to be repeated until all of the slack is taken out of the belts.)

Step 13
Replace the safety guard before removing all lockout and tag-outs. Note: The safety guard should be constructed from extruded open mesh steel as this permits free passage of air to circulate across the belt area in order to keep the belts cool and allow heat to escape.

Step 14
Start the unit and allow the belts to seat themselves in the grooves of the sheaves.

Step 15
Stop the unit after a few hours to check the tension of all of the belts. (Refer to Step 12). Note: Before checking the belt tension, ensure all of the lockout procedure is in place.

Step 16
Restart the unit. Note: This is probably the most ignored task in belt installation, but it is a very important step in the operation and maintenance of V-belts. As such, it is worth repeating the following:

After the machine has run for 48 hours, the tension on the new belts should be checked and retightened to the correct midspan deflection setpoint. This process must be repeated until all of the stretch has been eliminated. Belts that squeal during acceleration or when operating at full load usually have slippage. Never add a lubricant to the belts. Squealing merely indicates that the belts need to be tightened. This will extend the lifespan of the belts and bearings immensely.

Avoid leaving old V-belts and other maintenance debris lying around after maintenance activities are completed. Collect waste products in an approved container and dispose of this waste according to established procedures.