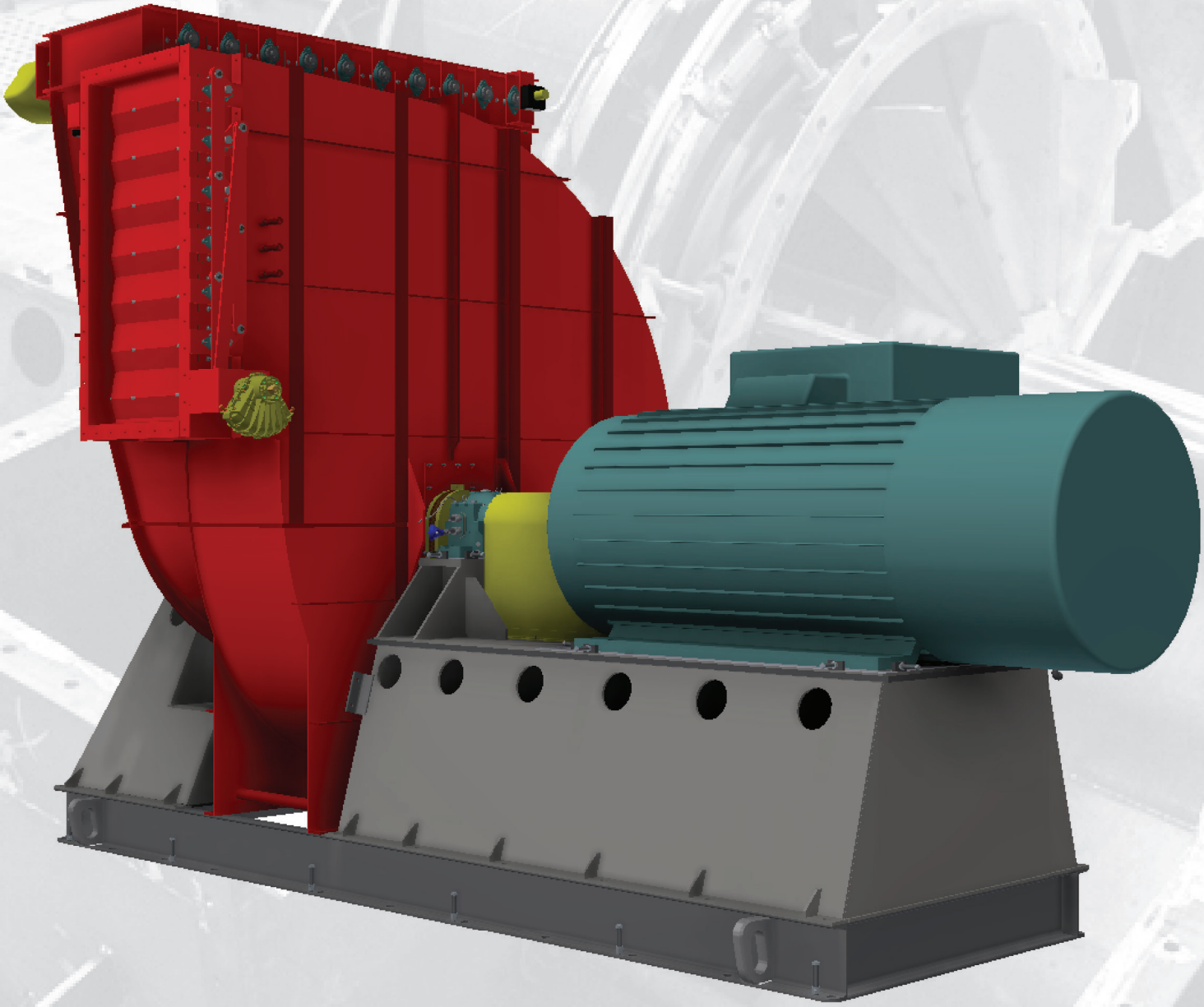
OPERATION AND MAINTENANCE INSTRUCTIONS



EDITION 10, REV. 7

Robinson Fans

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Robinson Field Service: Robinson's experienced field service technicians can help ensure a satisfactory fan installation and start-up. The technicians can also assist with problem detection and correction to maximize fan life and satisfactory operation. Robinson's field service technicians bring many years of plant and field experience and are able to quickly identify causes of problems and offer and implement satisfactory solutions.

I. PRE-INSTALLATION

A. INTRODUCTORY REMARKS

This manual was published to assist the customer in the storage, installation, operation, and maintenance of Robinson Fans, Inc. heavy-duty centrifugal fans. Due to the wide variety of arrangements and custom-built features, please use this manual in conjunction with the Robinson assembly drawings that were provided. Also, reference all other special tags on the fan equipment to insure complete satisfaction in installation and operation of equipment.

These instructions have been developed as a guide for the installation of heavy-duty fan equipment, and erection personnel have found the procedures and methods described herein to be satisfactory under usual conditions. These instructions are not considered complete in themselves, but as supplemental to general erection techniques. Robinson Fans, Inc. does not take responsibility for any omissions in this manual or on assembly drawings of details commonly considered good practice by competent erectors.

Should any questions or suggestions arise pertinent to these instructions, your correspondence will gladly be received at:

ROBINSON FANS, INC.
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Phone: (724) 452-6121 Fax: (724) 452-0388
Website: www.robinsonfans.com

Robinson Fans, Inc. warrants against defects in workmanship and material (refer to standard warranty).

NOTE: All information specifically outlined by Robinson Fans, Inc. in this manual and on assembly drawings supersedes that of any sub-vendor mentioned herein. Specific information shown on Robinson's assembly drawings takes precedence over information and data listed in this manual.

B. SAFETY PRECAUTIONS

It is the responsibility of the purchaser to insure that installation is handled by qualified personnel experienced in installing this type of equipment.

The following safety precautions must always be observed:

1. Maximum operating temperature and speed for fan equipment must not be exceeded. Refer to assembly drawings for the maximum speed and temperature for your equipment.
2. Bearing temperature must not be exceeded. Refer to "Bearing Temperature Limits" located in "OPERATION" (pg. 22).
3. Protect properly against electrical hazards related to motor operation. Refer to specific information supplied on motor installation.
4. Protective guards for shaft, coupling, heat flinger and belts must be provided and in place during operation. Refer to Figure 1.
5. Inlet and outlet screens must be provided and in place to prevent entrance of external objects into rotating parts.
6. Access doors to fan or duct system must never be opened during operation of fan. Those located on the discharge side of the fan may open violently if opened while fan is operating.
7. To prevent possible electrical start-up of fan during maintenance, be sure to electrically lock-out equipment before working on fan.
8. Beware of hot surfaces. Allow sufficient cool-down period before beginning any maintenance work.
9. Remove all loose materials from inside of housing and duct work prior to start-up. Before allowing anyone to enter the interior portions of the fan or ductwork, the customer's confined space entry procedure(s) must be strictly followed.
10. Inspect the fan rotor on a regular basis. The rotor is subjected to stresses from centrifugal force and vibration. It may also be exposed to particulate erosion (wear) and/or corrosion attack. A careful visual inspection of the cleaned rotor by a knowledgeable inspector should be performed periodically to insure that no cracking or other structural damage has occurred. Do not operate the fan if it has cracks or structural damage.
11. The vibration of the fan bearings (or of the shaft surface on units with sleeve bearings) should be carefully monitored. Observe the alarm and shutdown limits shown in Table 7 (pg. 22) of this manual. Be sure that vibration instruments are operating properly and that they are calibrated frequently.
12. For further safety practices, refer to AMCA Pub. 410.

FIGURE 1: *ILLUSTRATES USE OF PROTECTIVE GUARDS ON SHAFT AND V-BELT DRIVE*

C. SHIPPING AND RECEIVING

Upon arrival of the equipment, check that all items on bill of lading and/or invoice have been received. Partial shipments are often made.

All shipments are thoroughly inspected prior to shipment. Regardless, rough handling en-route may damage the fan components. The receiving party must thoroughly inspect all shipments for possible damage. Any damaged parts are the responsibility of the carrier and should be reported to them immediately upon arrival.

Robinson cannot be held responsible for adjustments of such claims if the delivery receipt is signed without specific notation of shortage or damage. Any damages noticed after delivery should be reported to the carrier at once. Request their inspection of the shipment and fill out a concealed damage inspection report.

Robinson Fans must be notified in writing immediately of any lost or undelivered parts. Complaints issued more than 30 days after delivery will not be reviewed.

D. HANDLING

Pre-Assembled Units:

Fans arriving at the job site assembled can be picked up using slings and padding or spreaders to avoid damage. Where slings are used, they should be placed under the bearing and at lifting lugs. Ensure that all lifting and handling equipment and techniques conform to current safety standards.

Avoid lifting fans or parts in a way that will concentrate stresses, which may bend or distort fan parts. Never pass slings or timbers through the inlets of the fan housings.

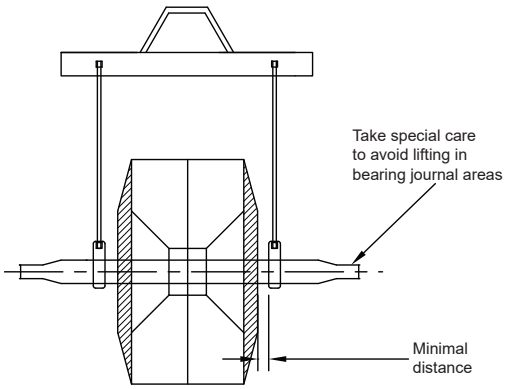
Dissassembled Units:

Special coverings (such as rubber, phenolic enamels, etc.) require care, as they are easily damaged. Touch up any chips or breaks prior to erection. Refer to sections on “Elastomeric Coated Fans” (pg. 19) and “Paint” (pg. 21) for more information on special coatings. Many rotor and shaft assemblies are shipped on a fabricated wood rotor cradle for ease of handling in shipment and unloading. To remove the rotor and shaft assembly from the cradle, place slings around the shaft as close to either side of the rotor as possible. A spreader bar must be used during lifting to help eliminate damage to the rotor. Refer to Figure 2.

The following must also be observed during handling:

1. Never allow chains to be in contact with the rotor during lifting.
2. Be sure that slings are not damaged in any way and are rated to lift the weight of the fan equipment.
3. Never lift rotor by blades or flanges.
4. Never roll rotor.
5. Never rest entire rotor weight on the housing side plates; block to prevent this.
6. Never set rotor down so that it supports the shaft; use wood supports under shaft to support rotor by shaft.
7. Never ship rotor leaning over and supported by the shaft; this can result in a bent shaft.
8. Never lift double width, double inlet housing by putting timber or sling through inlets. To lift, use skid under housing or sling around housing or through lift lugs provided in side sheet bracing.
9. Never lift rotor by shaft sleeves or in bearing journal area (if applicable).

FIGURE 2: *LIFTING ROTORS*



E. INLET BOX PLACEMENT

Inlet boxes may be shipped separate from housing, but are then bolted to the housing in the field and field welded after alignment. All welding is to be done after installation of fan unit is complete. Refer to “Bolted Inlet Box Construction” (pg. 14) for specific welding specifications.

F. STORAGE STANDARD REQUIREMENTS

Robinson’s fans are suitably prepared at the factory to protect them during shipment to the job site and for a reasonable period before installation (30 days). This normally includes protecting the shaft with a soluble removable coating and wooden slats. For shipment of assembled fans, the rotor may be blocked or strapped to avoid rotation during shipment. Be sure to remove the blocks or straps prior to operation.

Long-Term Requirements:

If fans must be stored for an extended period (longer than 30 days), the storage site should be a clean, dry, well-ventilated, properly drained, temperature controlled environment (60 - 90°F). For disassembled units, remove shaft protective coating once every 60 days and inspect shaft journal surface for possible corrosion. Replace the complete protective system prior to returning to storage.

Note: ***For disassembled units, rotors should not be rotated in their shipping skid.***

For pre-assembled units, include room for inspection, lubrication, and maintenance such as turning the fan rotor by hand to make certain all parts retain proper lubrication. The rotor should be rotated a minimum of 10 revolutions every week (can be increased to a monthly basis for equipment stored indoors under the controlled environmental conditions noted above) using the following sequence for final resting position:

- Week 1: 0°
- Week 2: 90°
- Week 3: 180°
- Week 4: 270°, etc.

BEARING PROTECTION (PERTAINING TO BOTH SHORT AND LONG-TERM STORAGE)

Ball Bearings:

Prior to shipment, fans with pillow blocks are usually factory tested. These bearings are pre-lubricated and should not require additional grease for start-up. If fan is not expected to be put into use immediately, it is advisable to add lubricant so as to eliminate any air gaps in the bearing reservoir which may collect moisture. At start-up, excess lubricant will be released through the seals. This is a normal purging action that will permit cooler operation, and the lubricant should not be replaced. Any time the fan unit is not in operation, the bearings should be protected by waterproof paper to avoid contamination.

SAF Spherical Roller Bearings:

These bearings may be factory or field mounted depending on fan size and design. If factory mounted, they may or may not have been test run, depending upon size. Factory mounted bearings have either been lubricated with correct amount of lubricant to permit operation upon installation, or the bearing race and housing has been completely packed full of grease and will be tagged to indicate this. Robinson advises that the bearing caps be removed, the bearing inspected for moisture contamination, and lubricant level confirmed prior to start-up.

NOTE: ***If field mounted, bearings are shipped with a preservative only and bearing must be lubricated before operation begins.***

If unit is not to be put into operation immediately, pillow block and bearing should be handpacked full of grease. Care must be taken to ensure that no moisture or dirt particles are entrapped during this procedure. Label the bearing that it contains too much lubricant for operation and cover with waterproof paper. When preparing the unit for operation, remove bearing cap and all lubricant using a clean instrument and unsoiled cloth. Inspect bearings, then apply fresh lubricant as specified. Greasing is complete if grease appears on the opposite side. Pack the bearing housing per the bearing manufacturers' instructions.

NOTE: ***Extreme caution must be taken not to contaminate bearings when working on them. Bearings which have top or side caps removed should never be left unprotected.***

Upon removal from storage, the following procedures should take place:

1. Removal of rust preventative from shaft journals.
2. Thorough examination to ensure that no build up of foreign material has occurred from the elements or nearby processes.
3. Examination to make certain that paint or coating is still in first-class condition.
4. Bearings re-lubricated to specifications as described in "Lubrication" section (pg. 25) and on assembly drawing. Do not use substitute lubricants unless approved by Robinson.

SLEEVE BEARINGS

Storage in Assembled Shaft Mode:

1. Drain pillow block sump and replace standard non-detergent specified oil with Mobil Vaprotec or equivalent.
2. Operate fan for 30 minutes or until all of the liner surfaces and housing inside surfaces are covered with this rust preventative oil.
3. Shut down the fan.
4. The fan must be rotated once a week for 15 minutes to restore the oil cover on shaft, liner and housing surfaces.
5. Fan may be left in this manner for a maximum of six months. If downtime exceeds this limit, the Vaprotec oil must be drained and fresh Vaprotec added. Fan must be rotated per steps 1-4.
6. Prior to fan start-up, the rust preventative oil must be completely drained out of housing sump and filled with standard non-detergent specified oil.

General Storage (Shipped loose):

1. Store in a heated and dry area. Temperature during storage should range between 50°-150°F with a maximum relative humidity of 60%.
2. Periodic inspections should be made of all exposed, unpainted surfaces at three month intervals or less.
3. Store bearings off of the floor and keep covered with plastic, but do not seal as sealing will trap moisture.

G. FOUNDATIONS

A rigid, level foundation is essential for every fan set-up. This ensures smooth, quiet operation, good performance, and reduces excess vibration and maintenance costs. The sub-foundation (soil, stone, rock, etc.) should be firm enough to prevent uneven settlement of the structure, and have adequate stiffness characteristics to avoid rocking or translational vibration resonances. Foundation bolt locations are found on the assembly drawings. An improperly constructed foundation may cause vibration and possible misalignment of the rotating assembly.

If the fan is to be mounted with sole plates under the bearing supports, make allowances for dimensions of sole plates and grouting when preparing the foundation. Fan foundation must be flat, level and rigid.

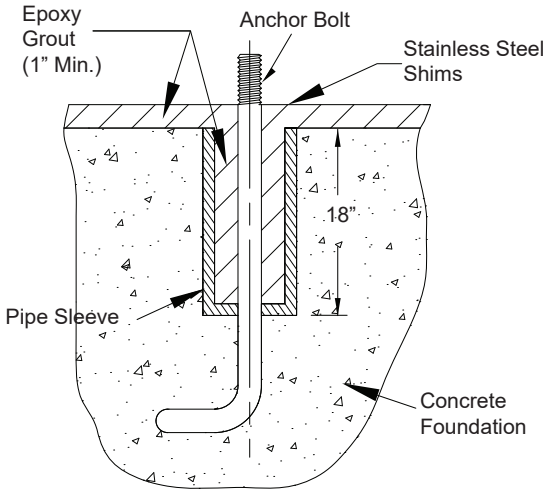
Poured concrete (single monolithic pour) under the fan and all drive components is the preferred fan foundation.

A generally accepted recommedation is that the weight of the foundation mat be at least five times the total weight of the equipment it will support. This weight acts as an inertia block to stabilize the foundation. The foundation should be flared or the footing course increased in size to resist settling. The top of the foundation should extend at least 6" outside the outline of the fan base and should be beveled on the edges to prevent chipping. The drive end and opposite drive end concrete pedestals should each have a minimum weight equal to that of the wheel and shaft assembly. Concrete pedestal sides should slope away a minimum of 15° starting at the top. The sides may be vertical if the drive end concrete pedestal is common with the motor concrete pedestal.

Very large fans and/or variable speed drive fans require special foundation considerations. The purchaser may elect to perform a system forced response analysis to determine the natural frequencies and expected vibration amplitudes with reasonable rotor unbalance forces. Refer to AMCA Publication 801. When a structural steel foundation is necessary, it must be sufficiently rigid to assure permanent alignment. It must be designed to carry, with minimum deflection, the weight of the equipment plus the loads imposed by centrifugal forces set up by the rotating element (generally 50% of rotating weight).

Fans installed above ground level should be located near to or above a rigid wall or heavy columns. An overhead platform or support must be rigidly constructed level and securely braced independently from the fan in all directions. In any above ground installation, design of the structure should permit field revisions (e.g: knee braces) if initial operation indicates a need for increased stiffness. Spring mounted vibration isolation bases are recommended for many fans mounted on structural steel to avoid vibration transmission problems. Refer to section on "Vibration Isolation" (pg. 20).

FIGURE 3: *TYPICAL FOUNDATION ANCHOR*



Anchor bolts in concrete should be “L” or “T” shaped (refer to Figure 3) and should be placed in pipe or sheet metal sleeves roughly 2” larger in diameter than the anchor bolts to allow for adjusting the bolts in case they move slightly when concrete is poured. Foundations must be level, and allowance must be made for a minimum of 1” of shimming and grouting when determining the top surface of the foundation.

Jacking bolts must be removed and hold-down bolts tightened prior to grouting. All space under the base angles should be grouted. Foundation bolts should be tightened and base re-checked for level.

On all large fans, foundations should be keyed to bedrock, and use of piling may be necessary. A civil engineer should be consulted before such a foundation is constructed.

H. DUCT DESIGN

Improper duct design can cause system effect that decreases fan performance. Some guidelines are shown in Figure 4. Also, refer to AMCA Publication 201. Expansion joints and/or flexible connections are essential and must be provided at fan inlet and outlet in order to isolate fan from duct temperature expansion loads, duct static loads, and vibration loads (refer to Figure 4). Flexible connections may be multiple bellows expansion joints, banded slip joints or fabric or sheet plastic flexible joints. The type of expansion joint is dependent on fan operating conditions, such as temperature, etc. Internal flow liners are required for inlet expansion joints to prevent expansion joint collapse, which can possibly result in reduction of fan performance. Internal flowliners are recommended for outlet expansion joints.Refer to “Expansion Joints” (page 18). Ductwork must be structurally anchored near the fan as specified on the Robinson Fans general arrangement drawing. Flexible connections may require acoustic treatment to reduce noise. Refer to “Sound Considerations” section (pg. 19) for more information on flexible connections.

Avoid elbow immediately adjacent to the fan inlet and outlet.

Butterfly dampers are not recommended for throttling at the fan inlet. Refer to AMCA Publication 201 “Fans and Systems” for additional information on duct design and system effects.

FIGURE 4: *INLET AND OUTLET CONNECTIONS*

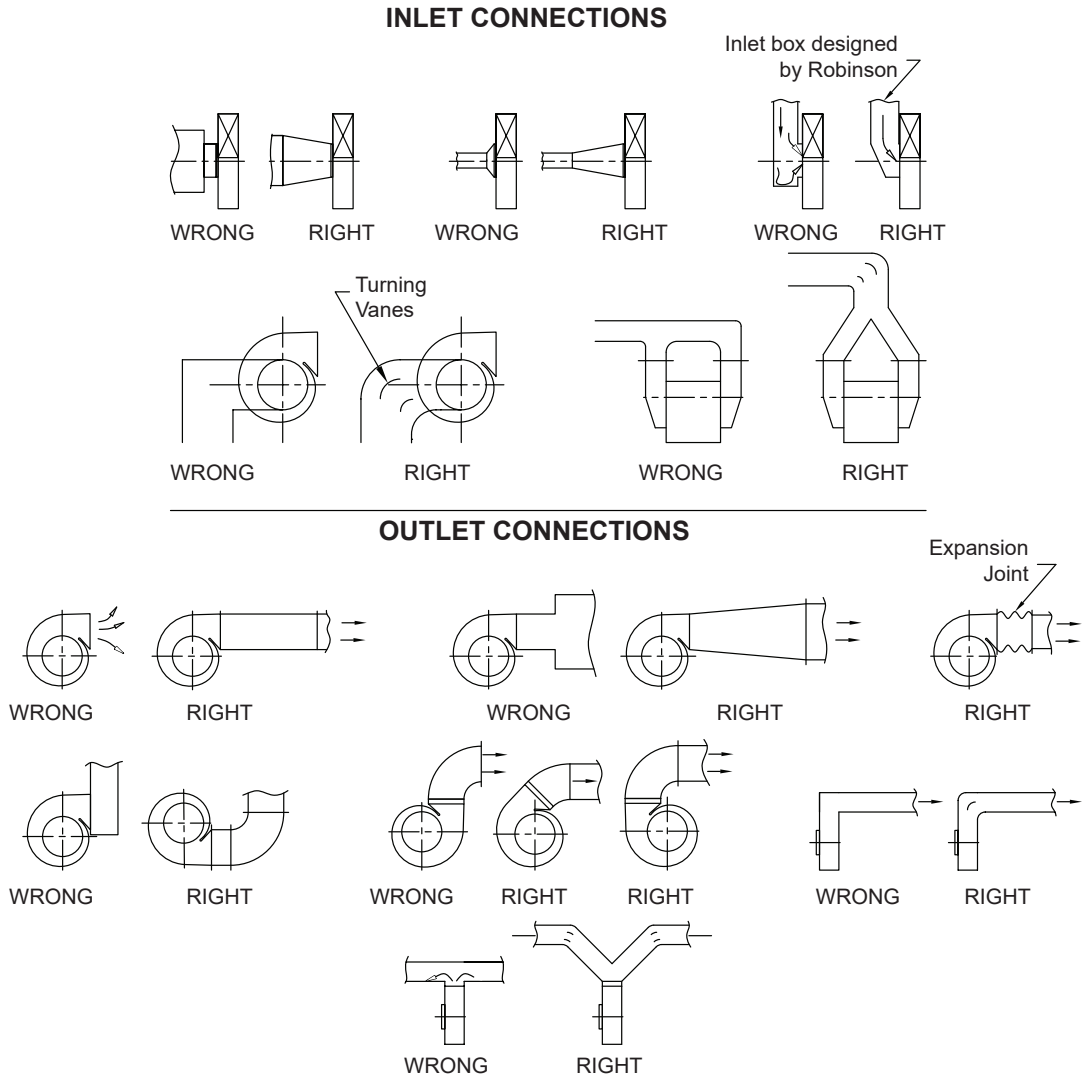
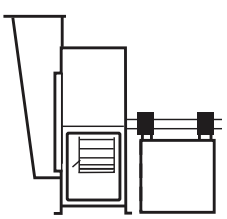
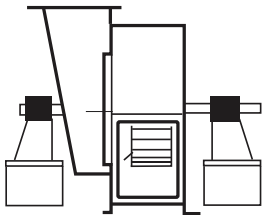


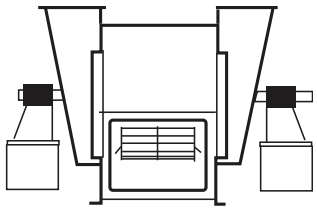
FIGURE 5: *ADAPTED FROM AMCA (PUBLICATION 99-10, STANDARD HANDBOOK) WITH WRITTEN PERMISSION FROM AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.*



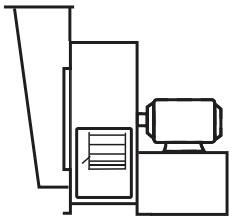
ARR. 1 SWSI WITH INLET BOX
For belt drive or direct connection. Impeller overhung, two bearings on base. Optional inlet box may be self-supported.



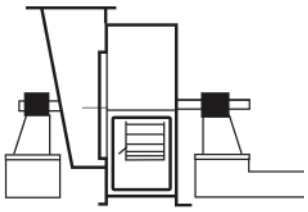
ARR. 3 SWSI WITH INLET BOX AND INDEPENDENT PEDASTALS
For belt drive or direct connection. Housing supporting. One bearing on each side supported by independent pedestals with shaft extending through the inlet box.



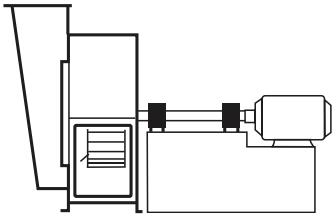
ARR. 3 DWDI WITH INLET BOXES AND INDEPENDENT PEDASTALS
For belt drive or direct connection. Housing supporting. One bearing on each side supported by independent pedestals with shaft extending through the inlet box.



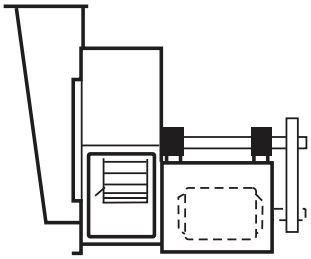
ARR. 4 SWSI
For direct drive. Impeller overhung on prime mover shaft. No bearings on fan. Prime mover base mounted or internally direct connected. Optional inlet box.



ARR. 7 SWSI WITH INLET BOX
Steel base for bearing and prime mover center hung impeller. Optional structural common sub-base available (not shown).

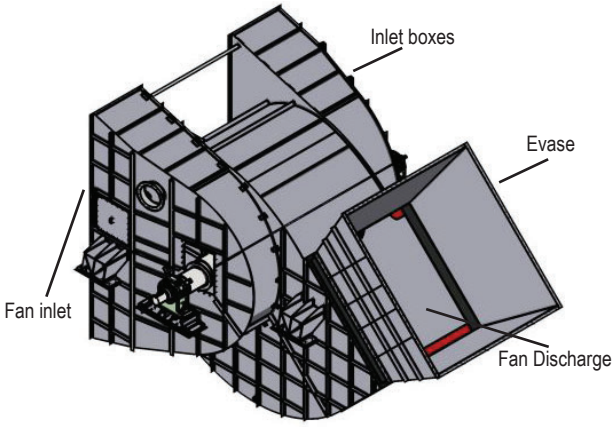


ARR. 8 SWSI WITH INLET BOX
For direct drive. Impeller overhung, common steel base for bearing and prime mover. Optional inlet box.

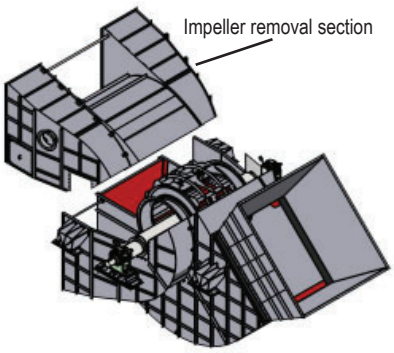


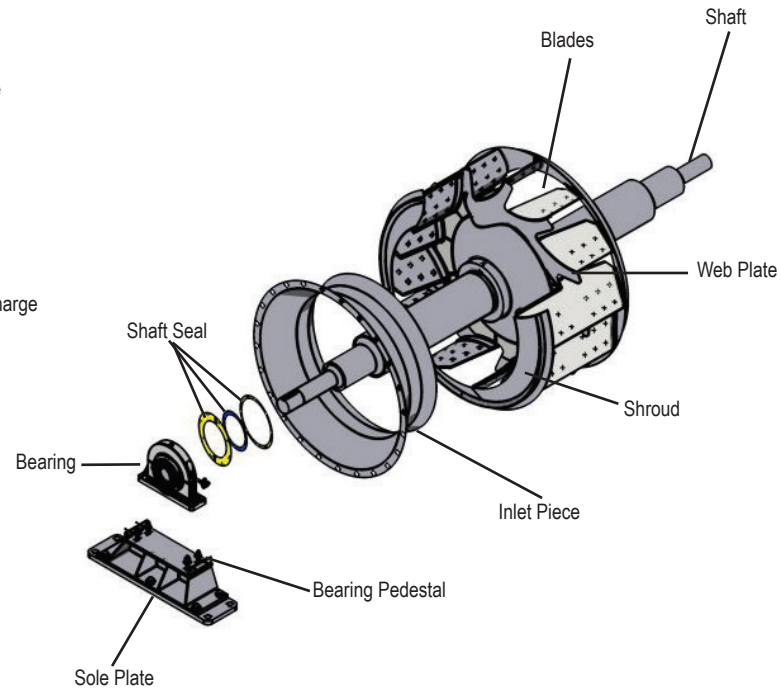
ARR. 9 SWSI WITH INLET BOX
For belt drive. Impeller overhung, two bearings, with prime mover on bearing base. Optional inlet box.

FIGURE 6: *TERMINOLOGY FOR CENTRIFUGAL FANS*



Double Width Double Inlet Fan with inlet boxes





II. INSTALLATION

NOTE: ***Be sure that all equipment is electrically locked out during all phases of installation***

A. RECOMMENDED TORQUES FOR BOLTS AND STUDS

If no specific torque value is shown on the assembly drawing, then use the torques per Table 1.

TABLE 1: *NON-LUBRICATED THREADS*

	BOLTS			BOLTS			STUDS	
Nominal Dia	UNC (Coarse Thread) TORQUE FT-LBS			UNF (Fine Thread) TORQUE FT-LBS			UNC TORQUE	UNF FT-LBS
	GR 2	GR 5	GR 8	GR 2	GR 5	GR 8	GR 2	GR8
1/4	5.5	8	10	6.3	10	12	4	4.5
5/16	11	17	21	12	19	24	8	9
3/8	20	30	40	23	35	45	14	16.5
7/16	32	50	60	36	55	70	23	26
1/2	50	75	95	55	90	100	35	40
5/8	100	150	190	110	180	210	71	80
3/4	175	260	320	200	300	360	125	140
7/8	170	430	520	180	470	580	202	223
1	250	640	800	270	710	860	303	339
1 1/8	350	800	1120	400	880	1260	---	---
1 1/4	500	1120	1580	550	1240	1760	---	---
1 1/2	870	1940	3160	980	2200	3560	---	---

B. HOUSING ALIGNMENT

Arrangement 1, 7, 8 AND 9:

1. Using machinist's precision level on shaft between bearings, shim at the foundation anchor bolts to attain level within 0.005 in/foot.
2. Tighten hold-down bolts on foundation.

Note: ***The above procedure for housing aligment applies to Arrangement 7 fans supplied with a common sub-base.***

Arrangement 3

1. If housing was shipped disassembled, lift bottom half of housing onto foundation. To prevent damage to anchor bolts while housing is being moved, place wooden blocks beside the anchor bolts.
2. Use spreader bars as necessary to minimize distortion while lifting housing. Lift housing from as many points as possible and align over anchor bolts.
3. Once aligned over anchor bolts, lift housing one side at a time, remove the block, and carefully lower housing onto foundation. **NOTE:** ***Parts are match-marked to aid in assembly***.
4. Place stainless shims (approximately the same thickness as the grout) on each side of the anchor bolt. Shims should be approximately 100mm wide and flush with the edge of the base angle. Refer to Figure 7.

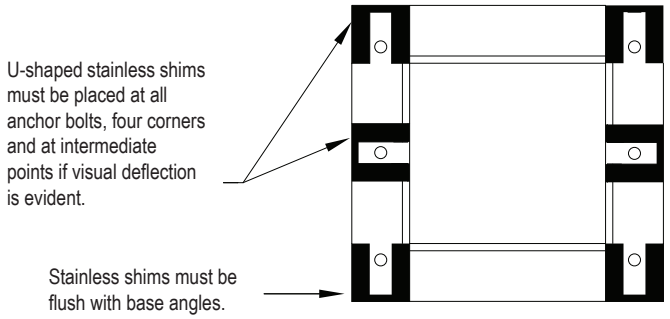
For center supported housings, refer to "High Temperature" section.

For Arrangement 7 fans supplied without a common sub-base, please follow the above Arrangment 3 procedure for housing alignment.

C. SETTING AND ALIGNMENT OF BEARING PEDESTALS

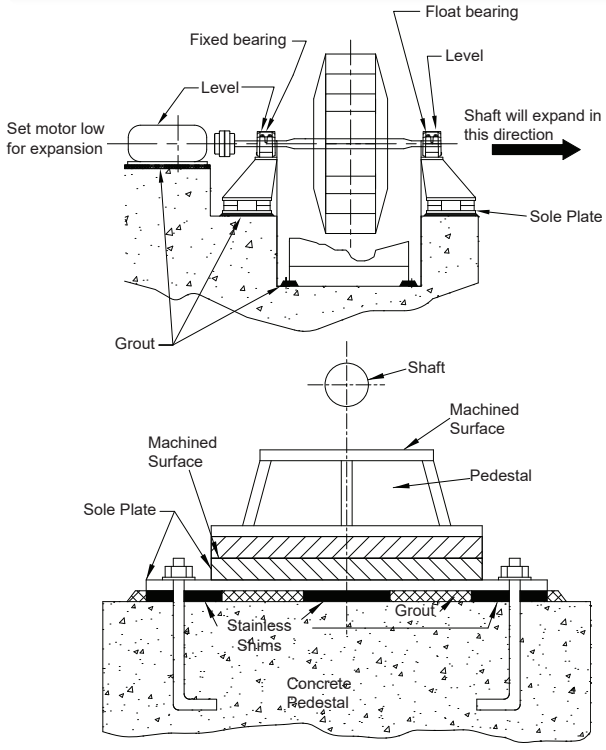
1. Use shims between the foundation and bearing pedestal to put bearing pedestals in place at the proper bearing centerline height. **NOTE:** ***Bearing pedestal may or may not be supplied with a sole plate that provides bolted separation for removal of bearing pedestal without disturbing foundation connections (Refer to Figure 7).***

FIGURE 7: *SHIM PLACEMENT DETAIL*



2. Leveling nuts not permitted. If used, leveling nuts must be removed before grouting.
3. Level the drive side bearing pedestal within 0.005 in/foot in all directions using stainless shims under the sole plate or under the bearing pedestal if supplied without sole plate. Use of a surveyor's transit is very helpful in this operation.
4. Level the opposite drive side bearing pedestal within 0.005 in/ft in all directions using stainless shims under the sole plate. Use of a surveyor's transit is very helpful in this operation.
5. Adjustment of "L" or "T" anchor bolts is helpful in leveling sole plate. After final alignments are made, place stainless steel shims next to each "L" or "T" bolt and at the shaft centerline (both sides) under the sole plate before grouting (Refer to Figure 8).

FIGURE 8: *ROTOR ALIGNMENT/SHIMMING DETAIL*

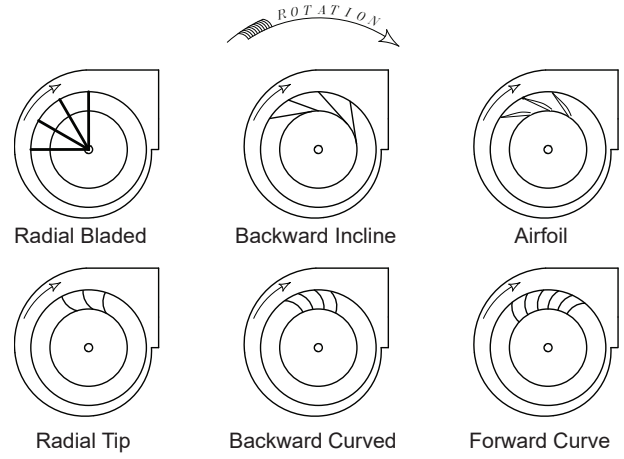


6. Temporarily bolt down bearing pedestals.

D. ROTOR ASSEMBLY PREPARATION

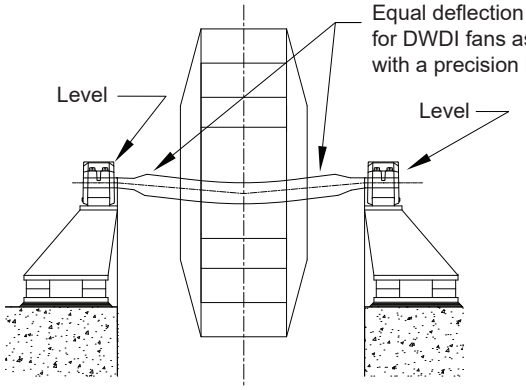
Most Robinson heavy duty rotors are shipped with a shrink fit to the shaft. Check the assembly drawing for proper rotation (refer to Figure 9)

FIGURE 9: *TYPES OF CENTRIFUGAL FAN IMPELLERS ADAPTED FROM AMCA (PUBLICATION 202-98, TROUBLE-SHOOTING) WITH WRITTEN PERMISSION FROM AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC.*



1. Place rotor on floor, ensuring proper bracing is in position.
2. Remove protective coatings (as applicable) from shaft and hub. Inspect for rust, corrosion, and nicks.
3. Clean up may be necessary. Crocus cloth or “Scotchbrite” may be used for clean up of journal surface. (NEVER use emery cloth on bearing journals.)

FIGURE 10: *CHECKING SHAFT LEVEL*



E. SETTING OF INLET PIECES

The inlet piece(s) must be placed over the shaft end before mounting the rotor assembly in the housing. (Please ensure match marks correspond on the inlet piece(s) and the fan housing). If variable inlet vanes are provided, check for proper rotation, inlet vanes in the half-closed position must pre-spin the air in the direction of rotor rotation. On a DWDI fan, one inlet vane control is counter-clockwise, the other clockwise. They must not be installed reversed. Secure inlet vane controls to rotor for lifting purposes. If vane center mechanism is allowed to rest on shaft, damage may result.

F. BEARING PREPARATION AND SETTING OF ROTOR ASSEMBLY

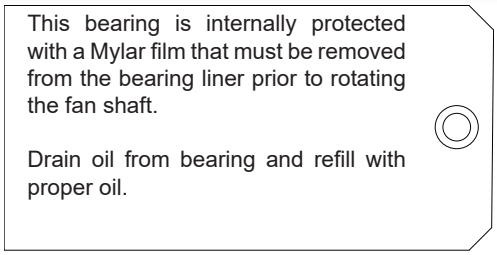
Sleeve Bearings

(Refer to Dodge instruction manual, if applicable for your fan.)

1. Remove bearing caps; clean with solvent.
2. Coat with new oil and cover bearings with plastic to avoid contamination.
3. Clean shaft seals and oil rings.
4. Loosely bolt lower half of bearing housing into place, then cover to avoid contamination.
5. Move rotor assembly into place, holding just above bearing housings. The bearing liner bottom halves should be rolled into place in their corresponding housings. Ensure the thermocouple holes in liners align with holes in housings. This requires the removal of one water cooling pipe nipple to allow for liner placement. After liner bottom halves are in place carefully lower the rotor assembly until just resting in the liners. The bottom halves of the RTL bearing thrust collar plate kit should now be installed. The rotor assembly should now be completely lowered into bearing liners.

For pre-assembled units with sleeve bearings, mylar film must be removed from the bearings prior to operation. See Figure 11.

FIGURE 11: *MYLAR TAG*



Dodge Plain and XC Bearings

Split thrust collars are field mounted during installation. Refer to specific instructions.

Dodge RT Bearings

Thrust collars are either integral to the shaft or split for factory or field mounting into pre-machined groove. Refer to specific instructions attached for field mounted thrust collars.

Anti-Friction Bearings – Solid Pillow Blocks

(Refer to bearing manufacturer literature)

Solid pillow blocks are placed over shaft ends before putting rotor in place (bearing adapter nuts to face fan rotor). Refer to assembly drawing for floating bearing and fixed bearing location.

NOTE: ***Two fixed bearings are used on some applications which may require spreading pillow blocks apart during bearing installation to accommodate maximum thermal shaft expansion between bearings during operation.***

Anti-Friction (Spherical Roller) Bearings – Adapter Mount, Split-Pillow Block

(Refer to bearing manufacturer literature)

1. Cleaning of internal parts is not necessary since the corrosion preventative compound applied by the manufacturer is compatible with the Robinson recommended lubricants. Carefully inspect all internal parts since corrosion, if undiscovered, can lead to mechanical problems.

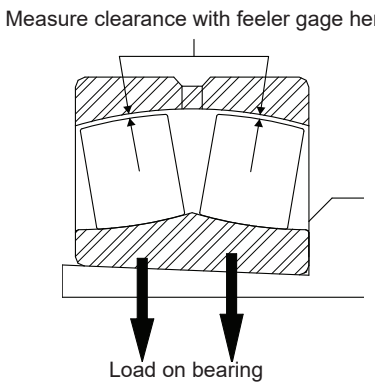
2. Cover open pillow blocks and bearing parts which are exposed to the atmosphere with a clean cloth to prevent dust or moisture contamination.
3. Assemble bearings onto shaft as per bearing manufacturer instructions. Loosely tighten bearings to shaft.
4. Sling rotor assembly as previously described and lift into place. Repositioning of bearings may be required.
5. Pay particular attention to bearing internal clearances before and after tightening. For cap loaded bearings, be sure to pull down shaft with strapping to properly check bearing internal clearances. Final tighten bearings. Refer to Table 2 and Figure 12.

TABLE 2: *ADAPTER MOUNT SPHERICAL ROLLER BEARING INTERNAL CLEARANCE AS MEASURED WITH FEELER GAUGE BETWEEN THE ROLLING ELEMENT AND THE OUTER RACE AT TOP DEAD CENTER*

Bearing Size Diameter (inches)	Initial Unmounted Clearance (inches)	Reduction in Clearance (inches)	Minimum Final Mounted Clearance (inches)
1 7/16	0.0024 – 0.0032	0.0010 – 0.0012	0.0012
1 11/16	0.0024 – 0.0032	0.0010 – 0.0012	0.0012
1 15/16	0.0030 – 0.0039	0.0012 – 0.0015	0.0014
2 3/16	0.0030 – 0.0039	0.0012 – 0.0015	0.0014
2 7/16	0.0037 – 0.0049	0.0015 – 0.0020	0.0016
2 11/16	0.0037 – 0.0049	0.0015 – 0.0020	0.0016
2 15/16	0.0044 – 0.0057	0.0018 – 0.0025	0.0020
3 3/16	0.0044 – 0.0057	0.0018 – 0.0025	0.0020
3 7/16	0.0044 – 0.0057	0.0018 – 0.0025	0.0020
3 11/16	0.0053 – 0.0069	0.0020 – 0.0028	0.0025
3 15/16	0.0053 – 0.0067	0.0020 – 0.0028	0.0032
4 3/16	0.0053 – 0.0067	0.0020 – 0.0028	0.0032
4 7/16	0.0063 – 0.0079	0.0025 – 0.0035	0.0036
4 15/16	0.0063 – 0.0079	0.0025 – 0.0035	0.0036
5 7/16	0.0071 – 0.0091	0.0030 – 0.0040	0.0035
5 15/16	0.0079 – 0.0102	0.0030 – 0.0045	0.0040

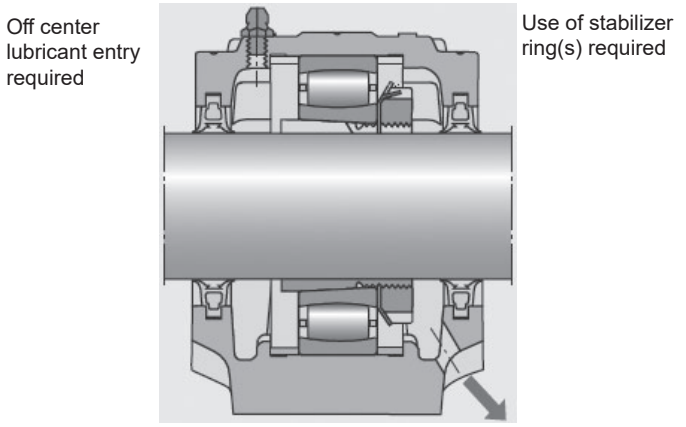
6. Prior to final alignment, replace bearing caps.
7. Locate floating bearing to allow for shaft axial expansion.

FIGURE 12: *SPHERICAL ROLLER BEARING INTERNAL CLEARANCE MEASUREMENT*



Anti-Friction (SKF CARB Toroidal Roller) Bearings – Adapter Mount, Split-Pillow Block

FIGURE 13: *SKF CARB BEARING ASSEMBLY (COURTESY OF SKF)*



NOTE: ***The SKF CARB Toroidal Roller bearing is only a float bearing.***

1. Cleaning of internal parts is not necessary since the corrosion preventative compound applied by the manufacturer is compatible with the Robinson-recommended lubricants. Carefully inspect all internal parts since corrosion, if undiscovered, can lead to mechanical problems.
2. Cover open pillow blocks and bearing parts which are exposed to the atmosphere with a clean cloth to prevent dust or moisture contamination.
3. Assemble bearings onto shaft as per bearing manufacturer instructions. Loosely tighten bearings to shaft.
4. Sling rotor assembly as previously described and lift into place. Repositioning of bearings may be required.
5. Ensure that stabilizer ring(s) are installed in the bearing housing for a SKF CARB as stabilizer ring(s) are required for proper operation.
6. Ensure that lubricant fitting (grease or oil) is in an off-center location as the SKF CARB bearing does not have a W33 groove which allows lubricant to enter the bearing insert through lubricant holes. Failure to properly locate the lubricant fitting may result in rapid failure of the CARB bearing.
7. For circulating oil or oil mist, lubricant must enter the CARB bearing from the side of the bearing insert (off-center location). Drains should be located on the opposite side of the housing from the lubricant entry point.
8. Ensure that bearing inner race to outer race axial positioning is set per the detail provided on the fan assembly drawing. The SKF CARB bearing inner race floats relative to a stationary outer race.
9. Pay particular attention to bearing internal clearances before and after tightening. Final tighten bearings. Refer to Table 3 on the following page.

TABLE 3: *ADAPTER MOUNT TOROIDAL ROLLER BEARING INTERNAL CLEARANCE AS MEASURED WITH FEELER GAUGE BETWEEN THE ROLLING ELEMENT AND THE OUTER RACE AT TOP DEAD CENTER*

Bearing Size Diameter (inches)	Initial Unmounted Clearance (inches)	Reduction in Clearance (inches)	Minimum Final Mounted Clearance (inches)
1 3/16	0.0024 – 0.0031	0.0006 – 0.0009	0.0015
1 7/16	0.0024 – 0.0031	0.0008 – 0.0012	0.0017
1 11/16	0.0029 – 0.0037	0.0008 – 0.0012	0.0017
1 15/16	0.0029 – 0.0037	0.0010 – 0.0015	0.0019
2 3/16	0.0029 – 0.0037	0.0010 – 0.0015	0.0019
2 7/16	0.0035 – 0.0044	0.0013 – 0.0019	0.0022
2 11/16	0.0043 – 0.0054	0.0013 – 0.0019	0.0022
2 15/16	0.0052 – 0.0068	0.0016 – 0.0024	0.0028
3 3/16	0.0052 – 0.0068	0.0016 – 0.0024	0.0028
3 7/16	0.0052 – 0.0068	0.0016 – 0.0024	0.0028
3 15/16	0.0061 – 0.0079	0.0020 – 0.0028	0.0033
4 7/16	0.0061 – 0.0079	0.0024 – 0.0033	0.0042
4 15/16	0.0071 – 0.0091	0.0024 – 0.0033	0.0042
5 3/16	0.0083 – 0.0106	0.0028 – 0.0038	0.0049
5 15/16	0.0094 – 0.0119	0.0031 – 0.0043	0.0055

9. Prior to final alignment, replace and tighten bearing caps.

Tunnel/Mono Block Bearings
(Two bearing races in one bearing housing)

Bearing races and housing placed on shaft before installing rotor and coupling. Bearing assembly instructions are provided separately and/or may be included on Robinson assembly drawing.

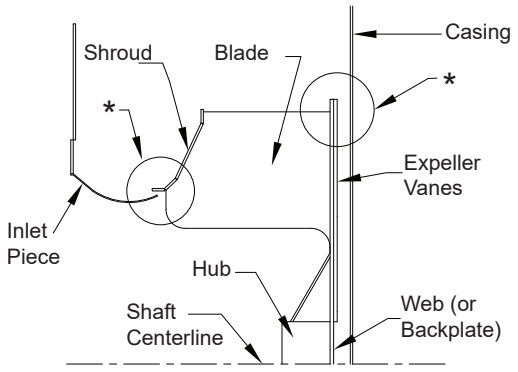
NOTE: ***Special instructions required for rotor removal and re-installation.***

G. ROTOR AND HOUSING ALIGNMENT

Be sure that shaft centerline is the proper height for connection to the driver.

Alignment details of rotor to inlet piece are included on the Robinson assembly drawing. The assembly drawing gives dimensions for the inlet piece to rotor and back plate to housing. Check this alignment before final tightening of pedestals, bearing bolts and bearing locking devices (See Figure 14).

FIGURE 14: **CRITICAL RUNNING CLEARANCES*



H. SETTING AND ALIGNMENT OF BEARINGS

The drive side bearing, non-drive side bearing and motor are all to be set level. Refer to Figure 10. Check to be sure the bearing seal has equal clearance to the shaft all around. No grouting is to be done until all components are leveled and aligned. Adapter mounted spherical roller bearings are to be set per Table 2 (pg. 9) and adapter mounted CARB bearings are to be set per Table 3.

NOTE: Avoid excessive tightening or minimum clearances on stainless steel or high alloy shafts.

I. COUPLING INSTALLATION AND ALIGNMENT

On completely assembled units with pre-mounted motor and coupling, alignment must be re-checked after fan is secured onto its permanent foundation. Adjustments regarding alignment must be made and the coupling relubricated if necessary.

The following is a general description of the installation of grid and gear couplings. For example: Refer to Figures 15-19. Reference specific manufacturer's instructions for other coupling types shown. All bearings, inlet vanes, etc. must be installed prior to aligning couplings.

1. Install each coupling half cover with O-ring (if equipped) on its shaft.
2. Refer to coupling manufacturer's manual to determine which direction long/short shank of coupling hub is to be located (if applicable).
3. Using a hot oil bath, electric heater, or oven, heat coupling hub to temperature of 300° F being careful not to apply flame to hub teeth.
4. Install coupling hub(s) on shaft. (Hub and shaft end should normally be flush).
5. Key couplings to shafts while hubs are at elevated temperature. Allow to cool.
6. Adjust the gap between coupling hub faces. Refer to assembly drawings for proper coupling gap.
7. If using a sleeve bearing motor, and the magnetic center of the motor is not marked, equally divide the maximum end play to determine the mechanical center, then align in this position. A limited end float coupling must be used with sleeve bearing motors. Refer to assembly drawing.
8. Check to insure that the faces of fan and driver couplings are parallel using a tapered wedge, feeler gauges, dial indicator or laser alignment. Refer to Tables 4 and 5 for maximum allowable angular and parallel misalignments.

Notes: ***Align the driver to the fan. Determine if the driver needs to be set low to allow for thermal expansion of the driver. For electric motors, a general guideline is to allow 0.001 inches per inch of motor shaft diameter. Prior to completing coupling alignment, a motor "soft foot" check should be completed to ensure solid motor anchoring.***

9. Align shafts until parallel. Repeat procedure at 90° intervals and re-check angular alignment and hub separation.

Suggested method of alignment is with coupling laser alignment equipment.

Alternate method of alignment: Using a dial indicator clamped on one hub with the dial indicator button resting on the other hub, rotate hubs in unison and take indicator reading. Refer to Figures 15A/B. Repeat procedure at the three remaining 90° intervals. Refer to Tables 4 and 5 for allowable angular and parallel misalignments.

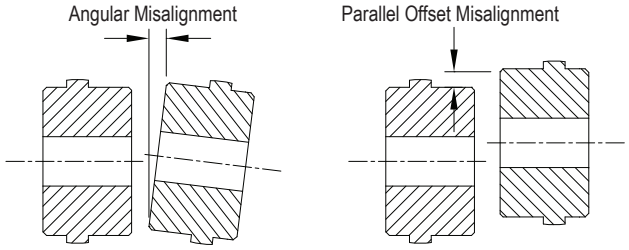
TABLE 4

HUB Outside DIA (inches)	Maximum Allowable Angular Misalignment (Difference in inches between coupling hub gaps measured 180° apart)
2	0.001
4	0.002
6	0.003
8	0.004
10	0.005
12	0.006
14	0.007
16	0.008
18	0.009
20	0.010

TABLE 5

Speed (RPM)	Parallel Offset Misalignment (Maximum allowable total indicated runout in inches)
3600	0.002 – 0.003
1800	0.004 – 0.005
1200	0.005 – 0.006
900	0.005 – 0.006
720	0.005 – 0.006

FIGURES 15 A/B: *COUPLING MISALIGNMENT*



10. As a general rule, set motors low approximately 0.001” per inch of motor shaft diameter to allow for driver expansion during operation. This is intended to bring coupling into alignment during operation. Please refer to the original manufacturer’s instructions for cold alignment settings for other drivers such as turbines, gearboxes, etc.

The following drive unit installation issues may impact coupling misalignment:

a) Rough or dirty surfaces between motor foot and base.

b) Short or tilted motor leg (soft foot condition).

c) Angled or warped motor mounting plate.

d) Dirty, bent, or oversized shims.

e) Too many shims or shims with burrs.

If any of these conditions present themselves in your application, it is essential that they be corrected to provide proper alignment.

11. Inspect gasket for tears or damage.

12. Install gasket between coupling halves. Coupling flanges should then be drawn together keeping gasket in line with bolt holes.

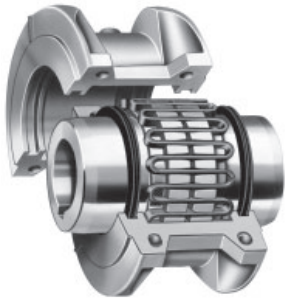
13. Bolts, lockwashers, and nuts are now to be inserted and tightened.

14. Lubricate according to specifications as outlined in grease lubrication charts found in “Maintenance” section (pg. 24).

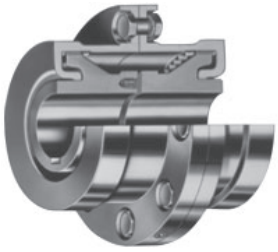
Once unit has been in operation and thermal expansion complete, re-check coupling alignment making adjustments, if necessary.

FIGURES 16: *FALK LIFELIGN ‘G20’ STYLE GEAR COUPLING COURTESY OF FALK CORPORATION*

FIGURES 17: *FALK ‘T10’ STYLE STEELFLEX COUPLING COURTESY OF FALK CORPORATION*

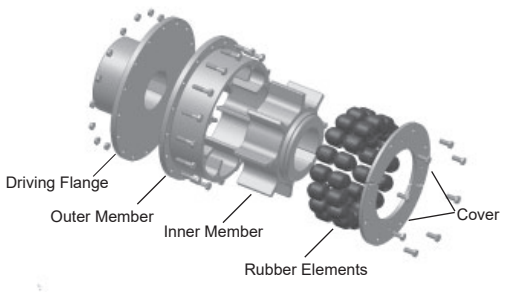


FIGURES 18: *FAST GEAR TYPE COUPLING COURTESY OF THE EMERSON POWER TRANSMISSION*



FIGURES 19: *NON-LUBRICATED METAL DISK-TYPE COUPLING THOMAS COUPLING SERIES 71- COURTESY OF REXNORD*

FIGURES 20: *EXPLODED VIEW OF RENOLD PM COUPLING COURTESY OF RENOLD*



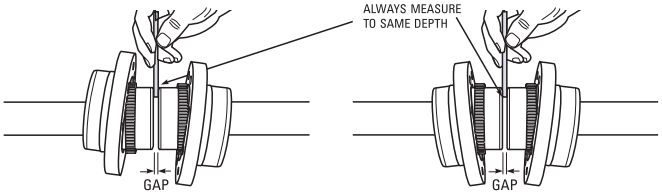
Often recommended for variable speed driven units (Inspect elements once/year and replace if necessary)

To inspect the rubber elements, unbolt the cover of the coupling so that the faces of the rubber elements can be seen. It is not necessary to remove the rubber elements of the coupling. The rubber element should be replaced if any of the following are found:

1. Deep cuts, over 10% of the width of the rubber element
2. Rubber elements which are loose in their cavities.
3. Rubber elements with cracked or sticky surfaces.

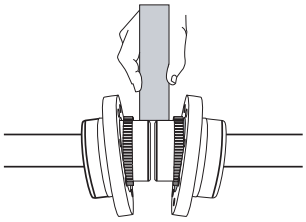
Large amounts of rubber dust and an impression of the coupling inner member on the cover are signs of excessive misalignment.

FIGURE 21: *GAP AND ANGULAR ALIGNMENT*



Use a spacer bar equal in thickness to gap specified in Table 4. Insert bar as shown above to same depth at 90° intervals and measure clearance between bar and hub face with feelers. Courtesy of Falk Corporation.

FIGURE 22: *OFFSET ALIGNMENT*



Align so that a straight edge rests squarely (or within the limits specified in Table 5) on both hubs as shown above and also at 90° intervals. Check with feelers. Courtesy of Falk Corporation.

J. INLET ALIGNMENTS

1. Install gasketing in housing split. Then install split portion of housing.
2. Re-position inlet piece to give correct clearance. Inlet piece should be centered around inlet eye of the rotor unless stated otherwise on assembly drawing.
3. Tighten all remaining fasteners in foundation.
4. Install shaft seals (if applicable).
5. Turn rotor to insure it runs freely.
6. It is often a good practice to add inlet piece support blocks against the inlet piece flange and tack weld them to the housing sides as a means of “fixing” the inlet piece location.

Note: ***Refer to detailed bearing installation information and install bearings.***

K. FAN DRIVERS (MOTORS, ENGINES, TURBINES)

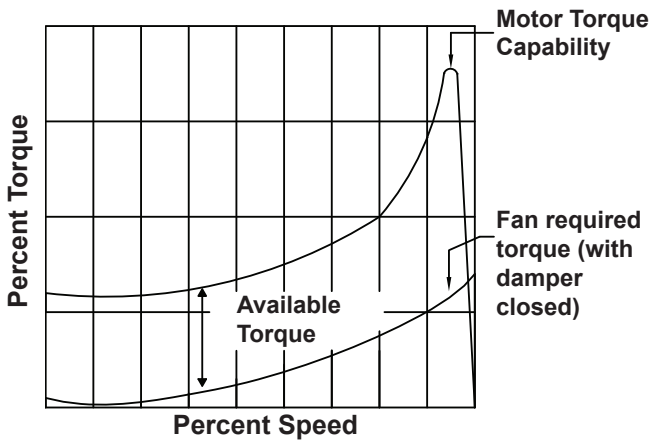
(Fan drivers may be supplied by Robinson or by others.)

STARTING TIME: can be calculated as follows:

$$\text{Time} = \frac{(WR^2)\ (\text{delta RPM})}{(307.2)\ (\text{avail. torque})}$$

time (seconds) delta RPM = change in speed (rev/min) avail. torque = (motor torque capability)-(fan torque requirement) at all speeds from zero to normal operating speed (lb-ft). Refer to Figure 23; WR^2 = fan rotor rotational moment of inertia (lb-ft^2).

FIGURE 23: *TYPICAL SPEED/TORQUE CURVES*



Most single speed fans will achieve full operating speed in 25 seconds or less. Longer starting times can result in motor overheating. The following are typical causes of excessively long starting time:

1. Driver torque not adequate for fan rotor WR^2.
2. Low voltage, causing reduction in motor torque capability.
3. Partially open fan inlet damper causing increase in fan torque requirement.
4. Low temperature (high density gas) causing increase in fan torque requirement.
5. Driver speed-torque curve not providing enough available torque when compared to fan torque requirement (especially on gasoline/diesel engine driver units).

NOTE: ***Drivers are often sized for the operating horsepower at process temperatures and are incapable of starting the fan at cold conditions unless the inlet damper is fully closed throughout the start up.***

Starting switch gear, overload protection, and other electricals are supplied by others unless specifically stated in the purchase order.

Motor Overcurrent Protection

The electric current during starting is typically 5 to 7 times the motor full load current. Motor thermal overload protection is recommended to prevent burnout from excessive starts. Thermal overload protection must be selected to allow high current for up to 25 seconds or more in some cases when starting high-inertia fans. Reference appropriate National Electric Code for guidance.

Starters and Controls

Full Voltage Starting (Across-the-line) initially connects the motor directly to the power lines. The advantages of this method are its low cost, high starting torque, low maintenance, and the fact that it may be used with any standard motor. **NOTE:** ***The high starting torque and high starting current may shock the driven fan equipment.***

Auto Transformer Starting (Reduced Voltage) limits input voltage and reduces inrush current. Normally an adjustable timer is provided for switching to full voltage after the motor has partially accelerated. **NOTE:** ***Motor output torque is reduced by the square of the voltage reduction at the motor and, therefore, starting time is extended.***

Wye Start/Delta Run allows starting at reduced phase voltage at reduced load and inrush current. Starting voltage is full voltage divided by the square root of three. High transient currents are possible at the transition from wye to delta. This is a non-standard motor connection that must be specified at time of order.

NOTES:

1. ***Full load amperage and the motor service factor are listed on the motor name plate.***
2. ***Monitor the motor current and DO NOT OPERATE THE MOTOR IN AN OVERCURRENT CONDITION. In most cases the fan must be connected to the system duct work and/or dampers closed to provide a system resistance before operating the fan.***

Detailed start up limitations are available from the motor manufacturer.

Variable Frequency Applications

To avoid torsional natural frequency problems, a special coupling may be required. Operation below 30% of the motor normal speed at 60Hz should be reviewed with the drive supplier. Variable frequency drives should be properly matched to the motor. Belt drives are not recommended for variable speed applications.

Synchronous Motors

These drivers are designed to eliminate the slip that occurs in induction speeds of 3600, 1800, 1200, 900 RPM, etc. They are rarely used in fan applications. High transient torque pulses are common with synchronous motors and can lead to coupling and/or shaft failures. A torsional analysis is required.

Motor Bearings

Refer to motor bearing manual for lubrication instructions. The recommended vibration alarm and shutdown limits for motor bearings are the same as those of fan bearings. Motor bearings must be sized for rotor weight on Arr. 4 and for belt pull on Arr. 1 and 9. Large motors sometimes supplied with sleeve bearings, allowing axial shaft movement; use a limited end float coupling. Do not use a sleeve bearing motor on belt driven applications.

Motor Rotation

Drive rotation must be specified to match fan rotation. In some instances, motors are uni-directional and should not be assumed to be bi-directional. Fan rotation is determined from the drive side of the fan. For single width fans, the drive side is opposite the fan inlet (reference AMCA 99-10). Motor rotation is “as viewed from the end bell” (opposite the shaft end). Gasoline and diesel engine rotation is “as viewed from the shaft end” and are available only in counter-clockwise rotation.

Motor Mounting

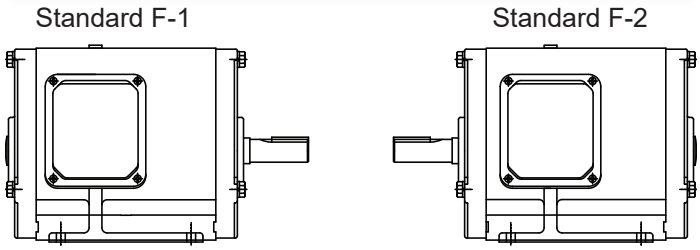
On all belt driven fans the motor must be mounted on a slide rail base for proper belt tension adjustment.

Drivers mounted on concrete pedestals require an auxiliary steel base or soleplate. This mounting plate must be shimmed (during alignment) prior to final grouting.

Motor Main Conduit Box

Conduit box location is important on Arr. #1 and Arr. #9. F1 is standard. F2 is non-standard. Refer to Figure 24.

FIGURE 24: *CONDUIT BOX LOCATIONS - FLOOR MOUNTED OPTIONAL ASSEMBLY POSITIONS*



L. V-BELT DRIVE ALIGNMENT

To insure proper alignment, tensioning, and long belt life perform the following procedures:

1. Check that motor and fan shafts are parallel. Shim motor if necessary.
2. Check for axial alignment of fan and motor sheaves.
3. Balanced sheaves of special materials are required above sheave manufacturer specified peripheral speed.
4. Properly adjust tension of belts:

Force Deflection Method

a) Move driver unit forward to allow for easy installation of belts onto sheave.

b) Refer to manufacturer’s instructions for required force and deflection values.

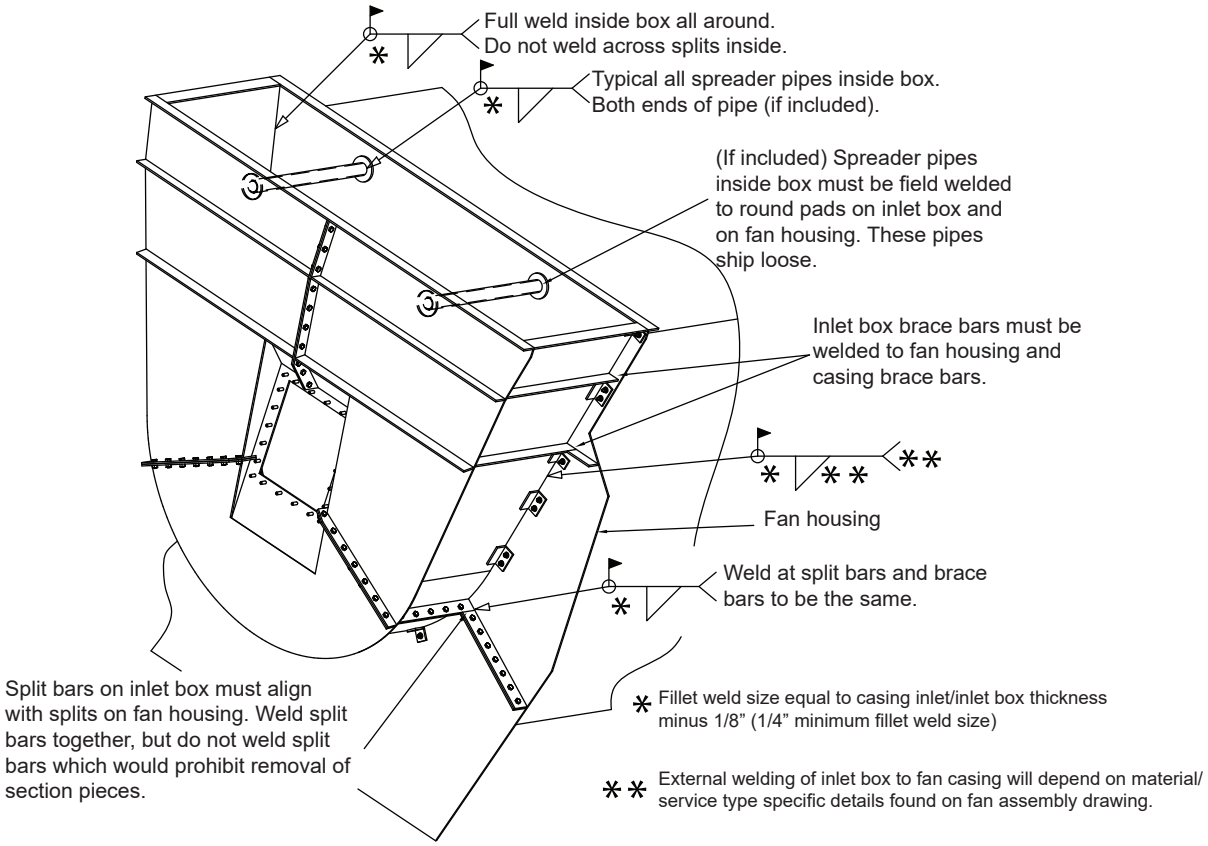
c) Using a spring scale, apply a perpendicular force to any one of the belts. Increase or reduce the centers as is necessary to obtain proper deflection.

d) It will be necessary to readjust tensioning the first few hours of operation after new V-belts have been installed.

e) Periodic inspection and alignment of the drive is recommended.

Refer to manufacturer’s instructions for further information.

FIGURES 25: *BOLTED INLET BOX FIELD WELDING INSTRUCTIONS*



M. BOLTED INLET BOX CONSTRUCTION

(Applies only to large fans shipped with separate inlet box/boxes.)

Bolt the inlet box(es) to casing before setting the assembly on the foundation. Only after all installation and alignment procedures are complete is welding of the inlet box(es) to take place. Inlet box is to have continuous weld inside and stitch weld outside unless specified otherwise on fan assembly drawing. Housing brace bars and inlet box brace bars are to be welded together where they meet. Check that split bars on inlet box line up with respective split bars on housing. Refer to Figure 25.

NOTES:

1. Prior to installing bottom section of casing, Robinson recommends the bottom section of inlet box be bolted to the casing to prevent interference issues with the concrete pedestals.
2. Inlet boxes that are shipped separate from casing are to be bolted to the casing in the field and welded by customer.
3. Robinson recommends that inlet box section (other than the bottom section) be added to the casing in the assembled condition to avoid fitup issues with the split bars. Welding the inlet box to the casing in the disassembled condition can result in fitup issues that may require rework.
4. Check that split bars on box line up with respective split bars on casing.
5. Supplied spreader pipes are to be located on center at each of the round pads inside the boxe(s). Weld into place at each end to properly stiffen the housing.
6. Robinson recommends welding the inlet box sections to the casing after all alignments are confirmed to allow for any needed adjustment. Revisions after welding inlet boxes can be difficult to complete.

N. GROUTING UNIT

Following completion of installation and alignment, it is suggested that a Robinson service technician check the installation before any grouting is done. Robinson service fees are noted on Schedule List #9100. After inspection, grouting may be completed. Robinson recommends the use of an epoxy type grout such as U.S. Grout 5-Star Epoxy (mix A and B add C aggregate) or Chockfast grouting systems. Unless specified otherwise, surfaces to be grouted will be coated with a protective primer. Removal of the primer is not required prior to grouting as the intention is to fill the voided areas. Removal of any protective coating will be at the end users discretion.

O. SPECIAL FEATURES

Dampers

Dampers are furnished in separate channel sections either structural or fabricated. It is best to close the damper when installing to prevent damage to the damper blades. Damper blades and linkage are preset to give a tight fit between blades when the damper is closed. Check the damper operation to insure that all blades can operate without binding and can close tightly. On double inlet fans, inlet box dampers are controlled from a common shaft, usually arranged for automatic control. Check all levers, linkage, and blade hardware to see that they are secure.

Mount dampers in place on inlet boxes and position control shaft to housing according to assembly drawing.

Frequency of lubrication per the following table below is every 4 weeks. Refer to fan assembly drawing for information concerning lubrication of damper bearings, if required or refer to Table 6.

TABLE 6: *DAMPER BEARING RE-LUBRICATION AMOUNTS*

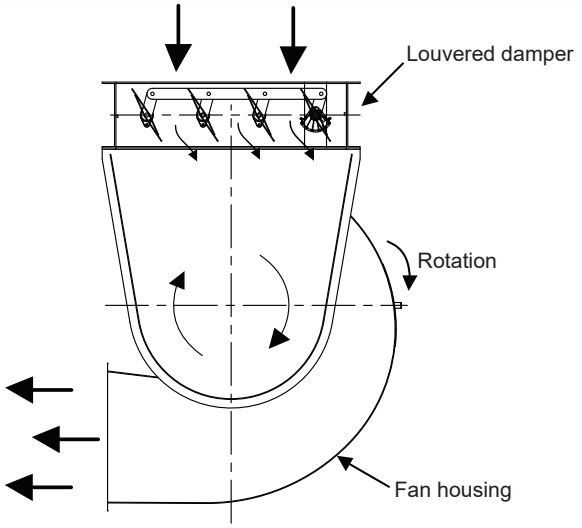
Shaft/Bearing Size (inches)	Amount of Grease (oz)
1/2 to 1	0.06 oz
$1^{1/16}$ to $1^{7/16}$	0.15 oz
$1^{1/2}$ to $1^{3/4}$	0.23 oz
$1^{7/8}$ to $2^{3/16}$	0.27 oz

Shaft/Bearing Size (inches)	Amount of Grease (oz)
$2^{1/4}$ to $2^{7/16}$	0.29 oz
$2^{1/2}$ to 3	0.70 oz
$3^{1/16}$ to $3^{1/2}$	1.15 oz
$3^{9/16}$ to 6	2.58 oz

Some dampers are furnished with bearings that are not to be re-lubricated such as lubed-for-life bearings, graphite sleeve bearings, etc.

After installation, manually operate the damper several times to insure that nothing interferes with damper operation. Check inlet damper operation for correct rotation relative to the fan. Inlet dampers should spin the gas stream in the same direction as the fan rotor rotation when partially open. Refer to Figures 26 and 27.

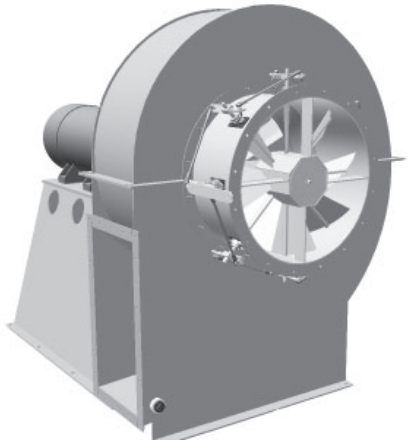
FIGURES 26: *INLET DAMPER MUST BE ORIENTED SO THAT IT PRESPINS THE GAS STREAM IN THE SAME DIRECTION AS IMPELLER ROTATION.*



NOTE: ***Field installation of the damper connecting shaft couplings and bearings is often required on double inlet fans. Field welding is typically required. Be sure that the dampers are synchronized throughout the full range of operation.***

On dirty gas streams, dust build-up may occur and hinder movement of the vanes. If the damper normally requires operation over a small range, and only occasionally is required to move to full open or full closed position, it is recommended that full open and full closed positions be reached daily for the purpose of sweeping accumulated dust from damper vane area (if the system can accommodate this daily damper movement).

FIGURES 27: *FIGURE ILLUSTRATES INLET DAMPER BLADE POSITIONING TO PRESPIN AIR IN SAME DIRECTION AS THE IMPELLER ROTATION. BLADES SHOWN 50% OPEN.*



Damper Operators

If the operator was installed at the Robinson factory, the unit should be ready for connection to utilities and can be put into operation after reviewing specific product instructions (attached). If operator is to be field installed:

1. Adjust operator to damper control arm linkage to allow free operation over the full 90° operating range. Cycle several times.
2. Check damper blades (visually) to be sure they are fully closed and fully open when moved by the operator to the indicated open position. Confirm proper blade rotation.
3. On modulating systems, set-up an input signal to the damper operator controller to insure that the operator output responds correctly to variations in the input signal.

Shaft Seals

Standard gasket type shaft seals are designed to compensate for a small amount of vertical expansion of the fan housing. A single or double floating gasket shaft seal may be utilized to accommodate increased amounts of horizontal and vertical expansion. All shaft seal components are to be centered about the fan shaft unless stated otherwise on fan assembly drawing. Special shaft seals involving carbon rings and/or mechanical seals for gas tight operation may require center-supported housing construction. Refer to Figures 28 A-C for examples.

FIGURE 28A: *GASKET SHAFT SEAL*

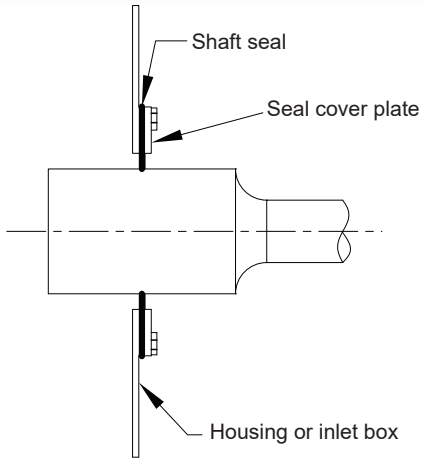


FIGURE 28B: *FLOATING GASKET SHAFT SEAL*

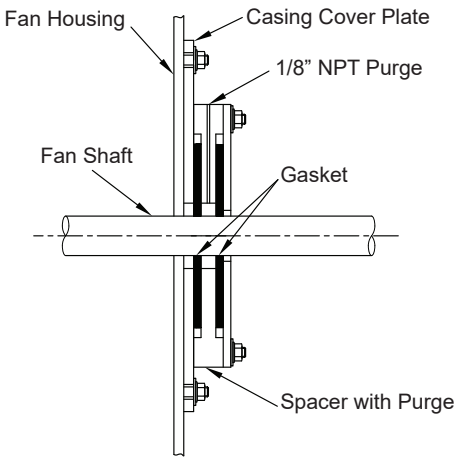
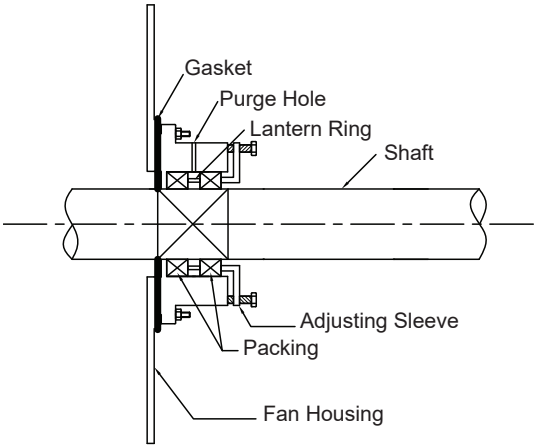
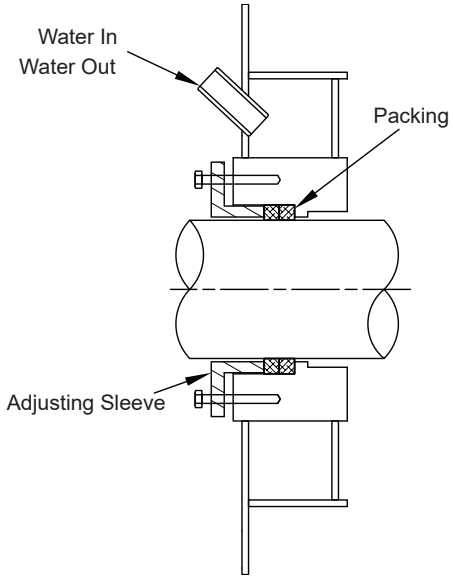


FIGURE 28C: *PACKING GLAND (OPTION WITH PURGE SHOWN)*



On high temperature fans, packing gland type shaft seals often include water-cooled cavities to prevent overheating of the packing as in Figure 29. Refer to assembly drawing for your application.

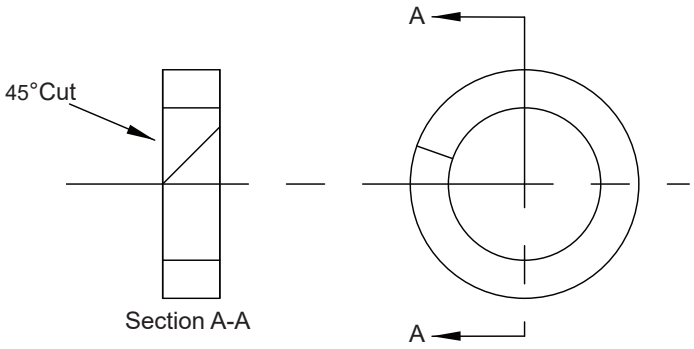
FIGURE 29: *WATER COOLED PACKING GLAND*



Packing Gland Installation (Typical)

1. Clean the packing gland thoroughly. If old packing is being replaced make sure all old packing is removed. Check shaft for smoothness. Scored shafts should be repaired or replaced. Refer to Figure 30.

FIGURE 30: *RECOMMENDED PACKING SPLICE CUT*



2. Install rings one at a time using split ring bushings or packing tamper to be sure that each ring is seated properly before adding next ring.
3. Make sure that the joints are staggered 90° apart.
4. Turn shaft by hand to make sure that rings are free and not installed too tightly.
5. Tighten packing gland until finger tight, then start equipment and carefully tighten the gland to reduce leakage. Make sure that during this adjustment period the temperature of the packing gland does not rise. An adjustment of approximately 1/8 turn at a time is maximum. Allow approximately 15 to 20 minutes between adjustments for the packing to adjust to its new load. If, during this period, heating occurs, back off on the gland and allow to run until packing gland cools. This process could take several hours on a high temperature application.
6. In some cases a lantern ring, along with a purge tap, is supplied with a packing gland seal. As an alternate, a purge tap only may be supplied. Refer to the assembly drawing for instructions as the tap may be for a gas purge, or, in some cases, for lubrication, depending on instructions.
7. For replacement seal material information, please refer to the fan assembly drawing or consult Robinson Fans, Inc.

HIGH TEMPERATURE FANS

High Temperature Design Limits

Observing the maximum operating temperature as noted on the assembly drawing is essential for insuring satisfactory operating life. Material yield strength as well as creep and rupture strength properties drop off dramatically with only slight increase in temperature. When designing furnaces, avoid a direct line-of-sight from the heat source to the fan rotor. This radiant energy can greatly increase the actual rotor operating temperature and cause premature failure unless taken into consideration during design stages.

All high temperature fan units are normally furnished with temperature sensitive pellets that serve as a record of the highest temperature to which the rotor has been exposed.

Temperature Rate of Change

Unless otherwise specified, the maximum allowable heating or cooling rate for Robinson fan equipment is 100° F/hour. Special designs are available to permit temperature changes up to 300° F/hr. Normally this information will be shown on your fan assembly drawing. High temperature axial flow plug units are normally suitable for a temperature rate of change of 900° F/ hour. If temperature rate-of-change is exceeded, loosening of hub to shaft fit may occur resulting in high vibration, movement of the rotor on the shaft, impeller cracking, etc. Thermal fatigue and premature rotor failure can result if extremely rapid changes in temperature occur.

High Temperature Emergency Shutdown and Auxiliary Drives (Turning Gears)

In the event of power failure or interruption in fan operation at high temperatures, it is imperative that the fan be rotated by hand or other available means continuously until the gas temperature decreases to 200° F or lower. Failure to do this may result in permanent distortion of the shaft which, in turn, would cause high vibration. An auxiliary drive (turning gear) is desirable with large fans for slow rotation of the fan rotor during shutdowns. The low RPM auxiliary drive also helps eliminate extremely high vibration levels that can occur upon re-starting. Auxiliary drives are typically designed to maintain a minimum speed (i.e. 40-60 RPM) as the fan slows down. They are typically not intended for use in starting the fan rotor from a dead stop.

High Temperature Corrosion

Due to the presence of certain chemical compounds, special alloys or special treatment of material exposed to high temperatures may be required. Sulfidation and carburization are two common examples which can occur. Evidences of such problems include metal embrittlement, surface pitting, corrosion of fillet weld material, etc. Contact the factory for advise on combatting these problems.

Clearances

Special clearance requirements may be necessary at inlet piece to rotor fit up area to allow for the vertical expansion of housing and axial expansion of shaft. The fit up may be non-symmetric during initial ambient fit up so that symmetry is achieved during the designed high temperature operation.

Heat Flingers

Heat flingers of aluminum (or other highly conductive material) are often used on fans above 250° F to reduce flow of heat through the shaft to bearings. These are typically clamped onto the shaft. Rotate the rotor and shaft assembly to be sure the heat flinger turns freely without contacting the guard.

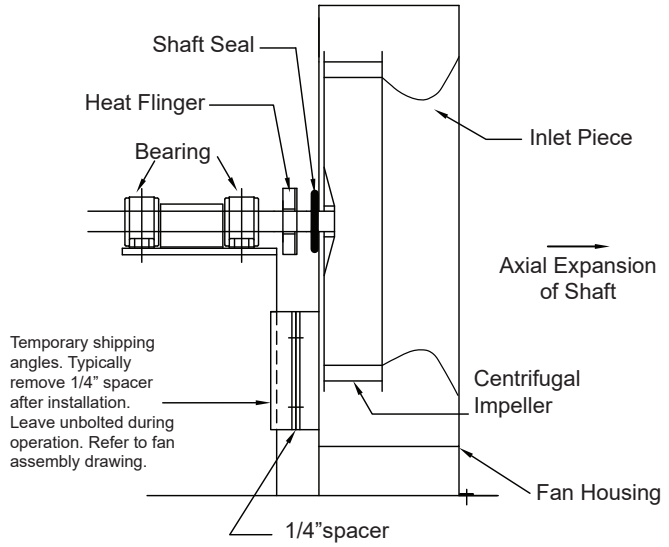
Notes:

1. ***For oil lubricated bearings the heat flinger fins must face the fan casing.***
2. ***For grease lubricated bearings the fins must face the bearing.***
3. ***For oil lubricated monoblock BLO bearings the fins must face the bearing.***

Bearing Base

Bearing base may be separated from fan housing on some high temperature units. Check assembly drawing to see if shipping angle bolts and spacer should be disconnected before the fan is put into operation. Refer to Figure 31.

FIGURE 31: *VERTICAL EXPANSION OF CASING*



Water Cooled Shaft Seal

A water packing gland may be used on higher temperature applications. Insure that the specified water flow is maintained (typically 1.0 GPM). Refer to "Packing Gland Installation" section (pg. 16) for tightening procedure.

Other shaft cooling means may be necessary above 1300° F. This may include air or water-cooling of the shaft. Refer to assembly drawing and special equipment information if applicable.

Center Supported Housings

Center supported housings are sometimes provided on high temperature fans with special shaft sealing requirements. By supporting the fan housing near the shaft centerline, the housing is free to expand radially in all directions about the center without affecting shaft seal clearances. Refer to Figure 32 and 33. Robinson strongly recommends that factory field service personnel be present during the installation (prior to grouting) of center supported fan equipment.

FIGURE 32: *STANDARD HOUSING*

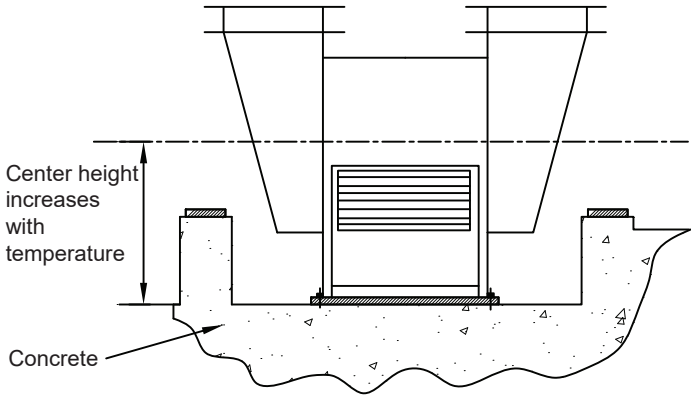
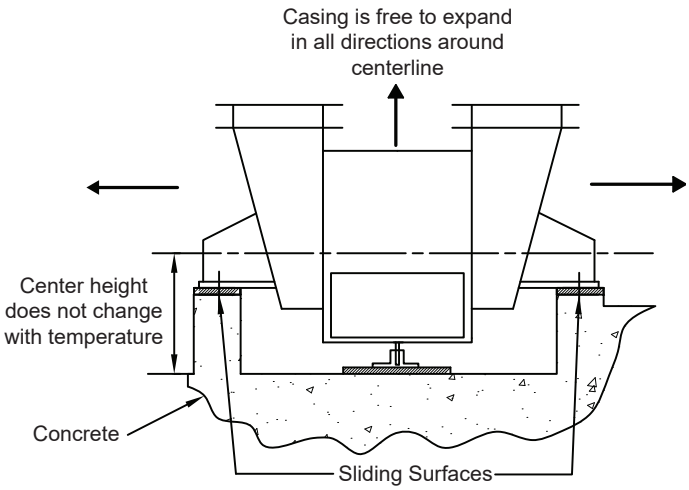


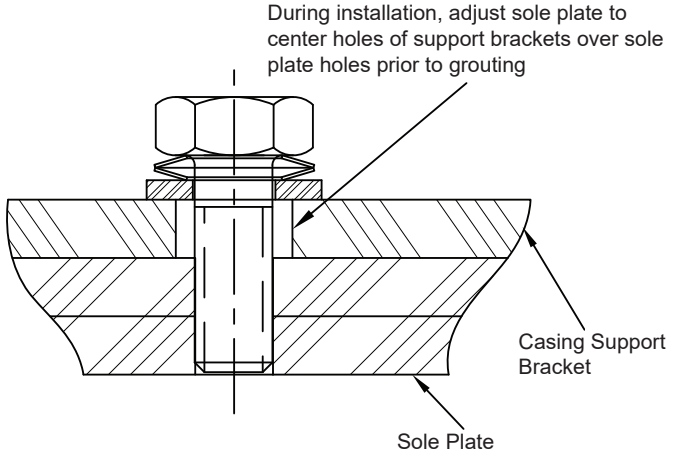
FIGURE 33: *CENTER SUPPORTED HOUSING*



SPECIAL INSTALLATION PROCEDURES FOR CENTER SUPPORTED FAN HOUSINGS:

1. Refer to fan assembly drawing and center support arrangement detail drawing identified with proper Robinson factory order and customer number for the fan being assembled **NOTE:** ***All housing support plates to be at same height and level. Independent bearing pedestal and motor sole plates may be at different levels as shown on drawings but also must be level. No grouting to be done until all components are leveled and aligned. Refer to other installation procedures for specific details on bearing, coupling, inlet piece, etc.***
2. Initially level and align housing support bracket sole plates as shown on drawings using steel shims at each anchor. Do not fully tighten foundation anchors yet. Use of special spring washers is required.
3. Install bottom half of fan housing to support plates. **Note:** ***Consult step 7 if bearing/motor base supports housing.***
4. Adjust shims beneath support bracket sole plates as necessary to obtain uniform contact between center support brackets and bracket support sole plates and to obtain proper casing center height. **NOTE:** ***Sole plates may not necessarily be level. Holes in brackets must be centered over the holes in the support bracket sole plates to provide adequate clearance for casing expansion.***

FIGURE 34: *CENTER SUPPORT BRACKET - SOLE PLATE ALIGNMENT*



5. Tighten bolts to proper torque and check outlet flange and inlet flange alignment to ducts. Check fan housing to be sure it is level with support plates.
6. Install independent bearing pedestal and motor soleplates. Level pedestals within 0.005 in/foot in all directions and align. Install bearing pedestals, level and align pedestal unit with U-shaped shim at bolts between sole plate and concrete. Form for grouting.
7. If arrangement #1 or #8 with fabricated bearing base or bearing/motor base, install base, level and align. Use U-shaped shim pack at each foundation bolt, form for grouting. If bearing base is used for one or more casing supports, this step must be done before step 3.
8. Install centering guides as shown per fan assembly drawing(s).
9. Mount bottom half of bearing on to pedestal. Refer to “Setting and Alignment of Bearing Pedestals” (pg. 7) for further installation instructions.

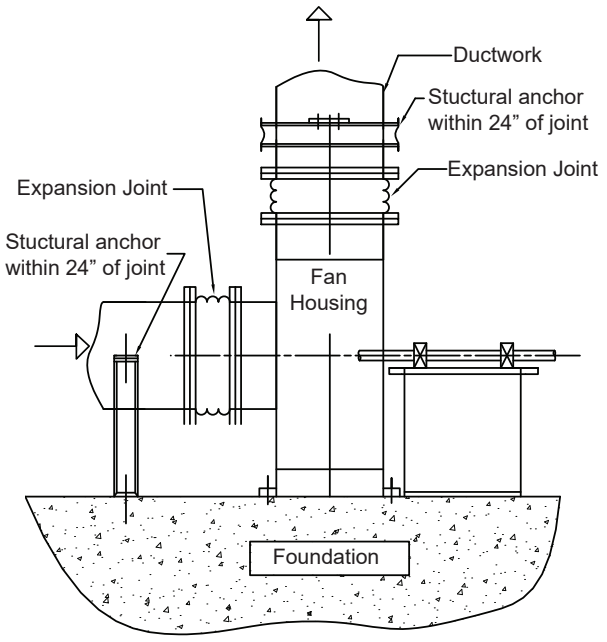
Expansion Joints

Expansion joints are recommended on all fans with operating temperatures up to 250° F.

Expansion joints are required / essential on all fans above 250° F and for fans mounted on vibration isolators/bases (regardless of fan operating temperature).

The expansion joints are to be mounted at the fan inlet and outlet connections, drain pipes, and other connections to/from the fan. They must have adequate lateral and longitudinal flexibility to allow for thermal expansion of the fan. The ductwork adjacent to the expansion joints is to be structurally anchored so that no loads will be transmitted from the ductwork to the fan. The ductwork must be 100% supported by structural members other than the fan. Refer to Figure 35.

FIGURE 35: *EXPANSION JOINTS AND ANCHOR LOCATIONS*



Robinson recommends that internal flow liners be installed for inlet expansion joints to prevent the inward collapse of expansion joints which may result in a reduction of fan performance. If expansion joints are to be supplied by others, internal dimensions of expansion joint/flow liners must be no less than the internal dimensions of the upstream/downstream ducting.

INSULATION

Factory Insulation

If provided, factory insulation is applied to reduce external surface temperature, however take appropriate precautions to avoid burn injuries to personnel.

Typically, the housing can be disassembled and the rotor removed without disturbing the insulation.

NOTE: ***Some portion of insulation may need to be removed for fan disassembly. Refer to "Maintenance, Rotor and Shaft Removal" (pg. 27).***

Field Insulation

Field insulation is normally done by others over insulation clips. Be sure that field mounted insulation does not restrict movement of inlet/outlet expansion joints. The additional weight of the insulation should be considered in sizing springs if a spring isolation base is to be used. Leave adequate clearance in the area around the shaft heat flinger for air circulation cooling. Refer to Figure 31 (pg. 17).

Spark Resistant Fans

Fans constructed for spark resistance are made to correspond to specifications as outlined in AMCA Standard 401-66.

Types of Spark Resistant Construction

Type A: All parts of fan in contact with the air or gas being handled shall be made of non-ferrous material.

Type B: The fans shall have an entirely non-ferrous rotor or impeller and non-ferrous ring about the opening through which the shaft passes.

Type C: The fans shall be so constructed that a shift of the rotor or impeller will not permit two ferrous parts of the fans to rub or strike.

NOTES:

1. ***Bearings shall not be placed in the air or gas stream.***
2. ***The user shall electrically ground all fan parts.***

Access and/or Inspection Doors

Access and/or inspection doors are included on fan housings for inspection of the interior of the fan housing, rotor and shaft. Access doors are to be opened only after the fan has been shut down and has come to a complete stop. In no case should the access doors be open unless the fan is at a complete stop and the driver electrically "locked out".

In the case of doors which are hinged to open vertically, it will be necessary for the user to make provisions for safely opening and closing the door considering its weight. The weight will be indicated on the door prior to shipment or shown on the assembly drawing. If the weight is not shown, obtain it from the factory. Some cases will require mechanical assistance to open doors.

All hinges and hinge pins are to be periodically checked and lubricated to make certain that they are in satisfactory condition and not damaged or deteriorated. Periodic inspection of the mounting and retaining components must be made to assure that they are in first class condition.

Elastomeric Coating (Rubber, Butyl, Neoprene, Etc.)

Due to the corrosive nature of gases flowing through the fan, elastomeric coatings may be used to protect the fan from corrosion, premature aging, etc. These fans have special considerations to be taken into account while fan is in operation and prior to performing maintenance.

No welding is to be done on the outside of housings coated with elastomeric materials. This would result in damage to the elastomer. Gas stream temperature limits must be strictly observed so as not to damage the coating. Some coatings, especially natural rubber, are flammable causing potentially hazardous conditions if operating temperature is exceeded. Refer to assembly drawing for maximum operating temperature. Exposure to certain chemical agents in the process environment could cause deterioration of coating. Exposure to gasoline, cleaning fluids, abrasives, paints and other such materials should be avoided with many elastomers.

Elastomer coated fans warrant special care in handling to avoid damage to surface. Spark testing should be used to detect holes or imperfections in elastomer coating once every 6 months in highly corrosive environments. Damaged areas should be repaired using a patch kit with proper material, adhesive, and curing conditions as prescribed by the original supplier or the coating.

Temperature Detectors

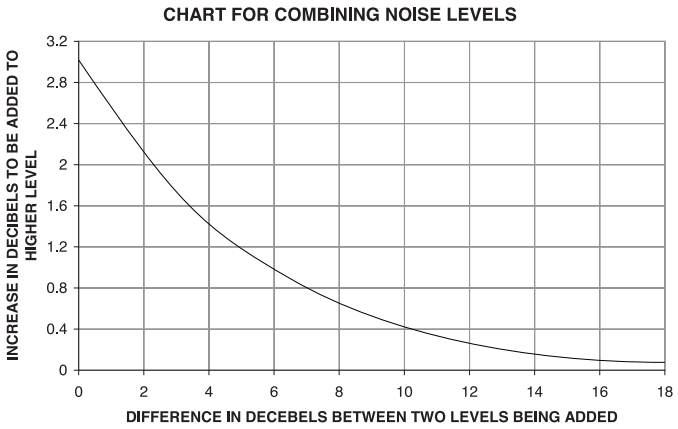
It is recommended that bearings be equipped with thermocouples or electrical resistance temperature detectors; this is an option available to customers. Both types are mounted by inserting the end of the probe through the tapped hole in the pillow block into the liner on sleevoil bearings or up to the outer race on anti-friction bearings. Refer to Table 8 for recommended bearing temperature alarm and shutdown limits. Robinson recommends spring loaded, field-cuttable detectors. Monitors, transmitters, junction boxes and wiring are normally supplied by others.

Sound Considerations

Sound Power Level ratings shown are decibels referred to 10^{-12} Watt and obtained in accordance with AMCA Standard 300. Sound Power Level for each band and dBA are calculated per AMCA Standard 301. Levels shown do not include motor or auxiliary equipment. Refer to Figure 35 information on additive noise effect due to the fan motor or other equipment in the area.

Data is for use by a system acoustical design engineer for evaluation of the fan singularly and within a system. Because of the infinite variations in system arrangements and the many factors which affect sound pressure levels, it is the designer's responsibility to properly apply this data based on his knowledge of the system. Some guidelines for use of this data are: for "NEAR FIELD" reported data to apply to ducted inlet and outlet installations, any opening in the duct must be a minimum of 100 ft. away from the fan.Openings within this range are assumed to emit a sound pressure equal to the fan Sound Power Level. This also applies to untreated inlet and outlet expansion joints. Refer to Figure 36

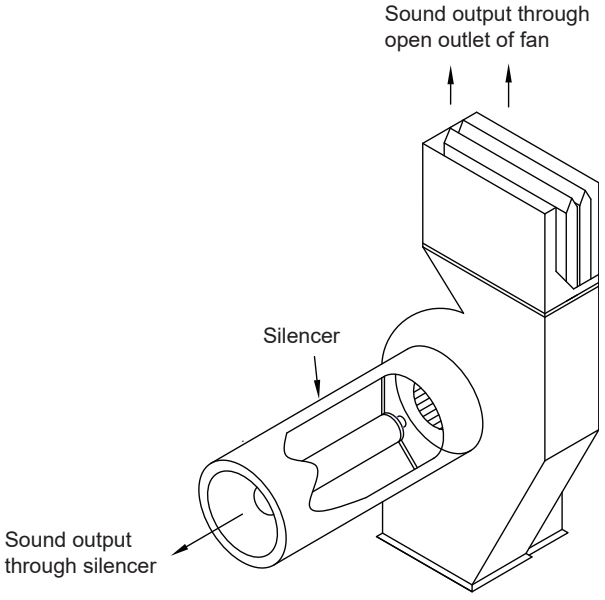
FIGURE 36: *CHART FOR COMBINING NOISE LEVELS*



NOTES:

1. ***For ducted inlet/outlet, ductwork thicknesses must equal the fan housing thickness to achieve the sound levels noted.***
2. ***If expansion joints are supplied at the fan inlet/outlet acoustical treatment must be used to achieve the sound levels noted.***
3. ***For open inlet/outlet fans, acoustic treatment must be used or sound levels will equal fan sound power levels at the acoustic center of the fan. Reference Figure 37.***

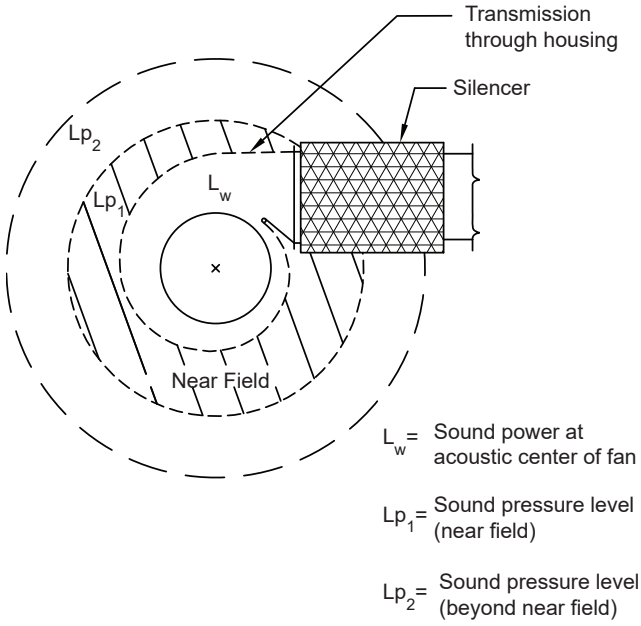
FIGURE 37: *FAN INLET/OUTLET ACOUSTIC TREATMENT*



NEAR FIELD – A hemispherical space where sound pressure waves from one radiating surface tend to interfere with waves generated by other surfaces, NEAR FIELD boundary, distance from radiating surface, is related to the wavelength of lowest frequency and overall size of source.

FREE FIELD – Area beyond near field, with no obstructions, where Sound Pressure Levels decay 6 dB for each doubling of distance from near field. Effects of the room constant (for indoor installations), background noise levels, and directivity are not considered. Refer to Figure 38.

FIGURE 38: *FREE-FIELD SOUND DISTRIBUTION*

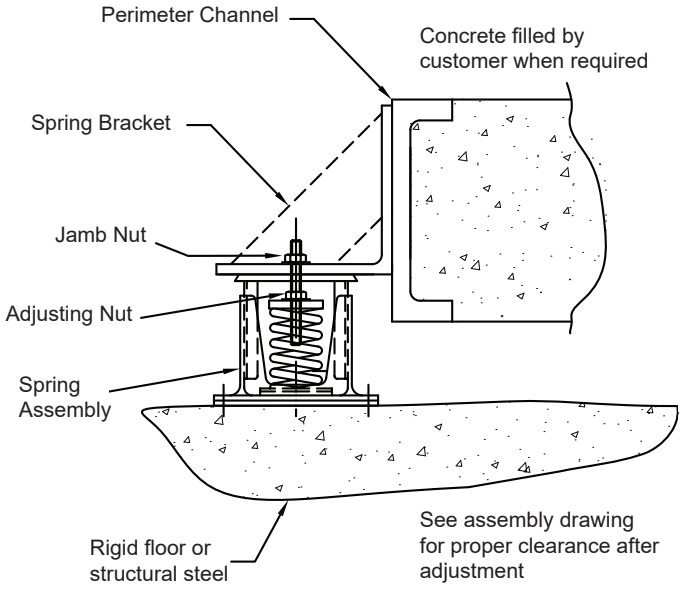


The tolerance on Estimated Sound Power and Sound Pressure Levels is typically ±2 dBA plus the accuracy tolerance of the measuring instrument.

Vibration Isolation

Vibration isolation bases reduce the transmission of vibrational energy from a rotating fan to the structure on which it is mounted. Robinson recommends that all fans which must rest on steel structures with stiffness ≤1.0 x 10^7 lbs/in. be mounted on spring isolation bases. Refer to Figure 39.

FIGURE 39: *FAN STRUCTURE SUB-BASE/SPRING ISOLATION BASE*



Transmissibility (the degree of isolation, related to the proportion of the disturbing force) is expressed as:

$$T = \frac{1}{(f/f_n)^2 - 1}$$

where f is the fan operating speed, and f_n is the spring base natural frequency. Transmissibilities of 5% should be targeted, while transmissibilities which remain under 10% are normally acceptable.

Expansion joints should be fitted to the fan inlet and outlet. Refer to sections on duct design and high temperature fans for more information on expansion joints.

PROCEDURE FOR FILLING CONCRETE INERTIA, VIBRATION ISOLATION BASE:

Fans fully assembled at the factory may have anchor bolts permanently attached to the top flange of the vibration base frame (this will be evident upon unbolting and removing all fan components from the frame). If anchor bolts are not preattached, then an adequately sized "pocket" is needed around each bolt area (before adding concrete) to allow the installation in tightening of anchor bolts later.

1. Position empty frame in place on tar paper or visqueen.
2. A pocket at each base frame bolt if needed.
3. Fill with concrete to top flange. Do not fill pockets for bolts. (Concrete by others) Assume concrete is 150 lb/cu. ft. density.
4. After concrete has completely cured, mount fan securely to the inertia base with the base resting on a level surface.

PROCEDURE FOR LEVELING VIBRATION ISOLATION BASE (WITH OR WITHOUT CONCRETE):

1. Position fan/base unit in the desired position.
2. Raise unit to allow clearance for the spring elements.
3. Install spring elements as shown on drawing according to size and location.
4. Loosen nuts on horizontal restraints (one per end) to allow ¼" clearance between lock nuts and the steel housing.
5. Tighten the spring elements adjusting nut, no more than one full turn at a time, working your way around the base, one spring at a time, until the unit lifts off spacer shims at both ends of each spring. Remove spacer shims.
6. Final leveling to be done as instructed above. Turn adjusting nut before moving on to the next spring as needed.

Vibration Detectors

It is strongly recommended that bearings be equipped with vibration detectors mounted on the bearing housing or on the bearing pedestal. This is an option available to customers. Accelerometer type devices mounted directly on the bearing are recommended for anti-friction type bearings. Such units should have adjustable alarm and shut down vibration set points and solid state electronics that are reliable over a long period of time with a high degree of accuracy. Typically, proximity type probes are the preferred method of vibration measurement for sleeve type bearings.

The operation of these vibration pickups should be checked monthly and calibrated at least once every 6 months. The use of these is highly recommended as operation at high vibration levels may result in catastrophic failure with resultant damage to equipment and injured personnel. Vibration monitors and wiring are typically supplied by others.

Paint

Steel equipment will normally be supplied with one coat of primer (suitable for acceptance of a wide range of customer finish coats) unless special paint is requested. No paint will be applied to stainless steel or aluminum parts. Take care in the handling of painted parts to avoid scraping that could result in rusting. Painted steel parts that are to be stored more than two months prior to being placed in service should be stored indoors at reasonable levels of temperature and humidity. Refer to "Storage Standard Requirements" section (pg. 3).

III. OPERATION

A. START-UP

Before starting fan, complete the following list:

1. Lock out the power source.
2. Check and tighten hold-down bolts.
3. Check and tighten rotor setscrews.
4. Rotate rotor to see that it does not rub and maintains proper inlet piece/rotor clearances.
5. Check coupling and bearings for proper alignment.
6. Check fan and ducts for any foreign material or dirt build up.
7. Secure all access doors.
8. Verify mylar film has been removed from sleeve oil bearings, if applicable.
9. Check lubrication levels and quality of lubricant of bearings, couplings, drive unit, etc.
10. Secure and check safety guards for clearance.
11. Bump start and check for proper rotation (after lube system is operating, if applicable).
12. Close dampers for adequate system resistance to prevent drive unit from overloading. Insure dampers are closed by a visual check inside.
13. Supply water to water-cooled bearings as instructed.
14. Start the equipment according to recommendations of drive unit and of starting equipment manufacturer.
15. Allow fan to reach full speed, then shut down. Make immediate corrections if any vibrations or unusual sounds have been detected.
16. During a run-in period, make observations of bearings at least once an hour. Higher bearing temperatures may occur due to break-in and can result if bearings are over-lubricated.
17. Refer to "Trouble-Shooting Guide" (pg. 23) for any unusual occurrences encountered during the run-in period. Only after any vibrations, misalignments, etc. have been corrected may the fan be restarted.

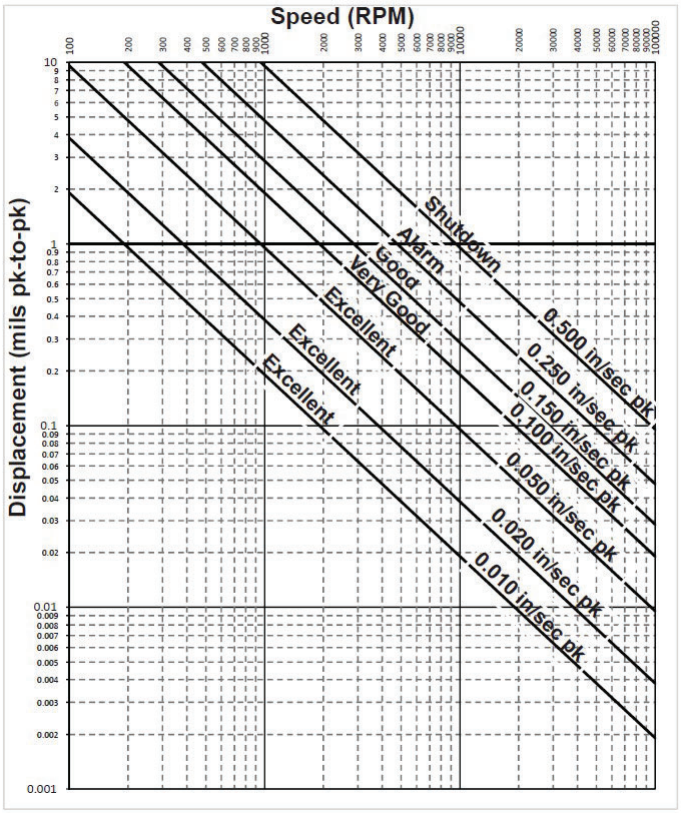
NOTE: ***Be sure to lock out power source when making corrections to system operation.***

B. RECOMMENDED OPERATIONAL PARAMETERS

Bearing Vibration Limits

Alert supervision when any reading increases by more than 50% in one week or if the levels exceed the alarm level as shown in the attached vibration severity chart. Refer to Figure 40.

FIGURE 40: *VIBRATION SEVERITY CHART*



Values shown above are for filtered readings taken on the machine structure or bearing cap.

TABLE 7: *VIBRATION SEVERITY RANGES*

	NOTE 1. RIGID SUPPORT The fundamental natural frequency of the machine/support system is higher than the operating speed.	NOTE 2. FLEXIBLE SUPPORT The fundamental natural frequency of the machine/support system is lower than the operating speed.
Excellent	0 to 0.10 in/sec pk	0 to 0.15 in/sec pk
Good	0.11 to 0.25 in/sec pk	0.16 to 0.40 in/sec pk
Alarm	0.26 to 0.50 in/sec pk	0.41 to 0.75 in/sec pk
Shutdown	> 0.50 in/sec pk	> 0.75 in/sec pk

Proximity Probe Vibration Setpoints (Reference AMCA 204-96)

(Values in pk-pk displacement)
Alarm = 50% of available diametral clearance.
Shutdown = 70% of available diametral clearance.

Shut down for balancing and inspection may be required above this level.

Bearing Temperature Limits

TABLE 8: *BEARING TEMPERATURE LIMITS*

BEARING TYPE	ALARM SOUNDS	SHUTDOWN
Anti-friction	200° F	220° F
Sleeve (Oil Film)	180° F	190° F

Do not run bearings at excessive temperatures; it can result in premature failure.

Cooling Water Flow and Temperature

Refer to assembly drawing for cooling water flow and temperature. Water flow rate is important. Too little flow means over-temperature operation. Too much flow can lead to higher lubricant viscosity and reduced film stiffness. Refer to assembly drawing for proper flow.

NOTE: ***Cooling water temperatures below 70° F may result in condensation within the bearing housing which will result in water contaminating the oil. Damage may occur to both the fan shaft and bearing liners.***

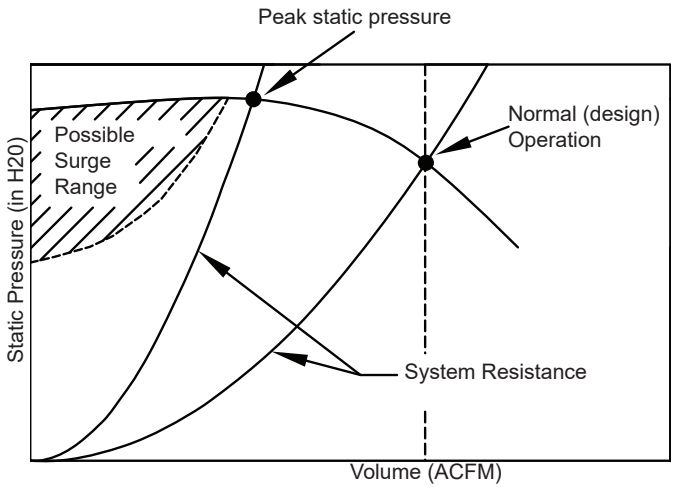
Damper Operating Limits

Robinson does not recommend operating fan inlet dampers at positions less than 20° open to avoid damage to the fan/damper equipment or unwanted system pulsations/vibrations.

Surging

Surge is an inherant characteristic of most centrifugal fans. Regardless of fan type or manufacturer, most high-pressure centrifugal fans (generally over 21 in-H_20) have static pressure characteristic curve which makes them susceptible to the surge phenomenon. Normal operation of a centrifugal fan is generally 4-6% below and to the right of the peak static pressure. As the operating point approaches the peak of the curve, a mild surge or stall condition develops. This means that small changes in pressure can result in large changes in volumemetric flow, including flow reversing through the system. Surging is characterized by a low frequency pulsation and amplitudes can range from low to very high, which can cause damage. Reference Figure 41 and Troubleshooting Duct Pulsation for means to reduce/eliminate surging.

FIGURE 41: *AERODYNAMIC INSTABILITY - SURGING*



C. TROUBLESHOOTING GUIDE (Defined by Problem)

VIBRATION

CHECK FOR:

- Loose bolts in bearings and pedestals, or improper mounting
- Misaligned v-belt drive
- Defective bearings
- Improper wheel rotation
- Improper alignment of bearings and coupling
- Operation near system critical speed
- Out of balance fan wheel
- Shaft bent or distorted during high-temperature shutdown
- Loose setscrews holding wheel to shaft
- Weld cracking
- Resonant frequencies of structural steel mounting
- Improper fan wheel clearance to inlet piece(s)
- Loose v-belts
- Material build-up and/or wear on wheel
- Beat frequency with other fans on common base
- Insure expansion joints in ductwork are not fully compressed
- Loose hub to shaft fit
- Defective motor

DUCT PULSATION

CHECK FOR:

This often occurs when a centrifugal fan is operated on a system with high resistance. The fan is forced to operate far below the normal or design volume. If the operating volume is lower than the value corresponding to the fan's peak static pressure, instability (surge) can occur. Refer to Figure 41 (pg. 22). Possible solutions include:

- Increase operating volume (reduce system resistance)
- Control volume with a radial inlet damper
- Add a "blow-down" valve on fan discharge to allow discharge of part of the gas stream to atmosphere
- Recirculate a portion of the gas stream back to the fan inlet
- Change to a special "surgeless" blower design (Robinson Patent #4,708,593)

HIGH MOTOR TEMPERATURE

CHECK FOR:

- Improper ventilation of cooling air to motor, (may be blocked by dirt)
- High ambient temperature
- Motor cooling fan is incorrect rotation for full cooling
- Input power problems. (Especially low voltage)
- High amperage

NOISE

CHECK FOR:

- Squealing v-belts, due to misalignment or improper tensioning
- Rubbing of shaft seal, wheel to inlet piece, or wheel to housing
- Heat flinger is contacting guard
- Foreign material in fan housing
- Defective bearings, or bearing seal rubbing
- Coupling failure
- Misaligned bearing seal
- Untreated expansion joints
- Misaligned housing shaft seal
- Ductwork is thinner than fan housing

POOR PERFORMANCE

CHECK FOR:

- Incorrect fan rotation
- Prespin condition at fan outlet; add splitter plate to inlet box
- Wheel is off-center; poor inlet piece fit-up allows recirculation of air
- Inlet damper installed backwards (counter-rotation)
- Fan drive sheaves selected for too low or too high RPM
- Fan speed too low/high
- Density may be different than design density
- System resistance is excessive compared to design requirements, (partially closed damper may be the cause)
- Poor duct design. Installation of elbow splitters or turning vanes could remedy problem

HIGH BEARING TEMPERATURE

CHECK FOR:

- Defective bearings
- V-belts too tight or too loose
- Over lubrication
- Improper lubrication or contaminated lubricant
- Low cooling water flow rate
- Lack of lubrication, cooling fluid, or circulation
- Heat flinger missing
- High ambient temperatures or direct exposure to sunlight
- Improper location; not enough room for free axial movement of floating bearing in its housing at elevated temperatures

EXCESSIVE STARTING TIME

CHECK FOR:

- Motor improperly sized for fan wheel WR^2
- Temperature at fan inlet is excessively low (high density)
- Inlet dampers not closed during start-up
- Low voltage at motor terminals
- Properly selected time-delay starter/fusing required
- Inadequate system resistance. (Many industrial fans take up to 20-25 seconds to reach operating speed)

NOTE: ***Do not exceed motor manufacturer's specified number of starts per hour.***

VIBRATION DIAGNOSTIC CHART

PROBABLE SOURCE	DISTURBING FREQUENCY	DOMINANT PLANE	COMMENTS
Rubbing	Subharmonic	Radial	Surging: Aerodynamic symptoms can occur at reduced flow rate. Inspect wheel, inlet piece and shaft seal for possible contact.
Unbalance	1 x RPM	Radial	Field Balance: Robinson Service personnel available.
Motor Problems	120 Hz	All	Peak disappears instantly when power to motor is cut off.
Misalignment	Parallel (1x, 2x RPM) Angular (1x, 2x RPM) Both (1x, 2x RPM)	Radial Axial Radial & Axial	Most misalignments will be combination. Errors are most common in the vertical plane. Through use of laser alignment devices, Robinson can check for alignment accruately.
Mechanical Looseness	Many multiples of 1x RPM, as high as 10x RPM	Radial	The presence of 1/2x RPM peaks is a good sign of progressed mechanical looseness. Check for loose bolts, bearings, poor shimming, etc.
DEFECTIVE BEARINGS			
Anti-Friction	Early Stages: 30k-60k depending on size and speed Late Stages: High 1x and multiple harmonics	Radial, except higher axial on thrust bearing.	Bandwidth broadens as bearing degrades. Check for "bumping" or other unusual sound in the bearing. Also, look for overheating (190F and above). Check inner-race to shaft fit.
Sleeve	Early Stages: Subharmonics Late Stages: Will appear as mechnical looseness (see above)	Radial	High baseline energies below 1x, 2x, 3x RPM. Look for poor babbit to housing fit, improper plunger screw torque, worn thrust collars, scorning and dirty lubricant.
Blade/Vane Pass Frequency	# of blades x RPM	Radial	Aerodynamic related.
Resonance	Requires only a small forcing function to excite its natural frequency	Axial or Radial	Vibration amplitude varies with time or temperature. System shows extreme sensitivity to slight amount of unbalance. Structure can be bump-tested to determine its natural frequency.
BELT DRIVE			
Mismatched, worn or stretched (also applies to adjustable sheave applications)	Many multiples of belt frequency, but 2x belt frequency usually dominant.	Radial, especially high in-line with belts.	Check each belt for appropriate tension. Replace worn belts with matching type.
Eccentric and/or unbalanced sheaves	1x (shaft speed)	Radial	Balancing possible with washers applied to taper lock bolts.
Drive belt of sheave face misalignment	1x (driver speed)	Axial	Check sheave face alignment (refer to "V-Belt Drive" section (page 13) for method. Confirm alignment with strobe light and belt excitation techniques.
Drive belt resonance	Belt resonance at only particular operating speeds	Radial	Adjust belt tension or belt length to eliminate problem. Belt stretch natural frequency is excited at particular operating speed. Avoid these speeds.

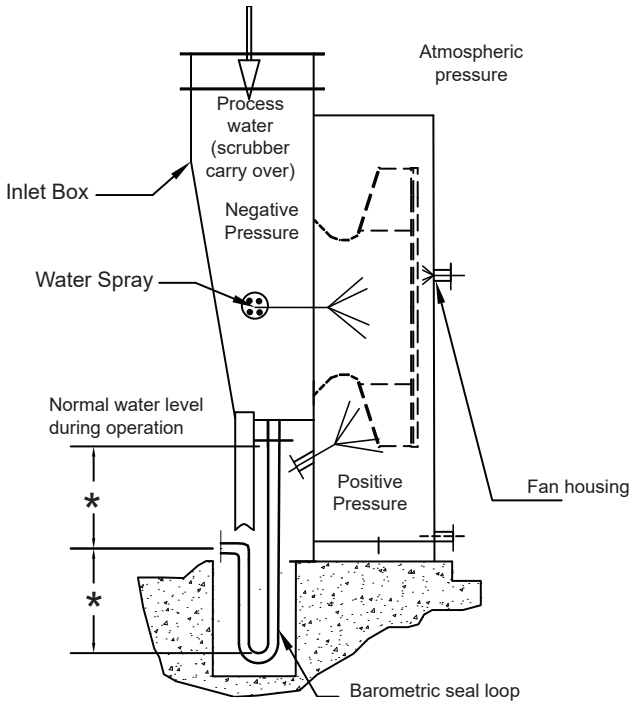
D. MAINTENANCE

Water Spray Cleaning Systems

The following are recommendations for use of water-spray cleaning systems:

1. Use only drinking quality (city) water (40 psig required).
2. Requirements at fan inlet: 1 GPM/16000 CFM/each inlet-FULL JET SPRAY.
3. Requirements at web and shroud: 1 GPM/32000 CFM/each inlet-FULL JET SPRAY.
4. Initially, use water spray system intermittently to determine the exact amount of time (and thus the amount of water) required for satisfactory cleaning. Suggest starting with sprays on for 5 minutes every 30 minutes with a goal of minimizing spraying time yet achieving satisfactory cleaning. Spraying systems are not to be used continuously.
5. A periodic check of the rotor for erosion is mandatory.
6. Piping from supply line to spray unit must include a manual of automatic valve for shut off and regulation; installation is to be consistent with good piping practice.
7. Provide proper drainage from housing and inlet box(es) when using sprays. To drain inlet boxes, a vertical seal loop below the drain point must be used to provide a height equal to the fan negative pressure. Refer to Figure 42.
8. Allow for approximately a 5% increase in horsepower when sprays are in use.

FIGURE 42: *INLET BOX DRAIN BAROMETRIC SEAL LEG*



Balancing

Robinson field service technicians are recommended for performing field balancing. Balance weights must be of the same material as the rotor. Welding of balance weights should be done using Robinson approved field welding procedures for the type of material involved. Prior to field balancing, please ensure that the rotor is thoroughly cleaned.

Field Repairs

Fans for heavy duty operation require inspection to insure continuity of operation. When an inspection reveals the presence of corrosion or erosion to fan components, it is advisable to analyze the cause and take steps to provide replacements or repairs. Your local Robinson representative can be of assistance in such cases and obtain factory recommendations that might be needed. Under no circumstances should any welding be attempted on rotors except with specific written welding recommendations from Robinson Fans, Inc.

LUBRICATION

Bearing Lubrication

Protective circuits should be set to alarm when bearing temperature exceeds the values shown in Table 8 (pg. 22). Alert supervision if bearing temperatures change abruptly or if circulating oil flow rate is less than the required flow.

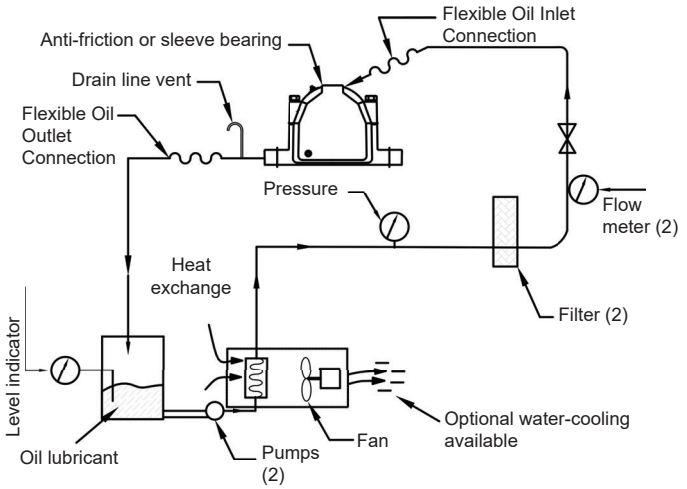
TYPICAL LUBRICATION SYSTEMS

Circulating Oil Systems

Circulating oil systems are recommended for fans operating on critical equipment when downtime must be minimized. Such systems provide a continuous flushing of filtered lubricant at controlled temperature and pressure which is very desirable for maximizing the life of bearings. These systems are typically furnished with redundant gear pumps that activate automatically to insure continuous lubrication. Local and/or remote monitoring of lubricant level, temperature, flow rate, pressure, etc. is available.

Piping for the lubricant return (from the bearing to the lubricant reservoir) should be large diameter (approximately 1½" to 2" or larger) and sloped at a minimum of ½" vertical per foot horizontal run. The flow to the bearing must be controlled (by valves or an orifice) to prevent flooding the bearing housing. Maximum distance from the bearing housing to the lubricant reservoir is 40 feet. The maximum height from the pumps to the bearing housing is 10 feet. Oil heaters and tracing may be required (by others) if low ambient temperatures are anticipated. Refer to Figure 43.

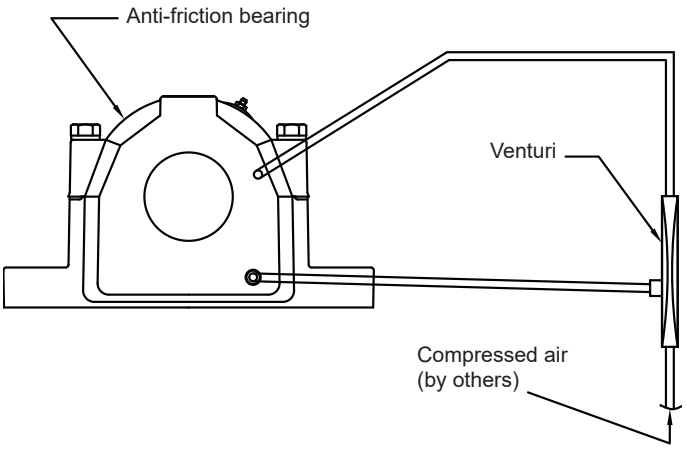
FIGURE 43: *CIRCULATING OIL SYSTEM*



Static Oil Lubrication

Static oil lubrication and oil mist lubrication are optional methods of lubrication. Refer to Figure 44.

FIGURE 44: *OIL MIST LUBRICATION*



For oil lubrication, Robinson recommends Mobil SHC 600 series oils for most anti-friction bearings. Refer to fan assembly drawing for recommended oil lubrication for sleeve type bearings. An extra wetting oil is recommended for sleeve type bearings with a stainless steel shaft or shaft that has chrome plated bearing journals.

Extra Wetting Agent Oils:

(Confirm the viscosity of oil required before installation)

Mobil DTE 24 (SAE 10 Wt)
Mobil DTE 26 (SAE 20 Wt)
Exxon Nuto H 32 to 150
Shell Tellus S2M 32 to 100
Texaco Meropa 68 to 100
Amoco Rykon 32 to 100

NOTE: ***For shipping purposes, bearings may have been shipped completely full of grease. The grease should be wiped out with a clean cloth and then flush the bearing with clean solvent. Wipe out the solvent and be sure the bearing is dry. Then fill it with appropriate oil. As an extra precaution to be sure all the grease is removed, run the fan for approximately one hour, remove the bearing caps and examine the bearing. If grease is present, repeat the procedure.***

Greases for Fan Bearings:

Unless specified otherwise, the recommended lubricant is Mobilith SHC 100. Please reference the Robinson general arrangement drawing for the specific grease recommendation. Mobil Mobilith SHC 100 is a NLGI 2 grease containing a synthetic base fluid in a lithium complex soap thickener,

Acceptable Mobilith SHC 100 Replacement Greases:
Shell Gadus S2 V1002
Shell Alvania Grease #2
Exxon Unirex N 2

Acceptable Mobilith SHC 220 Replacement Greases:
(If specified on Robinson general arrangement drawing)
Mobil Mobilgrease XHP 222
Exxon Unirex EP2
Texaco Starfak 2202
Castrol Tribol 4020/220-2

The recommended schedule for greasing is clearly spelled out in the notes on the assembly drawing. A determination should be made to the exact number of pumps of the grease gun that is equivalent to the grease required. If the recommended lubrication schedule and type of grease is adhered to, satisfactory bearing life is to be expected. If substitute greases are used (without Robinson's written approval), or the lubricant frequency is haphazard, our experience shows that premature bearing failures can result. Do not mix greases even if cross-referenced as an equivalent! Do not use greases containing molybdenum disulfide. To use an approved alternate lubricant, all existing grease is to be completely removed from the bearings. Refer to Table 9.

Special Instructions for Vertically Mounted Fan Assemblies

Whenever possible, each vertically mounted fan unit is test run in the vertical position before leaving Robinson's plant. The bearings are equipped with seals for retaining the grease lubrication. These bearings are described on the assembly drawing.

In Robinson's experience, vertically mounted units can have bearing failures if they are not lubricated on strict schedules. It will be necessary to lubricate bearings more frequently with this arrangement than if the unit were mounted horizontally. If the lubrication frequency is inadequate, the roller elements can become grease-starved, leading to a bearing failure.

The more frequent lube schedule may result in a somewhat higher bearing operating temperature. This should not be a significant problem as long as the ambient temperature near the bearing is less than 120° F. The consequences of the more frequent lubrication schedule are much less severe than the result of under lubrication in such applications.

TABLE 9: *GREASE LUBRICATION SCHEDULES (TYPICAL FOR AMBIENT TEMPERATURE HORIZONTAL SHAFT FANS)*

Pillow Block 225/226	Shaft Dia.	Relubrication Interval (hours)	Speed (RPM) 900	1200	1800	3600	Grease Added at Each Interval (oz) Roller Bearing	Ball Bearing
09	1 7/16		2140	1715	980	515	0.35	0.08
10	1 11/16		2000	1600	900	460	0.37	0.10
11	1 15/16		1880	1495	830	410	0.45	0.12
13	2 3/16		1670	1320	705	320	0.67	0.17
15	2 7/16		1495	1170	600	320	0.72	0.21
16	2 11/16		1420	1105	550	320	0.83	0.24
17	2 15/16		1345	1040	505		0.97	0.25
18	3 3/16		1280	980	460		1.15	0.26
20	3 7/16		1155	875	380		1.49	0.39
22	3 15/16		1045	775	300		1.91	
24	4 3/16		940	680			2.24	
26	4 7/16		845	595			2.65	
28	4 15/16		755	515			3.05	
30	5 3/16		670	440			3.54	
32	5 7/16		590	365			4.17	
34	5 15/16		515	295			4.79	

Coupling Lubrication

Couplings pre-lubricated from the factory will normally be filled with Mobil Mobilux EP111. For applications with ambient temperatures below 150°F and above 0°F, use a grease as recommended in Table 9. For ambient temperatures outside of the above stated range, contact Robinson Fans for specific recommendations. Greases listed in the chart are in response to request for specific recommendations. This list is not complete and is not intended to restrict the use of equivalent lubricants manufactured by companies not listed, nor is it intended to exclude improved lubricants developed since publication of this list. Relubrication every two months based on typical industrial applications is recommended. Refer to Table 10.

Greases for Couplings:

TABLE 10: *ACCEPTABLE COUPLING GREASES*

Manufacturer	Gear Couplings	Grid Couplings
Amoco Oil Co.	Rykon Grease #1 EP	Amolith Grease #2
BP Oil Co.	Energrease LS-EP1	Energrease LS-EP2
Chevron USA	Dura-Lith EP1	Dura-Lith EP2
Citgo	Premium Lithium EP1	Premium Lithium EP2
Conoco Inc.	EP Conolith Grease #1	EP Conolith Grease #2
Exxon	Lidok EP1	Unirex N2
Imperial Oil	Ronek EP1	Unirex N2L
Lyondell	Litholine Complex EP1	Litholine H-EP2
Mobil Oil Co.	Mobilux EP1 or EP111	Mobilux EP111
Petro-Canada	Multipurpose EP1	Multipurpose EP2
Shell Oil Co.	Gadius S2 V220 1	Gadus S2 V220 2
Texaco	Multifak EP1	Starplex HD2
Unocal 76	Unoba EP1	Unoba EP2

For spacers with limited end float thrust plates and for floating shaft arrangements, each end must be separately lubricated.

Water Cooled Bearings

Refer to Figure 45A/B for typical water line arrangements.

FIGURE 45A: *PREFERRED ARRANGEMENT*

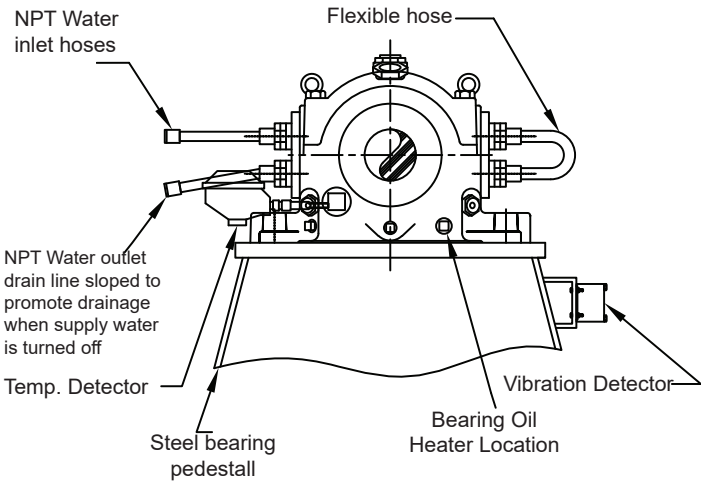
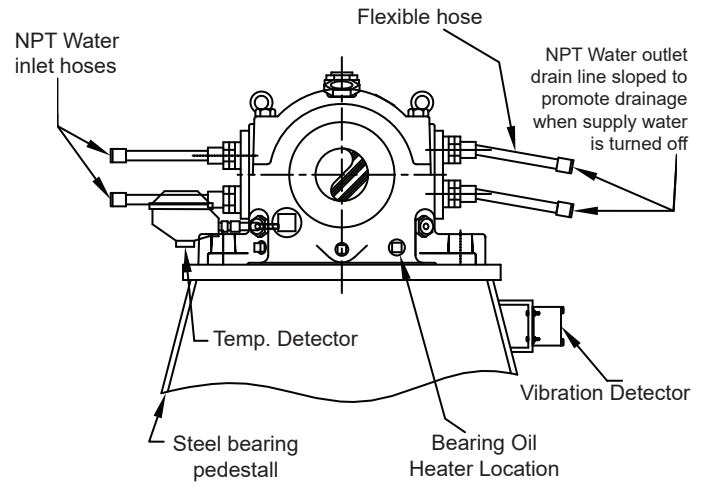


FIGURE 45B: *ALTERNATE ARRANGEMENT*



NOTE: ***During shut downs in cold weather be sure to either drain or blow out all water from water cooled bearing liners. Freezing will cause cracks in the bearing liner that lead to contamination of the lubricant with water. (Alternatively add an anti-freeze to the water to prevent freezing). Heat tracing of water lines may be required.***

Inspection

At least once every six months the fan should be shut down for inspection. Carefully inspect all anchor bolts for tightness and foundation/grouting for loosening or cracking. Repair any deficiencies. Check the rotor for wear especially near the inlet piece and along the center web plate. Any significant decrease in thickness of structural parts (i.e. less than 90% of the original material thickness) remaining should be reported. It may be necessary to repair these areas, contact the supplier.

Drain a sample of lubricant from the bearings. Any milkiness may indicate the presence of water contamination. Remove the top half of the bearing housing and inspect surface condition for damage or scars. Be sure to reassemble using proper procedure. Drain oil and change. Refer to bearing operating instructions and assembly drawing for type of oil.

Check coupling bolts, bearing pedestal bolts, and bearing mounting bolts for tightness. Check mounting pad hole clearance (on center supported housings) to be sure ample clearance exists for expansion and that hold-down bolts are properly torqued.

Rotor and Shaft Removal

1. Lockout the fan and damper drive systems electrically.
2. Disassemble the coupling using proper procedure.
3. Unbolt and remove the inlet piece(s). Unbolt shaft seals.
4. Locate the “pie-shaped” section of housing designated for rotor and shaft removal (refer to assembly drawing). Remove all necessary split and flange bolts.
5. Carefully remove pie-shaped portion of housing, exposing housing internal rotor and shaft.
6. Remove top half of bearing housings. Inspect liner and housing, then store in a clean, dry area.
7. Remove rotor.

Spare Parts List

Robinson recommends that the customer have the following spare parts on hand: rotor and shaft, one set of bearings, one coupling or one set of V-belt, if applicable. Refer to assembly drawing for specific size of parts.

Predictive Maintenance

Routine vibration monitoring and trend analysis is recommended. This allows early detection of problems so that potentially hazardous operation or unscheduled shut downs can be avoided. Contact Robinson for more information on this service.

IV. WARRANTY

NOTE: ***Customers must conform exactly to specifications as outlined in warranty. Failure to do so voids the Robinson Warranty.***

The following warranty terms and conditions will apply to the equipment:

a) Robinson warrants the equipment to be free of defects in materials and workmanship for a period of either ONE (1) YEAR from the date of installation (or, if applicable, start-up) of said equipment at the customer’s/end user’s plant or facility; or EIGHTEEN (18) MONTHS from the date Robinson ships said equipment per the applicable shipment terms (the “Original Warranty Period”), whichever period expires first. If any of the equipment is subject to repair or replacement during the Original Warranty Period, such equipment shallbe replaced and the Original Warranty Period shall be extended for ONE (1) YEAR (the “Extended Warranty Period”); provided that, the aggregate warranty period, including the Original Warranty and the Extended Warranty Period shall, in no event exceed TWO (2) YEARS as of the date on which the equipment was installed or shipped, as applicable, by Robinson hereunder.

b) There are no warranties, express or implied, which extend beyond the description on the face hereof. No implied warranties shall apply, including warranty of merchantability, warranty of fitness for any particular purposes whatsoever, or any other implied warranty.

c) The express warranty on the equipment does not guarantee against abrasion, erosion and wear, nor does the express warranty guarantee against failure due to operation under conditions which are in excess of design limits or operational standards and limitations expressed in this manual or in any approval drawings. The equipment must be operated in strict compliance with all operational standards and limitations specified within this manual. Any warranty claims forwarded to or otherwise made against Robinson must be accompanied by appropriate documentation demonstrating that circumstance.

d) Under no circumstances shall Robinson be held responsible or liable for your selection of, or failure to select, materials of construction which need to be incorporated into the manufacture and construction of any of the parts, linings or other components forming a part of the equipment in order for it to properly function in and endure any special, peculiar or extraordinary conditions, in or under which you will be using or operating the equipment. You are solely responsible for making certain that any such special material and construction needs are made known to Robinson and adequately incorporated into Robinson's design and manufacture of the subject goods and products.

e) Any of the following will void the express warranty made by Robinson: (1) any alterations to the equipment sold by Robinson, (2) your failure to observe operational and safety standards and limitations and design limits established by Robinson in this manual, or (3) your failure to purchase the items recommended by Robinson for use with its product whether the recommendation was oral or otherwise.

f) All items of equipment, parts and other materials specified, required or ordered by you which, although intended to be included in, attached to, or operated in conjunction with the equipment are manufactured and/or incorporated into Robinson's work by someone other than Robison, shall carry only the guarantee and warranty as supplied by that separate manufacturer and shall carry no guarantee or warranty, express or implied, of Robinson, nor shall Robinson be liable in any way whatsoever for any such third party goods, or any failure thereof.

g) ***EXCEPT FOR THE REPRESENTATIONS AND WARRANTIES OF ROBINSON CONTAINED IN THIS MANUAL OR AS OTHERWISE EXPRESSLY AGREED TO IN WRITING BY ROBINSON, IT IS EXPRESSLY UNDERSTOOD AND AGREED THAT ROBINSON MAKES NO OTHER REPRESENTATIONS OR WARRANTIES AND ASSUMES NO RESPONSIBILITY, EXPRESSED OR IMPLIED, FOR THE CONDITION, PERFORMANCE, MAINTENANCE, MANUFACTURE, OR DESIGN OF THE EQUIPMENT.***

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Shipping Address:
3955 Drane Field Road
Lakeland, FL 33811

Robinson Fans, Inc. - Texas Office

Phone: (325) 437-3267
Fax: (325) 437-3445

Shipping Address:
2424 Oak Street
Abilene, TX 79602

Robinson Fan, Inc. - Utah Office

P.O. Box 27477
Salt Lake City, UT 84104
Phone: (801) 972-3303
Fax: (801) 972-3445

Shipping Address:
725 South Gladiola Street (2900 West)
Salt Lake City, UT 8410

Robinson Fans Service and Equipment Co, Inc.

P.O. Box 707
Trussville, AL 35173-0707
Phone: (205) 655-8312
Fax: (205) 655-8327

Shipping Address:
4801 Commerce Drive
Trussville, AL 35173

NOTES:

SERVICE LOG:

ISO 9001 Certified Management System

WE WILL FULFILL OUR CUSTOMERS' VALUE EXPECTATIONS FOR SUPERIOR AIR MOVING SOLUTIONS, EQUIPMENT, AND SERVICES.

Robinson Fans, Inc.
400 Robinson Dr.
PO Box 100
Zelienople, PA 16063
Phone: (724) 452-6121
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MEMBER

www.robinsonfans.com