

Throughout this manual, there are a number of HAZARD WARNINGS that must be read and adhered to in order to prevent possible personal injury and/or damage to equipment. Two signal words "WARNING" and "CAUTION" are used to indicate the severity of a hazard and are preceded by the safety alert symbol.

 **WARNING**

Used when serious injury or death MAY result from misuse or failure to follow specific instructions.

 **CAUTION**

Used when minor or moderate injury or product / equipment damage MAY result from misuse or failure to follow specific instructions.

NOTICE

Indicates information considered important, but not hazard-related.

It is the responsibility of all personnel involved in installation, operation and maintenance to fully understand the

 Warning and  Caution procedures by which hazards are to be avoided.

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INTRODUCTION

This manual has been prepared to guide the users of heavy duty composite fiber fans in the proper installation, operation, and maintenance procedures to insure maximum equipment life with trouble-free operation. These fans are made from a corrosion resistant reinforced plastic (FRP). It is the responsibility of the purchaser, installer, and user to provide qualified personnel experienced in the installation, operation, and maintenance of composite fiber air moving equipment.

Since many fans of this type have custom features or

components, please refer to the attached appendices for additional information. When manufacturers of components provide detailed installation and operation manuals, they will be provided. Because of the wide variety of equipment covered in this manual, the instructions given here are general in nature.

Additional product and engineering information is available at www.tcf.com.

For safe installation, startup, and operational life of this equipment, it is important that all involved with the equipment be well versed in proper fan safety practices and read this manual. Please review the safety section before beginning any work. It is the user's responsibility to make sure that all requirements of good safety practices and any applicable safety codes are strictly adhered to.

SHIPPING and RECEIVING

All Twin City Fan & Blower products are carefully constructed and inspected before shipment to insure the highest standards of quality and performance. Compare all components with the Bill of Lading or Packing List to verify that the proper unit was received. Check each unit for any damage that may have occurred in transit. Any damage should be reported immediately to the carrier and the necessary damage report filed.

HANDLING

Handling of all air moving equipment should be conducted by trained personnel and be consistent with safe handling practices. Verify the lift capacity and operating condition of handling equipment.

 CAUTION
Maintain handling equipment to avoid serious personal injury.

Units shipped completely assembled may be lifted with slings and spreader bars. (Use well-padded chains, cables, or nylon straps.) On most units, lifting lugs are fashioned to protect the fan and fan housing from

damage. Never lift a fan by the inlet or discharge flange, shafting or drives, wheel or impeller, motor or motor base, or in any other manner that may bend or distort parts. Never lift with slings or timbers passed through the fan inlet.

Partial or disassembled units require special handling. All composite parts should be handled in a fashion which protects the laminate structure plus its outer gel coat surface from damage. All composite parts should be handled such that forces are not concentrated to avoid bending or distortion. Never allow the outer gel coat surface to be damaged due to any sudden impact forces or any stress that may cause the gel coat to be cracked.

The fan housing should be lifted using straps and spreaders. Do not distort the fan housing (scroll and side plates) when lifting.



CAUTION

Bearing pedestals should be lifted using straps or padded chains. Under no circumstance should an attached or separated bearing pedestal be lifted by the shaft, bearings, drives, motor or wheel.

The single width shaft and wheel sub-assembly may be lifted using a hoist with a sling around the shaft at a point nearest the wheel. Take care not to scratch the shaft where the bearings or drive will be mounted. Never lift or support the sub-assembly by the wheel. Never lift the shaft and wheel sub-assembly by the wheel blades, wheel cone, or the wheel back plate. Always support the sub-assembly by the shaft when lifting or storing. Never transport the shaft and wheel sub-assembly by rolling the wheel to its desired location, as this will damage the gel coat and can affect the wheel balance. Do not support the shaft and shaft sub-assembly on the fan housing sides.

Bent shafting is a source of vibration and bearing failure, so handle the shaft with care. Any scratches on the shaft may be removed with a fine grit emery cloth, crocus cloth, or whetstone.

SHORT TERM STORAGE

If fan installation is to be delayed, store the unit in an environmentally stable and protected area. During storage, the fan should not be subjected to vibration or shock loading from external sources, as bearing damage may occur. The unit should be reasonably protected from any impacts. Cover the fan to prevent any foreign material or moisture from entering the fan inlet or discharge. Protect the fan bearings, drives, and motor bearings from moisture.

LONG TERM STORAGE

Extended storage requires monthly inspections to be performed and documented.

Fan bearings tend to take on moisture if the atmosphere they are stored in is not at a constant temperature. To avoid corrosion, it is necessary to keep the bearings full of grease and to rotate the fan shaft periodically. Even when full of grease, bearings will take on moisture, so it is necessary to purge the bearings with new grease to expel moisture every thirty days. It is recommended that when the bearing are being greased, that the fan shaft is rotated by hand. Do not use high pressure greasers as they may ruin the bearing seals.

The drive and belt should be removed if the fan is to be stored for a prolonged period of time. Exposed machined surfaces on the sheaves, fan shaft, and motor shaft are to be suitably protected against rust. The drives

should be labeled for service and stored in a dry place. Belts should be coiled without kinks, placed in a heavy carton, and stored in a dry, well ventilated place. Storage conditions should not exceed 85°F (29°C) and 70% humidity to prevent belt deterioration.

If the unit was supplied with a motor, the motor should be stored in a clean, dry, vibration-free location. The motor windings resistance should be measured at this time and recorded for comparison prior to placing into service. The winding temperature should be kept slightly above that of the surroundings to prevent condensation from occurring. This can be accomplished by energizing the motor's internal heaters, if it is so equipped, or by using space heaters. If it is impossible to heat the windings, the motor should be wrapped tightly with a waterproof material which also encloses several bags of desiccant. Replace the desiccant regularly to prevent moisture problems. The motor rotor should also be rotated monthly to assure the bearings are well covered in grease.

If the fan housing was supplied with a drain connection, this plug should be removed to prevent any moisture from accumulating in this portion of the unit during storage.

Fan Storage Procedure – Fans should be stored indoors whenever possible in an area where control over temperature, moisture, shock, and dust is reasonably maintained. If units are to be stored outside exposed to the elements, they should be covered with a water-resistant material. Stored equipment should be stored on a clean, dry floor or blocked up off the ground on blocks to prevent unit from setting in any water. The floor or blocks upon which the fans rest upon must be stable and capable of providing continuous support to the fan structure which will prevent uneven loading of the fan structure. The fan bearings should be shielded individually from water and dirt; however, do not tightly seal the bearings to avoid trapping condensation. If shock or vibration will be present during the storage period, the unit may need to be placed on some type of vibration dampening material to aid in preventing brinelling of the bearing surfaces.

Periodic Check – On a monthly interval, the equipment should be checked to ensure that it has remained in an acceptable stored condition. Make sure there is no corrosion, no damage to the unit, and that there is no debris within the fan housing.

The fan (and motor, if supplied) should be rotated several times by hand while adding enough grease to replenish the bearing surfaces with fresh grease and to maintain a full bearing cavity. Grease used must be compatible with that already supplied in the motor and fan bearings. The fan impeller should be left at approximately 180° from that of the previous month to prevent the shaft and impeller from taking a set in one position.

Consult the motor manufacturer for proper storage, space heater connection, and lubrication, if applicable. Storage records should be maintained which indicate the above requirements have been followed.

Prior to Start-Up – When the unit is removed from storage, all grease in the fan bearings should be purged and replenished with fresh grease as per the lubrication decal. Spherical roller bearings split pillow block housings should be recharged with grease. The bottom half of the housing should be 1/3 full.

The motor winding resistance should be measured to verify that it is still at a satisfactory level compared to the value recorded prior to storage. Motor is to be installed on the fan per original location. Motor shaft and fan shaft to be cleaned to bare metal.

Drives are to be cleaned to bare metal, installed, and aligned per manufacturer's recommendations.

If belts show signs of deterioration, they should be replaced prior to start-up. Belts are to be installed and tensioned per manufacturer's recommendations. Replace the fan housing drain plug, if applicable.

FOUNDATION and SUPPORTING STRUCTURES

The preferred means of floor mounting a fan is on a well-designed, flat, level concrete foundation. The foundation should have a mass of at least three to five times that of the supported assembly. The foundation should extend at least 6" beyond the outer dimensions of the fan and driver; however, it should be no more than twice the area required for the equipment. If it is made larger, the mass should be increased accordingly to resist rocking modes of vibration. "J", "L", or "T" type anchor bolts of sufficient size should be used and should be tied into the foundation reinforcing bar. After the concrete is poured, a pipe sleeve with a diameter of 2 to 2-1/2 times the anchor bolt diameter should be provided around each anchor bolt to facilitate final adjustment (see Figure 8). The mounting surface of the foundation should be smooth for good shim contact. When deciding the thickness of the foundation, approximately 1" to 1-1/2" in height should be allowed for shimming, grouting, and leveling nuts.

If a structural steel base or platform is to be used for fan mounting, the support structure must be designed for the weight of the fan, the live loads imposed by rotation of the rotor and driver, and any external live loads. The structure should be designed to ensure that no natural frequency will be present within 30% of the fan speed and motor speed. This is especial true if the structure supports more than one fan.

Fan inlet and outlet ducting should have independent support. Do not use the fan to support ducting as the fan housing or pedestal may become distorted or cracked. Flex connectors at the fan inlet and discharge will isolate the duct loads from the fan plus eliminate transmission of vibration. Use stainless steel fasteners with large washers under the head and nut to increase the load bearing area. Do not tighten the fasteners to the point of crushing the flange.

FAN INSTALLATION

Follow proper handling instructions as given earlier.

1. Move the fan to the final mounting position.
2. Remove skid, crates, and packing materials carefully.
3. If vibration isolation is to be used, place isolation base on mounting bolts. Line up holes in fan base with bolts.
4. Place the fan on mounting structure. Carefully level the unit (checking the level on the fan shaft) on the foundation and shim as necessary using stainless steel shims on both sides of each anchor bolt. Be careful not to force the fan to the mounting structure/foundation. This may cause the bearings to become misaligned or pinched, which can cause vibration and premature failure.
5. Check the alignment of the bearings. Shim or reposition the bearings if necessary.
6. Check face alignment of sheaves on belt driven units (reference Figure 4). Check tension of belts to see if it is sufficient. Sheaves on belt driven fans are often provided with taperlock bushings. When tightening bushing bolts, proceed in a progressive manner to avoid cocking the tapered surfaces between the bushing and the sheave.
7. Check alignment of factory mounted couplings, as

they are subject to misalignment during shipping and installation. Realign to within 0.002" offset and parallel. Allow for thermal growth of the motor by setting the motor 0.001" low for each inch of shaft up to 0.005".

NOTICE

Grid-type and gear-type couplings require lubrication.

8. Check the tightness of the foundation bolts, motor bolts, sheaves, and bearings. Make sure there is no rubbing or binding and that the wheel-inlet cone clearances are correct.
9. Check that bearings are fully lubricated. For spherical roller bearings with split pillow block housings, the bottom half of the housing should be 1/3 full of grease. For oil lube bearings, the oil level should submerge the bottom-most roller halfway.
10. Install any accessories that were shipped loose from the factory.
11. Grouting is the final installation step. Check all stainless steel shims before grouting to make sure the fan is resting evenly on all points with anchor bolts secured to hold the shims. Use shims with sufficient space allowed for working the grout. The concrete foundation should be clean and well moistened before pouring grout. Use a commercial grade non-shrinking grout and be especially sure when pouring grout that the anchor bolt sleeves are filled. Refer to Figure 8 for a detail of a proper foundation, grout allowance, and anchor bolt sleeve.

BEARING INSTALLATION

The following section gives some general instructions on bearing installation. When bearings are field installed, the specific installation manual for the bearings should be followed carefully. Always make sure to check the fan assembly drawing or instructions for location of the non-expansion and expansion bearings. The position of these bearings cannot be interchanged.

Figure 1.

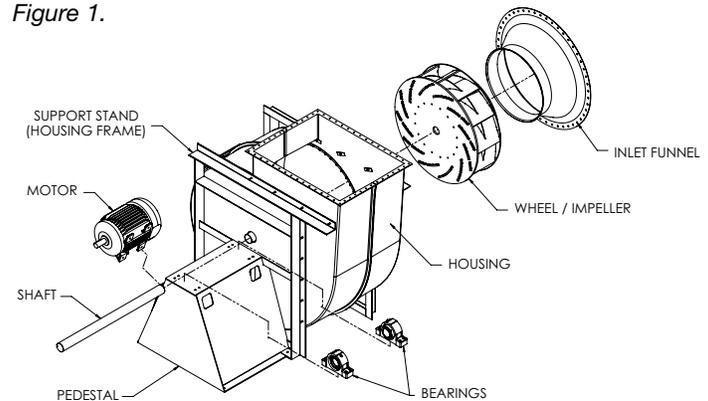
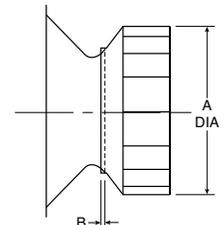


Figure 2. Wheel Placement

BCSF Wheel Placement								
Size	165	182	200	222	245	270	300	330
A	16.50	18.25	20.00	22.25	24.50	27.00	30.00	33.00
B	0.44	0.56	0.63	0.69	0.75	0.88	0.97	1.06

Size	365	402	445	490	542	600
A	36.50	40.25	44.50	49.00	54.25	60.00
B	0.94	1.03	1.13	1.25	1.38	1.56



Spherical Roller Bearings with Split Pillow Block Housing

1. The bearings should be disassembled, taking care not to interchange parts between bearings. Parts of one bearing are generally not interchangeable with parts from another bearing.
2. The lower bearing housing should be bolted loosely to the pedestal and seals, bearing, and adapter sleeve assembly should be placed loosely on the shaft.
3. The rotor assembly with the seals and bearings should next be positioned over the housing and carefully placed into the lower housing.
4. The thrust locking ring should be installed in the bearing closest to the drive sheave or coupling unless otherwise noted in the drawing.
5. When installing adapter sleeves, tighten for reduction in clearance per manufacturer's instructions.
6. Bend down a tab on the lockwasher after finishing adjustment.
7. Grease or oil according to manufacturer's instructions.
8. Install the bearing housing cap and cap bolts. Tighten bearing housing cap bolts and bearing mounting bolts. Torque to bearing manufacturer's instructions.

Solid Pillow Block

1. Slide shaft in bearing bore to proper location. Note: Shaft should slide easily if self-aligning feature of the shaft is within its limits. Sling the rotor assembly into place and loosely bolt the bearings in place.
2. When bearings are in place, torque the base bolts using values from Table 1, and tighten the collar setscrews to manufacturer's specification.
3. Grease the bearings per manufacturer's instructions.

BEARING MAINTENANCE

Proper lubrication of the fan bearings helps assure maximum bearing life. All fans are equipped with decals indicating relubrication intervals for normal operating conditions. Figures 9, 10 and 11 illustrate the lubrication schedules for ball bearings, solid pillow block spherical roller bearings, and split pillow block spherical roller bearings, respectively. Note that all speeds shown do not apply to all shaft sizes in that group. Consult the factory if in doubt of maximum speed for a particular bearing. Note that every installation is different and the frequency of relubrication should be adjusted accordingly.

On applications where there is high moisture or heavy dust, the lubrication frequency may need to be doubled or tripled to adequately protect the bearings.

Observation of the conditions of the grease expelled from unit ball or roller bearings at the time of relubrication is the best guide as to whether regreasing interval and amount of grease added should be altered.

Figure 3.
Sheave Position

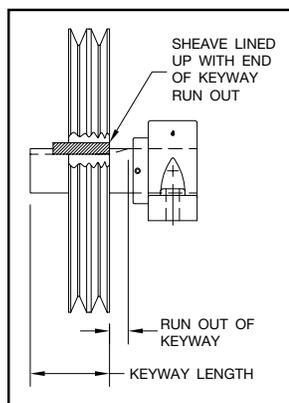
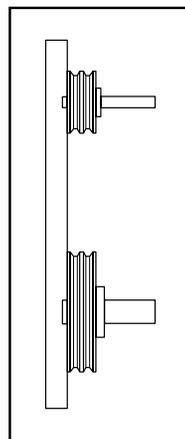


Figure 4.
Sheave Alignment



Spherical roller bearings with split pillow block housings should be lubricated until grease purges or overheating may result. Follow the lubrication interval and amount noted in Figure 11. Spherical roller bearings with split pillow block housings should be serviced once per year. Remove cap, clean out old grease, and replace by filling the bottom half of the housing 1/3 full.

Greases are made with different bases. There are synthetic base greases, lithium base, sodium base, poly urea base, etc. Avoid mixing greases with different bases. They could be incompatible and result in rapid deterioration or breakdown of the grease. The lubrication sticker identifies a list of acceptable lubricants. All bearings are filled with a lithium based grease before leaving the factory. When the fans are started, the bearings may discharge excess grease through the seals for a short period of time. Do not replace the initial discharge because leakage will cease when the excess grease has worked out. Sometimes the bearings have a tendency to run hotter during this period. This is no reason alarm unless it lasts over 48 hours or gets very hot (over 200°F). When relubricating, use a sufficient amount of grease to purge the seals. Rotate bearings by hand during relubrication.

DRIVE INSTALLATION

Mount drives as follows:

1. Slip (do not pound) proper sheave and its bushing onto corresponding shaft (position per Figure 3).



2. Align sheaves with a straightedge extended along sheave face, just making contact in two places on outside perimeters of both sheaves (reference Figure 4). This "four-point" alignment may also be checked with a string tied to the shaft behind one of the sheaves. The string is then pulled taut over the faces of the sheaves to check the alignment at the four points at the outside perimeters. Each sheave should be rotated about one-half revolution during the check to look for excessive runout or a bent shaft.
3. Install and tighten the belts. Run the drive for a few minutes to seat the belts. When tightening the belts, slide the motor in to slip the belts on. Do not use a pry bar, as this may damage the belt cords. Tighten the belts to the proper tension. Ideal tension is just enough tension so that the belts do not slip under peak load. Many drives are provided with tensioning data which identifies the load to apply at the center of the span and the allowable deflection from this force. This may be checked visually (look for a slight bow on slack side), or listen for a squeal on startup, indicating that the belts are too loose. Recheck sheave alignment.
4. After initial installation of belts, recheck belt tension again after a few days and adjust tension as needed. (New belts require a break-in period of operation.)

DRIVE MAINTENANCE

V-belt drives need periodic inspection, re-tensioning, and occasional belt replacement. Look for dirt buildup, burrs, or obstructions when inspecting drives. These can cause premature belt or drive replacement. If burrs are found, use fine emery cloth or a stone to remove the burr. Be careful that dust does not enter the bearings.

Check the sheaves for wear. Excessive slippage of belts on the sheaves can cause wear and vibration.

Replace worn sheaves with new ones. Carefully align sheaves to avoid premature sheave failure.

Observe belts for signs of wear. If fraying or other wear is observed to be mostly on one side of the belts, the drives may be misaligned. Reinstall the drives according to instructions given for "Drive Installation". Never use belt dressing on any belts. Make sure the sheaves and belts are free from all forms of lubricants.

Always replace the entire set of v-belts and never mix used belts with new belts. Follow instructions given for "Drive Installation".

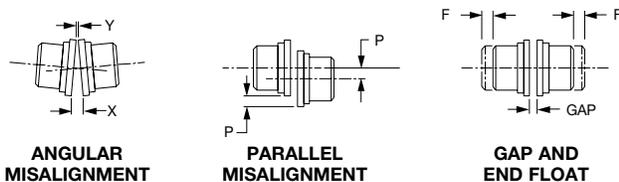
FLEXIBLE COUPLING INSTALLATION

These instructions are general for the installation of several types of flexible couplings and should not be used as a substitute for more specific manufacturer's instructions. The coupling manufacturer's installation data is available and will give specific dimensions for alignment limits, lubricants, etc. Refer to Item 7 in "Fan Installation" section for alignment requirements.

Before preparing to mount the coupling, make sure that all bearings, shaft seal, or other shaft mounted components have been installed on the shaft.

When mounting and keying the interference fit coupling halves to the shaft, follow supplied instructions for heating and shrink fitting. Set the coupling halves for the normal gap specified by the manufacturer. Coupling gap is illustrated in Figure 5.

Figure 5. Coupling Installation



X-Y = ANGULAR MISALIGNMENT
P = PARALLEL OFFSET (MISALIGNMENT)
F = END FLOAT

The two types of misalignment are illustrated in Figure 5. Typically angular alignment is checked with feeler gages between the hub faces. When angular alignment has been adjusted to within manufacturer's specification by shimming, if necessary, then parallel alignment can be checked with a straightedge and feeler gages on the hub halves' O.D. When shimming has brought parallel alignment within specification, angular alignment and gap should again be checked, and adjustments made if necessary. A dial indicator or laser alignment method may be used to more accurately take the measurements described above. Special adjustments may need to be made for couplings used with some equipment. As an example, when couplings are used with motors which have sleeve bearings, the coupling may require provisions for limiting end float. Larger drives may grow vertically in operation (due to thermal expansion) requiring the driver side to be set slightly low when at ambient temperature. Refer to specific instruction manuals or assembly drawings.

Thoroughly clean the coupling halves after completion of alignment. Reassemble the coupling and tighten cover bolts, washers, and nuts. Lubricate per manufacturer's recommendations.

GENERAL MOTOR MAINTENANCE

The three basic rules of motor maintenance are keep the motor clean, keep the motor dry, and keep the motor properly lubricated.

Keeping the motor and its windings clean is important because dirt and dust serve as thermal insulation. Heat

normally dissipated by the motor is trapped causing overheating and/or premature failure. Blow dust and dirt out of windings and off the motor periodically. Use a clean and dry low pressure (50 psig) airstream so that winding damage does not occur. Keep the area surrounding the motor open so that air can circulate through the motor cooling fan.

Motors should be kept dry to avoid electrical short circuits. Motors kept in storage for long periods of time can have moisture condense on the windings. Be certain the motor windings are dry before energizing the motor.

Lubrication requirements are normally attached to the motor. Do not overlubricate. Motor lubricants are often not the same as the fan bearing lubricant. Some smaller motors are lubricated for life. Motor bearing lubrication, if required, must follow a rigorous schedule. Motors less than 10 hp running about eight hours a day in a clean environment should be lubricated once every five years; motors 15 to 50 hp, every three years; and motors 60 to 150 hp, yearly. For motors in a dusty or dirty environment or running 24 hours a day, divide the service interval by two. If the environment is very dirty or has a high ambient temperature, then divide the service interval by four.

Motors controlled by variable frequency drives (VFD) should be wired in accordance with the VFD manufacturer's instructions. The motor must be grounded to earth and proper shielded cabling must be used. Motor shaft grounding rings should be considered to minimize shaft voltage from arcing through the motor bearings.

FRP MAINTENANCE

Corrosion Resistance – The type of reinforcement fiber used in making the laminate structure will influence its weight, strength, and also the wheel maximum safe speed. The resin selected will influence the corrosion resistance of the laminate and hence the product durability. The Twin City Fan & Blower standard resin used for manufacturing wheel components is the epoxy vinyl ester product Derakane 510A40 from Ashland. The TCF standard resin used for manufacturing housing components is the polyester product Hetron 92FR from Ashland with the option of using Derakane 510A40. Both products (without addition of antimony trioxide) have a flame spread rating less than 25 as tunnel tested per ASTM E84.

See the "Corrosive Atmosphere Guide" that is located within TCF Catalog 410 for suggested resin to use in various corrosive environments. Final selection of the resin should always be based upon customer's experience and/or testing conducted with desired fume concentration and temperature. Additional corrosion resistance information is available from Ashland at ashland.com.

Perform periodic visual inspection of the FRP laminate to determine there is no adverse deterioration occurring which will compromise the product's structural integrity. Periodic cleaning can prolong product life and should be investigated.

Abrasion Resistance – Fans constructed of FRP materials are intended for clean air service with humidity less than 100% or for air laden with corrosive fumes. FRP laminate is inherently "softer" than carbon steel and stainless steel. FRP products should not be used to convey air which contains particulate or water (liquid or fog). Severe erosion can occur if these items are present in the airstream. The resin rich outer surface is subject to wear and if this layer is compromised, the corrosive fumes can then attack the reinforcement fiber. The combination of corrosion and abrasion can quickly lead to product failure.

Perform periodic visual inspection of the FRP laminate to determine there is no adverse deterioration occurring which will compromise the product's structural integrity.

Weather Resistance – FRP products installed outdoor without adequate protection are subject to damage from local weather conditions. This can include impact damage resulting from hail or windblown objects, surface chalking or discoloration from ultraviolet light exposure, and reduced strength due to temperature effects resulting from high ambient temperature and solar radiation combined with high internal air temperature.

WHEEL and SHAFT MAINTENANCE

Periodically inspect the fan shaft and FRP wheel for buildup, corrosion, and signs of excess stress or fatigue.

Dust or chemical deposits will usually build up on the wheel evenly and they present no problem to performance or operation until they become thick enough to break away in crust-like pieces. When this happens, the wheel may be thrown out of balance and the resulting vibration could be serious. When removing this crustaceous accumulations, care should be taken not to clean the fan wheel with sharp objects which might damage the laminated surface and reduce its corrosion resistance. Replace the wheel and shaft sub-assembly if it shows signs of excessive wear or damage to the laminate.

The fan wheel and shaft sub-assembly is factory balanced and then the entire fan assembly is test run to assure vibration levels are within tolerance. It is not uncommon for the fan wheel to require some trim balancing after installation or after some period of time in operation. Addition of FRP weights to the backplate or frontplate can be made to bring the vibration levels back within specification.

Check the interface between the shaft sleeve and the wheel backplate. This joint is critical to prevent infiltration of corrosive fluids to the shaft and hub. Replace the sub-assembly if needed.

Check the condition of the shaft to verify it has not suffered any corrosive attack. Replace the sub-assembly if needed.

HOUSING MAINTENANCE

The fan housing is assembled from two FRP halves that are bolted together with stainless steel bolts and the interior joint is secondary bonded to prevent leakage. Check the interior surfaces for any evidence of FRP damage and repair, if possible, or replace if necessary. An optional Inspection Door and Drain is available.

The inspection door is bolted to the housing with stainless steel bolts and sealed with a corrosion resistant gasket.

The FRP drain is secondarily bonded to the low point in the housing to minimize accumulations of liquid. Check to insure the drain is not clogged and any fluid is discharged appropriately.

STRUCTURAL MAINTENANCE

All structural components or devices used to support or attach the fan to a structure should be checked at regular intervals. Vibration isolators, bolts, foundation, etc. are all subject to failure from corrosion, erosion, and other causes. Improper mounting can lead to poor operation characteristics or fan fatigue and failure. Check metallic components for corrosion, cracks, or other signs of stress. Concrete should be checked to insure the structural integrity of the foundation.

DUCT CONNECTIONS

The fan support structure is normally not designed to carry static loads imposed by the weight of ducts, silencers, stacks, etc. or dynamic loads from wind or seismic events. Supporting these loads on the fan inlet and discharge can

cause housing distortion and may cause performance problems due to the relation of fan housing to wheel. Excessive loads on the fan housing may damage the FRP housing and render it unfit for service.

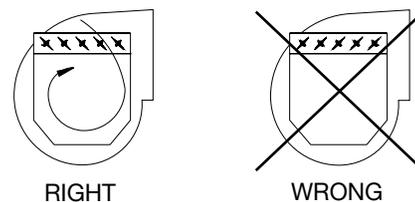
Since FRP is used primarily for its corrosion resistance, it is recommended that stainless steel fasteners be used. Use a large washer under the head of the bolt and nut to increase the load bearing area in contact with the FRP. Do not tighten these fasteners to the point of crushing the FRP laminate.

Use of flexible connections is recommended for all installations and especially when the fan is mounted on vibration isolators.

OPTIONAL ACCESSORIES

1. Shaft Seals – The standard shaft seal is a Teflon membrane style shaft closure seal that minimizes leakage around a FRP sleeve that is encapsulated over a carbon steel shaft. Optional shaft seal is either a Viton or Teflon lip seal that is installed in a cast FRP seal housing. The shaft is encased with a stainless steel shaft sleeve over a steel shaft. Care must be taken to insure the integrity of the joint between the shaft sleeve and the wheel backplate. Other configurations of shaft seals are available for special applications.
2. Bolt-On Variable Inlet Vanes – Variable inlet vanes made of FRP are provided as assemblies externally to the fan in flanged cylinders that are bolted to the fan inlet. The vanes are used to control volume and save power in installations where different volumetric operating conditions are used. Variable inlet vanes may be provided for operation with powered operators or for manual operation. Powered operator instructions and operating manuals will be provided when included.
3. Inlet Box and Inlet Box Dampers – FRP inlet boxes may be provided to allow transition from a rectangular duct to the fan inlet. FRP inlet box dampers may also be provided for volumetric regulation similar to inlet vanes. FRP inlet dampers are usually provided as a complete assembly and are installed with the damper axis parallel to the fan shaft. They must be installed to pre-spin the air in the direction of fan rotation. See Figure 6 below. Damage may occur if the fan is operated regularly with dampers less than 30% open.
4. Outlet Dampers – FRP outlet dampers are usually provided completely assembled like the inlet dampers. The damper is bolted to the fan discharge flange for volume control.

Figure 6. Orientation of Damper Blades



5. Oil Circulating System – Usually the following modifications will have to be made to the split pillow block bearings if an oil circulating system is used.
 - a. Four drain holes will be drilled in the bearing, two on each side of the bearing. Because of this, the bearing may be drained from either side. (Drain from both holes on one side of the bearing.)

- b. The bearing will be packed with grease to prevent corrosion until installed and started up. The drain holes will be plugged with plastic covers to make sure they are open.

NOTICE
The customer MUST REMOVE most of the grease using solvent and remove the plastic covers prior to starting the oil circulating system.

- c. A wet sump will be added in case of circulating oil pump failure. Seals will be provided to minimize oil leakage due to oil splashing.
 - d. The grease zerk on top of the bearing will be removed for that hole to be used as the oil inlet.
6. Anti-Rotation Clutch – Damage will occur if the fan is operated in the wrong rotation. Run the motor uncoupled from the fan to establish the proper rotation.

FAN OPERATION - SAFETY

For general safety practices relating to air moving equipment, see AMCA Publication 410.

Twin City Fan & Blower has many safety accessories available. These safety devices include (but are not limited to) belt guards, shaft guards, inlet guards, and discharge screens. The use, abuse, or non-use of safety devices is the responsibility of the purchaser.

Facility-related safety conditions include fan accessibility and location.

- How easily can non-service personnel access the unit?
- Is the fan in a hazardous duty environment?
- Was the unit ordered for this duty?

Other concerns must also be addressed.

All fans should be powered through safety switches which are easily accessible to service personnel and in close proximity to the fan. Every safety switch should have the capability to be “Locked Out – Tagged Out” by the service person working on the unit. The key to the lock is to be retained by the service person to prevent the accidental powering up of the fan while the service person is working on the fan.

Appropriate hearing protection is to be used by all personnel in the area of the fan while it is in operation. Due to the nature of applications where FRP fans may be used, it is highly probable that the airstream constituents should not come in contact with body parts of the service person or their clothing. Follow all local plant safety requirements in regards to the exposure for the specific airstream constituents present.

Fan housings equipped with optional access doors should never be opened while the fan is in operation. The close proximity of the fan wheel to the access door opening is very dangerous when operating and can present a fatal consequence.

Fans by their nature develop a negative pressure (suction) at their inlet while in operation. Great care must be taken to prevent this force from causing anything that is near the inlet to be sucked into the rotating fan wheel. Great harm to the fan as well as to the object taken inside the fan can occur. This can also present a fatal consequence. The same affect can be had due to the high velocity air stream present which will also force objects into the fan.

Even when the fan is not in operation, sometime there are pressure differences present which can cause

the fan wheel to “windmill”. Great care must be exercised to prevent injury when working on the fan. It is advisable to temporarily block the wheel to prevent unexpected rotation and potential injury from occurring.

OPERATION CHECKLIST

WARNING
Verify that proper safety precautions have been followed. Electrical power must be locked off.

- Fan Assembly is properly grounded for static dissipation option.

Check Fan Mechanism Components:

- Nuts, bolts, and setscrews are tight.
- Mounting connections are properly made and tightened.
- Bearings are properly lubricated.
- Wheel, drives, and fan surfaces are clean and tightened.
- Rotating assembly turns freely and does not rub.
- Check for fan/wheel overlap per Figure 2.
- Drives mounted on correct shaft, properly aligned, and properly tensioned.

Check Fan Electrical Components:

- Motor is wired for proper supply voltage.
- Motor was properly sized for power required by the rotating assembly.
- Motor is properly grounded.
- All leads are properly insulated.

Trial “Bump”:

- Turn on power just long enough to start assembly rotating.
- Check rotation for agreement with rotation arrow
- Listen for any unusual sounds.

Run Unit Up To Speed:

- Bearing temperatures are acceptable (<200°F) after one to two hours of operation.
- Check for excessive levels of vibration. Filter in readings should be 0.15 in/sec (peak) or less.

After One Week Of Operation:

- Check all nuts, bolts, and setscrews and tighten if necessary.
- Readjust drive tension if necessary.

TROUBLESHOOTING GUIDELINES

Use current safety practices when investigating fan or system performance problems. General safe practices and performance troubleshooting guidelines can be found in AMCA Publications 410 and 202, respectively. Fan application and field measurement procedures can be found in AMCA Publications 201 and 203.

Below is a list of possible areas to check when air, sound, or operational values do not match expectations. Most fan problems can be pinpointed to one of these common causes.

TROUBLESHOOTING PROBLEMS

Air Capacity Problems

1. Resistance of the system is not at design rating. If resistance is lower than expected, both airflow and horsepower may be up. If resistance is higher than anticipated, air volume will be down.
2. Fan speed is not at design speed.
3. Air density at the fan inlet is not at the design value. Also check air performance measurement techniques and procedures.
4. Devices for air modulation are closed or plugged. Also check filters.

5. Wheel mounted improperly or is rotating in reverse.
6. Parts of the system or fan have been damaged or need cleaning.

Noise Problems

1. Air performance is incorrect and the fan is not at the design point of operation. Fan is being forced to operate in an unstable flow region.
2. Bearing failure. Check bearing lubrication, alignment, and fastener tightness.
3. Supply voltage high or inconsistent supply frequency. Adjustable frequency controllers (VFD) can generate motor noise.
4. Objects which are installed in a high velocity air stream can generate noise. This includes flow sensors, turning vanes, etc.
5. Poor fan inlet conditions.
6. Acoustic or sound measurement procedure is incorrect.

Vibration Problems

1. Misalignment of drive components. Check belts or coupling.
2. Poor foundation or mounting structure (resonance).
3. Foreign material attached to the rotating components.
4. Damaged rotating components (bearings, shaft, fan wheel, sheaves, coupling, seals, etc.)
5. Broken, loose, or missing setscrews, bolts, or fasteners.
6. Vibration transmitted by another source.
7. Fan is operating in stall or unstable flow region.

Figure 7. Vibration Guidelines

Seismic Vibration Velocity Limits for Operation In-Situ

Condition	Fan Application Category	Rigidly Mounted mm/s (in./s)	Flexibly Mounted mm/s (in./s)
Start-up	BV-3	6.4 (0.25)	8.8 (0.35)
	BV-4	4.1 (0.16)	6.4 (0.25)
Alarm	BV-3	10.2 (0.40)	16.5 (0.65)
	BV-4	6.4 (0.25)	10.2 (0.40)
Shutdown	BV-3	12.7 (0.50)	17.8 (0.70)
	BV-4	10.2 (0.40)	15.2 (0.60)

Value shown are peak velocity, mm/s (inches/s), Filter out.
 Table taken from ANSI/AMCA Standard 204-05, Table 6.3.
 AMCA defines BV-3 for applications up to 400 HP; BV-4 for applications over 400 HP.

Bearing Problems

Generally speaking, Twin City Fan & Blower uses three types of bearings:

1. Ball bearings with setscrew lock;
2. Spherical roller bearing with setscrew lock;
3. Spherical roller bearing with adapter sleeve/taper lock feature to attach them to the shaft.

Ball Bearings with setscrew lock - These are self-aligning bearings and should present no alignment problems with one exception: i.e., on Sealmaster bearings, there is a pin beneath the grease fitting which prevents the bearing outer race from rotating. Should this pin jam, the bearing loses its alignment feature.

Common failure causes are (a) setscrews loosening and shaft turning within the bearing inner race, and (b) crowned bearing supports. Loosen one bolt and measure the clearance between the bearing foot and the support. Add shims to compensate.

Spherical Roller Bearings with setscrew lock - The self-aligning characteristic of these bearings are inherent in the spherical roller design. The closer that these bearings are to perfect alignment, the cooler they will operate.

Common failure causes are the same as with the ball bearings, mainly setscrews loosening and crowned bearing supports.

Spherical Roller Bearings with adapter lock - Again, the self-aligning feature is inherent in the spherical design. Good alignment results in a cooler operating bearing. The faster the bearing operates the more critical this becomes.

A common cause of failure is improper installation practice. Removing too much radial internal clearance from the bearing can cause preloading of the bearing with the result of premature failure; and removing not enough internal clearance can allow the shaft to rotate within the adapter sleeve with the result of noise, heat, and failure. Properly tightened, this method of attaching a bearing to a shaft is second only to an interference fit. Crowned bearing supports can also preload these bearings and should be checked by loosening one bolt and checking the clearance between the bearing foot and the support. Add shims to compensate.

Lubrication - The major cause of bearing failure is contamination of grease, insufficient grease, or incompatibility of grease. If a fan is to be stored for any length of time at the job site, the bearings immediately should be filled

Table 1. Tightening Torques (in lb-ft)

SIZE	FASTENER			TAPER BUSHINGS (DRIVE)	
	GRADE 2	GRADE 5	GRADE 8	SPLIT	QD
#10	—	—	—	—	6
¼-20	5.5	8	12	7.9	9
⅝-18	11	17	25	16	15
¾-16	22	30	45	29	30
7/16-14	30	50	70	—	—
½-13	55	75	110	70	60
9/16-12	—	—	—	—	75
5/8-11	100	150	200	140	135
¾-10	170	270	380	250	225
7/8-9	165	430	600	—	300
1-8	250	645	900	600	450
1¼-7	500	1120	1500	—	—

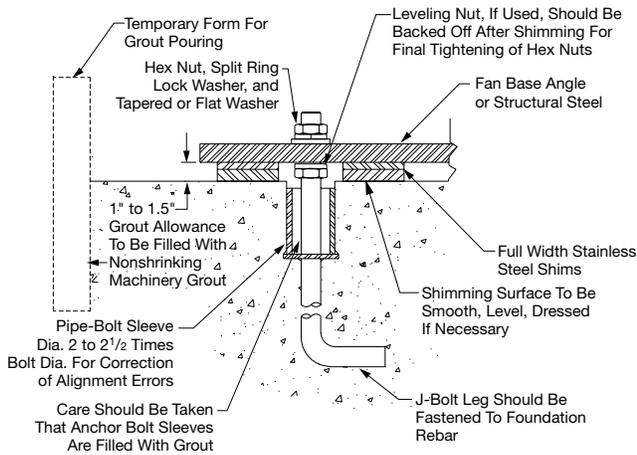
Tolerance: ± 5%
 For wheel setscrews use Grade 2 values.

The torque values are for nonlubricated fasteners and Browning Bushings.

For bearing setscrews, use manufacturer's recommendations.

If other bushings are used, utilize bushing manufacturer's specifications.

Figure 8. Typical Foundation Section



with grease while rotating the shaft and then the bearings should be regreased and shaft rotated monthly. This will prevent moisture, which condenses within the bearing, from corroding the raceways. Most of the grease used on fan pillow block bearings are lithium base. Use the greases shown on the bearing decal. Do not mix greases with different type of bases, but always purge out the initial grease having one base with the new grease having a different base.

Initially, follow the lubrication instruction on the side of the fan. The frequency of lubrication should be adjusted depending on the condition of the old grease being purged. This is the responsibility of the user. If the grease is dirty, the lubrication frequency should be more often.

Figure 9. Safety & Lubrication Instructions for Fans with Ball Bearings

WARNING

- This equipment must not be operated without proper guarding of all moving parts. While performing maintenance be sure remote power switches are locked off. See installation manual for recommended safety practices.
- Before starting: Check all setscrews for tightness and rotate wheel by hand to make sure it has not moved in transit.

Relubrication Schedule (Months)* Ball Bearing Pillow Blocks									
Shaft DIA	Speed (RPM)								
	500	1000	1500	2000	2500	3000	3500	4000	4500
1/2" thru 1 1/16" (13 - 45)	6	6	5	3	3	2	2	2	1
1 1/16" thru 2 3/16" (50 - 60)	6	5	4	2	2	1	1	1	1
2 1/16" thru 2 5/16" (65 - 75)	5	4	3	2	1	1	1		
3 1/16" thru 3 5/16" (80 - 100)	4	3	2	1	1				

*Suggested lubrication interval under ideal continuous operating conditions. Relubricate while running, if safety permits, until some purging occurs at seals. Adjust lubrication frequency depending on conditions of purged grease. Use one-half of listed interval for vertical shaft applications or for 24 hour operation. Hours of operation, temperature, and surrounding conditions will affect the relubrication frequency required.

- Lubricate with a high quality NLGI No. 2 lithium-base grease having rust inhibitors and antioxidant additives, and a minimum oil viscosity of 500 SUS at 100°F (38°C). Some greases having these properties are:
 Shell - Gadus S2 V100 2 Exxon - Ronex MP
 Mobil - Mobilith SHC100 Mobilith - Mobilith SHC220
- Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.

Bearing Noise – If a bearing is increasing in noise intensity and/or vibration, it will probably result in failure.

Bearing Temperature – If a bearing temperature begins to gradually rise, it will generally result in failure. A bearing can operate up to 200°F and perform satisfactorily as long as the temperature remains constant and the bearing receives adequate lubrication. Remember that a roller bearing under the same load and speed will be somewhat noisier and run warmer than a ball bearing. This is normal.

Rough handling and /or dropping a fan can result in brinelling the bearing. This appears as a clicking noise at first, and then gradually worsens until failure occurs. When replacing a bearing, always align the bearings first, then bolt the pillow blocks to their support, rotate the shaft, fasten the bearing to it. If the bearing is fastened to the shaft first, tightening the pillow block blocks may bind the shaft and preload the bearings.

Drive Problems

- Belts improperly tensioned.
- Drive alignment is poor. Check belts or coupling.
- Coupling lubrication.

Motor Problems

- Incorrect wiring.
- Speed of fan is too high.
- Parts improperly installed or binding.
- Bearings improperly lubricated.
- WR² capability of motor is too low for application.
- VFD compatible.
- Cable and grounding correct.

Figure 10. Safety & Lubrication Instructions for Fans with Unit Roller Bearings

WARNING

- This equipment must not be operated without proper guarding of all moving parts. While performing maintenance be sure remote power switches are locked off. See installation manual for recommended safety practices.
- Before starting: Check all setscrews for tightness and rotate wheel by hand to make sure it has not moved in transit.

Relubrication Schedule (Months)* Spherical Roller Bearing - Solid Pillow Blocks									
Shaft DIA	Speed (RPM)								
	500	1000	1500	2000	2500	3000	3500	4000	4500
1" thru 1 7/16" (25 - 35)	6	4	4	2	1	1	1	1	1/2
1 1/16" thru 2 3/16" (40 - 55)	4	2	1 1/2	1	1/2	1/2	1/2	1/2	1/2
2 3/16" thru 3 1/16" (60 - 85)	3	1 1/2	1	1/2	1/2	1/4	1/4		
3 1/16" thru 4 1/16" (90 - 125)	2 1/2	1	1/2	1/4					

*Suggested lubrication interval under ideal continuous operating conditions. Relubricate while running, if safety permits, until some purging occurs at seals. Adjust lubrication frequency depending on conditions of purged grease. Use one-half of listed interval for vertical shaft applications or for 24 hour operation. Hours of operation, temperature, and surrounding conditions will affect the relubrication frequency required.

- Lubricate with a high quality NLGI No. 2 lithium-base grease having rust inhibitors and antioxidant additives, and a minimum oil viscosity of 500 SUS at 100°F (38°C). Some greases having these properties are:
 Shell - Gadus S2 V100 2 Exxon - Ronex MP
 Mobil - Mobilith SHC100 Mobilith - Mobilith SHC220
- Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.

Figure 11. Safety & Lubrication Instructions for Fans with Spherical Roller Bearings with Split Pillow Block Housings

WARNING

1. This equipment must not be operated without proper guarding of all moving parts. While performing maintenance be sure remote power switches are locked off. See installation manual for recommended safety practices.
2. Before starting: Check all setscrews for tightness, and rotate wheel by hand to make sure it has not moved in transit.

Shaft DIA	Relubrication Schedule (Months)* Spherical Roller Bearing - Split Pillow Blocks									Grease to be added at each interval
	Speed (RPM)									
	500	750	1000	1500	2000	2500	3000	3500	4000	
1 ^{1/8} " thru 1 ^{15/16} " (35 - 50)	6	4 1/2	4	4	3 1/2	2 1/2	2 1/2	1	1	0.50 oz.
2 ^{3/16} " thru 2 ^{13/16} " (55 - 70)	5	4 1/2	4	2 1/2	2 1/2	1 1/2	1/2	1/4	1/4	0.75 oz.
2 ^{19/16} " thru 3 ^{1/4} " (75 - 100)	4 1/2	4	3 1/2	2 1/2	1 1/2	1	1/2			2.00 oz.
4 ^{1/8} " thru 4 ^{1/4} " (110 - 135)	4	4	2 1/2	1	1/2					4.00 oz.
5 ^{1/16} " thru 6 ^{15/16} " (140 - 180)	4	2 1/2	1 1/2							7.00 oz.

*Suggested lubrication interval under ideal continuous operating conditions. Remove bearing cap and observe condition of used grease after lubricating. Adjust lubrication frequency as needed. Use one-half of listed interval for vertical shaft applications or for 24 hour operation. Hours of operation, temperature, and surrounding conditions will affect the relubrication frequency required. Clean and repack bearings annually. Remove old grease, pack bearing full and fill housing reservoir on both sides of bearings to bottom of shaft.

1. Lubricate with a high quality NLGI No. 2 lithium-base grease having rust inhibitors and antioxidant additives, and a minimum oil viscosity of 500 SUS at 100°F (38°C). Some greases having these properties are:
 Shell - Gadus S2 V100 2 Exxon - Ronex MP
 Mobil - Mobilith SHC100 Mobil - Mobilith SHC220
2. Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.
3. Purge or remove old grease when changing lubrication brands or types.

Static Oil Lubrication

1. Use only high quality mineral oil with a VG grade indicated on the customer submittal drawing.
2. Static oil level should be at the center of the lower-most roller (Do not overfill.)
3. Complete lubrication change should be made annually.

LIMITATIONS OF WARRANTIES and CLAIMS

Seller warrants to the original purchaser that the goods sold hereunder shall be free from defects in workmanship and material under normal use and service (except in those cases where the materials are supplied by the buyer) for a period of one year from the date of original installation or eighteen (18) months from the date of shipment, whichever occurs first. The liability of seller under this warranty is limited to replacing, repairing, or issuing credit (at cost, F.O.B. factory and at seller's discretion) for any parts which are returned by buyer during such period provided that:

- a. Seller is notified in writing within ten (10) days following discovery of such defects by buyer, or within ten (10) days after such defects should be reasonably have been discovered, whichever is less;
- b. The defective unit is returned to seller, transportation charges prepaid by buyer.
- c. Payment in full has been received by seller or said products; and
- d. Seller's examination of such unit shall disclose to its satisfaction that such defects have not been caused by misuse, neglect, improper installation, repair, alteration, act of God, or accident.
- e. Seller cannot guarantee sound pressure levels or dBA.

No warranty made hereunder shall extend to any seller product whose serial number is altered, effaced, or removed. Seller makes no warranty, express or implied, with respect to motors, switches, controls, or other components of seller's product, where such components are warranted separately by their respective manufacturers. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WHETHER STATUTORY OR OTHERWISE, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. In no event shall seller be liable to buyer for indirect, incidental collateral, or consequential damage of any kind. (BUYER'S FAILURE TO PAY THE FULL AMOUNT DUE WITHIN SIXTY (60) DAYS OF DATE OF INVOICE SHALL OPERATE TO RELEASE SELLER FROM ANY AND ALL LIABILITY OR OBLIGATION ARISING PURSUANT TO ANY WARRANTY, EXPRESS OR IMPLIED, WHETHER STATUTORY OR OTHERWISE, INCLUDING ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, MADE IN CONNECTION WITH ANY CONTRACT HEREUNDER. BUYER AGREES THAT SUCH FAILURE TO PAY SHALL CONSTITUTE A VOLUNTARY WAIVER OF ANY AND ALL SUCH WARRANTIES ARISING PURSUANT TO SUCH CONTRACT.)



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