



CENTRIFUGAL FANS

Ventilating / Industrial

SERVICE MANUAL

SECTION III

OPERATION

BEFORE STARTUP

1. **Fastenings** — all foundation bolts, wheel hub set screws and bearing locking collars must be tight.
2. **Access doors** should be tight and sealed.
3. **Bearings** — check bearing alignment and make certain they are properly lubricated. Crack the water valve to water cooled bearings. Make sure there are no water leaks. See BEARING SECTION of this manual.
4. **Couplings** must be in alignment and lubricated if required.
5. **Fan wheel** — turn over rotating assembly by hand to see that it runs free and does not bind or strike fan housing. If wheel strikes housing, the wheel may have to be moved on the shaft or the bearing pillow blocks moved and re-shimmed. Check location of wheel in relation to fan inlets. Be sure fan housing is not distorted. See ALIGNMENT section.
6. **Driver** — check electrical wiring to the motor. See MOTOR section. Connections to a steam turbine should be made according to the manufacturer.
7. **V-belt drive** must be in alignment; with belts at proper tension. See V-BELT DRIVE section.
8. **Duct connections** from fan to ductwork must not be distorted. Ducts should never be supported by the fan. Expansion joints between duct connections should be used where expansion is likely to occur or when the fan is mounted on vibration isolators. All duct joints

should be sealed to prevent air leaks. All debris should be removed from ductwork and fan.

9. **Dampers and VIV's** should operate freely and blades close tightly. Adjust linkage to close any open blades. All dampers and VIV's should be partially closed during starting periods to reduce power requirements. This is particularly important for a fan designed for high temperature operation being "run in" at room temperature or at appreciably less than design temperature. When air is up to temperature, the damper or VIV may be opened. Completely closing dampers could cause the fan to run rough.

START-UP

10. "Bump" the motor or turbine to check for proper wheel rotation. The driver should be started in accordance with manufacturer's recommendations.
11. Fan may now be brought up to speed. Watch for anything unusual such as vibration, overheating of bearings and motors, etc. Multi-speed motors should be started at lowest speed and run at high speed only after satisfactory slow speed operation. Check fan speed on V-belt driven units and adjust motor sheave to give desired RPM. Balance system by adjusting dampers or VIV's.
12. At first indication of trouble or vibration, shut down fan and check for difficulty. See FAN TROUBLES/CORRECTION section.

FAN BALANCING

Fan and blower wheels are balanced statically and dynamically by the factory and, if undamaged, should require no further balancing. Fans shipped completely assembled have had a running test to check balance.

Before any attempt is made at balancing, check other causes of vibration or unbalance as listed in the FAN TROUBLES/CORRECTION section.

Portable instruments are available that will indicate vibration displacement in mils (1 mil = 0.001 inches). The following table can be used as a guide to determine when a fan is operating with too much vibration:

TABLE I

FAN SPEED RPM	SMOOTH	FAIR	ROUGH	VERY ROUGH
600	2 mils	4 mils	8 mils	15-20 mils
900	1.5	2.75	6	8 - 10
1200	1.0	2	4.5	6 - 8
1800	0.75	1.5	3.5	5 - 7
3600	0.4	0.7	2.5	4 - 5

The fan can also be balanced by a trial-and-error method. This is done by chalking the motor shaft on Arrangement 4 fans and the fan shaft on other arrangements.

Chalk the shaft as follows:

1. Bring the fan up to highest operating speed. If the fan and motor and bearing base are on vibration isolators, place blocks under the fan to make the isolators unoperative. The fan must be rigid while checking balance.
2. Clean the shaft by holding piece of emery cloth against rotating shaft at the housing on the drive side of single inlet fans. Double inlet fans must be chalked on both sides of the fan and balanced as if two separate wheels.
3. Hold a sharpened piece of chalk or soapstone so the point just touches the rotating shaft. The chalk will scribe a line on the shaft, the length of line indicating amount of unbalance. 3 or 4 lines should be made so an average can be taken. The chalk must be held firmly, so it will be touched only by the high spot, not allowed to "ride" the shaft. When there is unbalance, the shaft will be forced to deflect outward by the unbalanced weight, producing the highspot.
4. Stop the fan.
5. Turn wheel by hand to see how long and heavy the scribed lines show. Mark the center of the lines and place a trial weight on the

heel of the wheel blade opposite the heavy side—180 degrees away from the center mark.

6. "U" shaped or hairpin type clips can be used as trial weights; being made from sheet metal or bar stock. Weights should be made so they can be forced on the heel (inside) of a wheel blade where they will not fly off. For double inlet fans, it is a good idea to make clips in pairs.
7. Size of weight will be determined by length of lines on the shaft. Short lines will indicate fan badly out of balance and a larger weight should be used.
8. After the trial weight is placed on the heel of the blade, run the fan again and rechalk the shaft. If the scribed lines are longer and the center of the lines have not shifted from the ones scribed initially, add more weight on the same blade and run again. Repeat test runs with varying weights until the lines are scribed all around the shaft. A balance will then be obtained.
9. If the center of the lines shift from that scribed initially, move the weight forward or backward to the next wheel blade, so the center mark (heavy side) will not move from its initial position. Move weights less than 90° if vibration decreases. Move weights 180° if the lines remain in the same original position but vibration increases. When lines return to the original position, increase the weight until balance is obtained.
10. If the weight is too great, the center of the lines will shift 180° from the initial run. Reduce weight until balance is obtained; chalk line scribed all around shaft.
11. When the position and amount of weight are established, the trial weights, or equal weights, may be welded or riveted to the wheel, preferably on the outside of the flange or backplate. The weight of the weld bead or rivets should be taken into account.
12. If chalk marks extend all the way around the shaft but considerable vibration persists, a weak foundation or loose bolts might be the trouble.

A fan handling clean air should not need balancing once it is balanced. Dust build-up on fan blades or wear can unbalance the fan. Periodic inspection of the fan should be made to determine amount of dust build-up or wear.

MAINTENANCE

1. A definite time schedule for inspecting all rotating parts should be established. The frequency of inspection depends on the severity of operation and the location of the equipment.
2. Fan Bearing and flexible coupling alignment should be checked at regular intervals. Misalignment can cause overheating, wear to bearing dust seals, bearing failure and unbalance.
3. Fan Bearings should be lubricated at regular intervals. Periodic inspections will be necessary. If oil lubrication is used and the oil becomes dirty or cloudy, it should be drained and the bearing flushed with mineral oil. Drain the mineral oil and add new lubricant. If grease is used and the grease is breaking down, flush the bearing out and re-grease to 1/3 full. See section on Bearing Lubrication & Cleaning.
4. Bearings on high speed fans tend to run hot — 50° to 75° above ambient. Do not replace a bearing because it feels hot to the touch. Place a contact thermometer against the bearing pillow block and check the temperature.
Ball or roller bearing pillow blocks can have total temperatures of 165°F (74°C) and ring oiled sleeve bearings may go up to 150°F (65.5°C) running temperature before the cause of high temperature be investigated. Water cooled sleeve bearings will run satisfactorily up to 110°F (43°C).
5. **All metal couplings** such as Falk Steelflex, Fast gear type and Waldron gear type couplings require periodic lubrication inspections. Lubricant should be maintained at proper level and be free of contaminants. Grease is recommended for operating periods exceeding six months. If oil is used re-lubricate at six month intervals for normal operation. Other conditions such as very slow speeds, ambient temperatures above 150°F and severe environments should be referred to the coupling manufacturer for specific recommendations.

In the absence of coupling manufacturers lubrication instructions, the following can be used for normal conditions with ambient temperatures below 150°F:

OILS: Use a mineral base oil having a viscosity no lighter than 150 ssu. Gear oil SAE 140 or #8AGMA oil is suitable.

GREASES: ESSO Fibre Grease C —
ESSO Standard Oil Co.

Atlantic Lubricant #17 —
Atlantic Refining Co.

Shell Alvania Grease #2 —
Shell Oil Co.

Litholine Multi-Purpose Grease
Sinclair Refining Co.

Marfak #1 Grease —
The Texas Co.

This grease list is far from complete. Equivalent lubricants by other manufacturers can be used.

To re-lubricate, remove both lube plugs (only one on Falk coupling — other plug is a grease fitting) and add lubricant until excess runs out lower opening. Replace lube plugs.

Other flexible couplings such as Thomas discing, T. B. Wood's rubber insert, Poole's rubber insert and Buffalo Forge's rubber bushed couplings do not need lubrication. Rubber bushed couplings should be inspected for wear of pins and bushings.

6. Foundation bolts and all set screws should be inspected for tightness.
7. Fans should be inspected for wear and dirt periodically. The wheel might have to be cleaned. A wash down with steam or water jet is usually sufficient. Cover the bearings so water won't enter the pillow block. Dirt piled in the housing should be removed. Fan wheels having badly worn blades should be replaced or rebuilt. Where wear is severe in spots, the worn places may be built up by welding, but be careful to prevent heating distortion. Rebuilt or repaired wheels require careful balancing before being returned to service. See Fan Balancing section.
8. On V-belt drives check belt wear, alignment and proper belt tension. Replace belts when necessary with all new belts. New belts will not work properly in conjunction with used belts due to difference in length. Always use matched belts.
9. If excessive vibration or bearing temperature occurs, it might be due to unbalance, misalignment, loose belts, poor lubrication, dirt build-up on the wheel, etc. **DO NOT PERMIT VIBRATION.**

MAINTENANCE (CONT.)

10. Repainting of exterior and interior parts of fans and ducts will extend the service life of the installation. Select a paint which will withstand the operating temperature. For normal temperature, a good machinery paint may be used. If moisture is excessive or if fans are exposed to the weather, bitumastic paint is suitable. Corrosive fumes require all internal parts to be wire brushed, scraped clean and repainted with an acid resisting paint. Competent advice should be secured when corrosive fumes are present.
11. Never run the fan at a higher speed than it was designed for unless you check Buffalo Forge first. The higher speed may be over the critical speed of the rotating parts, causing severe damage. Also, the power required by the fan may increase enough to overload and burn out the motor.
12. Re-grease or lubricate motor or turbine bearings according to the manufacturer's recommendations. **DO NOT OVER LUBRICATE.** Motor manufacturer's lubrication recommendations are printed on tags attached to the motor. Should these tags be missing, the following will apply:

A. FRACTIONAL HORSEPOWER SLEEVE BEARING MOTORS —

1. Under normal operation at ordinary temperatures and clean surroundings after 3 years of service. Then lubricate annually with electric motor or SAE 10 oil.
2. Under continuous operation at higher temperatures (but not to exceed 104°F ambient) after one year of service. Then lubricate annually with electric motor or SAE 10 oil.

B. FRACTIONAL HORSEPOWER BALL BEARING MOTORS —

1. Under normal conditions, ball bearing motors will operate for five years without re-lubrication. Under continuous operation at higher temperatures (but not to exceed 104°F ambient) re-lubricate after 1 year. To re-lubricate where motors are **not** equipped with pressure fittings, disassemble motor and clean the bearings and housings thoroughly. Repack each bearing and fill cavity in

back of bearing 1/3 full with ball bearing grease.

C. INTEGRAL HORSEPOWER BALL BEARING MOTORS —

1. Motors having pipe plugs or grease fittings should be re-lubricated while warm and at stand still. Replace one pipe plug on each end shield with grease fitting. Remove other plug for grease relief. Use low pressure grease gun and lubricate until new grease appears at grease relief. Allow motor to run for 10 minutes to expel excess grease. Replace pipe plugs.
2. Motors not having pipe plugs or grease fittings can be re-lubricated by removing end shields, cleaning grease cavity and refilling 3/4 of circumference of cavity.
3. Recommended re-lubrication intervals—general guide only.

TABLE II

MOTORS ONLY

HP RANGE	STANDARD DUTY 8 HRS. A DAY	SEVERE DUTY 24 HR. DAY Dirty, Dusty	EXTREME DUTY VERY DIRTY High Ambients
1 1/2 - 7 1/2	5 yrs.	3 yrs.	9 mos.
10-40	3 yrs.	1 yr.	4 mos.
50-150	1 yr.	9 mos.	4 mos.

4. These ball bearing greases or their equivalents are satisfactory for ambients from -15°F to 130°F. For motors:

Mobilplex EP #1 — Socony Mobil Oil Co.

Alvania grease #2 — Shell Oil Co.

Andok B grease — Esso Standard Oil Co.

Prestige #42 grease — Sun Oil Co.

13. Blow out open type motor windings with low pressure air to remove dust or dirt. Air pressures above 50 psi. should not be used as high pressures may damage insulation and blow dirt under loosened tape. Dust can cause excessive insulation temperatures.
14. Make certain motor is not overloaded. Check amps with nameplate.
15. **KEEP MOTORS DRY.** Where motors are idle for a long time, single phase heating or small space heaters might be necessary to prevent water condensation in windings.

FAN TROUBLES / CORRECTION

In the event that trouble is experienced in the field, listed below are the most common fan difficulties. These points should be checked in order to prevent needless delay and expense of factory service.

1. CAPACITY OR PRESSURE BELOW RATING

- a. Total resistance of system higher than anticipated.
- b. Speed too low.
- c. Dampers or variable inlet vanes not properly adjusted.
- d. Poor fan inlet or outlet conditions.
- e. Air leaks in system.
- f. Damaged wheel.
- g. Incorrect direction of rotation.
- h. Wheel mounted backwards on shaft.

2. VIBRATION AND NOISE

- a. Misalignment of bearings, couplings, wheel or V-belt drive.
- b. Unstable foundation.
- c. Foreign material in fan causing unbalance.
- d. Worn bearings.
- e. Damaged wheel or motor.
- f. Broken or loose bolts and set screws.
- g. Bent shaft.
- h. Worn coupling.
- i. Fan wheel or driver unbalanced.
- j. 120 cycle magnetic hum due to electrical input. Check for high or unbalanced voltage.
- k. Fan delivering more than rated capacity.
- l. Loose dampers or VIVs.
- m. Speed too high or fan rotating in wrong direction.
- n. Vibration transmitted to fan from some other source.

3. OVERHEATED BEARINGS

- a. Too much grease in ball bearings.
- b. Poor alignment.
- c. Damaged wheel or driver.
- d. Bent shaft.
- e. Abnormal end thrust.
- f. Dirt in bearings.
- g. Excessive belt tension.

4. OVERLOAD ON DRIVER

- a. Speed too high.
- b. Discharging over capacity due to existing system resistance being lower than original rating.
- c. Specific gravity or density of gas above design value.
- d. Packing too tight or defective on fans with stuffing box.
- e. Wrong direction of rotation.
- f. Shaft bent.
- g. Poor alignment.
- h. Wheel wedging or binding on inlet bell.
- i. Bearings improperly lubricated.
- j. Motor improperly wired.

LUBRICATION OF ANTI-FRICTION BEARINGS

Bearings on assembled fans receive their initial lubrication at Buffalo Forge. Bearings shipped separate from the fan or as replacements are almost never lubricated before shipping, except prelubricated types such as the Fafnir RAK. When there is the slightest doubt, the safe practice is to assume that the bearing has not been lubricated. For lubrication type refer to G1000 on page 8.

GREASE LUBRICATION

For grease lubricated ball or roller bearing pillow block, a good grade of grease, free from chemically or mechanically active material should be used.

These greases are a mixture of lubricating oil and a soap base to keep the oil in suspension. They have an upper temperature limit where oil and soap base oxidize and thermally decompose into a gummy sludge.

Separate lube data sheets list the lubricant installed at the factory in the particular bearings furnished on your Buffalo fan. For best results, use the same grease when relubricating. Mixing of

different lubricants is not recommended. If necessary to change to a different grade, make, or type of lubricant, flush bearings thoroughly before changing. Regreasing will vary from 3 months to a year depending upon hours of operation, temperature and surrounding conditions. Special greases may be required for dirty or wet atmospheres (consult your lubricant supplier).

When grease is added, use caution to prevent any dirt from entering the bearing. The pipe plug or grease relief fitting should be open when greasing to allow excess grease to flow out. The pillow block should be about 1/3 full, as excess grease may cause overheating. Use low pressure grease gun.

OIL LUBRICATION

Oil lubricated ball or roller bearings should use mineral oils, free from water sediment, acid, resin and other substances not derived from petroleum products. Where possible, the viscosity at the operating temperature should be at least 70 seconds Saybolt for ball bearings, 100 seconds Saybolt for roller bearings and 150 seconds Saybolt for spherical roller thrust bearings. Information regarding change in viscosity should be obtained from the oil supplier.

Oil lubricated bearings have an oil sight gauge or oil cup attached to the pillow block housing. With fan **stopped**, add oil until level is 1/4" below cap of oil cup (to prevent oil loss by capillary action) or until oil is at level mark indicated on the sight gauge. Oil cup must be on down side of bearing rotation.

When not possible to stop fan to check oil level or add oil, an operating oil level must be determined. With oil at proper level, start and run fan until oil temperature stabilizes. Then mark operating oil

level on indicator. The minimum safe operating oil level is 1/8" below the established operating oil level.

When the oil has been changed or on initial start-up of the fan, the unit should be brought up to speed and then stopped so the oil level can be rechecked. Then the fan can go into regular service.

A separate lube data sheet for your fan lists recommended oils (or equivalents) for normal operating conditions. Frequency of oil additions or changes depend primarily on the speed and temperature at which bearing operates. Deterioration of oil is caused by heat, oxidation, catalytic reactions and dirt or water contamination. Therefore, periodic oil changes must be made. Oil changes should be made when the oil becomes dirty or cloudy.

For unusual operating conditions such as extremely dirty or wet atmospheres, consult your lubricant supplier.

LUBRICATION OF SLEEVE BEARINGS

Dodge sleeve bearing pillow blocks shipped mounted on assembled fan have oil added at the factory. The oil level should be checked before startup.

Sleeve bearings shipped separate from fan do not have oil in them. Fill to top of red circle in oil gauge with good grade of turbine oil having suitable rust and oxidation inhibitors. After placing in operation, remove inspection covers and check oil rings to see that they are rotating freely and bringing up oil.

Temperature on Dodge plain sleeveoil pillow blocks reach 10 to 70° F above room temperature; decrease as operation continues.

Observe operation frequently first few days. If noise develops, check alignment of pillow block housing, collar runout, plunger screw and all operating parts.

A separate lube data sheet for your fan lists recommended oils (or equivalents) for normal operation. Additions or changes depend upon speed and temperature of operation. Oil should be changed when it becomes cloudy or dirty. If questionable, change it. As temperatures or speeds increase, heavier oils are desirable. For unusual or severe conditions, consult your lubricant supplier.

DODGE SLEEVE OIL GENERAL DATA

TABLE VIII

SIZE	COOLING WATER IF REQUIRED (gals. per min.)	OIL SUMP CAPACITY (pints)	WATER PIPE SIZE (inches)		THRUST COLLAR CLEARANCE (thousandths)	
			BABBITT LINER	BRONZE LINER	BABBITT LINER	BRONZE LINER
1-7/16	—	3/8	—	—	8-12	—
1-11/16	.5	1/2	1/4	—	8-12	—
1-15/16	.55	1/2	1/4	—	8-12	—
2-3/16	.6	5/8	1/4	—	8-12	—
2-7/16	.75	15/16	1/4	—	8-12	—
2-11/16	1.0	1-1/8	1/4	—	8-12	—
2-15/16	1.25	1-1/8	1/4	—	8-12	—
3-7/16	1.5	2-1/16	1/4	—	8-12	—
3-15/16	1.75	3-1/8	1/2	1	8-12	9-14
4-7/16	2.25	4	1/2	1	8-12	9-14
4-15/16	2.5	5-5/8	1/2	1-1/4	8-12	10-15
5-7/16	3	6-1/4	1/2	1-1/4	8-12	10-16
6	4	8-1/4	3/4	1-1/4	8-12	12-18
7	5	15	3/4	1-1/4	8-12	14-20
8	6.5	20	3/4	1-1/4	8-12	16-22
9	8	20 (24 w.c.)	1-1/4	2	8-12	16-22
10	9	20 (40 w.c.)	1-1/2	2-1/2	8-12	16-22

CLEANING OF BEARINGS

Bearings removed from their shafts should be placed in a suitable container with a clean petroleum solvent or kerosene and allowed to soak. Revolve each bearing by hand to help dislodge any dirt particles.

When using kerosene all parts must be wiped dry with a clean cloth. Other solvents similar to "Inhibisol" made by Penetone Company of Tenaflly, New Jersey can be used.

All the old grease and oil must be removed from the bearing pillow block. The solvent or kerosene can be used to clean the housing.

Where the grease in a grease-lubricated bearing is badly oxidized, it may help to soak the bearings in 200 - 240° F. light oil (anything heavier than SAE 10 motor oil is not recommended). After this soaking, the bearings should be cleaned as described above.

The clean bearing should then be spun in light oil to remove the solvent. If the bearing is not to be re-assembled immediately, coat it with grease.

Bearings can be cleaned without removing them from the pillow blocks by flushing 180 - 200° F. light oil, kerosene or solvent through the pillow block while rotating the shaft slowly. Badly oxidized grease can be removed by flushing with hot aqueous emulsions. The solutions must then be drained, pillow block flushed with hot light oil and again drained before adding new lubricant.

After the bearings and pillow block have been cleaned, reassemble bearings and add lubricant to the proper level.



STANDARD
LUBRICANT FOR BEARINGS

NAME AND TYPE OF GREASE USED IN BEARINGS FURNISHED WITH BUFFALO FORGE CO. EQUIPMENT

BEARING MFR.	BEARING TYPE	GREASE	GREASE BASE
FAFNIR	LAK, RAK, LCJ, RCJ, LCJO, RCJO, LSAO, RSAO.	SHELL ALVANIA #3	LITHIUM
	SAOL	MOBIL MOBILUX #2	LITHIUM
	MUOA-IN B.F. CO. ARR. #2 PILLOW BLOCK	MOBIL MOBILUX #2	LITHIUM
	G-KRR-IN B.F. CO. ARR. #2 TRIPOD BLOCK		
LINKBELT	SERIES 200 & 300 B-22400 & B-22500	MASTER LUBRICANTS CO. LUBRIKO M32	SODIUM
	SERIES 6800 & 6900	MOBIL MOBILUX #2	LITHIUM
SEALMASTER	ALL TYPES	SOCONY-MOBIL ARMYAC #781	LITHIUM
SKF	SYR, FYR	SHELL ALVANIA #2	LITHIUM
	SY, FY	SHELL ALVANIA #3	LITHIUM
	SAF-22500 SAF-22600 SAF-1500 SAF-1600 SAF-22200 SAF-22300	MOBIL MOBILUX #2	LITHIUM

It is recommended that the same grease be used during relubrication. If not available, consult your local bearing or lubrication representative for a recommendation of a compatible grease.

The greases shown in this table are those applied to standard bearings for normal applications.

BUFFALO FORGE COMPANY
AIR HANDLING DIVISION / BUFFALO, NEW YORK
Canadian Blower & Forge Co., Ltd. / Canada Pumps, Ltd. / Kitchener, Ont.