# GENERAL INFORMATION

The **Amercool Mfg., Inc.** Air Cooled Heat Exchanger should be inspected thoroughly by receiving personnel. Damage in transit will be the result of dropping or being struck by heavy objects. Observe sub-skid flanges, plenum side panels and coil sections for obvious physical damage. Dents, bent flanges, crushed tubes, damaged instruments or piping among other things should be described on receiving documents presented by the carrier. Prompt claim filing will expedite early compensation from the offending carrier.

The unit should be placed on its foundation as soon as practicable after being received.

Basically this unit is a completely shop assembled cooling unit. Occasionally special accessory devices will be required which must be shipped disassembled to meet height or width limitations of the carrier.

In the event some assembly of this type is required, the appropriate assembly instructions will accompany the shipment. Detail parts to be installed will normally be secured in place on the skid base (if the unit is so designed) or in the plenum chamber. Examine the interior of the plenum for any storage.

Coil piping should be installed in accordance with engineering instructions supplied in connection therewith. Attention is invited to the approved cooler drawings which identify the "INLET" and "OUTLET" nozzles.

# START UP PROCEDURE

**Prior to Run-In:**

It is imperative that the units be checked for good working order prior to run-in. The following general check list is provided to insure that all equipment has been properly installed and is ready to go on stream.

## 1. HYDROSTATIC TEST

**AMERCOOL MFG., INC.** tube bundles are hydrostatically tested to one and a half times the design pressure before being released for shipment. To ensure that no damage has been done during shipment and/or erection, it is good practice to hydrostatically test the entire system, including piping, heat exchangers, pumps, etc., prior to start-up.

## 2. BEARINGS

Check bearings for lubrication. **Caution**: Do not overgrease. The bearings were greased by manufacturer and no additional grease is necessary to start. Remote lubrication lines when provided should be loosened at the bearing end, then filled with grease from fitting end. This will ensure that the lube lines are full of grease and free of air and debris.

## 3. FANS

Check fan blade bolts and hub set screws for tightness. Ÿ **Note**: These should be checked again after the first four hours of operation and then again each two months of continuous operation thereafter.

The fan should be rotated by hand to ensure that the shaft, speed reducer and driver turn freely.

The fan should also be checked for adequate fan blade tip clearance. To measure this, first move all blades past a fixed point on the inside of the fan ring and observe which blade has the least amount of clearance at that point. Then move the blade selected 360 degrees to the point of minimum clearance. Refer to section on fans.

Switch on the fan driver momentarily to check for proper direction of rotation and fan blade orientation. The leading edge of the fan blade is the thick edge. When properly pitched, this leading edge will be the lower edge.

If the starting torque trips the vibration switch turn the adjusting screw located on the right hand side of the vibration switch to the right (clockwise) for a heavier setting. Please see the section on vibration switches.

4. **V-BELT DRIVES** (when applicable)

Check V-Belt tension in accordance with V-Belt tensioning section of this manual.

5. **GEAR BOX**

Check gear box for oil. Gears are shipped without oil and must be filled and serviced in accordance with instructions contained later in this operating manual.

6. **LOUVERS**

Check all mounting brackets and bolts for tightness. On manually operated units, manual operator should be moved from full open to full closed several times to ensure proper linkage adjustment and that louvers will operate freely. On air motor operated (automatic) units, all air supply line fittings should be checked for tightness and air motor should be energized to ensure proper linkage adjustment and that louvers operate freely with sufficient air supply.

7. **STRUCTURES** (Field Erection)

Bolt-up structures are to be erected per erection drawing furnished. All pieces should be installed per position shown on drawing and part number marked on piece.

Bolt-up structures are to be erected with bolts loose then plumbed, and finally all bolts thoroughly tightened.

Some structures are primed with structural steel primers, but most units are galvanized. When repainted, outdoor paints or enamels should be used along with good preparation and painting practices.

Bolting should be periodically checked for loose bolts.

# PERFORMANCE

Prior to or following the initial "start-up" and the final determination that the mechanical equipment is performing as designed, the product to be cooled may be valved into the cooling coils. The temperature-indicating equipment should be observed closely to detect the anticipated temperature drop that should occur at a time interval dependent on proper response of temperature control equipment, louver settings (if any), piping distances, previous temperature and heat rejection rates.

In the event it appears that the product is not being cooled as designed, the following inspections should be made. Any one or a combination of the following could impact the equipment performance:

1. Check valving to insure proper circulation.

2. By-pass equipment, if any, should be checked for proper flow control for the existing conditions.

3. Endeavor to confirm that the temperature-indicating equipment is functioning normally, and the product temperature is in the range that would require cooling.

4. Carefully analyze the temperature control system to ensure that temperature sensing elements are properly installed and calibrated, and that the electrical circuits are sound
   and energized. Where temperature sensing equipment is designed to cause a reactive response in the product flow, motor speeds, fan pitch or louver settings, such reaction should be examined to determine that the reaction is correct as to proportion, direction or amount. The operational instructions provided by the control equipment supplier should provide troubleshooting procedures which will expose a malfunction, if one exists.

5. Louvers should be checked for full open position of proportional setting if required
   by the temperature control equipment.

6. Fan speed should be checked and compared to design speeds shown on data sheet.

7. Fan blade pitch settings should be inspected and confirmed on data sheets.

8. Direction of rotation of the fan should be compared to the design drawings.

9. The coils should be inspected for obstructions such as protective panels which have not been removed, weeds, lint, and matted insects. If such an obstruction does exist, the drive equipment should be shut down and the obstruction removed.

10. To isolate the cause if the equipment fails to cool, a simple test may be made by disabling the temperature control equipment and manually positioning the louvers and motor speed setting to design maximum. If this does not produce the desired cooling response and the foregoing items have revealed no cause for malfunction, the system should be shut down and the factory notified for instructions.

    It is important for the operating personnel to know that the probability of the cooling elements of the equipment being defective is extremely remote based on improbability of error and past performance records. Usually, a methodical examination of the elements mentioned above will reveal the cause of the malfunction, and following correction, the continued year-in and year-out reliable performance, as designed, will result.

## RUN-IN

1. Start fan driver and check as outlined in general motor information section of this operating manual.

2. Check unit for excessive vibration. When vibration is present, check bolting for tightness.

3. V-belt drives (when applicable)

   Run fan for several hours; observe driver and bearings carefully during this period for abnormal heating (see section on V-belts for maximum allowable start-up and operating temperatures). Tighten V-Belts as required in accordance with V-Belt tensioning information contained in component equipment section. Belts may continue to stretch during the first 30 days of operation.

4. Gear Drives (when applicable)

   Run fan for several hours; observe driver, gear and bearings carefully during this period for abnormal heating. See section on gear drives for maximum allowable start-up and operating temperatures.

5. Tube Bundles

A. On plug type headers, plugs are installed at room temperature in our plant. Frequently, it is necessary to tighten plugs in the field when coils are hot to avoid minor leaking through plugs.

B. Fins should be kept as free as possible of excessive debris, oil, bugs, and other fouling material. This may be done by steam cleaning or directing a stream of hot water over outside of coil.

## PROCESS START-UP

1. The process start-up procedure should be conducted in a manner that will minimize thermal shock of the tube bundles and prevent overcooling of critical services during periods of low ambient temperature and low heat load.

2. For low pour point and low viscosity services, admit the process fluid at a low rate, and gradually increase the flow to the design rate. Start the fans one at a time as the process fluid begins to exceed the design operating temperature, until all the fans are on or the process fluid is at the design temperature.

3. Special precautions should be observed in starting up units with process streams of (a) high viscosity fluids and (b) fluids with pour points the prevailing air temperature. For units of either type, admit the process stream to the tube bundle readily to prevent excessive cooling of the first liquid to reach the cold tubes. Care must be exercised to prevent undue shock from causing a "hammering" effect. When normal flow is attained, start the fans one at a time until the desired fluid outlet temperature is reached.

# INTERNAL CLEANING OF TUBES

The internal cleaning of air cooler tubes used the same method as conventional shell and tube units.

These cleaning methods fall into three types:

1. **MECHANICAL CLEANING**

   This consists of using drills, (or wire brushes), on long rods, and rotating the rods with air or electric motors. This type of cleaning is usually followed by water wash or air purge. This type of cleaning is not good for "Tarry" materials.

   The Elliot Company handles a complete line of these cleaners and will be glad to furnish recommendations on inquiry.

2. **CHEMICAL CLEANING**

   This consists of circulating hot chemical solutions through the tubes. The solutions contain inhibitors to avoid corrosion of the tube walls.

   Among the companies specializing in this work are: Dowell, Halliburton, and the Oaktie Company. They require a sample of the fouling material to determine the required chemical solution to be used in cleaning.

   One and one-half inch to three inch inlet and outlet nozzles to each bundle are required for circulation of the solutions. They also require a solution makeup tank and circulating pump. In some localities these companies have portable equipment on trucks.

   The use of chemical cleaning is growing rapidly in process plants, as it saves downtime and disassembly of units. It is not suitable with plugged tubes.

3. **HIGH PRESSURE WATER SPRAYS**

   The use of high pressure water sprays of "Hydro Jets" has been increasing in the United States and Europe. In the United States, several service companies specialize in cleaning tubes with portable high pressure pumps mounted on trucks. Water capacity is usually 25 gpm with pump discharge pressure up to 9,000 psig.

   The high pressure water jet heads are placed on the ends of hollow rods, similar to mechanical cleaning, and pushed through the individual tubes. The correct water pressure to the jet is determined by trial. Usually, the softer the fouling deposit, the lower the required jet pressure. For instance, an amine cooler deposit can usually be cleaned at about 2,000 psig. A water carbonate scale requires higher pressure in the range of 6,000 - 9,000 psig. Again it should be stated that this process won't work on plugged tubes. They must be drilled out mechanically.

   Among the service companies who specialize in "Hydro Jet" cleaning are:

| | |
|---|---|
| Chemical Cleaning, Inc. | New Orleans, La. |
| Chemical Cleaning, Inc. | Beaumont, Texas |
| Ohmstede Machine Works | LaPorte, Texas |
| The Halliburton Company | Duncan, Oklahoma, and Nationally |

# INSTRUCTIONS FOR FIELD INSTALLATION OF TUBES IN A SECTION

1. Shut off flow and let section drain through outlet connection.

   a. Vent headers so that the section may drain.

   b. ***Completely*** drain section either through drain provided in header or by removing a plug in the bottom row of tubes.

2. Remove plugs opposite both ends of bad tube and for 3 or 4 tubes all around faulty tubes to allow ample working space.

3. The section will not need to be removed from the top of the structure if the faulty tube is close to the top of the section.

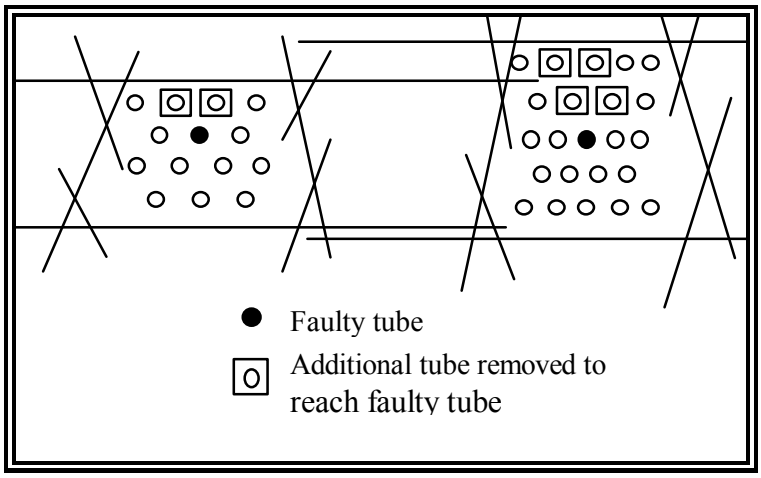
   If the tube is closer to the bottom of the section it is advisable to remove the section from the structure and turn it upside down, thus minimizing tube replacement.

4. If louvers or recirculation panels are on top of the section, these must be removed.

   In some cases, not all of the recirculation panels will need to be removed unless the section is to be removed from the structure.

   If the unit is an induced draft type, everything above the section must be removed.

5. Tubes to be removed are determined by the figures below:



**FIELD INSTALLATION cont.**

6. Now remove 2 bolts in each end of each tube binder and remove each tube binder on the ***top*** only.

   If the section has been removed from the structure, be sure that it is supported well so that no damage will be done to the fins and that it cannot "fall."

   If the section has been turned over (bottom side up) remove the tube binder on the top ***only***.

| **NOTICE: DO NOT loosen the supports on the "down" side as this will allow the tubes to "sag."** |
|---|

7. You are now ready to remove the tubes from the section:

   a. To determine which tubes must be removed, refer to the diagram in step 5.

   b. Cut off both ends of each tube to be removed, about 1/8" to 1/4" back from tube sheet and lift out the tubes in top row.

   c. Cut off the ends in the next row in a similar manner.

   d. With an abrasive grinder or hack saw, cut the tube support bars on top of the tubes on inner rows, then lift out tubes.

   e. After all required tubes have been cut off and taken out, remove the short pieces from each tube sheet as follows:

      1). Select a "drift pin" about .010" smaller than the O.D. of the tube with a shoulder 1/2" long and the same I.D. as the tube.

      2). Insert the drift pin through the plug hole and into the end of the tube and force the tube end out of the tube sheet, either with a pneumatic tool or a hammer.

8. After all tube ends have been removed from the tube sheets, install new tubes in the section:

   a. "Bow" tube up in the middle and place each end in hole in tube sheet. Keep a slight upward "bow" in the tube until it is determined that each end of the tube protrudes through the tube sheet about equal on each end, then press the tube down firmly on the support bar beneath it. It may be

necessary to take a screwdriver and push 1 or 2 fins apart to allow the tube to rest securely on the support bar.

**FIELD INSTALLATION cont.**

b. Where support bars were cut out, cut a new piece of similar metal long enough to extend over one tube on each side of tubes removed. Slide the new piece between the tubes and then back so that it will rest on the tube on each side and be next to the original bar.

   Put in new pieces at each tube support where the original bar was put.

c. Repeat steps 7a and 7b until all tubes have been installed.

d. If the protrusion of the tube ends through the tube sheets are not equal (1/16"), "drift" the tube from the ***longer*** end until equal (1/16").

9. Replace the top tube keepers and bolt the end tightly to side frame.

   Be sure support is pressed down securely against top of the tubes and held until the bolts in the ends are tightened.

10. Roll tubes into tube sheets in accordance with "**INSTRUCTIONS FOR TUBE EXPANDING BY HAND"** (next section). The same rolling procedure is followed for a power roller.

11. Replace plugs in headers and hydrostatically test section at 1.5 times the design pressure shown on the name plate and check new tubes for leaks. If a leak appears, reroll tube end and test again.

12. The section is now ready to be put back into service.

If any serious problems arise while performing this procedure, contact:

**Sales Office**
Amercool Mfg., Inc.
640 West 41st Street
Tulsa, OK 74107
Phone: (918) 445-5366

**Plant Office**
Amercool Mfg., Inc.
12783 FM 346 East
Whitehouse, TX 75791
Phone: (903) 839-2451

# INSTRUCTIONS FOR TUBE EXPANDING BY HAND

1. Remove plug opposite the tube end.

2. Set the expander for the proper location in the tube sheet. The end of the rolls should be set flush with the tube side of the tube sheet. The adjustment can be visualized by holding the tube expander on top of the header and parallel to the tube axis with the bearing collar against the plug sheet, similar to the cross section view below. If the rolls protrude through the tube sheet, the rolls will tend to cut the tube on the inside.

   If the rolls do not protrude in the tube sheet far enough, there is danger of getting inadequate surface bond.

   To set the rolls: loosen the Allen screw on the thrust collar and screw in or out to position the rolls.

3. After inserting the tube expander into the tube, turn the Mandrel clockwise. This rotation progresses the Mandrel forward.

   Since the Mandrel is tapered, this forward progression forces the rolls against the tube wall.

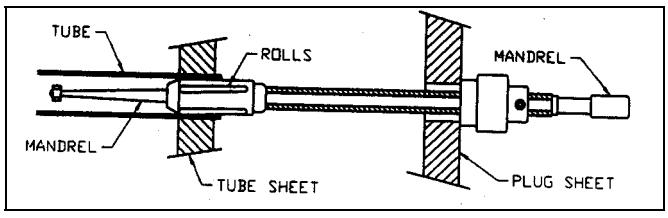
   To determine the proper amount of expansion:

- A few rotations of the Mandrel begins to bring the rolls up against the tube. At this point the Mandrel gets harder to turn. **From this initial point of contact, expanding is in progress.**

- Continue to turn the Mandrel in a clockwise direction as many turns as is required to progress the Mandrel 1/4” beyond the point of the initial contact.

- In installing a new tube that has not been previously expanded, progress the Mandrel 3/8” beyond the point of the initial contact.

4. Tubes are originally expanded in our plant to a specified torque rating by electronically controlled equipment.



# INSTRUCTIONS FOR CHECO FANS

## SETTING THE BLADE ANGLE

Set the blade angle as marked on the blade or on the certified outline drawing. To accomplish this:

a) Set the correct angle on the machinist's protractor.

b) Place protractor on position indicated by label on blade.

c) Observing the bubble on the protractor, tap the blade shank with a rubber mallet until bubble centers.

d) To tighten the blade bolts, torque 1/2" nut to 45 ft-lbs.

e) Recheck the blade angle with the protractor.

***Follow the above procedure for all blades. Be sure that blades are installed in pairs as marked in order to assure perfect balance.***

## CHECK ROTATION

a) Recheck all bolts and centering of fan in fan ring.

b) Check to make sure the motor and gear or belt sheave speeds are correct.

c) "Bump" the motor to make sure it is turning in the direction required.

## MAINTENANCE

Your Checo fan, properly installed, requires little if any maintenance. However, all bolts and clamps should be checked occasionally to ensure tightness. At the same time, inspect blades for any nicks or cracks. For greatest air movement efficiency, blades should be kept clean.

# START-UP PROCEDURES FOR MOORE FANS

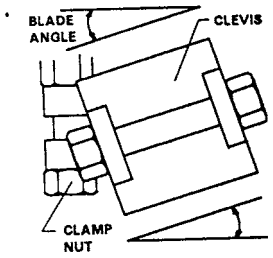
## ADJUST BLADE ANGLE (EXCEPT SERIES 19)

Hubs are shipped from the factory with the clevises set for the blade angle indicated by the design performance. A change in the blade angle is usually necessary to adjust to actual site conditions. Failure to adjust the blade angle when required may result in motor overload. To check, measure the input amps to the motor while the fan is operating. See "Start-up Procedures" below. If the current draw is higher or lower than desired, slightly decrease or increase the blade angle.

**WARNING!** The fan is designed to consume the horsepower stated on the Fan Specification Sheet. This is not necessarily the full load horsepower of the motor. Increasing the blade angle to fully load an oversize motor can cause serious blade overload which will stall the blades. In this condition, the fan will actually deliver less air and blade life may be shortened.

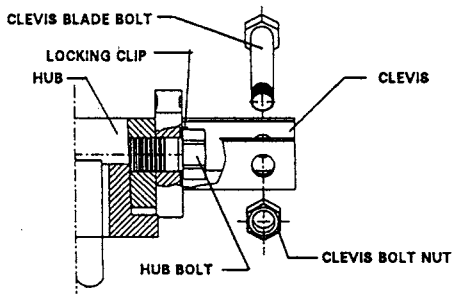
**NOTE:** If the hub is not level, the blade angles will not be accurately measured. To check, rotate the fan while checking the angle of a blade. If the measured angle varies as the fan is rotated, find the two locations, 180°apart, where the angles are identical. Only at these two points will the angle measured be accurate. Set each blade angle with the blade rotated to one of these two positions.

Place a protractor level on the flat upper or lower surface of the clevis as shown in the illustration below. (This is the point of measurement of the blade angle stated on fan specifications.) Make a permanent record of the final clevis angle selected and take care that all blades on the fan are set at the same angle. A typical adjustment may be ± 3°. The maximum recommended clevis angle is 15°. For all fans except Series 19, the blade angle is changed by loosening the clamp nut, rotating the clevis and retightening. Torque all clamp nuts to 50 ft.-lb (7m-kg).



## ADJUST BLADE ANGLE ON SERIES 19

Read the previous section and follow all the precautions stated. To adjust, remove the blade. Flatten the tab on the locking clip and loosen the hub bolt just enough to allow the clevis to be turned. Place a protractor level on the flat upper side of the clevis and rotate the clevis in the desired direction. Retighten the hub bolt to 90 to 100 ft-lb (12.5 to 13.8 m-kg) of torque. Recheck the angle after tightening. Bend one corner of the locking tab against a flat side of the bolt head to secure the bolt from turning. Operate the fan and recheck the current draw. Repeat adjustment if necessary until amperage readings are as desired.




## START-UP PROCEDURES

Before starting the fan, manually check all bolts or nuts to see if they are tightened. Take care not to exceed the stated torque limits.

Lift each blade to the horizontal position and walk the blade around while checking for proper clearance.

Start the fan and watch it in operation. All blades should lift to the same operating position, indicating that the blade angles are properly set and that all blades are equally loaded.

If vibration or unbalance is evident, see maintenance section.

After the fan has been operating for several minutes, stop the fan and observe the blades as the fan comes to rest. All of the blades should fall to their droop position at the same rate.

Inspect the inner surface of the fan ring and the blade tips for any indications of scoring.

Check the motor amperage and consult the motor manufacturer's specification sheet for the actual motor output horsepower for that amperage. The HP given on the Fan Specifications is the calculated HP (at the fan shaft) that is required for the specified performance. The motor output HP may be allowed to be 3% or 5% above the specified fan HP to allow for gear drive or belt drive losses respectively.

Consult the factory or the fan curve before increasing the blade angle for the fan to consume more than the specified HP.

# MAINTENANCE

**PURPOSE**

Fan failure is most likely the result of destructive repetitive stress acting over a period of time. These stresses may be caused by mechanical abuse, e.g., rough gears or drive shaft imbalance or by aerodynamic abuse such as blade overload or abnormal flow conditions. Fortunately, these stresses manifest themselves in typical ways that may easily be detected on inspection, if one knows what to look for. The purpose of this section is to describe the symptoms of potentially damaging mechanical problems and how they can be corrected.

**FREQUENCY OF INSPECTION**

The frequency of inspection varies widely in accordance with the severity of service and a suitable inspection schedule should be developed with experience over time. During the first week of operation, at least one inspection should be made. At these initial inspections, in addition to the items listed below, check all nuts for tightness to make certain that all were tightened properly at installation (but do not re-torque already tightened nuts). Following the first week, it is probable that inspections of the fan need be made no more frequently than inspection of the drive.

**CHECK BLADE DROOP AND ANGLE**

Turn off the unit and watch the blade tips. A looseness of the clamp nut will permit a blade to flatten in angle. This usually can be detected by looking at the tips of the blades while the fan is slowing down. At the same time, before the unit comes to a complete stop, watch the track of the blade tips to see that all blades have the same droop. If one or more blades has a substantially different droop than the other blades, or if all of the blades show a greater droop than at the last inspection, investigate further. Excessive droop has two possible causes:

1. A damaged resilient mount that requires replacement.

2. Wear at the end of the box section against the clevis, indicating that the box section has been riding against the clevis during operation. This type of wear indicates that the blade is not rising a sufficient distance during operation to clear the stop. If only one blade is affected, that blade is set at a steeper angle than the other blades. This should be checked and corrected.

**CHECK FOR WEAR ON CLEVISES**

Clevises should be examined at each inspection for possible wear against the end of the box section. Since contact between the box section and the face of the clevis provides a stop to prevent excessive droop when the fan is shut down, there will undoubtedly be a mark on the face of the clevis at the point of contact. There should, however, be no evidence of wear which would indicate repetitive contact between the two parts during operation. If wear at this point is indicated, a check should be made of blade loading. If blade overload is not responsible, the end of the box section can be dressed off with a file to permit greater blade droop when the fan is not operating so long as the greater droop will not cause the blade to hit an obstruction. If the fan has been operating for a considerable length of time and previous inspections have not disclosed wear at this point, it is possible that a recent unusually high wind condition might have disturbed the blades sufficiently to cause them to temporarily make repetitive contact with the clevis while in operation.

**OPERATION BY VARIABLE SPEED MOTORS**

Moore fans are ideal for use with variable speed motors. The resilient blade mounting, unique with these fans, eliminates resonant frequencies. There are no critical speeds to be avoided. There is, however, a minimum RPM below which there is not enough centrifugal force to lift the blades enough to prevent their repeatedly striking the clevis during operation. This is a cause of damaging clevis wear in addition to the causes discussed in the preceding paragraph.

The minimum RPM should be no less than 10% of full RPM or the minimum recommended by the motor or drive manufacturer, whichever is greater. The fan

should be shut off rather than reducing the motor speed beyond this point.

**CRACKS, DENTS AND CORROSION**

Skin cracking may be caused by the tips dragging on the fan ring, or it may be the result of long-term fatigue due to continued operation under conditions of vibration or unbalance. Skin cracking can also be caused by continued operation under overload conditions.

Cracking in air seals can occur if the air seal has been improperly installed. Check to be sure the resilient washers are present and the nuts properly tightened.

The fatigue strength of materials, whether metal or plastic may be lowered by long-term exposure to water.

Dents in blades are caused by objects falling into the fan or the fan striking some obstacle. Minor dents may sometimes be repaired by drilling a small hole in the center of the dent and pulling outward on the blade skin. Blades may be ordered from the factory for replacement. If there is any evidence of this type of damage, the hub should be carefully inspected.

The type 5052 aluminum, a marine alloy, used as the blade material on Moore fans works well with either fresh or sea water. Waters that are acid, alkaline or contain copper salts, however, should be avoided for all aluminum alloys. If you have questions regarding the suitability of the fan materials under certain water conditions, please contact the factory.

# VIBRATION SWITCH INSTALLATION INSTRUCTIONS

Vibration switches are available in a variety of models for application on machinery or equipment where excessive vibration or shock can damage equipment or otherwise pose a threat to safe operation.

**Murphy Models**

**VS2-EX/VS2-EXR**

**VS2-EXR-B**

## ELECTRIC MODELS

Make the necessary electrical connections to the vibration switch. **Do not exceed voltage or current rating of the contacts.** Follow appropriate electrical codes/methods when making electrical connections. Be sure that the run of electrical cable is secured to the machine and is well insulated from electrical shorting. Use of conduit is recommended.

## PNEUMATIC MODELS

Attach a pressure source of 20-80 psig (138-552 kPag) to the supply port. Best operation is obtained with 60 psi (414 kPag). Pressure medium must be clean, dry air or gas. Use a filter and pressure regulator as necessary.

Connect an exhaust line to the exhaust port and to the equipment shutdown device to be operated.

## SENSITIVITY ADJUSTMENT

1. Replace all covers, lids, and electrical enclosures.

2. If the vibration switch trips on start-up, allow the machine to stop. Turn the sensitivity adjustment 1/4 turn clockwise. Depress the reset button and restart the machine. Repeat process until the vibration switch does not trip on start-up.

3. If the vibration switch does not trip on start-up, stop the machine. Turn the sensitivity adjustment 1/4 turn counter clockwise. Repeat start-up/stop process until the vibration switch trips on start-up. Turn the sensitivity adjustment 1/4 turn clockwise (less sensitive). Restart the machine to verify that the vibration switch will trip when abnormal shock or vibration exists.

# TYPICAL WIRING DIAGRAMS

## VS2 MODEL TYPICAL WIRING DIAGRAM FOR ELECTRIC MOTOR

## VS2-EX, VS92, AND VS92-EX MODELS TYPICAL WIRING FOR ELECTRIC MOTOR

# HTD AND V-BELT INSTRUCTIONS

## SIMPLIFIED BELT TENSIONING METHOD

This tensioning method assumes average static tensions for drives, thereby eliminating the need for calculating static tension. Use this method if the small sheave diameter, small sheave rpm and speed ratio fall within the limits as given in table number 1; the number of belts used corresponds to the number recommended in this manual; and the drive has at least 2 belts.

***Step 1: Determine the force required to deflect one belt 1/64" per inch of span length***

- Measure the span length (t) or your drive.
- At the center of the span measure the force required to deflect one belt on the drive 1/64 per inch of span length from its normal position. The adjacent belt can be used as a reference for measuring the deflection. (see figure pg. 22) Be sure to apply the force perpendicular to the belt.
- Measure the force required to deflect a band of belts 1/64 per inch of span length as discussed above. Divide the value by the number of belt strands in the band to find the deflection force per belt.

**Note**: Lay a steel bar or a narrow block of wood across the belt and apply the deflection force to the bar so that all of the individual strands in the band are deflected the same amount. If more than one belt is used in the drive, the neighboring band can be used as a reference for measuring the deflection, just as is done with individual belts. If only one band is used, lay a straightedge or stretch a string from sheave-to-sheave to use as a reference for measuring the deflection. Lay the straightedge or string across the back of the belt on the sheaves.

***Step 2: Compare this deflection with the range of forces given in TABLE NUMBER 1.***

- If it is less than the minimum recommended force, the belts should be retensioned.
- If it is more than the maximum recommended force, the drive is tighter than it needs to be.

# TABLE NUMBER 1

RECOMMENDED DEFLECTION FORCE PER BELT

## HTD BELT INSTALLATION PROCEDURE

When pulleys have been mounted and properly aligned, put belt over flanged pulley first, then slip it onto the unflanged pulley. Tension belt by adjusting center distance.

### CENTER DISTANCE ALLOWANCE

Do not pry or otherwise force belts onto pulleys as this can result in permanent damage to

the belt.

## BELT TENSION

HTD drives do not require as much tension as other belt drives that depend on friction to transmit the load. HTD belts should be installed with a snug fit, neither too taut nor too loose. After the belt has been so tensioned, a force to deflect the belt by a certain amount to assure proper tension can be measured. Stop the drive and measure the belt span (see sketch). Using a spring scale, apply a perpendicular force to the center of the belt width and the center of the belt span. Measure the force required to deflect the belt 1/64" for each inch of belt span. For example, the deflection for a 32" belt span is 32 x 1/64 = 1/2" deflection. The force required to deflect the belt this amount at the proper tension is listed in table below.

**DEFLECTION FORCE FOR HTD BELTS**

# GENERAL MOTOR INFORMATION

## MOTOR STORAGE PROCEDURES

## ATMOSPHERE

| Controlled | Partially Controlled |
|---|---|
| Required: Even temperatures, 10°F or more above dew point; relative humidity 50% or less; little dust, no harmful fumes. | Desired: Clean and dry as possible. |

**BEARINGS:**

Nothing required. Ball bearings grease-packed at factory.

**SHAFT, FLANGE SURFACES:**

Coat with easily removable rust-preventative Tectyl No. 502-C, mfd by Ashland Oil and Refining Co., Ashland, KY or equal.

**RODENTS:**

Prevent rodents or other small animals from nesting inside motor.

**LONG STORAGE:**

(Over six months)

If in an controlled environment - nothing more is required.

If stored in a partially controlled environment, the following applies:

1. Disassemble main parts and clean thoroughly.
2. Repaint previously painted surfaces before reassembly.
3. Remove condensation drain plugs (if present). Insert silica gel (desiccant) plugs in openings.
4. Cover completely to exclude dirt, dust, moisture and foreign materials. If possible, insert motor in strong transparent plastic bag. Attach moisture indicator to side of motor, place several bags of silica-gel inside, then seal plastic bag.

5. If motor cannot be sealed in bag and relative humidity exceeds 50%, use space heaters (installed inside motor when possible) to keep it at least 10°F above ambient air.

## EXTERNAL WIRING

Starting and over-load control devices must be matched to motor rating. For safety or convenience they may need to be installed some distance from the motor. Follow the control manufacturer's instructions to make proper installation and connections.

**Observe the following:**

Connect electrical power supply to conform with National Electrical Code and any local regulations. Line voltage and wire capacity must match motor rating stamped on the nameplate.

Only when the drive is disconnected, momentarily energize the motor to check that rotation is in the proper direction.

If motor is three-phase type, reverse rotation (if required) by interchanging any two of the three power leads.

If two-phase, interchange stator leads of either phase, being careful not to interchange leads from one phase to the other.

## OPERATION

### A. INITIAL START

After installation is completed, but before motor is put into regular service, make an initial start as follows:

1. Motor starting and control device connections must agree with wiring diagrams.

2. Voltage, phase and frequency of line circuit (power supply) must agree with motor nameplate.

3. Check motor service record and tags accompanying motor to be certain bearings have been properly lubricated. Bearings should be

lubricated when shipped from factory to give six months of satisfactory service.

4. If possible, remove external load (disconnect drive) and turn shaft by hand to insure free rotation.

- If drive is disconnected interrupt the starting cycle after motor has accelerated to low speed. Carefully observe for unusual conditions as motor coasts to a stop. Repeat several times if necessary.

- If drive is not disconnected, interrupt the starting cycle after motor has accelerated to low speed. Carefully observe for unusual conditions as motor coasts to a stop. Repeat several times if necessary.

**CAUTION!** Repeated trial starts can overheat the motor (particularly for across the line starting). If repeated trial starts are made, allow sufficient time between trials to permit heat to dissipate from windings or rotor to prevent overheating. Starting currents are several times running currents and heating varies as the SQUARE of the current.

## B. NORMAL OPERATION

Start the motor in accordance with standard instructions for the starting equipment used. Some loads should be reduced to the minimum, particularly reduced voltage starts and/or high inertia connected loads.

Run high temperature motors (Class H insulation) at reduced load until bearings reach operating temperature.

## C. VOLTAGE REGULATION

Motors will operate successfully under the following conditions of voltage and frequency variation, but not necessarily in accordance with the standards established for operating under rated conditions:

- When the variation in voltage does not exceed 10% above or below normal, with all phases balanced.

- When the variation in frequency does not exceed 5% above or below normal.

- When the sum of the voltage and frequency variations does not exceed 10% above or below normal (provided the frequency variation does not exceed 5%).

## REGULAR MAINTENANCE

Several of the more important items of good maintenance are discussed in the following paragraphs. Others should be added when adverse or unusual conditions exist.

**Inspection:**

Each motor should be inspected at regular intervals. The frequency and thoroughness will depend on the amount of operation, nature of service and the environment.

**Cleanliness:**

The motor exterior should be kept free of oil, dust, dirt, water and chemicals. For fan-cooled motors, it is particularly important to keep the air intake opening free of foreign material. Do not block air outlet.

**Moisture:**

On non-explosion proof TEFC motors, a removable plug in the bottom center of the motor frame permits removal of any accumulated moisture. Drain regularly.

**Lubrication Schedule:**

Relubricate bearings each six months (more often if conditions require) as follows:

| MOTOR SPEED (R.P.M.) | RELUBRICATING FREQUENCY |
|---|---|
| 3600 | 6 Months (4,000 Hours) |
| 1800 or Less | 12 Months (8,000 Hours) |

(Operating environment may dictate more frequent lubrication)

1. Stop the motor. Lock out the switch, particularly if end shield is to be withdrawn.

2. Thoroughly clean off and remove the pipe plugs from bearing housing.

3. Remove hardened grease from drains with stiff wire or rod.

4. Add grease to inlet with hand gun until small amount of new grease is forced out drain. Catch used grease in suitable container.

For best results, grease should be compounded from a lithium soap base and a good grade of petroleum oil. It should be of No. 2 consistency and stabilized against oxidation. Operating temperature range should be from -15⌗F to +250⌗F for Class B insulation and to +300⌗F for Class F and H. Most major oil companies have special bearing greases that are satisfactory.

**CAUTION! Adding grease to bearing when motor is operating will cause grease to go thru clearance around inside end cap and be slung onto motor windings.**

**NOTE:**

**For vertical shaft motors, it is wise to check the inner cap of the top bearing for grease slumping through the bearing and filling the inner cap grease reservoir. Since it is necessary to remove the housing, this check is best done during periodic shut down inspections. (Bottom bearing inner cap should be 2/3 full.)**

5. Remove excess grease from ports, replace inlet plugs and run motor 1/2 hour before replacing drain plug.

6. Put motor back into operation.

# INSTRUCTIONS FOR BEARINGS

***WARNING!*** ***To ensure that drive is not unexpectedly started, turn off and lock out or tag power source before proceeding. Failure to observe these precautions could result in bodily injury.***

The bearing has been greased at the factory and is ready to run. The following table is a general guide for relubrication. However, certain conditions may require a change of lubricating periods as dictated by experience.
Many ordinary cup greases will disintegrate at speeds far below those at which bearings will operate successfully if proper grease is used. Bearings have been lubricated at the factory with number 2 consistency lithium base grease which is suitable for normal operating conditions. Relubricate with lithium base grease or a grease which is compatible with original lubricant and suitable for ball bearing service. In unusual or doubtful cases the recommendation of a reputable grease manufacturer should be secured.

**LUBRICATION GUIDE**

# CHECO ACTUATOR

| ITEM | QTY | DESCRIPTION |
|---|---|---|
| 1 | 1 | CLEVIS |
| 2 | 1 | GUIDE BUSHING |
| 3 | 1 | LOWER HOUSING |
| 4 | 1 | SNAP RING |
| 5 | 1 | STEM |
| 6 | 8 | HOUSING NUT |
| 7 | 12 | LOCKWASHER |
| 8 | 12 | HOUSING SCREW |
| 9 | 1 | DIAPHRAGM |
| 10 | 3 | LOCKNUT |
| 11 | 1 | DIAPHRAGM PLATE |
| 12 | 1 | UPPER HOUSING |
| 13 | 1 | DIAPHRAGM WASHER |
| 14 | 1 | CONNECTOR NUT |
| 15 | 1 | O-RING |
| 16 | 4 | SPRING COVER SCREW |
| 17 | 1 | SPRING ROD |
| 18 | 1 | MAIN SPRING |
| 19 | 1 | SPRING COVER |
| 20 | 1 | SPRING WASHER |
| 21 | 1 | WASHER |
| 22 | 1 | POSITIONER SPRING |
| 23 | 1 | POSITIONER WASHER |
| 24 | 1 | GASKET |
| 25 | 1 | POSITIONER |
| 26 | 6 | POSITIONER SCREW |
| 27 | 6 | LOCKWASHER |
| 28 | 6 | COVER PLATE SCREW |
| 29 | 1 | COVER PLATE |
| 30 | 1 | WASHER |
| 31 | 1 | LOCKNUT |

# FISHER ACTUATORS

## INSTALLATION

If the actuator is mounted on a valve body, follow the specific valve body instruction sheet when installing the control valve in the pipeline. For actuator s that are shipped separately, four holes are tapped in the yoke boss to provide a method of securing it to a mounting plate or bracket (factory will supply mounting plate or bracket when specified).
Standard actuator sizes 30 and 40 have mounting holes tapped 3/8" unc, while the size 60 mounting holes are tapped 1/2" unc.

A 1/4" npt loading pressure connection is located in the top of the upper diaphragm case. Using either pipe or tubing, connect either the loading pressure connection or valve positioner input connection (if a valve positioner if furnished, the loading pressure connection to the actuator will be made at the factory) to the output pressure connection on the controller. Keep the length of the pipe or tubing as short as possible to avoid transmission lag in the control signal.

## ADJUSTMENT

When the actuator is completely installed and connected to the controller, it should be checked for correct travel, freedom for friction, and correct action "push-down-to-open" or "push-down-to-close".
The actuator spring and diaphragm have been selected to meet the requirements of the application. It should be noted that the actuator spring has a constant rate of compression, and that adjustment of the spring compression merely shifts the initial spring set point up or down to make the actuator travel within the initial spring set point and the maximum diaphragm pressure indicated on the actuator nameplate.

Parts reference
Description part no.

DIAPHRAGM CASE ASSEMBLY, STEEL
STANDARD

| | | |
|---|---|---|
| SIZE 30 | 2J7138 28992 | |
| SIZE 40 | 2L4418 28992 | *KEY 1* |
| SIZE 60 | 30A005 5X012 | |

LOWER DIAPHRAGM CASE, STEEL

| | | |
|---|---|---|
| SIZE 30 | 2E7922 25062 | |
| SIZE 40 | 2E8063 25062 | *KEY 5* |
| SIZE 60 | 2E8474 25062 | |

ACUTATOR SPRING
STEEL SEE FOLLOWING TABLE *KEY 6*

DOWN TRAVEL STOP, STEEL
SIZE 30 (3 REQ'D) 1F8429 24092
SIZE 40 (3 REQ'D) 1F8428 24092 *KEY 7*
SIZE 60 (4 REQ'D) 1E7979 24092

CAP SCREW, STEEL
SIZE 30 & 40 (3 REQ'D), 60 (4 REQ'D)
ALL SIZES 1A3684 24052 *KEY 8*

YOKE, CAST IRON
TYPE 656
SIZE 30 2F9986 19042
SIZE 40 3L4404 19042 *KEY 9*
SIZE 60 4L9191 19042

ACTUATOR STEM, STEEL
TYPE 656
SIZE 30 1F9994 24102
SIZE 40 1L4502 24102 *KEY 10*
SIZE 60 2L9192 24102

LOWER SPRING SEAT, STEEL
TYPE 656
SIZE 30 1F9990 24102
SIZE 40 10A702 1X012 *KEY 11*
SIZE 60 1L9193 24272

ADJUSTING SCREW, BRASS
TYPE 656
SIZE 30 1J9924 14012
SIZE 40 1L4501 14012 *KEY 12*
SIZE 60 1L9194 14012

THRUST BEARING, STEEL
TYPE 656 (BALL BEARING)
SIZES 30 & 40 1F9992 28992 *KEY 13*
SIZE 60 1L9195 28992

LOWER BEARING SEAT, STEEL
TYPE 656
SIZES 30 & 40 1F9991 24012 *KEY 14*
SIZE 60 1L9196 24272

CAP SCREW, STEEL
SIZE 30 (12 REQ'D) 1E7603 24052
SIZE 40 ( 16 REQ'D) 1E7603 24042 *KEY 19*
SIZE 60 (24 REQ'D) 1A6751 24052

HEX NUT, STEEL

| | | |
|---|---|---|
| SIZE 30 (12 REQ'D) | 1A3465 24122 | |
| SIZE 40 16 REQ'D) | 1A3465 24122 | *KEY 20* |
| SIZE 60 (24 REQ'D) | 1A3465 24122 | |

VALVE STEM, 316 SST

TYPE 656

| | | |
|---|---|---|
| SIZE 30 ONLY | 1J9925 35162 | *KEY 21* |

SET SCREW, STEEL

TYPE 656

| | | |
|---|---|---|
| ALL SIZES | 1H1999 28992 | *KEY 22* |

HEX NUT, STEEL

TYPE 656 (2 REQ'D)

| | | |
|---|---|---|
| SIZE 30 | 1A3537 24122 | |
| SIZES 40 & 60 | 1A3511 24122 | *KEY 23* |

# POSITIONER INSTRUCTIONS

Reconnect the flexible air lines. The supply line enters the top of the union.

Turn on air pressure and check for leaks.

The positioner must be adjusted for proper operation. First, remove the small adjustment cover on the top of the positioner. This cover is held in place with a small screw. Set the instrument air pressure to 4 psi*. With the adjustment cover removed you will see a brass hexagonal shaft with a slot in it. The shaft must be turned until the blades just begin to move (because the positioners vary, the shaft may have to be adjusted either up or down.) When this adjustment is made, change the instrument pressure to 15 psi*. The blade should cycle through a full pitch change. If not, repeat the zero adjustment.

***NOTE: If the instrument air signal range is not 3-15 psig, choose the beginning pressure 1 psig over your minimum and adjust the pressure to your maximum to check change in pitch.**

# GEAR INSTRUCTIONS

## LUBRICATION INSTRUCTIONS

Type of oil:

Lubricating oil for use in air-cooled heat exchangers should be an extreme pressure type lubricant compounded with sulfur phosphorous in a well-refined oil. The lubricant must not be corrosive to gears or roller bearings; must be neutral in reaction; contain no grit, abrasive or other foreign material; should have good de-foaming properties and moisture resisting characteristics. It must have good resistance to oxidation and a pour point of 0°F to 5°F. It must not be corrosive to a copper strip at 212°F.

Recommended lubricants are as follows:

| AMBIENT-DEGREES F | 15 - 50 | 50 - 125 |
|---|---|---|
| AGMA NUMBER | 4EP | 5EP |
| VISCOSITY RANGE | 626-755 SSU @ 100°F | 918-1122 SSU @ 100°F |

The user should consult his regular lubricant supplier for recommendations of brand name to meet the above specifications.

**For unit equipped with a backstop, do not use EP-type oil as this may cause the backstop to become ineffective. Use only straight mineral oil of the same viscosity.**

## SYNTHETIC GEAR LUBRICANTS

Synthetic oils have been used in enclosed gear drives for special operating conditions. Synthetic lubricants can be advantageous over standard oils in that they are generally more stable, have a longer life, and operate over a wider temperature range.

## INSTRUCTIONS FOR INSTALLATION AND STARTING NEW UNIT

1. When units leave the factory, the internal parts are protected by a polar rust preventive film. Flushing of this film is not required since it is soluble in the lubricant. Merely fill the case with the recommended lubricant to the proper oil level. **Note**: **units are shipped without oil and must be filled before starting.**

2. The gears are carefully set-up with respect to each other during the factory assembly to give proper tooth contact. Nothing should be done to disturb this factory setting.

3. Gear units are shipped with the breather port plugged. Prior to operation, a breather type plug (supplied with the unit) must be installed in the upper housing.

4. Each unit is given a short run-in at the factory as part of the inspection procedure. When circumstances allow, it is recommended that the fan blades be set at a minimum output pitch and the reducer operated for one or two days to allow final “break-in” of gears. After this “break-in” period, fan blades can be set to produce rated load on unit.

5. Coupling connections should be aligned for minimum parallel and angular misalignment.

6. Where it is required to shim the unit for alignment, care must be taken to prevent distortion of the housing. **Note: coupling and unit alignment should be rechecked after two weeks operation.**

7. When units furnished with force feed lubrication are first started up, it should be observed that oil is being pumped.

8. For cold temperature operation where oil viscosity on starting is greater than 5,000 SUV, heaters must be used. For units with pressure lubrication systems, check that pump is pumping cold oil.

9. Minimum viscosity required under operating conditions ranges from 150 to 400 SUV. Oils having this viscosity under operating conditions are not normally satisfactory for cold temperature starting and heaters must be used.

10. Where unit will not heat up under intermittent operating conditions, low-viscosity oil may be selected for cold temperature operation.

# OIL CHANGES

After a gear unit is first installed, the first oil should be changed after two weeks of operation. If desired, the original oil may be strained and replaced. Do not use a strainer finer than 25 microns to avoid filtering out the additives. After the original oil has been drained, fill the case to the indicated level with SAE-10 straight run mineral flushing oil containing no additives. Fan should be started, brought up to speed and shut down immediately as a flushing procedure. Drain off flushing oils and fill with recommended lubricant to the proper level.

After this initial oil change, an oil change every six months should be sufficient unless there are unusually high temperature conditions combined with intermittent high loads where the temperature of the gear case rises rapidly and then cools off quickly. This condition may cause sweating on the inside wall of the unit thus contaminating the oil and forming sludge. Under these conditions, or if the oil temperature is continuously above 200°F, or if the unit is subjected to an unusually moist atmosphere, oil changes may be necessary at one, two or three month intervals, as determined by field inspection of the oil.

Every precaution should be taken to prevent any foreign matter from entering the gear case. Dust, dirt, moisture, and chemical fumes form sludge - the biggest enemy of proper and adequate lubrication.

## INSTRUCTIONS FOR MAINTENANCE

1. Check oil level once a week. Level should be checked with unit stopped since the indicated oil level will rise when unit it running. Lubricant level should not be more than 1/4” below specified level.
2. The lubrication instructions for oil change and for shutdown periods should be followed.
3. Units should be given daily routine inspection consisting of visual inspections and observations for oil leaks or unusual noises. If either occurs, unit should be shut down, cause of leakage or noise found and corrected.
4. The operating temperature of the unit is the temperature of the oil inside the housing. The maximum operation should not exceed 200°F.
5. This sump temperature is considered maximum because many lubricants lose stability properties when exposed to temperatures above the stated maximum.

## INSTRUCTIONS FOR SHUTDOWN PERIODS

If the unit will be idle for a period longer than one week, it will be necessary to run the unit for ten minutes every week it is idle. This short operation will keep the

gears and bearings coated with oil and prevent rusting due to condensation of moisture resulting from temperature changes.

# COUPLINGS

## EQUIPMENT ALIGNMENT

Coupling alignment is directly related to equipment and coupling life.

Although couplings can withstand gross misalignment, care should be taken for best possible alignment to assure optimum performance. The caliper/straightedge alignment procedure is described below. If greater alignment accuracy is desired, a dial indicator method is recommended. There are occasions when equipment manufacturers require more specific alignment tolerances, in which case the manufacture's recommendations should be followed.

1. To correct for angular misalignment use calipers to check toe gap between hubs. Adjust or shim equipment until the gap is the same at all points around the hubs.

2. To correct parallel offset, place a straightedge across the hub flanges in two places at 90 degrees to each other. Adjust or shim equipment until the straightedge lays flat on both sides.

3. Tighten down connected equipment and recheck alignment.

4. Install elastomer element, tightening all capscrews to the values shown in Table.

5. If practical, recheck and tighten capscrews after several hours of operation.

## RECOMMENDED CAPSCREW TORQUES FOR PROPER INSTALLATION

**Important!** Capscrews have self-locking patches which should not be reused more than twice.

Capscrews can be further used with application of a thread-locking adhesive.
**DO NOT LUBRICATE CAPSCREW THREADS.**

# DRY TORQUE TABLE

| COUPLING SIZE | INCH-LBS. | FOOT-LBS. | N-M |
|---|---|---|---|
| 2<br>3<br>4<br>5<br>10 | 204 | 17 | 23 |
| 20<br>30<br>40<br>50 | 360 | 30 | 56 |
| 60<br>70<br>80 | 900 | 75 | 100 |
| 100<br>120 | 3240 | 270 | 440 |

# OPERATING INSTRUCTIONS
# LOUVERS

Louvers are shipped assembled which makes them easier to install. Due to aluminum construction, louvers are lightweight and can easily be handled by two men.

When lifting equipment is required to move large sections of louvers, it is suggested that two pieces of crating lumber be placed beneath the section at 1/3 and 2/3 the length. Then slings may be used to lift the louver section to the top of the cooler on which they are to be used. Spreader bars must be used to prevent damage to the louver sideframe.

Manually-operated louvers are furnished with an operating handle which may be adjusted to the preferred position. To adjust this handle simply loosen the tightening bolts, reset handle to desired position and then re-tighten. Automatically operated louvers are shipped with operator bracket already mounted. The operator will be in a separate crate. Bolts are furnished for bolting this operator to the bracket. Connecting link should be attached, adjusted and then tightened.

For louvers to be connected end-to-end, a connecting link is furnished. This link connects the actuating rods of each set together.

For louvers to be connected side-by-side, a torque tube clamp is provided. Place clamp on torque tubes to be connected and close all blades. Then tighten the bolts provided. Any end-to-end adjustment in torque tubes must be made by loosening collars and the actuator levers. Slide torque tube to desired position and retighten collars and actuator lever. If both sections do not close evenly, adjust actuator lever and/or clamps. **DO NOT OVER-TIGHTEN BOLTS.**

Plywood or boards of some type should be placed on CLOSED blades for walking on.