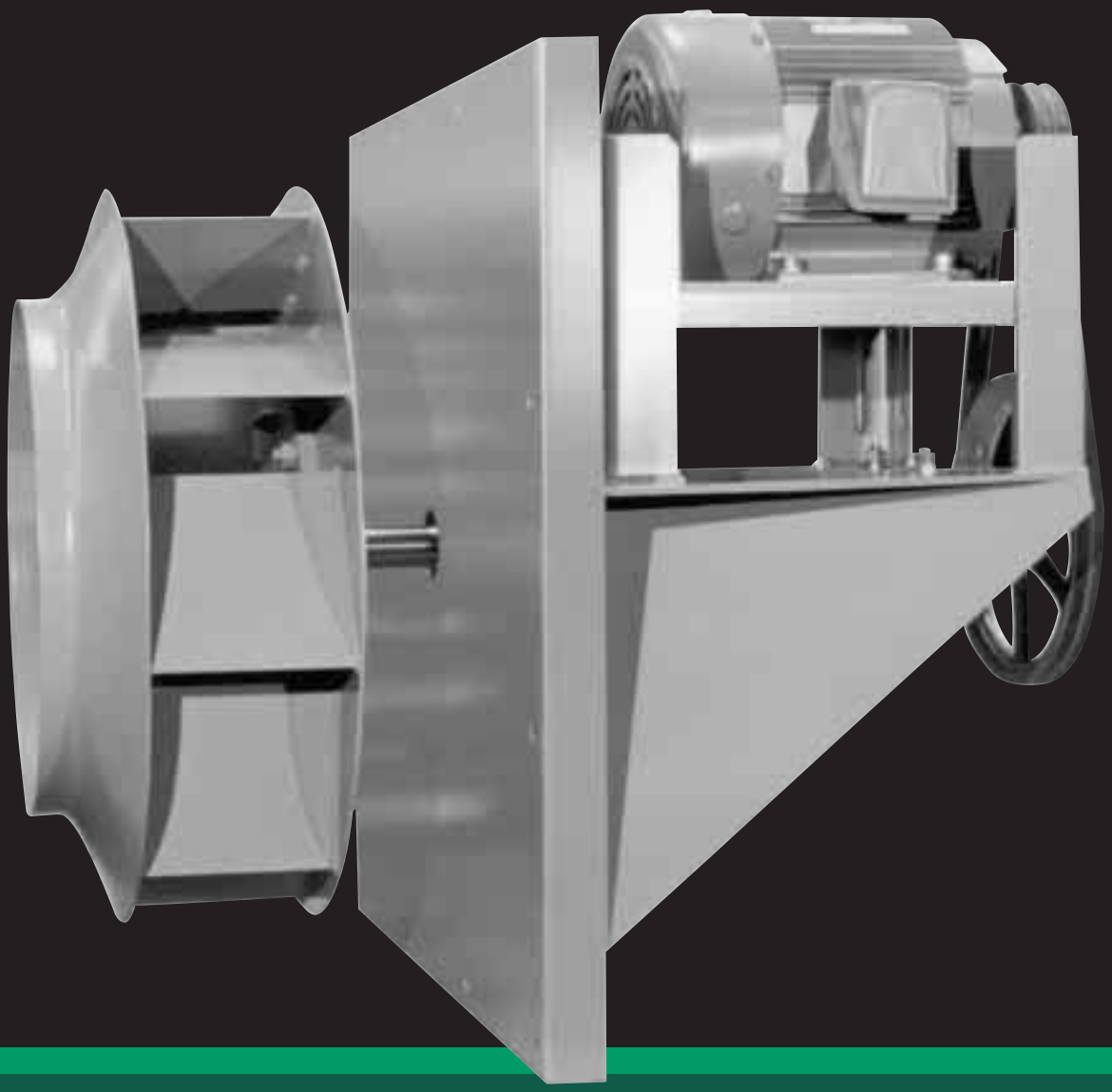
# PLUG FANS

## *Model PLG*



GREENHECK

# MODEL PLG PLUG FAN

Greenheck plug fans, Model PLG, are designed and built to provide reliable service in industrial and commercial applications where unhoused backward inclined wheels operate with in a plenum, often at high temperatures. Model PLG standard construction is suitable for airstream temperatures up to 200° F. Optional high temperature construction permits operation up to 750° F.

Unhoused plug fans feature compact size and high efficiency, making them an ideal selection in many HVAC installations, spray booths, air curtains, ovens, dryers and kilns. Standard construction permits either horizontal or vertical mounting for maximum flexibility in fan placement.

Where air distribution through ductwork is required, plug fans can be furnished with housing.

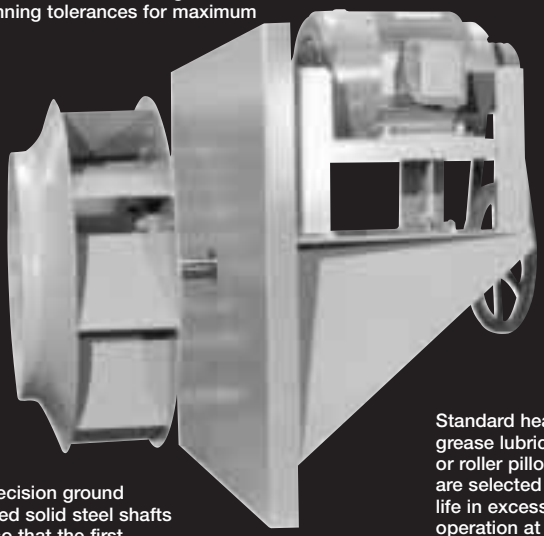
Greenheck plug fans are available in sizes 12-49, single width, in Class I and Class II construction. Plug fan capacities extended to 50,000 CFM and static pressures to 8". These fans have been thoroughly tested in Greenheck's modern AMCA licensed research and development facility to assure complete and accurate performance ratings. To assure smooth vibration free operation, each fan wheel is statically and dynamically balanced to precise tolerances. Prior to shipment, each fan is given a final balance test at operating speed.

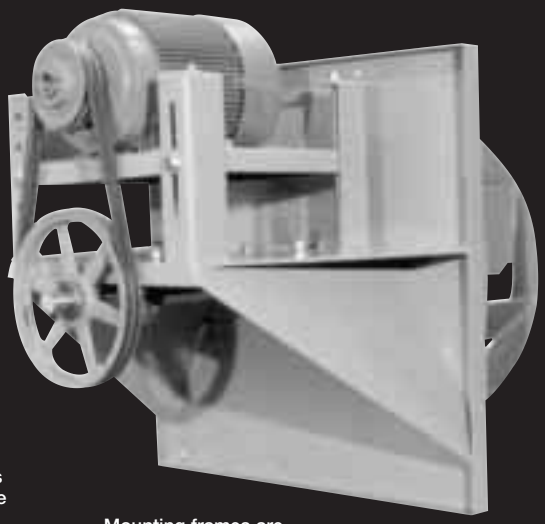
## CONSTRUCTION FEATURES

Inlet Cones (not shown) are supplied with each plenum fan. These cones are heavy gauge spun steel with prepunched mounting holes. Wheel cones and inlet cones are designed with precise running tolerances for maximum efficiency.

Non-overloading, single width, backward inclined wheels are constructed of heavy gauge steel with each blade continuously welded to the wheel cone and to a heavy gauge backplate.

Motor mounting plates are adjustable to maintain proper belt tension.





Turned, precision ground and polished solid steel shafts are sized so that the first critical speed is at least 25% over the maximum operating speed. Standard shaft length will accommodate wall thicknesses up to 4 inches.

Standard heavy duty bearings are grease lubricated, self aligning ball or roller pillow block type. Bearings are selected for a minimum average life in excess of 200,000 hours operation at maximum cataloged conditions for each pressure class.

Mounting frames are heavy gauge steel prepunched for ease of installation, with die formed flanges and welded corners. Rigid steel gussets are welded to the frame and motor supports to assure precise drive alignment.

## ACCESSORIES

**BELT GUARD**
Sturdy fabricated steel, three sided belt guards are available for protection from rotating pulleys and belts. Optional totally enclosed belt guards are also available.

**INLET VANES**
Nested inlet vanes built into the fan inlet cone are available for fan sizes 24-49. External inlet vanes are available for fan sizes 12-36. Vanes feature steel rods and stainless steel bushings to assure uniform blade movement and positive control. Inlet vanes are suitable for air temperatures up to 200° F.

**HEAT SLINGER**
The heat slinger, a finned aluminum cooling wheel, is mounted on the fan shaft between the inboard bearing and the drive panel to dissipate heat conducted along the shaft.

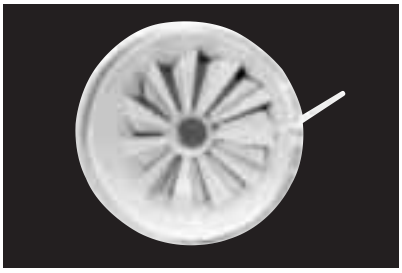
**INSULATED PLUG**
Insulated plugs provide a thermal barrier available in 4", 5" or 6" thicknesses.

**SHAFT GUARDS**
Protective guards of expanded metal are available to cover the shaft and bearings.

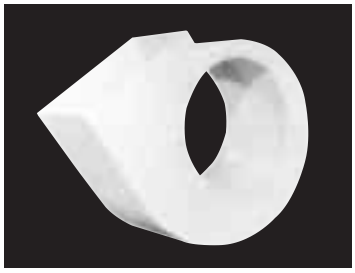
**HOUSING**
Conventional centrifugal fan housings are available for applications requiring specific direction of airflow or connection to ductwork. Housings are designed for mounting to the plenum wall and are universal in rotation and discharge. No flanges or support frames are supplied.

**EXTENDED SHAFT**
Fan shafts longer than standard are available to accommodate walls up to 6 inches thick.

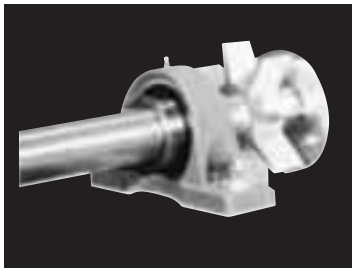
**SHAFT SEAL**
Shaft seals are available for applications handling high temperature or contaminated air. Shaft seals are not gas tight.



INLET VANE



HOUSING



HEAT SLINGER & SHAFT SEAL

# SELECTION AND APPLICATION

This catalog contains comprehensive air performance data for Greenheck's backward inclined plug fans. Air performance is shown in both fan tables and fan curves. This selection and application section will assist the system designer in evaluating fan performance and in selecting Greenheck plug fans for industrial and commercial applications.

The first consideration in any fan selection is the amount of air to be moved and the resistance to this air movement. The determination of airflow and system resistance defines the point of operation that the fan must be capable of providing. In most applications, several fan sizes may meet the required airflow and system resistance conditions. Larger fans tend to turn slower in a given performance range. These fans generally have lower operation costs; however, this may be offset by higher initial costs when compared with a smaller fan. Smaller fans will have higher speeds for a given application and a steeper performance curve. The steeper performance curve minimizes airflow changes in the system as system resistance varies. Smaller sizes also tend to have wider stable modulation ranges in variable air volume systems.

An optimum fan selection requires evaluation of the alternative fan sizes as they relate to initial cost, horsepower, available space and specific application.

In addition, air density, effects of installation on performance, temperature limitations, and motor starting torque should be evaluated.

## SELECTION

The information presented in this section of the catalog and in the fan performance tables and curves can be used to determine the proper plug fan selection. All performance data is based on an unhoused fan with at least 1/2 wheel diameter clearance between the fan wheel and the nearest wall.

### EFFECTS OF AIR DENSITY

Ratings in the fan performance tables and curves of this catalog are based on standard air: clean, dry air with a density of 0.075 lbs./Ft.$^3$ at 70° F. and a pressure of 29.92 in. of mercury.

A change in elevation, temperature, or the type of gas handled will affect density.

With a fan at a constant speed and installed in a fixed system, a change in density will cause the fan pressure and horsepower to vary. The air volume delivered by the fan will remain constant.

The table below gives air density correction factors for calculating the effects of elevation and temperature on fan performance.

**AIR DENSITY CORRECTION FACTORS**

| Air Temp. °F | ELEVATION (Feet Above Sea Level) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1000 | 2000 | 3000 | 4000 | 5000 | 6000 | 7000 | 8000 | 9000 | 10000 |
| 0 | 0.87 | 0.90 | 0.94 | 0.97 | 1.01 | 1.05 | 1.08 | 1.13 | 1.17 | 1.22 | 1.26 |
| 50 | 0.96 | 1.00 | 1.04 | 1.08 | 1.11 | 1.15 | 1.20 | 1.24 | 1.30 | 1.34 | 1.40 |
| 70 | 1.00 | 1.04 | 1.08 | 1.12 | 1.16 | 1.22 | 1.25 | 1.30 | 1.35 | 1.40 | 1.45 |
| 100 | 1.06 | 1.10 | 1.14 | 1.18 | 1.22 | 1.27 | 1.32 | 1.37 | 1.42 | 1.48 | 1.54 |
| 150 | 1.15 | 1.19 | 1.24 | 1.30 | 1.33 | 1.38 | 1.44 | 1.49 | 1.55 | 1.61 | 1.67 |
| 200 | 1.25 | 1.29 | 1.34 | 1.40 | 1.44 | 1.50 | 1.56 | 1.61 | 1.68 | 1.75 | 1.81 |
| 250 | 1.34 | 1.39 | 1.44 | 1.50 | 1.55 | 1.61 | 1.67 | 1.74 | 1.80 | 1.88 | 1.95 |
| 300 | 1.43 | 1.49 | 1.54 | 1.60 | 1.66 | 1.72 | 1.79 | 1.86 | 1.93 | 2.01 | 2.08 |
| 350 | 1.53 | 1.58 | 1.64 | 1.71 | 1.77 | 1.84 | 1.91 | 1.98 | 2.06 | 2.14 | 2.22 |
| 400 | 1.62 | 1.68 | 1.75 | 1.81 | 1.88 | 1.94 | 2.03 | 2.09 | 2.19 | 2.27 | 2.37 |
| 500 | 1.81 | 1.88 | 1.96 | 2.03 | 2.11 | 2.19 | 2.26 | 2.34 | 2.43 | 2.53 | 2.62 |
| 600 | 2.00 | 2.08 | 2.16 | 2.24 | 2.33 | 2.42 | 2.50 | 2.59 | 2.68 | 2.80 | 2.90 |
| 700 | 2.19 | 2.27 | 2.36 | 2.46 | 2.55 | 2.65 | 2.73 | 2.83 | 2.94 | 3.06 | 3.17 |
| 800 | 2.38 | 2.48 | 2.57 | 2.66 | 2.76 | 2.86 | 2.96 | 3.07 | 3.20 | 3.33 | 3.45 |

The following example shows the procedure for selecting a fan at temperatures and elevations other than standard.

A fan must be selected to meet the following requirements:

10,000 CFM
3.00" Static Pressure
250° F Temperature
3000 Ft. Altitude
6" Wall Thickness

The nonstandard atmospheric conditions in the above example must be corrected to standard conditions.

1. An altitude of 3000 Ft. and a temperature of 250° F require a correction factor of 1.5 as shown in the table above.

   Air volume remains at 10,000 CFM, since the volume delivered is not affected by air density.
2. The density correction factor may now be used to correct for standard static pressure. Multiply the original static pressure by the correction factor.

   3.0" SP x 1.5 = 4.5" SP
3. From the fan performance tables at 27 PLG fan will deliver 10,050 CFM at 4.5" SP with 1466 RPM and 11.58 BHP.
4. The 1466 RPM needs no correction.
5. The horsepower selected must by divided by the correction factor.

   BHP at 250° F = 11.58 ÷ 1.5 = 7.72

When a fan is selected to operate at high temperatures, the motor must be large enough to handle the increased BHP at any lower operating temperature where the air is more dense. Assume the air entering the 27 PLG fan at start-up is 0° F. For 0° F and 3000 ft. altitude, the air density correction factor is 0.97.

BHP at 0° F = 11.58 ÷ 0.97 = 11.93

Therefore a 15 HP motor is required.

### HIGH TEMPERATURE LIMITS

The maximum allowable wheel RPM shown on the fan performance pages are for fans of standard construction operating at 70° F. Since the strength of fan wheels, shafts and bearings decreases with increases in temperature, the maximum allowable speed must be reduced by the RPM correction factors shown below.

**RPM CORRECTION FACTORS FOR HIGH TEMPERATURE OPERATION**

| OPERATING TEMPERATURE | RPM CORRECTION FACTOR |
|---|---|
| 70°F | 1.00 |
| 200°F | .97 |
| 300°F | .95 |
| 400°F | .93 |
| 500°F | .90 |
| 600°F | .85 |
| 700°F | .80 |

### HIGH TEMPERATURE CONSTRUCTION

Recommended options and accessories for high temperature operations are shown below.

**HIGH TEMPERATURE CONSTRUCTION**

| OPERATING TEMPERATURE | CONSTRUCTION |
|---|---|
| — 20° to 200°F | Standard |
| 201° to 500°F | Heat Slinger<br>Shaft Seal<br>High Temperature Grease Bearings<br>Insulated Plug<br>High Temperature Aluminum Paint |
| 501° to 750°F | Heat Slinger<br>Shaft Seal<br>High Temperature Grease Bearings<br>Insulated Plug<br>High Temperature Aluminum Paint |

The following table shows maximum allowable fan speeds for plug fans as determined by shaft length. Longer shafts used to accommodate walls or heat plugs beyond 4" thick require lower maximum speeds because the critical speed is reduced as the wheel overhang is increased.

| | WALL THICKNESS | | | | | |
|---|---|---|---|---|---|---|
| | 4" | | 5" | | 6" | |
| | CONSTRUCTION CLASS | | | | | |
| FAN SIZE | I | II | I | II | I | II |
| 12 | 3274 | 4270 | 2910 | 3796 | 2573 | 3354 |
| 13 | 2971 | 3875 | 2647 | 3453 | 2345 | 3057 |
| 15 | 2674 | 3488 | 2388 | 3116 | 2120 | 2764 |
| 16 | 2431 | 3171 | 2174 | 2836 | 1933 | 2521 |
| 18 | 2099 | 2738 | 1890 | 2465 | 1700 | 2217 |
| 20 | 1915 | 2498 | 1728 | 2254 | 1556 | 2029 |
| 22 | 1722 | 2246 | 1560 | 2034 | 1408 | 1836 |
| 24 | 1570 | 2048 | 1423 | 1857 | 1286 | 1678 |
| 27 | 1425 | 1859 | 1305 | 1702 | 1193 | 1557 |
| 30 | 1279 | 1668 | 1174 | 1532 | 1077 | 1404 |
| 33 | 1163 | 1517 | 1071 | 1397 | 984 | 1284 |
| 36 | 1051 | 1371 | 970 | 1266 | 893 | 1165 |
| 40 | 936 | 1221 | 871 | 1136 | 808 | 1054 |
| 44 | 847 | 1105 | 790 | 1031 | 735 | 959 |
| 49 | 769 | 1003 | 720 | 939 | 672 | 876 |

**MOTOR STARTING TORQUE**

When selecting a motor for a plug fan, the motor must be capable not only of driving the fan at operating speed, but also must be capable of accelerating the fan wheel, shaft and drive to the operating speed.

The fan performance tables and curves in this catalog show the brake horsepower required to operate the fan once it is brought to speed. For applications requiring a large air volume at a low static pressure the BHP required at the fan's operating RPM may not be sufficient to initially start the fan. If the time required to bring the fan to speed is excessive, the motor winding insulation can be damaged due to excessive temperature rise and the life of the motor seriously affected.

For a belt drive plug fan the required motor starting torque capability can be expressed by the following formula:

$$WR^2_M = WR^2_F \left(\frac{FRPM}{MRPM}\right)^2 \quad (1.1)$$

Where:

$WR^2_M$ – The moment of inertia that the motor must be capable of turning at the motor shaft, LB-Ft.$^2$.

$WR^2_F$ – The moment of inertia of the fan wheel and shaft, LB-Ft.$^2$.

FRPM – Fan RPM

MRPM – Motor RPM

MInimum motor sizes are critical for backward inclined plug fans, size 36 and larger, operating at low static pressures. Motor starting torque can vary greatly among motor manufacturers. When motors other than those supplied by Greenheck are used, the available $WR^2_M$ at the motor should be obtained from the motor manufacturer.

The table below shows the wheel and shaft moments of inertia for backward inclined fans.

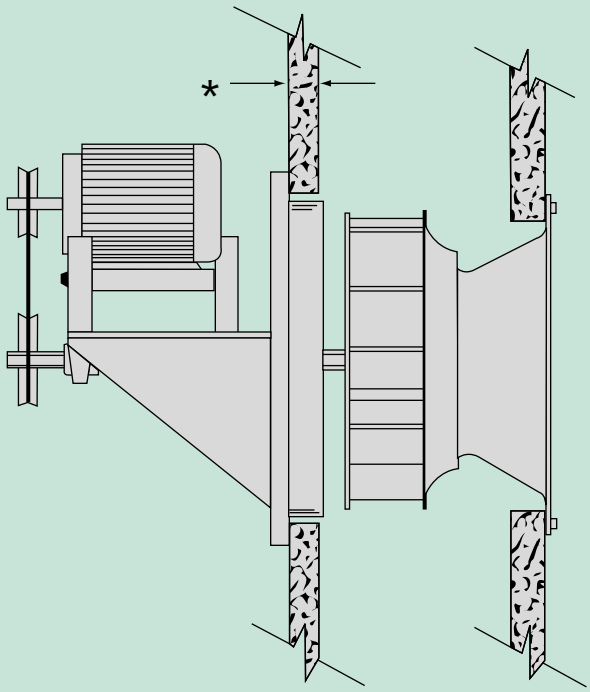
| FAN SIZE | CLASS I | CLASS II |
|---|---|---|
| 12 | 1.5 | 1.8 |
| 13 | 2.1 | 2.5 |
| 15 | 3.3 | 3.7 |
| 16 | 5.2 | 6.5 |
| 18 | 8.5 | 10.6 |
| 20 | 11.8 | 14.7 |
| 22 | 24.0 | 24.8 |
| 24 | 34.1 | 40.2 |
| 27 | 49.1 | 57.6 |
| 30 | 78.0 | 91.5 |
| 33 | 110 | 129 |
| 36 | 184 | 211 |
| 40 | 358 | 420 |
| 44 | 515 | 570 |
| 49 | 784 | 868 |

## TYPICAL INSTALLATION AND APPLICATIONS

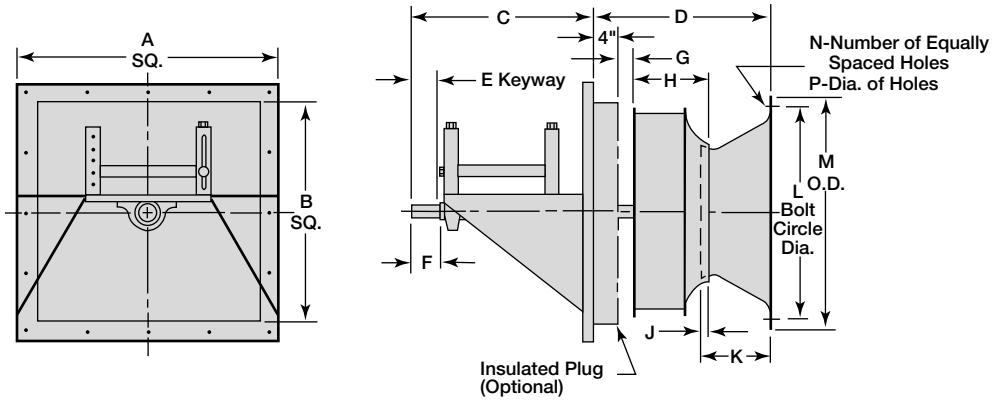
Typical commercial applications include heating and air conditioning systems and air curtains.

Industrial applications include high temperature processes such as ovens, dryers and kilns, in addition to spray booths evaporators and textile dust collectors.

*Maximum wall thickness for a standard length shaft is 4 inches. For a wall thickness of 5 or 6 inches optional longer shafts are available.



# DIMENSIONAL DATA




| SIZE | A | B | C | D | E | F | G | H | J | K | L | M | N | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | 22 | 17 1/2 | 20 | 13 13/16 | 3 | 3 1/4 | 15/16 | 4 9/16 | 3/8 | 4 11/16 | 14 | 15 1/2 | 8 | 1/2 |
| 13 | 22 | 17 1/2 | 20 | 14 13/16 | 3 | 3 1/4 | 1 1/16 | 5 1/16 | 7/16 | 5 1/8 | 15 | 16 1/2 | 8 | 1/2 |
| 15 | 22 | 17 1/2 | 20 | 16 | 3 | 3 1/4 | 1 3/16 | 5 11/16 | 1/2 | 5 5/8 | 16 3/4 | 18 1/4 | 8 | 1/2 |
| 16 | 22 | 17 1/2 | 20 | 17 3/16 | 3 | 3 1/4 | 1 5/16 | 6 3/16 | 1/2 | 6 3/16 | 18 1/2 | 20 | 8 | 1/2 |
| 18 | 31 | 25 1/2 | 25 | 18 5/8 | 4 1/2 | 4 3/4 | 1 5/8 | 7 1/8 | 5/8 | 6 1/2 | 20 1/2 | 22 | 8 | 5/8 |
| 20 | 31 | 25 1/2 | 25 | 20 | 4 1/2 | 4 3/4 | 1 11/16 | 7 13/16 | 5/8 | 7 1/8 | 22 1/2 | 24 | 16 | 5/8 |
| 22 | 31 | 25 1/2 | 25 | 21 3/4 | 4 1/2 | 4 3/4 | 1 15/16 | 8 11/16 | 11/16 | 7 13/16 | 24 1/2 | 26 | 16 | 5/8 |
| 24 | 31 | 25 1/2 | 25 | 23 1/2 | 4 1/2 | 4 3/4 | 1 15/16 | 9 9/16 | 3/4 | 8 3/4 | 28 | 30 | 16 | 5/8 |
| 27 | 44 | 37 1/2 | 31 | 25 1/2 | 5 | 5 1/4 | 2 3/16 | 10 9/16 | 7/8 | 9 5/8 | 30 | 32 | 16 | 5/8 |
| 30 | 44 | 37 1/2 | 31 | 27 13/16 | 5 | 5 1/4 | 2 5/16 | 11 11/16 | 15/16 | 10 3/4 | 33 1/4 | 35 1/4 | 16 | 5/8 |
| 33 | 44 | 37 1/2 | 31 | 30 1/4 | 5 | 5 1/4 | 2 11/16 | 12 13/16 | 1 1/16 | 11 13/16 | 36 1/4 | 38 1/4 | 16 | 5/8 |
| 36 | 44 | 37 1/2 | 31 | 33 | 5 | 5 1/4 | 2 7/8 | 14 1/4 | 1 3/16 | 13 1/16 | 40 | 42 | 16 | 5/8 |
| 40 | 52 | 46 1/2 | 36 | 35 15/16 | 5 1/2 | 5 3/4 | 3 1/16 | 15 11/16 | 1 1/4 | 14 7/16 | 44 | 46 | 16 | 3/4 |
| 44 | 52 | 46 1/2 | 36 | 39 5/16 | 5 1/2 | 5 3/4 | 3 1/2 | 17 5/16 | 1 7/16 | 15 15/16 | 48 1/2 | 50 1/2 | 16 | 3/4 |
| 49 | 57 | 50 | 37 | 42 13/16 | 5 1/2 | 5 3/4 | 3 13/16 | 19 | 1 9/16 | 17 9/16 | 53 | 55 | 16 | 3/4 |

## TYPICAL SPECIFICATIONS FOR MODEL PLG

Plug fans shall be of the centrifugal type with single width, backward inclined wheels.

Bearing supports shall be constructed of welded structural steel members to prevent vibration and to rigidly support the fan shaft and bearings.

The fan wheel shall be of the non-overloading, backward inclined centrifugal type. Wheels shall be statically and dynamically balanced. The wheel cone and fan inlet cone shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

Turned, precision ground and polished steel shafts shall be sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class. Shaft length shall allow wheel adjustment for wall thicknesses up to 4 inches. Close tolerances shall be maintained where the shaft makes contact with the bearing. Bearings shall be heavy duty, grease lubricated, self aligning ball or spherical roller, pillow block type. Bearings shall be selected for a minimum average life in excess of 200,000 hours at maximum operating speed for each pressure class.

Fan performance shall be based on tests conducted in accordance with AMCA Standard 210 test code for air moving devices.

After assembly, each fan shall be given a final balance test at the specified operating RPM to insure smooth, vibration free operation.

Plug fans shall be Model PLG as manufactured by Greenheck Fan Corporation of Schofield, Wisconsin, and shall be supplied as shown on the plans and in the fan schedule.

## WARRANTY

Greenheck warrants this equipment to be free from defects in material and workmanship for a period of one year from the purchase date.

Any units or parts which prove defective during the warranty period will be replaced at our option when returned to our factory, transportation prepaid.

Motors are warranted by the motor manufacturer for a period of one year. Should motors furnished by Greenheck prove defective during this period, they should be returned to the nearest authorized motor service station. Greenheck will not be responsible for any installation or removal costs.

GREENHECK
P.O. BOX 410 SCHOFIELD, WISCONSIN 54476-0410
PH. 715-359-6171