



## DIRECT GAS-FIRED INDOOR AND OUTDOOR HEATING AND MAKE-UP AIR UNITS



HORIZONTAL CONFIGURATION



VERTICAL CONFIGURATION

# Direct Fired Make-Up Air Units

## Table of Contents

Direct-fired make-up units are designed to provide an economical and efficient means of supplying tempered make-up air to a space or building. Any building with exhaust is a candidate for the application of a direct-fired make-up air unit to replace the exhausted air.

This catalog describes the design benefits, construction features, performance data, unit selection procedure, control applications, and the optional and accessory devices available for the direct-fired make-up air units.

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### WARNING

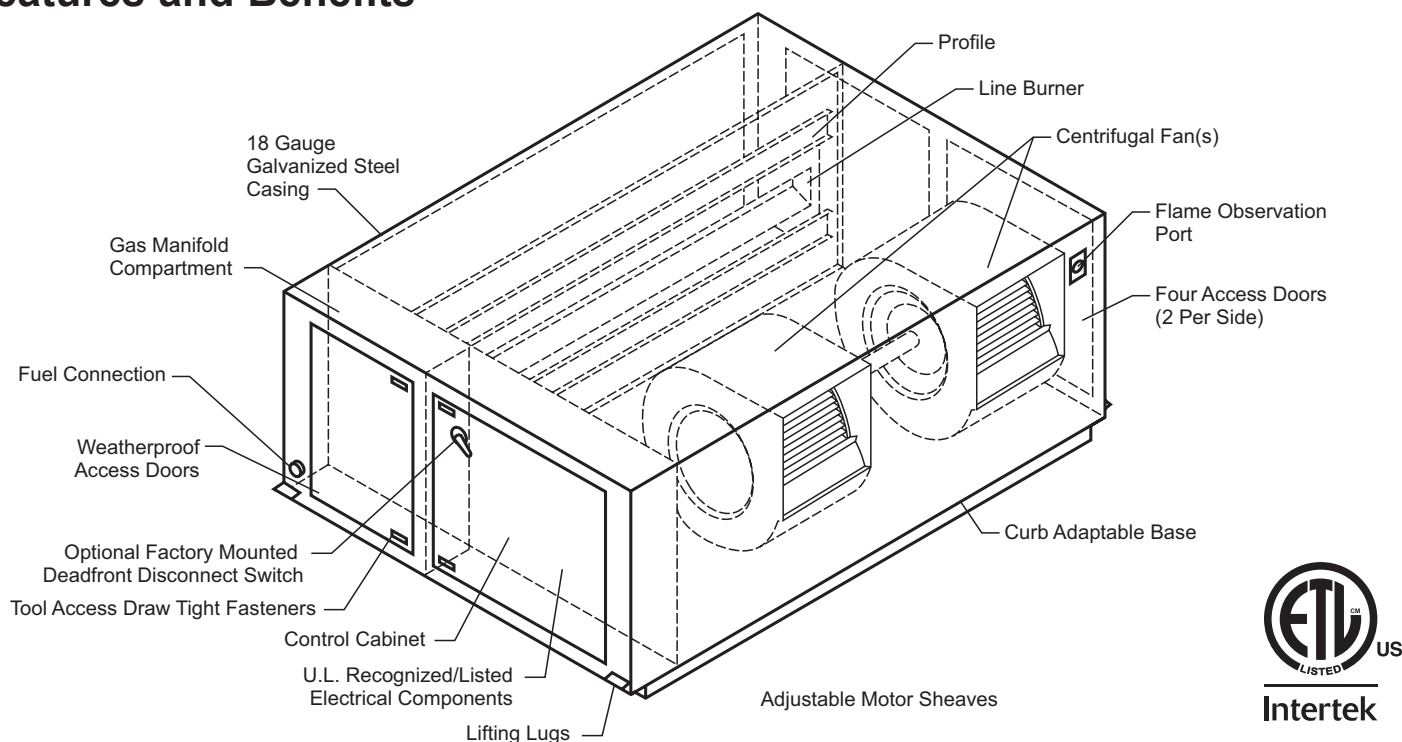
Do not locate ANY gas-fired unit in areas where chlorinated, halogenated or acid vapors are present in the atmosphere.

### WARNING

Appliances must not be installed where they may be exposed to a potentially explosive or flammable atmosphere.

As Modine has a continuous product improvement program, it reserves the right to change design and specifications without notice.

## Features and Benefits



### Feature

### Benefit

- |                                                       |                                                                                                                                             |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| • Fuel efficient line burner with fixed profile ..... | • 100% efficient (92% sensible), clean burning, low NOx                                                                                     |
| • Blower performance up to 3.0" W.C. ....             | • Applications with longer ductwork or high pressure drop accessories                                                                       |
| • Building management system compatible controls..... | • Allows for maximum control flexibility                                                                                                    |
| • Input range up to 7,425 MBH .....                   | • Flexibility to accommodate a variety of heating requirements                                                                              |
| • Centrifugal fan(s) rated to 60,000 CFM .....        | • AMCA-rated fans assure quality and performance                                                                                            |
| • ETL approved and certified.....                     | • Third-party agency certified to national safety standards in both the U.S. and Canada (except model MRB which is not available in Canada) |

### Easy Installation/Service

- |                                                             |                                                                                                                         |
|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| • Exterior fuel connection NPT pipe stub .....              | • Provides contractor/installer with easy connection point                                                              |
| • Adjustable motor sheaves.....                             | • Simplifies onsite air balancing                                                                                       |
| • Separate manifold and electrical control compartments.... | • Isolated compartments allowing easy and unobstructed access                                                           |
| • Tooled-access, draw-tight door fasteners .....            | • Discourages non-authorized access and assures positive seal                                                           |
| • Deadfront main disconnect switch (Optional) .....         | • Saves labor time compared to mounting a box type switch and insures power is deactivated when control cabinet is open |
| • Terminal strip wiring .....                               | • Allows for quick and accurate field wiring connections                                                                |
| • Four access doors (2 per side).....                       | • Provides maximum access for easy adjustments and service                                                              |
| • Flame observation port .....                              | • Allows external observation of burner performance                                                                     |
| • U.L. recognized/listed electrical components .....        | • Assures reliable and safe electrical components                                                                       |
| • Job specific wiring diagrams.....                         | • Allows for easy installation/troubleshooting                                                                          |

### Variable Frequency Drive (MDB Units Only)

- |                                             |                                                                                                                     |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| • Significant energy savings feature.....   | • Adjusting fan speed to meet air system needs allows substantial energy reductions compared to fixed-speed systems |
| • Reduced noise level.....                  | • Reduced airflow noise reduces customer noise complaints                                                           |
| • Stall prevention/overload protection..... | • Reduced drive output during a temporary motor overload                                                            |
| • Reduced maintenance cost .....            | • Soft start reduces wear on motors, belts and system components                                                    |

# Direct Fired Make-Up Air Units

## General Description

### 100% Makeup Air (MDB)

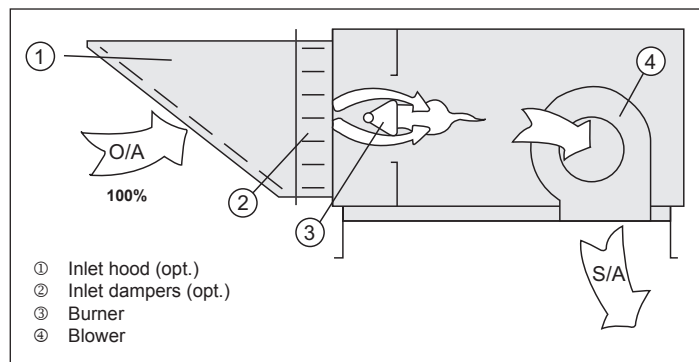
For buildings requiring 100% make-up air, direct-fired units provide the best fuel efficiency (100% thermal efficiency, 92% sensible). The make-up air is heated directly by the gas flame, eliminating the need for a heat exchanger and associated efficiency losses of indirect-fired equipment. Model MDB units provide maximum application flexibility with input ratings up to 7,425,000 Btu/hr and maximum airflow capability of 60,000CFM.

Model MDB units are available with various types of motor control:

- Single speed blower motor for constant volume application.
- Variable frequency drive (VFD) control for variable volume applications between 40% and 100% of rated airflow.

For units with VFD variable air volume control, in addition to makeup air volume flexibility, substantial electrical savings can be achieved by reducing motor horsepower requirements during reduced loading periods (please see Variable Air Volume Principles on page 13 for additional details).

**Figure 4.1 - 100% Makeup Air Unit (MDB)**



### Return Air Units (MRB)

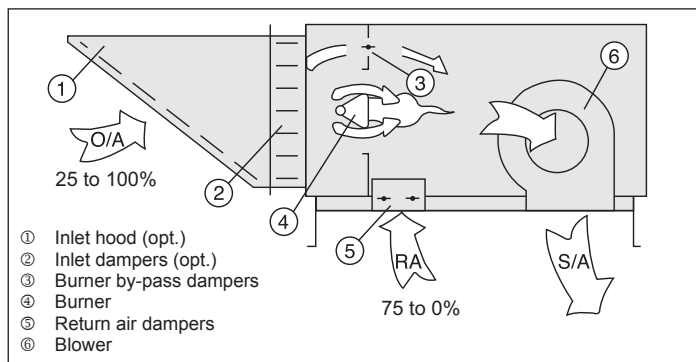
Direct-fired units can be used as combination make-up air and heating units with the capability of operating with recirculated air as well as make-up air. Model MRB units provide maximum application flexibility with input ratings up to 5,500,000 Btu/hr, maximum airflow capability of 41,000CFM and up to 75% return air capability (units must always deliver at least 25% outside air for dilution).

There are two types of return air control available:

- Two-position fixed return air units operate either in maximum return air mode (75% or 70%) or 100% outside air mode. These units are provided with two-position burner by-pass and return air damper.
- Floating position return air units operate by automatically and continually varying the percentage of return air and outside air (from 0% to a maximum of 75% return air) to provide makeup air for a varying exhaust fan load.

For floating control applications, 100% outside air Model MDB units with a 40-100% variable air volume control provide an excellent alternative to MRB units with floating controls. Please see Variable Air Volume Principles on page 13 for a discussion of the substantial electrical savings that can be achieved.

**Figure 4.2 - Return Air Unit (MRB)**



## Design Features and General Performance Data

### Standard Features

- ETL Certification
- IRI compliant manifold assemblies (FM available)
- 100% Thermal Efficiency, (92% sensible)
- Natural or propane manifolds
- 18 gauge galvanized steel cabinet (paint optional) with insulated burner and blower sections
- Units designed for roof curb, slab, or suspension mounting
- Four full access service doors
- Separate manifold and electrical controls compartments
- Numbered terminal strip wiring and job specific wiring diagram for ease of field wiring
- Permanent lifting/mounting lugs
- Model sizes 110 through 118 have a single double-width, double-inlet (DWDI) blower wheel with spider bearings (pillow block bearings optional)
- Model sizes 120 through 130 have a single DWDI blower wheel with pillow block bearings
- Model sizes 220 through 230 have twin DWDI blowers with pillow block bearings
- Motors include adjustable motor sheaves
- Modulating discharge air temperature controls
- Flame rod flame supervision
- High and low airflow proving switches
- High limit switch

### Optional Features - Factory Installed

- Painted unit casing
- Inlet hood, unpainted (paint optional) with or without filters (field installed for Model sizes 125 and above)
- Insulated V-bank 2" filter section, unpainted (paint optional) with permanent, throwaway, or Farr 30/30 (field installed for Model sizes 125 and above and vertical units)
- Inlet damper, unpainted (paint optional) (field installed for Model sizes 125 and above and vertical units)
- Pillow block bearings on Model sizes 110 through 118
- Internal spring blower and motor vibration isolation (requires pillow block bearings)
- Extended grease lines (requires pillow block bearings)
- Deadfront non-fused disconnect switch
- High and low gas pressure switches
- Building management system control options
- Control power transformer for 208, 230, 460, or 575V supply voltages
- Timed freeze protection
- Mild temperature inlet on/off duct stat
- Motor starter auxiliary contacts for starting exhaust fan (starter circuit by others) (single speed motor starters only)
- Double Pole Double Throw (DPDT) control relays
- Circuit analyzer for 10 or 12 points

### Accessory Features - Field Installed

- NEMA 1 remote control panels
- Discharge dampers, unpainted (paint optional)
- Discharge louvers (3 or 4 way), unpainted (paint optional)
- Evaporative cooler with pre-filters (optional rainhood with pre-filters) with 12" Celdek or Glasdek media
- Evaporative cooler fill and drain kits, manual or automatic with optional freeze stat
- Inlet stand, painted in 24" or 48" heights, with or without inlet screen (vertical units only)
- Vibration hangers for suspended units
- Vibration feet for slab mounted units
- Box style disconnect switch

## General Performance Data

Table 5.1 - General Performance Data ① ②

| Model Size | Min CFM (All Units) | Model MDB Units |                    | Model MRB Units   |                   |
|------------|---------------------|-----------------|--------------------|-------------------|-------------------|
|            |                     | Max CFM         | Max Input Btu/hr ③ | Max CFM (75/25) ④ | Max CFM (70/30) ⑤ |
| 110        | 1,600               | 3,300           | 432,400            | 3,000             | 3,000             |
| 112        | 2,000               | 4,700           | 615,800            | 4,380             | 4,500             |
| 115        | 3,000               | 6,500           | 851,700            | 6,000             | 6,000             |
| 118        | 3,500               | 10,000          | 1,310,300          | 6,190             | 6,630             |
| 120        | 6,000               | 13,500          | 1,769,000          | 12,000            | 12,000            |
| 122        | 8,000               | 16,500          | 2,162,100          | 12,980            | 13,900            |
| 124        | 10,000              | 21,500          | 2,162,100          | n/a ⑤             | n/a ⑤             |
| 125        | 10,000              | 21,500          | 2,817,300          | 20,000            | 20,000            |
| 127        | 12,000              | 26,000          | 3,406,900          | 23,260            | 24,000            |
| 130        | 14,000              | 30,000          | 3,931,100          | 23,260            | 24,920            |
| 220        | 18,000              | 27,000          | 3,538,000          | 25,345            | 26,000            |
| 222        | 25,000              | 33,000          | 4,324,200          | 25,345            | 27,155            |
| 225        | 30,000              | 46,000          | 6,027,700          | 38,685            | 41,450            |
| 230        | 36,000              | 60,000          | 7,862,200          | 38,685            | 41,450            |

① See blower performance data on pages 20-21 for available total static pressure drop capability.

② ETL certified maximum allowable discharge air temperature is 105°F. Maximum air temperature rise is 115°F for Natural Gas, 100°F for LP Gas.

③ Maximum Btu/hr based on max CFM and temp rise with -30°F entering air. Actual max Btu/hr may be lower depending on job conditions.

④ CFM shown is with -10°F outside air with a 100°F air temperature rise. Actual capability may vary with different conditions. Please refer to the AccuSpec software with your conditions.

⑤ Model Size 124 is available only for 100% outside air applications.

# Direct Fired Make-Up Air Units

## Model Nomenclature Description

### Digits 1-2 - Unit Type

MD = 100% makeup air unit for single speed or variable frequency drive (VFD) applications

MR = Outside and return air unit

### Digit 3 - Development Sequence

B = Design sequence (internally assigned)

### Digit 4,5,6 - Blower Wheel Quantity and Diameter

For information on determining the proper blower size, review the Sizing and Selection Example on pages 18 and 19.

|                                    |                               |
|------------------------------------|-------------------------------|
| 110 = (1) – 10" blower wheel       | 125 = (1) – 25" blower wheel  |
| 112 = (1) – 12" blower wheel       | 127 = (1) – 27" blower wheel  |
| 115 = (1) – 15" blower wheel       | 130 = (1) – 30" blower wheel  |
| 118 = (1) – 18" blower wheel       | 220 = (2) – 20" blower wheels |
| 120 = (1) – 20" blower wheel       | 222 = (2) – 22" blower wheels |
| 122 = (1) – 22" blower wheel       | 225 = (2) – 25" blower wheels |
| 124 = (1) – 25" x 22" blower wheel | 230 = (2) – 30" blower wheels |

### Digit 7 - Unit Configuration

Determines the casing orientation and access side. The access side is determined by looking into the intake of the unit and specifying the access side (right or left hand). Includes access to gas manifold and electrical control wiring compartments.

A = Horizontal, right access, straight discharge (bottom return on MR)

B = Horizontal, left access, straight discharge (bottom return on MR)

C = Horizontal, right access, bottom discharge (bottom return on MR)

D = Horizontal, left access, bottom discharge (bottom return on MR)

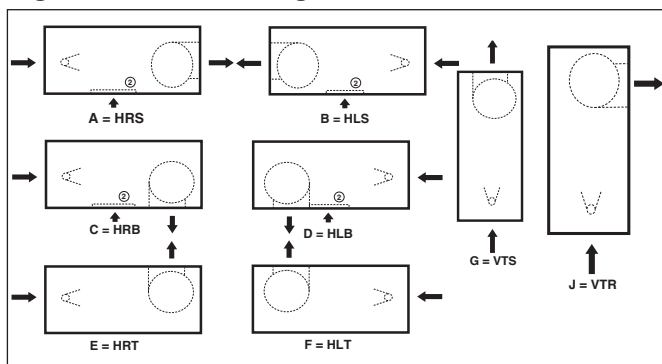
E = Horizontal, right access, top discharge (not available on MR)

F = Horizontal, left access, top discharge (not available on MR)

G = Vertical, right access, top discharge (not available on MR)

J = Vertical, right access, top-right discharge (not available on MR)

Figure 6.1 - Unit Configurations ①



① Configurations shown facing the side of unit with the gas and electrical controls.

② For models with return air (Series MRB).

### Digit 8 - Cabinet Finish and Installation Location

Casings can be provided either unpainted G90 galvanized or painted. Both can be specified for indoor or outdoor installation. Casing is insulated with 1", 1-1/2 lb. density insulation.

A = Unpainted, Outdoor      C = Painted, Outdoor

B = Unpainted, Indoor      D = Painted, Indoor

### Digit 9,10,11,12 - Maximum Burner Input (MBH)

Manifold assemblies are sized with burner lengths in 6" increments at 275MBH per 6" increment. The model number will reflect the maximum rating for the selected burner length.

#### Example:

Unit is to be sized for a firing rate of 1750MBH. A burner length of 36" has a maximum firing rate capability of 1650MBH (6 x 275MBH), while a 42" burner has a maximum firing rate capability of 1925MBH (7 x 275MBH). While the unit will be designed for a firing rate 1750MBH, Digits 9-12 of the model number will reflect 1925. (1650MBH would be too small).

### Digit 13 - Gas Type and Inlet Pressure

Specifies the gas type and gas inlet pressure being used.

A = Natural Gas (8-14")

B = Natural Gas (1-5 psi) ①

C = Propane Gas (11-14") (MDB Units Only)

D = Propane Gas (1-5 psi) (MDB Units Only) ①

① Available for manifolds over 720MBH only (Digits 9-12 = 0825 or above). For applications with 1-5 psig gas pressure on units with Digits 9-12 = 0275, 0400, 0550 or 720, use a manifold rated for either 8-14" W.C. (natural gas) or 11-14" W.C. (propane gas) and install a field supplied step-down pressure regulator accessory.

### Digit 14 - Gas Control System

The gas control system controls the burner firing rate of the unit. All gas controls offered feature electronic modulation.

#### A = Maxitrol System 14

System 14 features a remote temperature dial for adjusting the discharge air temperature set point and a field mounted and wired discharge air sensor and controls an electronic modulating gas valve which modulates the main burner gas flow to maintain the desired discharge air temperature. The temperature set point range for this system is 55-90°F.

This system can be used with an accessory room temperature override thermostat. The stat automatically overrides the discharge air temperature setting by 15°F to provide warmer discharge air until the room override stat is satisfied.

For MRB units, also included are outside air and return air low limit stats. If the temperature being monitored falls below the factory set point, the dampers open to 100% outside air and remain in that position until the low temperature condition is cleared for both low limit stats. Please refer to Table 7.1 for additional guidance.

#### B = Maxitrol System 44

System 44 features a modulating room thermostat to control the main burner firing rate based on the room air temperature set point. The temperature set point range for this system is 55-90°F.

This control system also includes a field mounted and wired discharge air sensor, which is used as a high and low temperature limit control. The discharge air sensor will prevent make-up air from being delivered to the space at temperatures below the low setpoint, even if the room thermostat is satisfied. It will also prevent the room thermostat from over firing the burner when mild outdoor temperatures exist and the maximum firing capacity of the burner is not required to achieve an

## Model Nomenclature Description

appropriate discharge air temperature.

For MRB units, also included are outside air and return air low limit stats. If the temperature being monitored falls below the factory set point, the dampers open to 100% outside air and remain in that position until the low temperature condition is cleared for both low limit stats. Please refer to Table 7.1 for additional guidance.

### Maxitrol SC10 for DDC Compatibility (C = 4-20mA control or D = 0-10VDC control)

The DDC compatible control system utilizes a 4-20mA or 0-10VDC input signal (by others) to control the discharge air temperature.

This system requires a field supplied air temperature sensor that is compatible with the building management system. This sensor is wired to the building management system and based on the temperature reading from that thermostat, the building management system will increase or decrease the signal to the makeup air unit gas controls.

Provided with this system is a discharge air sensor high temperature limit control. The discharge air sensor will prevent make-up air being delivered to the space that is above the operating limit of 105°F.

For MRB units, also included are outside air and return air low limit stats. If the temperature being monitored falls below the factory set point, the dampers open to 100% outside air and remain in that position until the low temperature condition is cleared for both low limit stats. Please refer to Table 7.1 for additional guidance.

### Gas Control Selection for Model MRB Units

Table 7.1 is to be used for Model MRB units only to determine applicability of the various available gas control systems to meet requirements of ETL certification and ANSI Z83.18.

For additional information on these control systems, please see Gas Control Descriptions above.

**Table 7.1 - Gas Control System Selection for Model MRB Units**

| Gas Control System        | RA/OA Ratio | Minimum Outside Air Temperature (per ASHRAE) ① | Maximum Discharge Air Temp | Room Override  |
|---------------------------|-------------|------------------------------------------------|----------------------------|----------------|
| Maxitrol 14               | 75/25       | -30°F and Above                                | 90°F                       | Not Available  |
|                           | 70/30       | -30°F to Lower than 10°F                       |                            |                |
|                           | 70/30       | 10°F and Above                                 | 90°F ②                     | Accessory      |
| Maxitrol 44<br>or<br>SC11 | 75/25       | -30°F to Lower than -10°F                      | 90°F                       | Not Applicable |
|                           |             | -10°F to Lower than 0°F                        | 95°F                       |                |
|                           |             | 0°F and Above                                  | 100°F                      |                |
|                           | 70/30       | -30°F to Lower than -20°F                      | 95°F                       |                |
|                           |             | -20°F to Lower than -10°F                      | 100°F                      |                |
|                           |             | -10°F and Above                                | 105°F                      |                |

① Minimum return air temp is 55°F. For temps below 55°F, contact the factory.

② Room override accessory can override discharge air setting by 15°F to a maximum discharge air temperature of 105°F.

### Digit 15 - Insurance

All standard manifold arrangements are ETL certified to meet the ANSI standards for direct fired makeup air heaters. As standard, the manifolds also meet the requirements of IRI (Industrial Risk Insurers) for all manifold sizes.

Optional manifold arrangements are available to meet the requirements of FM (Factory Mutual), "with restriction" or "less restriction". The arrangement for "with restriction" is the most common and is required anytime there is a restriction on the inlet of the unit. Restrictions include filters, inlet dampers, etc.

1 = IRI (standard ETL)

2 = FM less Restriction

3 = FM with Restriction

### Digit 16 - Additional Manifold Options

A low gas pressure switch monitors the gas supply pressure upstream of all the gas controls and disables the gas controls if low gas pressure is experienced. This will shut off all gas flow to the burner to avoid the burner from having difficulty lighting properly or maintaining a proper flame.

A high gas pressure switch monitors the gas supply pressure downstream of all the gas controls and disables the gas controls if high gas pressure is experienced immediately before the burner. This will shut off all gas flow to the burner to avoid the gas controls from being damaged or causing the unit to over fire.

Both the low and high gas pressure switches are manual reset so that a service person must inspect the unit to make sure that none of the gas controls have been damaged. The switch must then be reset to allow the unit to operate when the gas conditions are returned to the normal operating pressure.

C = High & Low Gas Pressure Switch

N = None

### Digit 17 - Air Control Options

Determines the control package for the unit sequence of operation.

Digit A for single speed 100% makeup air applications is simply continuous operation when on, normally controlled via a Summer/Off/Winter switch.

For detailed sequence of operation descriptions on all Air Control Options other than Digit 17=A, please see pages 12 through 14.

A = 100% MUA - Single Speed

B = 100% MUA - Two Speed (VFD) - Type A

C = 100% MUA - Two Speed (VFD) - Type B

D = 100% MUA - DDC Control (VFD only) - Type A

E = 100% MUA - DDC Control (VFD only) - Type B

F = Space Pressure Control (MD with VFD or MR) - Type A

G = Space Pressure Control (MD with VFD or MR) - Type B

H = Space Pressure Control (MD with VFD or MR) - Type C

I = Return Air - Fixed 75/25 Dampers - Type A

J = Return Air - Fixed 75/25 Dampers - Type B

K = Return Air - Fixed 75/25 Dampers - Type C

L = Return Air - Fixed 70/30 Dampers - Type A

M = Return Air - Fixed 70/30 Dampers - Type B

N = Return Air - Fixed 70/30 Dampers - Type C

# Direct Fired Make-Up Air Units

## Model Nomenclature Description

### Digit 18 - Supply Voltage

Indicates the supply voltage for the unit. A step down transformer is included for voltages above 115V to reduce the supply voltage to 115V for the unit controls.

|                   |                              |
|-------------------|------------------------------|
| 1 = 115V/60Hz/1Ph | 5 = 230V/60Hz/3Ph            |
| 2 = 208V/60Hz/1Ph | 6 = 460V/60Hz/3Ph            |
| 3 = 230V/60Hz/1Ph | 7 = 575V/60Hz/3ph (MDB only) |
| 4 = 208V/60Hz/3Ph |                              |

### Digit 19 - Bearings and Vibration Isolation

A = Spider Bearings (No Vibration Isolation)

Spider bearings include blower mounted bearing brackets with permanently lubricated ball bearings. Spider bearings are designed for use in low motor horsepower applications and are standard for all single speed model MDB unit sizes 110-118.

B = Pillow Block Bearings (No Vibration Isolation)

Pillow block bearings include heavy-duty pillow block bearing housings with greasable internal ball bearings that are rigidly fastened to two 18 gauge minimum blower support channels. Pillow block bearings are optional on model MDB single speed unit sizes 110-118 and standard on all other MDB models and on all MRB models.

C = Pillow Block Bearings (With Spring Vibration Isolation)

Spring vibration isolation is available for units with pillow block bearings. This feature provides an independent blower and motor mounting frame that is supported in each corner by a 1" deflection spring isolator. Only available on units with Digit 7=A, B, C, or D and not available on 124 size units.

For pillow block bearings, extended grease lines are available as an option to allow for greasing of the bearings from outside the unit cabinet. Please see page 10 for additional information on this option.

For suspended or slab mounted units, vibration hangers or feet may be a more cost-effective solution than spring vibration isolation. Please see Vibration Hangers or Vibration Feet in the Accessories section.

### Digit 20 - Motor Horsepower (HP)

The required motor horsepower is determined by the required CFM and total static pressure (internal static pressure + external static pressure) from the blower performance data. For additional information on selecting the proper motor horsepower, review the Sizing and Selection Example on pages 16 and 17. Refer to pages 20 and 21 for blower performance data.

All units (except MDB units with a variable frequency drive) include a factory installed motor starter with overload protection as standard. For MDB units with a VFD, a motor starter is not necessary and therefore not included.

|           |        |
|-----------|--------|
| A = 3/4   | H = 10 |
| B = 1     | I = 15 |
| C = 1 1/2 | J = 20 |
| D = 2     | K = 25 |
| E = 3     | L = 30 |
| F = 5     | M = 40 |
| G = 7 1/2 | N = 50 |

### Digit 21 - Motor Type

Blower motors are available in Open Drip Proof (ODP), Totally Enclosed (TE), and NEMA Premium Efficiency ODP or TE. All motors are continuous duty, ball bearing type, minimum Class "B" insulated with a rigid base. Motors rated 1HP and larger that are 3 phase are inverter duty motors.

|                                     |
|-------------------------------------|
| 1 = ODP ①                           |
| 5 = TE ①                            |
| 2 = ODP - NEMA Premium Efficiency ② |
| 6 = TE - NEMA Premium Efficiency ②  |

① All motors that are single phase voltages or motor that are three phase voltages and ¾ HP or smaller are either 1 or 5.

② All motors that are three phase voltages and 1 HP or larger are either 2 or 6.

### Digit 22 - Sheave Arrangement

All units are provided with adjustable motor sheaves so that the blower rpm can be adjusted for slight increases or decreases in the actual job external static pressure as compared to the design external static pressure.

### Digit 23 - Profile Assembly

Used for internal factory purposes to indicate the burner profile assembly to be included with the unit. The burner profile is fixed at the factory to provide the proper air velocity across the burner for proper combustion.

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# Direct Fired Make-Up Air Units

## Options

The following list details the available options, factory installed (unless otherwise noted).

### Extended Grease Lines (Requires Pillow Block Bearings)

Includes factory installed grease lines extending from the blower bearings to the outside of the unit cabinet. Also includes Zerk fittings for applying grease. Requires grease for initial start-up.

### V-Bank Filter Section

Used to filter outside air drawn through the unit. Available either painted or unpainted. The section is available with several filter configurations:

- With 2" permanent, aluminum mesh washable filters
- With 2" FARR 30/30 filters
- With 2" throwaway 30% filters

For horizontal unit sizes 110-124, the V-bank filter section is factory installed to the unit. For all other model sizes, the section is fully assembled but shipped loose for field installation.

All V-bank filter sections require additional support when installed. Please see V-Bank Filter Support Kit in the Accessories section for additional details.

### Inlet Damper

Used to prevent the building air from exiting the building through the unit when the unit is not operating. Includes a factory installed 2-position damper motor (unit sizes 220-230 include two damper motors). The damper motor includes an end switch to prevent unit operation unless the dampers are open. The inlet damper is available either painted or unpainted.

For horizontal unit sizes 110-124, the inlet damper is factory installed to the unit (or V-bank filter section if selected). For all other model sizes, the inlet damper is fully assembled but shipped loose (or to V-bank filter section if selected) for field installation.

Field installed discharge dampers are available. Please see Accessories section for additional details. Note that only inlet dampers or discharge dampers should be selected, not both.

### Inlet Hood (Horizontal units only)

Used to prevent entry of rain into the fresh air opening of the unit and includes meshed bird screen on opening. Available either painted or unpainted and with or without 2" permanent aluminum mesh washable filters. Inlet hood is factory assembled.

For outdoor units, sizes 110-124, the inlet hood is factory installed to the unit (or V-bank filter section or inlet damper, if selected). For outdoor units, sizes 125-222, the inlet hood is factory installed to the V-bank filter section or inlet damper, if selected, otherwise shipped loose for field installation. For outdoor units, sizes 225-230, the hood is shipped separate for field installation. For all indoor units, the hood is shipped separate for field installation at the entry to the building.

All hoods require additional support when installed. Please see Inlet Hood and/or V-Bank Roof Support in the Accessories section for additional details.

### Timed Freeze Protection

Includes a low limit discharge duct stat and a freeze protection timer. The duct stat monitors the discharge air temperature. On initial start-up, the timed delay in the system allows the unit to go through the normal ignition sequence. The timed delay is an automatic reset switch. In the event that the unit fails to fire after this period, the discharge air sensor will sense the cold air and will shut down the entire unit.

### Mild Temperature Inlet On/Off

Used to automatically shut off the burner when the inlet air temperature reaches the desired setpoint to prevent the burner from continually running at low fire during mild outdoor air temperature conditions.

### Exhaust Fan Interlock Contacts

An auxiliary contact on the motor starter can be used to start an exhaust fan starter circuit (by others) whenever the unit is running. Available only on single speed units. DPDT Interlocking Relay option (see option below) should be used for additional contacts.

To start exhaust fans from VFD equipped units, a DPDT Interlocking Relay (see option below) should be added.

For 2-position return air units that are to start an exhaust fan in the 100% outside air mode, a DPDT Interlocking Relay (see option below) should be added rather than an exhaust fan interlock contact.

### DPDT Interlocking Relay

A relay can be used to control any number of different functions, for example, to start an exhaust fan. Each relay has two sets of normally open and normally closed contacts. The function must be specified on the order.

### Service Door Interlock

Switch automatically breaks power in the unit when the service door is opened. For each door that is to be interlocked, one switch must be ordered. Available on Electrical Compartment, Piping Compartment, Blower Compartment, and/or Burner Compartment doors.

### Convenience Outlet

Includes a 115V/1ph duplex service receptacle mounted in the piping compartment. Requires a separate field connected 115V power supply.

### Deadfront Non-Fused Disconnect Switch

Factory installed in the door of the electrical control compartment, includes a disconnect switch that must be opened before entry to the cabinet can be obtained.

For field installed disconnect switches, please see Disconnect Switch in the Accessories section.

### Circuit Analyzer

Used to quickly assist service personnel in trouble shooting. Monitors the unit vital operating sequence steps. Lights will come on as a point of operation is passed and proven. If any light is not lit, that is the point where failure occurred. The circuit analyzer is mounted on the electrical control cabinet door. There are 10 and 12 point analyzers available. Select circuit analyzer appropriate to the number of points to be monitored. The following is a partial list of points that can be monitored (some points may not be available, depending on unit configuration):

|                    |                       |
|--------------------|-----------------------|
| Power On           | Fire Stat             |
| Blower Door Switch | Flame Failure         |
| Freeze Protection  | Damper Open           |
| Supply Fan On      | Main Airflow          |
| Inlet On/Off Stat  | High/Low Gas Pressure |
| High Limit         | Main Valve            |

## Accessories

The following list details the available accessories, field installed (unless otherwise noted).

### Inlet Hood and/or V-Bank Support Kits

Field installed support kits to provide required support of the inlet hood and/or V-bank filter section. See Literature #7-591.

### Inlet Stand (Vertical Units Only)

The stand is designed to provide a mounting platform and can be used with vertical inlet accessories. Available in 24" or 48" heights, with or without an inlet bird screen. Stands are painted with zinc paint.

### Vibration Feet (Slab Mounted Units Only)

Used to provide vibration isolation, vibration feet consist of rubber-in-shear double deflection isolators with support mounting. There are 4 feet for the unit and 2 additional feet for units with a V-bank filter section.

### Vibration Hangers (Suspended Units Only)

Used to provide vibration isolation, vibration hangers consist of rubber-in-shear double deflection hanging isolators. There are 4 hangers for the unit and 2 additional hangers for units with a V-bank filter section.

### Roof Curb

Roof curb is constructed of galvanized steel and is designed to support the blower and burner section of the direct-fired unit only. The curb does not extend to the optional V-bank filter and/or inlet damper sections. The curb is knocked down for field assembly and includes 1" x 4" nailer strips and curb to unit gasket material. Available in either 14" or 24" heights.

### Discharge Damper

Used to prevent the building air from exiting the building through the unit when the unit is not operating. Includes a factory installed 2-position damper motor. The damper motor includes an end switch to prevent unit operation unless the dampers are open. The discharge damper is available either painted or unpainted. The damper is fully assembled but shipped loose for field installation.

Inlet dampers are available, which may be factory installed for certain model sizes. Please see Options section for additional details. Note that only inlet dampers or discharge dampers should be selected, not both.

### Discharge Louvers (3-Way or 4-Way)

The adjustable louvers provide either 3-way or 4-way control of discharge airflow direction. The assembly is factory assembled but shipped loose for field installation. Available as either painted or unpainted.

### Disconnect Switches - Box Type

Used to cut power to all electrical components of the unit before servicing. For factory mounted Deadfront Non-Fused Disconnect switches, please see the Options section.

### Fire Stat

Used to break power to the unit in the event that a fire or excessive temperatures are detected.

### Time Clock

The 7-day time clock allows for simple and inexpensive automatic on/off control for 100% makeup air units. Requires a 115V/1ph power supply by others. Two types are offered:

- The Standard 7-Day Time Clock features a 7-day calendar allowing different On/Off schedules on different days of the week. The time clock has 2 normally open and 2 normally closed contacts.
- The Digital 7-Day Time Clock with Power Loss Carry-Over is similar to the Standard Time Clock except it features digital controls and 96-hour program memory carryover in the event of a power interruption.

### Room Override Thermostat

Used with Maxitrol 14 gas controls, the room thermostat automatically overrides the discharge air temperature setting to provide warmer discharge air until the room override stat is satisfied. Please see Gas Control Descriptions on page 6 for additional information.

### Remote Monitoring Panel

Used to control and monitor the operation of the makeup air unit. All panels include a Summer/Off/Winter switch and Main Valve and Alarm lights as standard. Maxitrol 14 panels also include the discharge temperature selector dial, while Maxitrol 44 panels include the modulating room stat. Remote panels are classified as NEMA 1.

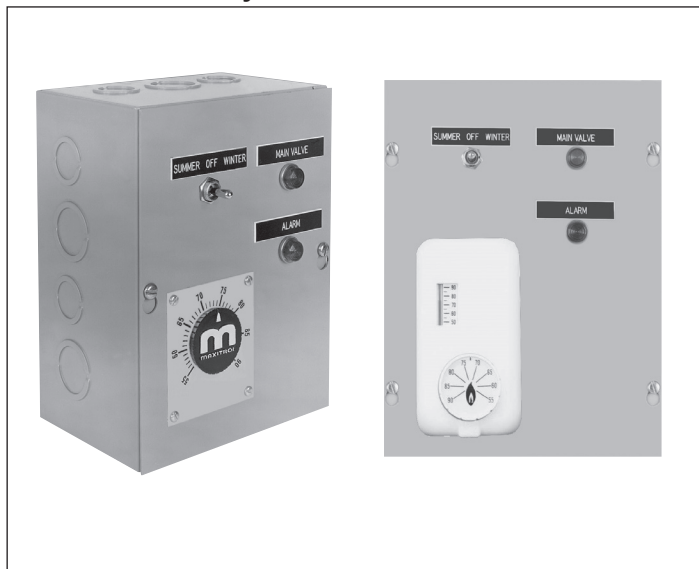
Remote panels may include an additional switch, based on the selection of the equipment. Other possible switches are:

- Evap On/Off switch for units with an Evaporative Cooler
- High/Low Speed switch for units with 2-speed motor control
- Occupied/Unoccupied switch for certain air Control Types (see pages 12 through 14 for additional information).

In addition, panels are capable of having up to 2 additional lights added to the panel. Additional available lights are as follows:

- Blower On
- Clogged Filters
- Blower On and Clogged Filters

**Figure 11.1 - Standard Control Panels for Maxitrol Series 14 and 44 Systems**



# Direct Fired Make-Up Air Units

## Control Applications - 100% Make-Up Air Units - Model MDB

Tables 12.1 through 12.3 show the sequence of operation for 100% Makeup Air Two Speed and VFD Airflow Control Options and associated Control Types. Note that in all cases, the controlling thermostat is based on the gas controls selected and the firing rate control is not controlled by the night setback thermostat. For additional information on gas controls options, please see pages 6 and 7. Refer to AccuSpec for the lowest speed available with VFD.

**Table 12.1 - Two Speed VFD Control Types**

| Control Type “A” – Manual High/Low Speed Switch          |                   |                      |                        |
|----------------------------------------------------------|-------------------|----------------------|------------------------|
| Changeover Switch Setting                                | Blower Operation  | Air Delivery         | Controlling Thermostat |
| Low                                                      | Continuous – Low  | 100% OA (50% CFM) ①  | Per Gas Controls       |
| High                                                     | Continuous – High | 100% OA (100% CFM) ① |                        |
| Control Type “B” – High/Low Speed Exhaust Fan Interlocks |                   |                      |                        |
| # of Exhaust Fans Operating                              | Blower Operation  | Air Delivery         | Controlling Thermostat |
| 0                                                        | Off               | None                 | Per Gas Controls       |
| 1                                                        | Continuous – Low  | 100% OA (50% CFM) ①  |                        |
| 2                                                        | Continuous - High | 100% OA (100% CFM) ① |                        |

① The VFD low speed is factory set as specified by the customer. If VFD low speed is 50% of high speed, then either fan can start the unit. If the low speed is higher or lower than 50% of high speed, it is critical that the exhaust fans always be started in the same order.

**Table 12.2 - VFD with Building Pressurization Controller Control Types**

| Control Type “A” – Continuous Operation                                            |                  |                                     |                        |
|------------------------------------------------------------------------------------|------------------|-------------------------------------|------------------------|
| Changeover Switch Setting                                                          | Blower Operation | Air Delivery                        | Controlling Thermostat |
| None (Power On)                                                                    | Continuous       | 100% OA (low speed-100% air volume) | Per Gas Controls       |
| Control Type “B” – Manual Occupied/Unoccupied Switch with Night Setback Stat       |                  |                                     |                        |
| Changeover Switch Setting                                                          | Blower Operation | Air Delivery                        | Controlling Thermostat |
| Occupied                                                                           | Continuous       | 100% OA (low speed-100% air volume) | Per Gas Controls ②     |
| Unoccupied                                                                         | Intermittent     | 100% OA (low speed air volume)      |                        |
| Control Type “C” – Time Clock with Night Setback Stat                              |                  |                                     |                        |
| Changeover Switch Setting                                                          | Blower Operation | Air Delivery                        | Controlling Thermostat |
| Same as Type B, except a Time Clock replaces the Manual Occupied/Unoccupied Switch |                  |                                     |                        |

② Gas controls enabled by night setback stat in the unoccupied mode. Unit then modulates based on gas control setting.

**Table 12.3 - VFD Building Management (DDC) System Control Types**

| Control Type "A" – 4-20mA Building Management Control System Analog Signal  |                  |                                       |                        |
|-----------------------------------------------------------------------------|------------------|---------------------------------------|------------------------|
| Changeover Switch Setting                                                   | Blower Operation | Air Delivery                          | Controlling Thermostat |
| Unit enabled by contact closure from DDC system                             | Continuous       | 100% OA (low speed-100% air volume) ② | Per Gas Controls       |
| Control Type "B" – 0-10VDC Building Management Control System Analog Signal |                  |                                       |                        |
| Changeover Switch Setting                                                   | Blower Operation | Air Delivery                          | Controlling Thermostat |
| Unit enabled by contact closure from DDC system                             | Continuous       | 100% OA (low speed-100% air volume) ③ | Per Gas Controls       |

③ The variable frequency drive varies the speed of the motor to provide between low speed and 100% of the total unit airflow, based on the 0-10Vdc or 4-20mA analog signal received from the building management system.

## Control Applications - 100% Make-Up Air Units - Model MDB

### Variable Air Volume Principles

For makeup air applications where the volume of air required changes based on varying building exhaust load, there are a number of methods for varying the makeup air volume delivered to the space. Examined below are two common methods. While both methods work in principle, there are substantial differences.

#### 1. Makeup air unit with variable frequency drive (VFD):

- As the exhaust load changes, the VFD adjusts motor speed to increase/decrease the outside air volume.
- A reduction in blower speed results in a substantial reduction in motor HP requirements.
- The airflow volume can be fully varied over the range from low speed to 100% of unit rated CFM. Refer to AccuSpec for the lowest speed available with VFD.

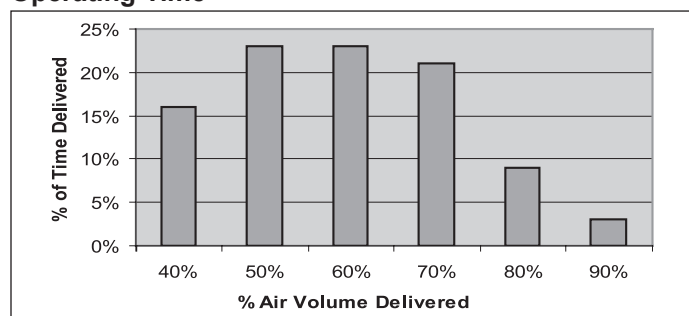
#### 2. Makeup air unit with floating fresh air bypass and outlet dampers (not offered by Modine):

- As the exhaust load changes, the damper positions are adjusted to increase/decrease the outside air volume.
- The outlet damper changes system static pressure to adjust the air volume delivered while maintaining blower speed.
- Motor HP requirements change only slightly.
- The ability of the airflow volume to be varied over a wide range is dependent upon the initial operating point on the blower curve (discussed later).

### The Methods Compared

The makeup air unit motor size is based on the maximum air volume to be delivered. However, in most cases this volume is only required at peak times. Approximately 83% of the unit operating time is spent delivering between 40% and 70% of the full rated air volume (Source: Yaskawa Electric America, Inc.).

**Figure 13.1 - Typical Air Volume Delivery vs. Operating Time**



Source: Yaskawa

As can be seen in Table 13.1, as the volume of air delivered is decreased, the reduction in motor input power requirements are far greater with the VFD equipped unit than with the outlet damper equipped unit.

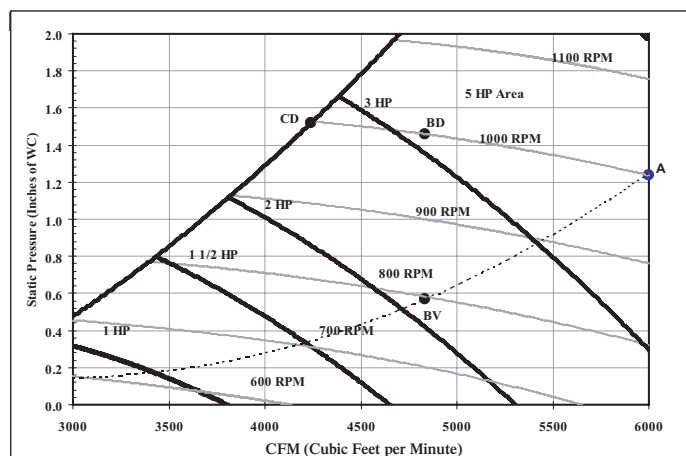
**Table 13.1 - Motor Input Power Reduction**

| CFM, % of Full Rating | Motor HP, % of Full Rated BHP |      |
|-----------------------|-------------------------------|------|
|                       | Outlet Damper                 | VFD  |
| 100%                  | 100%                          | 100% |
| 80%                   | 76%                           | 52%  |
| 60%                   | 60%                           | 28%  |
| 40%                   | 52%                           | 12%  |

The outlet damper equipped unit simply follows the blower performance curve fixed blower RPM line. As the static is

increased from the outlet damper, the unit airflow decreases while following the RPM curve. Motor HP will only see a slight decrease. On the VFD equipped unit, the blower speed is reduced and the motor HP follows the fan law (motor HP is proportional to the reduction in blower speed cubed). This curve can be seen in Figure 13.2 as a dotted line and is summarized in the following table:

|                   | CFM  | Static | RPM  | BHP |
|-------------------|------|--------|------|-----|
| Start (Point A)   | 6000 | 1.25"  | 1000 | 4.1 |
| Point BD (Damper) | 4800 | 1.50"  | 1000 | 3.1 |
| Point BV (VFD)    | 4800 | 0.60"  | 800  | 2.1 |



Note that as the airflow continues to be reduced, the outlet damper method will reach a point where further reductions are not possible without entering the unstable region of the blower performance curve. Point CD represents the point on the curve where further reductions are not possible. That point is at approximately 4200CFM or a maximum airflow reduction capability to only 70% of rated airflow. The curve for the VFD unit meanwhile will continue lower to achieve a far greater reduction. The important point is that reductions of rated airflow on outlet damper models can only occur as far as there is room on the curve to move. The VFD unit will always be capable of significant reductions to rated airflow.

The energy savings that can be achieved with a VFD can be substantial. The following chart demonstrates some approximate savings for a unit with a 10HP motor, assuming an average load of 60% airflow over 8000 hours per year:

|                                                             | Outlet Damper | VFD            |
|-------------------------------------------------------------|---------------|----------------|
| 10HP Motor, kW                                              | 7.46          | 7.46           |
| Input Power Adjustment @ 60% of full air volume             | 0.600         | 0.28           |
| Motor kW @ 60% of full air volume                           | 4.48          | 2.09           |
| Annual Operating Hours                                      | 8,000         | 8,000          |
| KWH                                                         | 35,840        | 16,720         |
| Electrical Cost per kWh                                     | \$0.10        | \$0.10         |
| Annual Operating Cost                                       | \$3,584       | \$1,672        |
| <b>VFD Annual Savings, Compared to Outlet Damper Method</b> |               | <b>\$1,912</b> |

If the design conditions require a variable air volume unit, a Modine model MDB unit with VFD control provides the energy efficient solution.

# Direct Fired Make-Up Air Units

## Control Applications - Return Air Units - Model MRB

Tables 14.1 through 14.2 show the sequence of operation for Return Air Two-Position and Floating Airflow Control Options and associated Control Types. Note that in all cases, the controlling thermostat is based on the gas controls selected and the firing rate control is not controlled by the night setback thermostat. For additional information on gas controls options, please see pages 6 and 7.

Model MRB units feature outside air bypass and return air dampers and either a two-position damper actuator or a floating damper actuator with a remote mounted room to outside air

photohelic pressure controller. The function of the dampers are as follows:

- As the outside air bypass dampers are opened and the return air dampers closed more outside air is introduced to the building (less return air).
- As the outside air bypass dampers are closed and the return air dampers opened less outside air is introduced to the building (more return air).

The maximum return air is based on the Return Air/Outside Air ratio selected. Available ratios are 75/25 or 70/30.

**Table 14.1 - Two Position (75/25 or 70/30 Return Air/Outside Air Ratio) Control Types**

| Control Type “A” – Manual Occupied/Unoccupied Switch                               |                  |              |                        |
|------------------------------------------------------------------------------------|------------------|--------------|------------------------|
| Changeover Switch Setting                                                          | Blower Operation | Air Delivery | Controlling Thermostat |
| Occupied                                                                           | Continuous       | 100% OA      | Per Gas Controls       |
| Unoccupied                                                                         | Continuous       | Minimum OA   |                        |
| Control Type “B” – Manual Occupied/Unoccupied Switch with Night Setback Stat       |                  |              |                        |
| Changeover Switch Setting                                                          | Blower Operation | Air Delivery | Controlling Thermostat |
| Occupied                                                                           | Continuous       | 100% OA      | Per Gas Controls ①     |
| Unoccupied                                                                         | Intermittent     | Minimum OA   |                        |
| Control Type “C” – Time Clock with Night Setback Stat                              |                  |              |                        |
| Changeover Switch Setting                                                          | Blower Operation | Air Delivery | Controlling Thermostat |
| Same as Type B, except a Time Clock replaces the Manual Occupied/Unoccupied Switch |                  |              |                        |

① Gas controls enabled by night setback stat in the unoccupied mode. Unit then modulates based on gas control setting

**Table 14.2 - Floating Position Outside Air Bypass and Return Air Dampers for Building Pressurization Control Types**

| Control Type “A” – Continuous Operation                                            |                  |                             |                        |
|------------------------------------------------------------------------------------|------------------|-----------------------------|------------------------|
| Changeover Switch Setting                                                          | Blower Operation | Air Delivery                | Controlling Thermostat |
| None (Power On)                                                                    | Continuous       | Floating Minimum to 100% OA | Per Gas Controls       |
| Control Type “B” – Manual Occupied/Unoccupied Switch with Night Setback Stat       |                  |                             |                        |
| Changeover Switch Setting                                                          | Blower Operation | Air Delivery                | Controlling Thermostat |
| Occupied                                                                           | Continuous       | Floating Minimum to 100% OA | Per Gas Controls ②     |
| Unoccupied                                                                         | Intermittent     | Minimum OA, 75% RA          |                        |
| Control Type “C” – Time Clock with Night Setback Stat                              |                  |                             |                        |
| Time Clock Mode                                                                    | Blower Operation | Air Delivery                | Controlling Thermostat |
| Same as Type B, except a Time Clock replaces the Manual Occupied/Unoccupied Switch |                  |                             |                        |

② Gas controls enabled by night setback stat in the unoccupied mode. Unit then modulates based on gas control setting.

③ The photohelic building pressure switch varies the ratio of outside and return air between minimum air and 100% outside air to maintain building pressure as set on the photohelic.

## MODINE BREEZE® ACCUSPEC SIZING AND SELECTION PROGRAM



The Modine Breeze® AccuSpec is the fastest way to generate performance data based on actual job conditions. The Breeze AccuSpec program is a Web-based sizing and selection program. The program provides a series of step-by-step questions that allow for the easy configuration of Modine products. After a model has been configured, the program can generate Submittal Schedules, Performance Data, Dimensional Drawings, and Specifications.

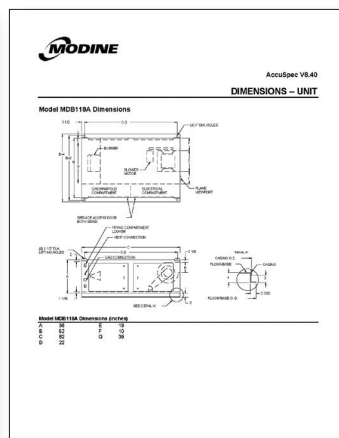
Pictures for Easy Visual Selection of Equipment

Calculates Equipment Capacities and Capabilities

Submittal Schedules

| Unit Tag             |                  |
|----------------------|------------------|
| Unit Application     | 100% Make-Up Air |
| Unit Configuration   | Not selected     |
| Cabinet Type         | Not selected     |
| Gas Controls         | Not selected     |
| Blower/Motor         | Not selected     |
| Gas Control Option   | Not selected     |
| Gas Manifold         | Not selected     |
| Gas Pressure         | Not selected     |
| Insurance Compliance | Not selected     |
| Additional Options   | Not selected     |
| Remote Panel         | Not selected     |

Dimensional Drawings



Specifications

| Unit Tag             |                  |
|----------------------|------------------|
| Unit Application     | 100% Make-Up Air |
| Unit Configuration   | Not selected     |
| Cabinet Type         | Not selected     |
| Gas Controls         | Not selected     |
| Blower/Motor         | Not selected     |
| Gas Control Option   | Not selected     |
| Gas Manifold         | Not selected     |
| Gas Pressure         | Not selected     |
| Insurance Compliance | Not selected     |
| Additional Options   | Not selected     |
| Remote Panel         | Not selected     |

Please contact your local Modine Sales Representative for a demonstration or access to the system.

# Direct Fired Make-Up Air Units

## Unit Selection

The next few pages provide an overview of how to select a Direct Fired Make-Up Air Unit, however units **MUST** be selected using Modine Breeze® AccuSpec, an online tool that allows easy, step-by-step selection of Modine HVAC equipment. Please see page 15 for information. In order to properly select a direct-fired heating, ventilating, cooling or make-up air unit, it is necessary to have the following basic information.

**1. Required air handling capacity (CFM).**

The air capacity of the unit is usually determined by the ventilation air requirements, exhaust load of the building, infiltration losses, or the air turns/changes of the space.

**2. Outdoor and indoor design temperature.**

The outdoor design temperature is determined by using the ASHRAE Guide design temperatures for the city where the equipment is to be installed. For heating and ventilating units, the desired room temperature would be used as the indoor design temperature. In the case of 100% make-up air units, the discharge air temperature should be at least equal to the temperature of the air being exhausted.

**3. Required heating input capacity (Btu/Hr).**

The heating input capacity of the unit is determined by using the formula (for sea level):  $\text{BTU/hr} = \text{CFM} \times \text{Temp Rise } (^\circ\text{F}) \times 621 / (460 + \text{Discharge Temp})$

**4. External static pressure to unit.**

The external static pressure (E.S.P.) is determined using the ASHRAE Guide for duct losses, or may be provided by the design engineer.

**5. Unit configuration with options and accessories (Rainhood, filters, dampers, or evaporative cooler).**

The unit configuration is determined by the location where the unit is to be installed. The critical options and accessories are those that add internal static pressure (I.S.P.) to the unit. Once these items are determined, the pressure drop curves would be used to calculate the total pressure drop (T.S.P.)

Total Static Pressure = Internal + External Static Pressure

**6. Type of fuel and gas pressure.**

Either natural or propane gas determined by the design engineer.

**7. Temperature control method.**

Either discharge, room or DDC compatible control as determined by the design engineer.

**8. Main power supply voltage to unit.**

**9. Altitude at which unit is to be installed.**

With this information a basic unit can be selected as shown in the following example.

### Selection Example - 100% Make Up Air

Select an outdoor, slab mounted, direct-fired, 100% make-up air unit, FM insurance option, with vibration isolation to meet the following:

1. CFM at sea level = 6,000 cfm
  2. Outdoor design temp = 10°F, Discharge temp = 70°F
  3. Heating input capacity =  $6000 \text{ cfm} \times (70^\circ\text{F} - 10^\circ\text{F}) \times 621 / (460 + 70) = 421,810 \text{ Btu/Hr}$
  4. External Static Pressure = 0.74" W.C.
  5. Right hand controls, airflow is to blow down into building.  
The following accessories are to be included: 2" Permanent Filters, Rainhood and Discharge Damper
  6. Gas Type = Natural gas, 8-14" W.C. supply pressure.
  7. 0-10VDC building management control is required.
  8. Supply Voltage: 460V/60Hz/3Ph. Altitude: 1000 feet
- With the information listed above, the basic model, using the Model Nomenclature shown on page 35, can be selected as shown in the following example:

**1. Determine the Product Type (Digit 2):**

The Product Type for 100% make up air is D. Digit 3 represents an internal design sequence and is always B. Digits 1-3 = MDB.

**2. Determine the Blower Quantity and Size (Digits 4-6) and Motor HP (Digit 20):**

Using Table 5.1, Model Sizes MDB115, 118 and 120 have blower capability to produce 6000 cfm. The blower performance tables can be found on page 20. Since all can provide the required 6000 cfm, the total static pressure for each blower performance curve must be determined. In this example, the selection process will be shown for 115 only (Digits 4-6 = 115).

A) The Pressure Drop of an option or accessory is determined by entering the table at the desired cfm and reading across the table until the cfm intersects the desired item. For this example, in Table 18.1 the 2" Permanent Filter has an approximate 0.17" W.C. pressure drop. This would be repeated for the other accessories. As a result, for MDB115:

- 2" Permanent Filters = 0.17" W.C.
- Rainhood without Filters = 0.02" W.C.
- Discharge Damper = 0.07" W.C.
- Total Internal Static Pressure Drops = 0.26" W.C.

The Total Static Pressure = Internal Static + External Static. For this example  $0.26" + 0.74" = 1.00" \text{ W.C. T.S.P.}$

B) Using the total static pressure (T.S.P.) calculated in step 2A, use blower performance table for the Model Size MDB115 in Table 20.1. Enter the table at the required 6000 cfm and follow the cfm line to the right until it intersects with the T.S.P. line of 1.00" W.C. which is shown at the top of the table. At the point of intersection of these two rows and columns, read the required horsepower. For this example the horsepower is 5. Digit 20 = F.

**3. Determine the Unit Configuration (Digit 7):**

Looking at the unit configurations shown on page 35, configurations C and D both blow down into the building. The specifier wanted right hand controls. The configurations shown on page 35 are facing the controls. For direct fired, the orientation is determined by looking into the inlet of the unit (air blowing at your back). For configuration C, the controls would be on the right hand side. Digit 7 = C.

**4. Determine the Cabinet Finish/Location (Digit 8):**

The unit is specified as being outdoor, so the choices are either A (unpainted) or C (painted). Unpainted units are constructed of galvanized steel and can outdoors without paint. Since paint was not specified, Digit 8 = A.

**5. Determine Maximum Input MBH rating (Digits 9-12):**

The Heating Input capacity was calculated to be 421,810 Btu/hr (422MBH) based on the CFM and indoor and outdoor design temperatures. The maximum input MBH rating is the maximum rating for the burner size and is not representative of the actual firing rate. In this case, a burner rated 550MBH would be required to satisfy 422MBH. Digits 9-12 = 0550.

**6. Determine the Gas Type, Inlet Pressure and Flame Proving (Digit 13):**

Since not specified, standard flame rod flame proving will be selected. For natural gas, 8-14" W.C. inlet pressure and flame rod flame sensing, Digit 13 = A.

**7. Determine the Gas Control System (Digit 14):**

Reviewing the gas control information on pages 6-7, MDB units can use Maxitrol 14, 44, or SC11 gas controls. The customer wants the unit to be building management control compatible. The Maxitrol SC11 control is required for this compatibility. Digit 14 = D (0-10VDC signal by others).

## Unit Selection

8. **Determine the Insurance Requirements (Digit 15):**  
The customer specified FM. Digit 15 = 2 or 3 covers FM less and with restriction respectively. From the information on page 7, if there are inlet blockages such as dampers or filters, FM with restriction must be selected (if FM is required). In the case of this unit, there are filters, so FM with restriction is required. Digit 15=3. Note that if FM was not specified, the standard IRI manifold could have been selected.
9. **Determine Additional Manifold Options (Digit 16):**  
Since high and low gas switches were not specified, Digit 16 = N.
10. **Determine the Air Control Option (Digit 17):**  
All 100% make-up air units with single speed motors have Digit 17 = A.
11. **Determine the Supply Voltage (Digit 18):**  
From item #8 listed above, the 460V/60Hz/3Ph results in Digit 18 = 6.
12. **Determine Bearings/Vibration Isolation (Digit 19):**  
Since the Bearing Type was not specified and dedicated blower vibration isolation was not specifically called out, the standard spider bearings will be used. Thus, Digit 19 = A. Specify accessory vibration feet for vibration isolation.
13. **Determine the Motor Horsepower (Digit 20):**  
This was completed in step #2 above. Digit 20 = F.
14. **Determine the Motor Type (Digit 21):**  
Reviewing the information on page 8 for motor type, 5HP 460V/60Hz/3ph motors are only available in NEMA Premium Efficiency ODP and TE. Since the motor type was not specified, NEMA Prem Eff ODP will be used. Digit 21 = 2.
15. **Determine the Sheave Arrangement (Digit 22):**  
This digit will be internally assigned by Modine to match the design blower speed.
16. **Determine the Profile Assembly (Digit 23):**  
This digit will be internally assigned by Modine.

### Selection Example - Return Air Unit

Select an outdoor, slab mounted, direct-fired, 75/25 return air unit, space pressure control during occupied and maximum return air with night setback during unoccupied, auto changeover from occupied to unoccupied, FM insurance option, with vibration isolation to meet the following:

1. CFM at sea level = 6,000 cfm
2. Outdoor design temp = 10°F, Return design temp = 60°F (based on night setback temp), Discharge temp = 70°F
3. Heating input capacity = 6000 cfm x (70°F -10°F) x 621 ÷ (460 + 70) = 421,810 Btu/Hr  
**Note:** Heating capacity is calculated based on 100% outside air mode, not return air mode.
4. External Static Pressure = 0.80"W.C.
5. Right hand controls, airflow is to blow down into building. The following accessories are to be included: 2" Permanent Filters, Rainhood and Inlet Damper
6. Gas Type = Natural gas, 8-14" W.C. supply pressure.
7. Discharge temperature control with room override is required.
8. Supply Voltage: 460V/60Hz/3Ph
9. Altitude: 1000 feet  
With the information listed above, the basic model, using the Model Nomenclature shown on page 35, can be selected as shown in the following example:
1. **Determine the Product Type (Digit 2):**  
The Product Type for return air units is R. Digit 3 represents an internal design sequence and is always B. Digits 1-3 = MRB.
2. **Determine the Blower Quantity and Size (Digits 4-6) and Motor HP (Digit 20):**

Using Table 5.1, Model Sizes MRB115, 118 and 120 have blower capability to produce 6000 cfm at 60°F temperature rise and 75/25 RA/OA ratio. The blower performance tables can be found on page 20. Since all can provide the required 6000 cfm, the total static pressure for each blower size must be determined. In this example, the selection process will be shown for 115 only (Digits 4-6 = 115).

A) The Pressure Drop of an option or accessory is determined by entering the table at the desired cfm and reading across the table until the cfm intersects the desired item. For this example, in Table 18.1 the 2" Permanent Filter has an approximate 0.17"W.C. pressure drop. This would be repeated for the other accessories. As a result, for MRB115:

- 2" Permanent Filters = 0.17" W.C.
- Rainhood without Filters = 0.02" W.C.
- Inlet Damper = 0.01" W.C.
- Total Internal Static Pressure Drops = 0.20" W.C.

The Total Static Pressure for the system is determined by Internal Static + External Static = Total Static Pressure. For this example 0.20" + 0.80" = 1.00" W.C. T.S.P.

B) Same as step 2B in the previous example. Digit 20 = F.

3. **Determine the Unit Configuration (Digit 7):**  
Same as step 3 in previous example. Digit 7 = C.
4. **Determine the Cabinet Finish/Location (Digit 8):**  
Same as step 4 in previous example. Digit 8 = A.
5. **Determine Maximum Input MBH rating (Digits 9-12):**  
Same as step 5 in previous example. Digits 9-12 = 0550.
6. **Determine the Gas Type, Inlet Pressure and Flame Proving (Digit 13):**  
Same as step 6 in previous example. Digit 13 = A.
7. **Determine the Gas Control System (Digit 14):**  
Reviewing the Gas Control Selection Table 7.1 on page 7, for discharge control, 75/25 units, outdoor air temperatures above -20°F, Maxitrol 14 controls are an acceptable control up to a maximum discharge air temperature of 90°F (the maximum setting on the TD114). Note that room override is not available on this control system, so an exception must be noted. Digit 14 = A.
8. **Determine the Insurance Requirements (Digit 15):**  
Same as step 8 in previous example. Digit 15 = 3.
9. **Determine Additional Manifold Options (Digit 16):**  
Since high and low gas switches were not specified, Digit 16 = N.
10. **Determine the Air Control Option (Digit 17):**  
Reviewing the Controls Applications in Table 14.2 on page 14, Control Type C provides the required sequence to meet space pressure control during the occupied period, maximum return air during unoccupied with night setback thermostat and auto changeover between occupied and unoccupied with the timeclock. Digit 17 = H.
11. **Determine the Supply Voltage (Digit 18):**  
Same as step 11 in previous example. Digit 18 = 6.
12. **Determine Bearings/Vibration Isolation (Digit 19):**  
As shown on page 10, MRB units come standard with Pillow Block Bearings. Digit 19=B.
13. **Determine the Motor Horsepower (Digit 20):**  
This was completed in step #2 above. Digit 20 = F.
14. **Determine the Motor Type (Digit 21):**  
Same as step 14 in previous example. Digit 21 = 2.
15. **Determine the Sheave Arrangement (Digit 22):**  
This digit will be internally assigned by Modine to match the design blower speed.
16. **Determine the Profile Assembly (Digit 23):**  
This digit will be internally assigned by Modine.

# Direct Fired Make-Up Air Units

## Static Pressure Drop Data

Table 18.1 - Accessory Static Pressure Drop Data (Inches W.C.)

| Model Size | CFM   | 2" Permanent V-Bank Filters | 2" Throwaway V-Bank Filters | 2" Farr 30/30 V-Bank Filters | Inlet Dampers | Inlet Hood with Filters | Inlet Hood without Filters | Evap Cooler with Flat Bank Filters | Evap Cooler with Rainhood & Filters | 3-Way Louvers | 4-Way Louvers | Discharge Damper | Ductless Discharge | CFM   |
|------------|-------|-----------------------------|-----------------------------|------------------------------|---------------|-------------------------|----------------------------|------------------------------------|-------------------------------------|---------------|---------------|------------------|--------------------|-------|
| 110        | 2600  | 0.15                        | 0.18                        | 0.19                         | 0.01          | 0.06                    | 0.01                       | 0.04                               | 0.08                                | 0.05          | 0.05          | 0.05             | 0.41               | 2600  |
|            | 2800  | 0.18                        | 0.20                        | 0.22                         | 0.01          | 0.07                    | 0.02                       | 0.05                               | 0.09                                | 0.06          | 0.05          | 0.05             | 0.47               | 2800  |
|            | 3000  | 0.20                        | 0.22                        | 0.25                         | 0.01          | 0.08                    | 0.02                       | 0.05                               | 0.10                                | 0.07          | 0.06          | 0.06             | 0.54               | 3000  |
|            | 3300  | 0.24                        | 0.26                        | 0.30                         | 0.01          | 0.09                    | 0.02                       | 0.06                               | 0.11                                | 0.09          | 0.08          | 0.08             | 0.65               | 3300  |
| 112        | 2000  | 0.10                        | 0.11                        | 0.12                         | 0.00          | 0.04                    | 0.01                       | 0.03                               | 0.05                                | 0.03          | 0.03          | 0.03             | 0.12               | 2000  |
|            | 2500  | 0.14                        | 0.17                        | 0.18                         | 0.01          | 0.06                    | 0.01                       | 0.04                               | 0.07                                | 0.05          | 0.04          | 0.04             | 0.19               | 2500  |
|            | 3000  | 0.20                        | 0.22                        | 0.25                         | 0.01          | 0.08                    | 0.02                       | 0.05                               | 0.10                                | 0.07          | 0.06          | 0.06             | 0.27               | 3000  |
|            | 3500  | 0.26                        | 0.29                        | 0.33                         | 0.01          | 0.10                    | 0.02                       | 0.06                               | 0.12                                | 0.10          | 0.09          | 0.09             | 0.37               | 3500  |
|            | 4000  | 0.34                        | 0.37                        | 0.43                         | 0.02          | 0.12                    | 0.03                       | 0.08                               | 0.15                                | 0.13          | 0.11          | 0.11             | 0.48               | 4000  |
|            | 4500  | 0.42                        | 0.45                        | 0.54                         | 0.02          | 0.15                    | 0.04                       | 0.10                               | 0.19                                | 0.16          | 0.14          | 0.14             | 0.61               | 4500  |
| 115        | 4700  | 0.45                        | 0.49                        | 0.59                         | 0.03          | 0.16                    | 0.05                       | 0.11                               | 0.20                                | 0.17          | 0.15          | 0.15             | 0.66               | 4700  |
|            | 3000  | 0.05                        | 0.07                        | 0.06                         | 0.00          | 0.03                    | 0.00                       | 0.03                               | 0.05                                | 0.02          | 0.02          | 0.02             | 0.14               | 3000  |
|            | 3500  | 0.07                        | 0.08                        | 0.08                         | 0.00          | 0.04                    | 0.01                       | 0.03                               | 0.06                                | 0.03          | 0.02          | 0.02             | 0.19               | 3500  |
|            | 4000  | 0.08                        | 0.10                        | 0.11                         | 0.01          | 0.05                    | 0.01                       | 0.04                               | 0.07                                | 0.04          | 0.03          | 0.03             | 0.25               | 4000  |
|            | 4500  | 0.10                        | 0.12                        | 0.13                         | 0.01          | 0.06                    | 0.01                       | 0.05                               | 0.09                                | 0.04          | 0.04          | 0.04             | 0.31               | 4500  |
|            | 5000  | 0.12                        | 0.15                        | 0.16                         | 0.01          | 0.07                    | 0.01                       | 0.06                               | 0.11                                | 0.06          | 0.05          | 0.05             | 0.39               | 5000  |
|            | 5500  | 0.15                        | 0.17                        | 0.19                         | 0.01          | 0.08                    | 0.02                       | 0.06                               | 0.12                                | 0.07          | 0.06          | 0.06             | 0.47               | 5500  |
|            | 6000  | 0.17                        | 0.20                        | 0.23                         | 0.01          | 0.09                    | 0.02                       | 0.07                               | 0.14                                | 0.08          | 0.07          | 0.07             | 0.56               | 6000  |
| 118        | 6500  | 0.20                        | 0.22                        | 0.26                         | 0.01          | 0.10                    | 0.02                       | 0.09                               | 0.16                                | 0.09          | 0.08          | 0.08             | 0.65               | 6500  |
|            | 3500  | 0.07                        | 0.08                        | 0.08                         | 0.00          | 0.04                    | 0.01                       | 0.03                               | 0.06                                | 0.03          | 0.02          | 0.02             | 0.09               | 3500  |
|            | 4000  | 0.08                        | 0.10                        | 0.11                         | 0.01          | 0.05                    | 0.01                       | 0.04                               | 0.07                                | 0.04          | 0.03          | 0.03             | 0.12               | 4000  |
|            | 5000  | 0.12                        | 0.15                        | 0.16                         | 0.01          | 0.07                    | 0.01                       | 0.06                               | 0.11                                | 0.06          | 0.05          | 0.05             | 0.19               | 5000  |
|            | 6000  | 0.17                        | 0.20                        | 0.23                         | 0.01          | 0.09                    | 0.02                       | 0.07                               | 0.14                                | 0.08          | 0.07          | 0.07             | 0.27               | 6000  |
|            | 7000  | 0.22                        | 0.25                        | 0.30                         | 0.02          | 0.11                    | 0.03                       | 0.10                               | 0.19                                | 0.11          | 0.10          | 0.10             | 0.37               | 7000  |
|            | 8000  | 0.28                        | 0.32                        | 0.39                         | 0.02          | 0.14                    | 0.04                       | 0.13                               | 0.24                                | 0.14          | 0.12          | 0.12             | 0.48               | 8000  |
|            | 9000  | 0.35                        | 0.39                        | 0.49                         | 0.03          | 0.17                    | 0.04                       | 0.16                               | 0.29                                | 0.18          | 0.16          | 0.16             | 0.61               | 9000  |
| 120        | 10000 | 0.43                        | 0.46                        | 0.60                         | 0.03          | 0.20                    | 0.06                       | 0.19                               | 0.35                                | 0.22          | 0.19          | 0.19             | 0.76               | 10000 |
|            | 6000  | 0.05                        | 0.06                        | 0.06                         | 0.00          | 0.03                    | 0.00                       | 0.04                               | 0.06                                | 0.02          | 0.02          | 0.02             | 0.13               | 6000  |
|            | 7000  | 0.06                        | 0.08                        | 0.08                         | 0.00          | 0.04                    | 0.01                       | 0.04                               | 0.08                                | 0.03          | 0.03          | 0.03             | 0.17               | 7000  |
|            | 8000  | 0.08                        | 0.09                        | 0.10                         | 0.01          | 0.05                    | 0.01                       | 0.05                               | 0.10                                | 0.04          | 0.03          | 0.03             | 0.23               | 8000  |
|            | 9000  | 0.09                        | 0.11                        | 0.12                         | 0.01          | 0.06                    | 0.01                       | 0.06                               | 0.12                                | 0.05          | 0.04          | 0.04             | 0.29               | 9000  |
|            | 10000 | 0.11                        | 0.13                        | 0.15                         | 0.01          | 0.07                    | 0.01                       | 0.07                               | 0.14                                | 0.06          | 0.05          | 0.05             | 0.35               | 10000 |
|            | 11000 | 0.13                        | 0.15                        | 0.17                         | 0.01          | 0.08                    | 0.02                       | 0.09                               | 0.17                                | 0.07          | 0.06          | 0.06             | 0.43               | 11000 |
|            | 12000 | 0.15                        | 0.17                        | 0.20                         | 0.01          | 0.09                    | 0.02                       | 0.10                               | 0.19                                | 0.09          | 0.08          | 0.08             | 0.51               | 12000 |
| 122        | 13000 | 0.17                        | 0.20                        | 0.24                         | 0.01          | 0.10                    | 0.02                       | 0.12                               | 0.22                                | 0.10          | 0.09          | 0.09             | 0.60               | 13000 |
|            | 13500 | 0.18                        | 0.21                        | 0.25                         | 0.02          | 0.11                    | 0.02                       | 0.13                               | 0.24                                | 0.11          | 0.10          | 0.10             | 0.64               | 13500 |
|            | 8000  | 0.08                        | 0.09                        | 0.10                         | 0.01          | 0.05                    | 0.01                       | 0.05                               | 0.10                                | 0.04          | 0.03          | 0.03             | 0.15               | 8000  |
|            | 9000  | 0.09                        | 0.11                        | 0.12                         | 0.01          | 0.06                    | 0.01                       | 0.06                               | 0.12                                | 0.05          | 0.04          | 0.04             | 0.19               | 9000  |
|            | 10000 | 0.11                        | 0.13                        | 0.15                         | 0.01          | 0.07                    | 0.01                       | 0.07                               | 0.14                                | 0.06          | 0.05          | 0.05             | 0.24               | 10000 |
|            | 11000 | 0.13                        | 0.15                        | 0.17                         | 0.01          | 0.08                    | 0.02                       | 0.09                               | 0.17                                | 0.07          | 0.06          | 0.06             | 0.29               | 11000 |
|            | 12000 | 0.15                        | 0.17                        | 0.20                         | 0.01          | 0.09                    | 0.02                       | 0.10                               | 0.19                                | 0.09          | 0.08          | 0.08             | 0.35               | 12000 |
|            | 13000 | 0.17                        | 0.20                        | 0.24                         | 0.01          | 0.10                    | 0.02                       | 0.12                               | 0.22                                | 0.10          | 0.09          | 0.09             | 0.41               | 13000 |
| 124        | 14000 | 0.19                        | 0.22                        | 0.27                         | 0.02          | 0.11                    | 0.02                       | 0.14                               | 0.25                                | 0.12          | 0.10          | 0.10             | 0.47               | 14000 |
|            | 15000 | 0.22                        | 0.25                        | 0.31                         | 0.02          | 0.13                    | 0.03                       | 0.15                               | 0.29                                | 0.13          | 0.12          | 0.12             | 0.54               | 15000 |
|            | 16000 | 0.25                        | 0.28                        | 0.35                         | 0.02          | 0.14                    | 0.03                       | 0.17                               | 0.32                                | 0.15          | 0.13          | 0.13             | 0.61               | 16000 |
|            | 16500 | 0.26                        | 0.29                        | 0.37                         | 0.02          | 0.15                    | 0.03                       | 0.18                               | 0.34                                | 0.16          | 0.14          | 0.14             | 0.65               | 16500 |
|            | 10000 | 0.11                        | 0.13                        | 0.15                         | 0.01          | 0.07                    | 0.01                       | 0.07                               | 0.14                                | 0.06          | 0.05          | 0.05             | 0.24               | 10000 |
|            | 12000 | 0.15                        | 0.17                        | 0.20                         | 0.01          | 0.09                    | 0.02                       | 0.10                               | 0.19                                | 0.09          | 0.08          | 0.08             | 0.35               | 12000 |
|            | 14000 | 0.19                        | 0.22                        | 0.27                         | 0.02          | 0.11                    | 0.02                       | 0.14                               | 0.25                                | 0.12          | 0.10          | 0.10             | 0.47               | 14000 |
|            | 16000 | 0.25                        | 0.28                        | 0.35                         | 0.02          | 0.14                    | 0.03                       | 0.17                               | 0.32                                | 0.15          | 0.13          | 0.13             | 0.61               | 16000 |
| 124        | 18000 | 0.30                        | 0.34                        | 0.44                         | 0.03          | 0.17                    | 0.04                       | 0.21                               | 0.40                                | 0.19          | 0.17          | 0.17             | 0.78               | 18000 |
|            | 20000 | 0.37                        | 0.40                        | 0.54                         | 0.03          | 0.20                    | 0.05                       | 0.24                               | 0.49                                | 0.24          | 0.21          | 0.21             | 0.96               | 20000 |
|            | 21500 | 0.42                        | 0.46                        | 0.62                         | 0.04          | 0.22                    | 0.06                       | 0.26                               | 0.56                                | 0.28          | 0.24          | 0.24             | 1.11               | 21500 |

# Direct Fired Make-Up Air Units

## Static Pressure Drop Data

Table 19.1 - Accessory Static Pressure Drop Data (Inches W.C.)

| Model Size | CFM   | 2" Permanent V-Bank Filters | 2" Throwaway V-Bank Filters | 2" Fair 30/30 V-Bank Filters | Inlet Dampers | Inlet Hood with Filters | Inlet Hood without Filters | Evap Cooler with Flat Bank Filters | Evap Cooler with Rainhood & Filters | 3-Way Louvers | 4-Way Louvers | Discharge Damper | Ductless Discharge | CFM   |
|------------|-------|-----------------------------|-----------------------------|------------------------------|---------------|-------------------------|----------------------------|------------------------------------|-------------------------------------|---------------|---------------|------------------|--------------------|-------|
| 127        | 16000 | 0.12                        | 0.14                        | 0.16                         | 0.01          | 0.10                    | 0.01                       | 0.07                               | 0.14                                | 0.05          | 0.04          | 0.04             | 0.25               | 16000 |
|            | 18000 | 0.14                        | 0.17                        | 0.20                         | 0.02          | 0.13                    | 0.02                       | 0.09                               | 0.17                                | 0.06          | 0.06          | 0.06             | 0.31               | 18000 |
|            | 20000 | 0.17                        | 0.20                        | 0.24                         | 0.02          | 0.15                    | 0.02                       | 0.11                               | 0.21                                | 0.08          | 0.07          | 0.07             | 0.38               | 20000 |
|            | 22000 | 0.20                        | 0.23                        | 0.29                         | 0.03          | 0.17                    | 0.03                       | 0.13                               | 0.24                                | 0.09          | 0.08          | 0.08             | 0.46               | 22000 |
|            | 24000 | 0.23                        | 0.26                        | 0.34                         | 0.03          | n/a                     | 0.03                       | 0.15                               | 0.28                                | 0.11          | 0.10          | 0.10             | 0.55               | 24000 |
|            | 26000 | 0.27                        | 0.30                        | 0.39                         | 0.04          | n/a                     | 0.04                       | 0.18                               | 0.33                                | 0.13          | 0.12          | 0.12             | 0.65               | 26000 |
| 130        | 14000 | 0.09                        | 0.11                        | 0.12                         | 0.01          | 0.08                    | 0.01                       | 0.06                               | 0.11                                | 0.04          | 0.03          | 0.03             | 0.14               | 14000 |
|            | 16000 | 0.12                        | 0.14                        | 0.16                         | 0.01          | 0.10                    | 0.01                       | 0.07                               | 0.14                                | 0.05          | 0.04          | 0.04             | 0.18               | 16000 |
|            | 18000 | 0.14                        | 0.17                        | 0.20                         | 0.02          | 0.13                    | 0.02                       | 0.09                               | 0.17                                | 0.06          | 0.06          | 0.06             | 0.23               | 18000 |
|            | 20000 | 0.17                        | 0.20                        | 0.24                         | 0.02          | 0.15                    | 0.02                       | 0.11                               | 0.21                                | 0.08          | 0.07          | 0.07             | 0.29               | 20000 |
|            | 22000 | 0.20                        | 0.23                        | 0.29                         | 0.03          | 0.17                    | 0.03                       | 0.13                               | 0.24                                | 0.09          | 0.08          | 0.08             | 0.35               | 22000 |
|            | 24000 | 0.23                        | 0.26                        | 0.34                         | 0.03          | n/a                     | 0.03                       | 0.15                               | 0.28                                | 0.11          | 0.10          | 0.10             | 0.42               | 24000 |
|            | 26000 | 0.27                        | 0.30                        | 0.39                         | 0.04          | n/a                     | 0.04                       | 0.18                               | 0.33                                | 0.13          | 0.12          | 0.12             | 0.49               | 26000 |
|            | 28000 | 0.30                        | 0.34                        | 0.45                         | 0.05          | n/a                     | 0.04                       | 0.21                               | 0.37                                | 0.15          | 0.13          | 0.13             | 0.57               | 28000 |
| 220        | 30000 | 0.34                        | 0.38                        | 0.52                         | 0.05          | n/a                     | 0.05                       | 0.24                               | 0.42                                | 0.18          | 0.15          | 0.15             | 0.65               | 30000 |
|            | 18000 | 0.12                        | 0.15                        | 0.17                         | 0.01          | 0.08                    | 0.01                       | 0.08                               | 0.15                                | 0.05          | 0.05          | 0.05             | 0.29               | 18000 |
|            | 19000 | 0.13                        | 0.16                        | 0.18                         | 0.01          | 0.08                    | 0.02                       | 0.09                               | 0.17                                | 0.06          | 0.05          | 0.05             | 0.32               | 19000 |
|            | 20000 | 0.15                        | 0.17                        | 0.20                         | 0.01          | 0.09                    | 0.02                       | 0.10                               | 0.18                                | 0.06          | 0.06          | 0.06             | 0.35               | 20000 |
|            | 21000 | 0.16                        | 0.19                        | 0.22                         | 0.01          | 0.10                    | 0.02                       | 0.11                               | 0.20                                | 0.07          | 0.06          | 0.06             | 0.39               | 21000 |
|            | 22000 | 0.17                        | 0.20                        | 0.24                         | 0.01          | 0.10                    | 0.02                       | 0.11                               | 0.22                                | 0.08          | 0.07          | 0.07             | 0.43               | 22000 |
|            | 23000 | 0.19                        | 0.21                        | 0.26                         | 0.02          | 0.11                    | 0.02                       | 0.12                               | 0.23                                | 0.08          | 0.07          | 0.07             | 0.47               | 23000 |
|            | 24000 | 0.20                        | 0.23                        | 0.28                         | 0.02          | 0.11                    | 0.02                       | 0.13                               | 0.25                                | 0.09          | 0.08          | 0.08             | 0.51               | 24000 |
|            | 25000 | 0.21                        | 0.25                        | 0.31                         | 0.02          | n/a                     | 0.03                       | 0.15                               | 0.27                                | 0.10          | 0.09          | 0.09             | 0.55               | 25000 |
| 222        | 26000 | 0.23                        | 0.26                        | 0.33                         | 0.02          | n/a                     | 0.03                       | 0.16                               | 0.29                                | 0.11          | 0.10          | 0.10             | 0.60               | 26000 |
|            | 27000 | 0.25                        | 0.28                        | 0.35                         | 0.02          | n/a                     | 0.03                       | 0.17                               | 0.31                                | 0.12          | 0.10          | 0.10             | 0.64               | 27000 |
|            | 28000 | 0.26                        | 0.30                        | 0.38                         | 0.02          | n/a                     | 0.03                       | 0.18                               | 0.33                                | 0.13          | 0.11          | 0.11             | 0.65               | 28000 |
|            | 29000 | 0.28                        | 0.31                        | 0.41                         | 0.03          | n/a                     | 0.04                       | 0.19                               | 0.35                                | 0.13          | 0.12          | 0.12             | 0.70               | 29000 |
|            | 30000 | 0.30                        | 0.33                        | 0.43                         | 0.03          | n/a                     | 0.04                       | 0.21                               | 0.38                                | 0.14          | 0.13          | 0.13             | 0.75               | 30000 |
|            | 31000 | 0.31                        | 0.35                        | 0.46                         | 0.03          | n/a                     | 0.04                       | 0.22                               | 0.40                                | 0.15          | 0.14          | 0.14             | 0.80               | 31000 |
|            | 32000 | 0.33                        | 0.37                        | 0.49                         | 0.03          | n/a                     | 0.04                       | 0.24                               | 0.42                                | 0.16          | 0.14          | 0.14             | 0.85               | 32000 |
|            | 33000 | 0.35                        | 0.39                        | 0.52                         | 0.03          | n/a                     | 0.05                       | 0.25                               | 0.45                                | 0.17          | 0.15          | 0.15             | 0.90               | 33000 |
|            | 25000 | 0.21                        | 0.25                        | 0.31                         | 0.02          | n/a                     | 0.03                       | 0.15                               | 0.27                                | 0.10          | 0.09          | 0.09             | 0.55               | 25000 |
| 225        | 26000 | 0.23                        | 0.26                        | 0.33                         | 0.02          | n/a                     | 0.03                       | 0.16                               | 0.29                                | 0.11          | 0.10          | 0.10             | 0.60               | 26000 |
|            | 27000 | 0.25                        | 0.28                        | 0.35                         | 0.02          | n/a                     | 0.03                       | 0.17                               | 0.31                                | 0.12          | 0.10          | 0.10             | 0.65               | 27000 |
|            | 28000 | 0.26                        | 0.30                        | 0.38                         | 0.02          | n/a                     | 0.03                       | 0.18                               | 0.33                                | 0.13          | 0.11          | 0.11             | 0.70               | 28000 |
|            | 29000 | 0.28                        | 0.31                        | 0.41                         | 0.03          | n/a                     | 0.04                       | 0.19                               | 0.35                                | 0.13          | 0.12          | 0.12             | 0.75               | 29000 |
|            | 30000 | 0.30                        | 0.33                        | 0.43                         | 0.03          | n/a                     | 0.04                       | 0.21                               | 0.38                                | 0.14          | 0.13          | 0.13             | 0.80               | 30000 |
|            | 31000 | 0.31                        | 0.35                        | 0.46                         | 0.03          | n/a                     | 0.04                       | 0.22                               | 0.40                                | 0.15          | 0.14          | 0.14             | 0.85               | 31000 |
|            | 32000 | 0.33                        | 0.37                        | 0.49                         | 0.03          | n/a                     | 0.04                       | 0.24                               | 0.42                                | 0.16          | 0.14          | 0.14             | 0.90               | 32000 |
|            | 33000 | 0.35                        | 0.39                        | 0.52                         | 0.03          | n/a                     | 0.05                       | 0.25                               | 0.45                                | 0.17          | 0.15          | 0.15             | 0.95               | 33000 |
|            | 34000 | 0.18                        | 0.21                        | 0.23                         | 0.02          | 0.11                    | 0.02                       | 0.09                               | 0.17                                | 0.06          | 0.05          | 0.05             | 0.40               | 34000 |
| 230        | 36000 | 0.20                        | 0.23                        | 0.26                         | 0.02          | 0.12                    | 0.03                       | 0.10                               | 0.19                                | 0.06          | 0.06          | 0.06             | 0.45               | 36000 |
|            | 38000 | 0.22                        | 0.25                        | 0.28                         | 0.02          | n/a                     | 0.03                       | 0.11                               | 0.21                                | 0.07          | 0.06          | 0.06             | 0.50               | 38000 |
|            | 40000 | 0.24                        | 0.27                        | 0.31                         | 0.02          | n/a                     | 0.03                       | 0.12                               | 0.23                                | 0.08          | 0.07          | 0.07             | 0.55               | 40000 |
|            | 42000 | 0.26                        | 0.29                        | 0.34                         | 0.02          | n/a                     | 0.03                       | 0.13                               | 0.25                                | 0.09          | 0.08          | 0.08             | 0.61               | 42000 |
|            | 44000 | 0.29                        | 0.32                        | 0.38                         | 0.03          | n/a                     | 0.04                       | 0.14                               | 0.27                                | 0.09          | 0.08          | 0.08             | 0.67               | 44000 |
|            | 46000 | 0.31                        | 0.34                        | 0.41                         | 0.03          | n/a                     | 0.04                       | 0.16                               | 0.29                                | 0.10          | 0.09          | 0.09             | 0.73               | 46000 |
|            | 44000 | 0.29                        | 0.32                        | 0.38                         | 0.03          | n/a                     | 0.04                       | 0.14                               | 0.27                                | 0.09          | 0.08          | 0.08             | 0.67               | 44000 |
|            | 46000 | 0.31                        | 0.34                        | 0.41                         | 0.03          | n/a                     | 0.04                       | 0.16                               | 0.29                                | 0.10          | 0.09          | 0.09             | 0.73               | 46000 |
|            | 48000 | 0.34                        | 0.37                        | 0.44                         | 0.03          | n/a                     | 0.04                       | 0.17                               | 0.31                                | 0.11          | 0.10          | 0.10             | 0.80               | 48000 |
| 230        | 50000 | 0.36                        | 0.40                        | 0.48                         | 0.03          | n/a                     | 0.05                       | 0.18                               | 0.34                                | 0.12          | 0.11          | 0.11             | 0.86               | 50000 |
|            | 52000 | 0.39                        | 0.43                        | 0.52                         | 0.04          | n/a                     | 0.05                       | 0.20                               | 0.36                                | 0.13          | 0.12          | 0.12             | 0.92               | 52000 |
|            | 54000 | 0.42                        | 0.46                        | 0.56                         | 0.04          | n/a                     | 0.06                       | 0.21                               | 0.39                                | 0.14          | 0.13          | 0.13             | 0.98               | 54000 |
|            | 56000 | 0.45                        | 0.49                        | 0.60                         | 0.04          | n/a                     | 0.06                       | 0.23                               | 0.41                                | 0.15          | 0.14          | 0.14             | 1.04               | 56000 |
|            | 58000 | 0.48                        | 0.52                        | 0.64                         | 0.05          | n/a                     | 0.07                       | 0.25                               | 0.44                                | 0.16          | 0.14          | 0.14             | 1.10               | 58000 |
|            | 60000 | 0.51                        | 0.55                        | 0.68                         | 0.05          | n/a                     | 0.07                       | 0.26                               | 0.47                                | 0.18          | 0.16          | 0.16             | 1.16               | 60000 |

# Direct Fired Make-Up Air Units

## Blower Performance Data

Table 20.1 - Unit Performance Table ①②

| Model Size | CFM   | Total Static Pressure ("W.C.) |      |       |      |       |      |       |      |       |      |       |      |       |      |       |      |       |      |       |      |
|------------|-------|-------------------------------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|
|            |       | 0.25                          |      | 0.5   |      | 0.75  |      | 1     |      | 1.25  |      | 1.5   |      | 1.75  |      | 2     |      | 2.5   |      | 3     |      |
|            |       | BHP                           | RPM  | BHP   | RPM  | BHP   | RPM  | BHP   | RPM  | BHP   | RPM  | BHP   | RPM  | BHP   | RPM  | BHP   | RPM  | BHP   | RPM  | BHP   | RPM  |
| 110        | 1600  | 0.49                          | 882  | 0.59  | 998  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 1800  | 0.58                          | 908  | 0.69  | 1017 | 0.82  | 1119 | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 2000  | 0.69                          | 939  | 0.83  | 1042 | 1.02  | 1139 | 1.14  | 1231 | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 2200  | 0.86                          | 974  | 1.04  | 1071 | 1.16  | 1163 | 1.27  | 1250 | 1.38  | 1334 | 1.48  | 1415 | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 2400  | 1.07                          | 1012 | 1.19  | 1103 | 1.30  | 1190 | 1.41  | 1274 | 1.52  | 1355 | 1.66  | 1432 | 1.80  | 1507 | 1.95  | 1580 | -     | -    | -     | -    |
|            | 2600  | 1.22                          | 1052 | 1.34  | 1139 | 1.45  | 1222 | 1.57  | 1302 | 1.72  | 1379 | 1.86  | 1453 | 2.01  | 1526 | 2.17  | 1596 | -     | -    | -     | -    |
|            | 2800  | 1.39                          | 1095 | 1.49  | 1177 | 1.64  | 1256 | 1.79  | 1332 | 1.93  | 1406 | 2.09  | 1478 | 2.25  | 1547 | 2.42  | 1615 | 2.76  | 1746 | -     | -    |
|            | 3000  | 1.57                          | 1140 | 1.72  | 1218 | 1.87  | 1293 | 2.02  | 1366 | 2.19  | 1437 | 2.36  | 1505 | 2.53  | 1573 | 2.70  | 1638 | -     | -    | -     | -    |
| 112        | 3300  | 1.95                          | 1210 | 2.11  | 1282 | 2.28  | 1353 | 2.45  | 1421 | 2.63  | 1487 | 2.80  | 1552 | 2.98  | 1615 | -     | -    | -     | -    | -     | -    |
|            | 2000  | 0.56                          | 717  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 2500  | 0.78                          | 751  | 1.02  | 843  | 1.15  | 927  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 3000  | 1.15                          | 795  | 1.30  | 880  | 1.43  | 959  | 1.57  | 1033 | 1.74  | 1103 | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 3500  | 1.46                          | 846  | 1.64  | 925  | 1.82  | 998  | 2.00  | 1068 | 2.20  | 1134 | 2.40  | 1197 | 2.60  | 1258 | 2.81  | 1317 | -     | -    | -     | -    |
|            | 4000  | 1.92                          | 904  | 2.13  | 976  | 2.34  | 1044 | 2.56  | 1109 | 2.78  | 1172 | 2.99  | 1232 | 3.22  | 1290 | 3.44  | 1346 | 3.89  | 1452 | 4.35  | 1553 |
|            | 4500  | 2.51                          | 965  | 2.74  | 1032 | 2.98  | 1096 | 3.22  | 1157 | 3.46  | 1216 | 3.70  | 1273 | 3.94  | 1328 | 4.18  | 1381 | 4.67  | 1483 | -     | -    |
| 115        | 4700  | 2.78                          | 991  | 3.02  | 1056 | 3.27  | 1118 | 3.52  | 1177 | 3.76  | 1235 | 4.01  | 1291 | 4.26  | 1345 | 4.51  | 1397 | 4.99  | 1491 | -     | -    |
|            | 3000  | 0.78                          | 599  | 1.06  | 682  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 3500  | 1.07                          | 618  | 1.25  | 696  | 1.42  | 768  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 4000  | 1.29                          | 641  | 1.46  | 715  | 1.67  | 784  | 1.89  | 848  | 2.14  | 909  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 4500  | 1.53                          | 668  | 1.76  | 737  | 1.99  | 802  | 2.24  | 864  | 2.50  | 922  | 2.77  | 978  | 3.05  | 1031 | -     | -    | -     | -    | -     | -    |
|            | 5000  | 1.89                          | 697  | 2.13  | 763  | 2.39  | 825  | 2.66  | 883  | 2.93  | 939  | 3.22  | 993  | 3.51  | 1044 | 3.81  | 1094 | -     | -    | -     | -    |
|            | 5500  | 2.32                          | 729  | 2.59  | 791  | 2.86  | 850  | 3.14  | 906  | 3.43  | 959  | 3.73  | 1011 | 4.03  | 1061 | 4.34  | 1109 | 4.97  | 1200 | -     | -    |
|            | 6000  | 2.83                          | 762  | 3.11  | 821  | 3.40  | 877  | 3.70  | 931  | 4.00  | 982  | 4.31  | 1032 | 4.63  | 1080 | 4.95  | 1126 | -     | -    | -     | -    |
| 118        | 6500  | 3.41                          | 798  | 3.71  | 853  | 4.02  | 907  | 4.33  | 958  | 4.65  | 1007 | 4.97  | 1055 | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 3500  | 0.99                          | 510  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 4000  | 1.16                          | 519  | 1.37  | 591  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 5000  | 1.51                          | 543  | 1.80  | 610  | 2.11  | 671  | 2.43  | 728  | 2.76  | 782  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 6000  | 2.07                          | 574  | 2.43  | 636  | 2.78  | 693  | 3.15  | 747  | 3.52  | 798  | 3.89  | 847  | 4.27  | 893  | 4.65  | 938  | -     | -    | -     | -    |
|            | 7000  | 2.82                          | 611  | 3.22  | 668  | 3.62  | 721  | 4.03  | 772  | 4.44  | 820  | 4.85  | 866  | 5.27  | 910  | 5.71  | 953  | 6.59  | 1034 | -     | -    |
|            | 8000  | 3.76                          | 652  | 4.20  | 705  | 4.64  | 754  | 5.09  | 802  | 5.56  | 847  | 6.03  | 891  | 6.50  | 933  | 6.98  | 974  | 7.94  | 1051 | 8.93  | 1124 |
|            | 9000  | 4.89                          | 696  | 5.39  | 745  | 5.89  | 791  | 6.40  | 836  | 6.91  | 879  | 7.43  | 920  | 7.94  | 960  | 8.46  | 999  | 9.51  | 1073 | -     | -    |
| 120        | 10000 | 6.30                          | 743  | 6.85  | 788  | 7.40  | 831  | 7.95  | 873  | 8.50  | 914  | 9.06  | 953  | 9.62  | 991  | -     | -    | -     | -    | -     | -    |
|            | 6000  | 1.53                          | 447  | 1.89  | 503  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 7000  | 1.94                          | 466  | 2.34  | 519  | 2.76  | 568  | 3.21  | 614  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 8000  | 2.48                          | 489  | 2.90  | 538  | 3.35  | 585  | 3.82  | 628  | 4.30  | 670  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 9000  | 3.14                          | 514  | 3.59  | 560  | 4.06  | 604  | 4.55  | 646  | 5.06  | 685  | 5.60  | 724  | 6.16  | 760  | 6.74  | 796  | -     | -    | -     | -    |
|            | 10000 | 3.93                          | 542  | 4.41  | 585  | 4.90  | 626  | 5.43  | 666  | 5.97  | 704  | 6.54  | 740  | 7.13  | 775  | 7.72  | 809  | 8.97  | 874  | -     | -    |
|            | 11000 | 4.86                          | 571  | 5.37  | 612  | 5.91  | 651  | 6.47  | 688  | 7.05  | 724  | 7.64  | 759  | 8.24  | 792  | 8.86  | 825  | 10.15 | 888  | 11.52 | 947  |
|            | 12000 | 5.97                          | 602  | 6.53  | 640  | 7.10  | 677  | 7.68  | 712  | 8.28  | 747  | 8.90  | 780  | 9.52  | 812  | 10.18 | 843  | 11.53 | 904  | 12.94 | 961  |
| 122        | 13000 | 7.27                          | 634  | 7.85  | 670  | 8.45  | 705  | 9.06  | 738  | 9.69  | 771  | 10.34 | 803  | 11.01 | 834  | 11.69 | 864  | 13.09 | 922  | 14.55 | 977  |
|            | 13500 | 7.98                          | 651  | 8.58  | 686  | 9.19  | 719  | 9.82  | 752  | 10.47 | 784  | 11.14 | 815  | 11.82 | 845  | 12.51 | 875  | 13.94 | 932  | -     | -    |
|            | 8000  | 2.24                          | 426  | 2.74  | 478  | 3.27  | 528  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 9000  | 2.75                          | 442  | 3.28  | 490  | 3.83  | 537  | 4.41  | 581  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 10000 | 3.36                          | 460  | 3.91  | 506  | 4.49  | 549  | 5.09  | 590  | 5.74  | 630  | 6.41  | 669  | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 11000 | 4.06                          | 481  | 4.65  | 523  | 5.26  | 564  | 5.91  | 603  | 6.59  | 641  | 7.28  | 677  | 8.00  | 713  | -     | -    | -     | -    | -     | -    |
|            | 12000 | 4.88                          | 503  | 5.51  | 542  | 6.17  | 580  | 6.85  | 617  | 7.55  | 653  | 8.27  | 688  | 9.01  | 722  | 9.77  | 756  | 11.38 | 820  | -     | -    |
|            | 13000 | 5.84                          | 526  | 6.51  | 563  | 7.20  | 599  | 7.91  | 634  | 8.64  | 668  | 9.39  | 701  | 10.16 | 734  | 10.96 | 766  | 12.62 | 827  | 14.35 | 887  |
| 124        | 14000 | 6.95                          | 551  | 7.65  | 585  | 8.37  | 619  | 9.11  | 652  | 9.87  | 685  | 10.66 | 716  | 11.47 | 747  | 12.30 | 778  | 14.01 | 837  | 15.79 | 894  |
|            | 15000 | 8.19                          | 576  | 8.92  | 609  | 9.68  | 641  | 10.46 | 672  | 11.26 | 703  | 12.08 | 733  | 12.92 | 763  | 13.78 | 792  | 15.55 | 848  | 17.39 | 903  |
|            | 16000 | 9.58                          | 602  | 10.36 | 633  | 11.16 | 663  | 11.98 | 693  | 12.81 | 723  | 13.66 | 751  | 14.54 | 780  | 15.43 | 807  | 17.26 | 862  | 19.15 | 914  |
|            | 16500 | 10.35                         | 615  | 11.15 | 645  | 11.96 | 675  | 12.80 | 704  | 13.65 | 733  | 14.52 | 761  | 15.41 | 789  | 16.31 | 816  | 18.18 | 869  | -     | -    |
|            | 10000 | 2.63                          | 362  | 3.19  | 407  | 3.78  | 451  | 4.40  | 493  | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 12000 | 3.68                          | 384  | 4.29  | 424  | 4.92  | 462  | 5.60  | 499  | 6.32  | 535  | 7.06  | 571  | -     | -    | -     | -    | -     | -    | -     | -    |
|            | 14000 | 5.03                          | 413  | 5.72  | 447  | 6.43  | 481  | 7.17  | 514  | 7.92  | 547  | 8.71  | 579  | 9.52  | 610  | 10.36 | 640  | -     | -    | -     | -    |
|            | 16000 | 6.81                          | 444  | 7.55  | 475  | 8.31  | 505  | 9.10  | 535  | 9.91  | 565  | 10.76 | 594  | 11.63 | 622  | 12.53 | 650  | 14.37 | 705  | 16.31 | 758  |
| 124        | 18000 | 8.99                          | 478  | 9.79  | 506  | 10.63 | 534  | 11.49 | 561  | 12.37 | 587  | 13.27 | 614  | 14.20 | 640  | 15.14 | 665  | 17.09 | 716  | 19.12 | 765  |
|            | 20000 | 11.67                         | 514  | 12.55 | 540  | 13.45 | 565  | 14.37 | 589  | 15.31 | 614  | 16.27 | 638  | 17.26 | 662  | 18.26 | 685  | -     | -    | -     | -    |
|            | 21500 | 14.03                         | 542  | 14.95 | 566  | 15.91 | 589  | 16.88 | 613  | 17.86 | 635  | 18.87 | 658  | 19.89 | 681  | -     | -    | -     | -    | -     | -    |
|            |       |                               |      |       |      |       |      |       |      |       |      |       |      |       |      |       |      |       |      |       |      |

① Total static pressure should include external static pressure and accessory / option static pressure from Tables 18.1 or 19.1.

② Brake Horsepower and RPM values are approximate. Please consult the AccuSpec selection software for accurate values.

# Direct Fired Make-Up Air Units

## Blower Performance Data

Table 21.1 - Unit Performance Table ①②

| Model Size | CFM   | Total Static Pressure ("W.C.) |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |
|------------|-------|-------------------------------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
|            |       | 0.25                          |     | 0.5   |     | 0.75  |     | 1     |     | 1.25  |     | 1.5   |     | 1.75  |     | 2     |     | 2.5   |     | 3     |     |
|            |       | BHP                           | RPM | BHP   | RPM | BHP   | RPM | BHP   | RPM | BHP   | RPM | BHP   | RPM | BHP   | RPM | BHP   | RPM | BHP   | RPM | BHP   | RPM |
| 125        | 10000 | 2.45                          | 356 | 3.08  | 404 | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   |
|            | 12000 | 3.30                          | 373 | 3.97  | 416 | 4.67  | 457 | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 14000 | 4.40                          | 395 | 5.11  | 434 | 5.88  | 471 | 6.70  | 507 | 7.55  | 541 | 8.43  | 575 | -     | -   | -     | -   | -     | -   | -     |     |
|            | 16000 | 5.80                          | 420 | 6.59  | 455 | 7.41  | 489 | 8.27  | 522 | 9.16  | 554 | 10.08 | 585 | 11.06 | 615 | 12.06 | 645 | -     | -   | -     |     |
|            | 18000 | 7.55                          | 448 | 8.40  | 480 | 9.27  | 511 | 10.18 | 541 | 11.13 | 571 | 12.11 | 600 | 13.13 | 628 | 14.17 | 656 | 16.36 | 709 | -     |     |
|            | 20000 | 9.67                          | 478 | 10.58 | 507 | 11.53 | 536 | 12.50 | 564 | 13.50 | 591 | 14.53 | 618 | 15.60 | 645 | 16.69 | 670 | 18.96 | 721 | -     |     |
|            | 21500 | 11.55                         | 501 | 12.51 | 529 | 13.49 | 556 | 14.51 | 582 | 15.56 | 608 | 16.63 | 634 | 17.73 | 659 | 18.86 | 684 | -     | -   | -     |     |
| 127        | 12000 | 2.69                          | 315 | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 14000 | 3.48                          | 327 | 4.17  | 366 | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 16000 | 4.45                          | 341 | 5.19  | 378 | 5.99  | 412 | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 18000 | 5.65                          | 358 | 6.47  | 392 | 7.32  | 424 | 8.20  | 455 | 9.11  | 485 | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 20000 | 7.12                          | 377 | 7.99  | 408 | 8.89  | 438 | 9.82  | 467 | 10.79 | 495 | 11.80 | 522 | 12.83 | 548 | -     | -   | -     | -   | -     |     |
|            | 22000 | 8.84                          | 397 | 9.77  | 426 | 10.74 | 454 | 11.74 | 481 | 12.77 | 508 | 13.82 | 533 | 14.90 | 558 | 16.01 | 583 | -     | -   | -     |     |
|            | 24000 | 10.87                         | 418 | 11.87 | 445 | 12.90 | 472 | 13.96 | 497 | 15.04 | 522 | 16.15 | 546 | 17.28 | 570 | 18.44 | 593 | -     | -   | -     |     |
| 130        | 26000 | 13.23                         | 441 | 14.30 | 466 | 15.39 | 491 | 16.51 | 515 | 17.65 | 538 | 18.81 | 561 | 20.00 | 584 | -     | -   | -     | -   | -     |     |
|            | 14000 | 3.23                          | 292 | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 16000 | 3.98                          | 300 | 4.85  | 338 | 5.82  | 374 | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 18000 | 4.88                          | 310 | 5.81  | 345 | 6.83  | 379 | 7.90  | 412 | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 20000 | 5.99                          | 323 | 6.98  | 355 | 8.02  | 387 | 9.12  | 417 | 10.29 | 446 | 11.52 | 475 | -     | -   | -     | -   | -     | -   | -     |     |
|            | 22000 | 7.30                          | 337 | 8.33  | 367 | 9.42  | 396 | 10.57 | 425 | 11.78 | 452 | 13.05 | 479 | 14.37 | 505 | -     | -   | -     | -   | -     |     |
|            | 24000 | 8.83                          | 352 | 9.91  | 380 | 11.06 | 407 | 12.26 | 434 | 13.51 | 460 | 14.82 | 486 | 16.17 | 511 | 17.57 | 535 | -     | -   | -     |     |
| 220        | 26000 | 10.60                         | 368 | 11.75 | 394 | 12.95 | 420 | 14.20 | 445 | 15.50 | 470 | 16.84 | 561 | 18.23 | 518 | 19.67 | 541 | 22.69 | 586 | -     |     |
|            | 28000 | 12.65                         | 384 | 13.85 | 409 | 15.10 | 434 | 16.40 | 457 | 17.75 | 481 | 19.13 | 504 | 20.57 | 526 | 22.05 | 548 | -     | -   | -     |     |
|            | 30000 | 14.96                         | 402 | 16.23 | 425 | 17.54 | 448 | 18.88 | 471 | 20.28 | 493 | 21.72 | 515 | 23.20 | 536 | 24.72 | 557 | -     | -   | -     |     |
|            | 18000 | 6.18                          | 516 | 7.08  | 562 | 8.02  | 606 | 8.98  | 648 | 9.98  | 688 | 11.03 | 726 | 12.10 | 763 | -     | -   | -     | -   | -     |     |
|            | 19000 | 6.94                          | 530 | 7.87  | 574 | 8.84  | 617 | 9.83  | 657 | 10.87 | 696 | 11.95 | 734 | 13.05 | 770 | 14.18 | 805 | -     | -   | -     |     |
|            | 20000 | 7.76                          | 545 | 8.73  | 587 | 9.72  | 628 | 10.76 | 668 | 11.84 | 706 | 12.94 | 742 | 14.07 | 778 | 15.22 | 812 | -     | -   | -     |     |
|            | 21000 | 8.66                          | 559 | 9.66  | 601 | 10.70 | 640 | 11.77 | 679 | 12.87 | 716 | 14.00 | 751 | 15.16 | 786 | 16.35 | 820 | 18.80 | 884 | -     |     |
| 222        | 22000 | 9.63                          | 575 | 10.67 | 615 | 11.75 | 653 | 12.85 | 690 | 13.99 | 726 | 15.15 | 761 | 16.34 | 795 | 17.55 | 828 | -     | -   | -     |     |
|            | 23000 | 10.69                         | 590 | 11.77 | 629 | 12.88 | 666 | 14.02 | 702 | 15.18 | 737 | 16.38 | 771 | 17.60 | 804 | 18.84 | 836 | -     | -   | -     |     |
|            | 24000 | 11.84                         | 606 | 12.96 | 644 | 14.10 | 680 | 15.27 | 715 | 16.47 | 749 | 17.69 | 782 | 18.94 | 814 | -     | -   | -     | -   | -     |     |
|            | 25000 | 13.08                         | 622 | 14.23 | 659 | 15.40 | 694 | 16.61 | 728 | 17.84 | 761 | 19.09 | 794 | -     | -   | -     | -   | -     | -   | -     |     |
|            | 26000 | 14.41                         | 639 | 15.59 | 674 | 16.80 | 708 | 18.04 | 742 | 19.30 | 774 | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 27000 | 15.83                         | 656 | 17.05 | 690 | 18.29 | 723 | 19.56 | 755 | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 25000 | 10.64                         | 518 | 11.92 | 556 | 13.25 | 593 | 14.64 | 628 | 16.07 | 663 | 17.56 | 697 | 19.08 | 729 | 20.66 | 761 | 23.95 | 823 | -     |     |
| 225        | 26000 | 11.64                         | 530 | 12.95 | 567 | 14.32 | 602 | 15.74 | 637 | 17.20 | 671 | 18.71 | 704 | 20.27 | 736 | 21.87 | 767 | 25.20 | 828 | 26.93 |     |
|            | 27000 | 12.71                         | 542 | 14.06 | 578 | 15.46 | 613 | 16.90 | 646 | 18.40 | 679 | 19.93 | 711 | 21.53 | 743 | 23.15 | 773 | 26.53 | 833 | 28.29 |     |
|            | 28000 | 13.85                         | 555 | 15.23 | 589 | 16.66 | 623 | 18.14 | 656 | 19.66 | 688 | 21.24 | 719 | 22.86 | 750 | 24.51 | 780 | 27.94 | 838 | 29.72 |     |
|            | 29000 | 15.06                         | 567 | 16.48 | 601 | 17.95 | 634 | 19.45 | 666 | 21.02 | 697 | 22.62 | 728 | 24.26 | 758 | 25.94 | 787 | 29.43 | 844 | -     |     |
|            | 30000 | 16.35                         | 580 | 17.81 | 613 | 19.30 | 645 | 20.86 | 676 | 22.44 | 707 | 24.08 | 737 | 25.74 | 766 | 27.46 | 795 | -     | -   | -     |     |
|            | 31000 | 17.72                         | 593 | 19.21 | 625 | 20.75 | 656 | 22.33 | 687 | 23.95 | 717 | 25.61 | 746 | 27.31 | 774 | 29.05 | 803 | -     | -   | -     |     |
|            | 32000 | 19.17                         | 606 | 20.71 | 637 | 22.28 | 668 | 23.89 | 698 | 25.53 | 727 | 27.23 | 755 | 28.97 | 783 | -     | -   | -     | -   | -     |     |
| 225        | 33000 | 20.72                         | 620 | 22.28 | 650 | 23.88 | 680 | 25.52 | 709 | 27.21 | 737 | 28.94 | 765 | -     | -   | -     | -   | -     | -   | -     |     |
|            | 30000 | 10.05                         | 411 | 11.57 | 448 | 13.17 | 483 | 14.84 | 516 | 16.59 | 547 | 18.42 | 577 | 20.32 | 606 | -     | -   | -     | -   | -     |     |
|            | 32000 | 11.54                         | 424 | 13.12 | 460 | 14.77 | 493 | 16.50 | 525 | 18.29 | 556 | 20.17 | 585 | 22.11 | 613 | 24.12 | 641 | -     | -   | -     |     |
|            | 34000 | 13.20                         | 438 | 14.83 | 472 | 16.55 | 504 | 18.32 | 535 | 20.18 | 565 | 22.10 | 594 | 24.08 | 621 | 26.13 | 648 | -     | -   | -     |     |
|            | 36000 | 15.04                         | 452 | 16.74 | 485 | 18.50 | 516 | 20.34 | 546 | 22.24 | 575 | 24.21 | 603 | 26.24 | 630 | 28.34 | 656 | 32.73 | 706 | -     |     |
|            | 38000 | 17.07                         | 466 | 18.82 | 498 | 20.65 | 528 | 22.55 | 557 | 24.50 | 586 | 26.52 | 613 | 28.60 | 639 | 30.74 | 664 | 35.24 | 713 | 37.58 |     |
|            | 40000 | 19.29                         | 481 | 21.12 | 512 | 23.00 | 541 | 24.95 | 569 | 26.96 | 597 | 29.04 | 623 | 31.17 | 649 | 33.38 | 673 | 37.97 | 721 | -     |     |
| 230        | 42000 | 21.73                         | 497 | 23.61 | 526 | 25.56 | 554 | 27.57 | 582 | 29.64 | 608 | 31.78 | 634 | 33.98 | 659 | 36.24 | 683 | -     | -   | -     |     |
|            | 44000 | 24.37                         | 512 | 26.32 | 541 | 28.34 | 568 | 30.40 | 595 | 32.55 | 620 | 34.75 | 645 | 37.01 | 670 | 39.32 | 693 | -     | -   | -     |     |
|            | 46000 | 27.25                         | 528 | 29.27 | 555 | 31.35 | 582 | 33.50 | 608 | 35.70 | 633 | 37.96 | 657 | -     | -   | -     | -   | -     | -   | -     |     |
|            | 36000 | 9.71                          | 312 | 11.56 | 347 | 13.50 | 381 | 15.53 | 414 | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 38000 | 10.78                         | 318 | 12.68 | 352 | 14.67 | 385 | 16.76 | 416 | -     | -   | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 40000 | 11.94                         | 325 | 13.90 | 357 | 15.95 | 389 | 18.09 | 419 | 20.32 | 449 | -     | -   | -     | -   | -     | -   | -     | -   | -     |     |
|            | 42000 | 13.20                         | 332 | 15.22 | 363 | 17.33 | 393 | 19.52 | 423 | 21.81 | 451 | 24.17 | 479 | -     | -   | -     | -   | -     | -   | -     |     |
|            | 44000 | 14.56                         | 339 | 16.64 | 369 | 18.81 | 398 | 21.07 | 427 | 23.40 | 455 | 25.81 | 482 | 28.30 | 508 | -     | -   | -     | -   | -     |     |
|            | 46000 | 16.03                         | 346 | 18.17 | 375 | 20.40 | 404 | 22.72 | 431 | 25.10 | 458 | 27.57 | 485 | 30.11 | 510 | -     | -   | -     | -   | -     |     |
|            | 48000 | 17.62                         | 354 | 19.82 | 382 | 22.12 | 410 | 24.48 | 436 | 26.92 | 462 | 29.50 | 488 | 32.05 | 513 | 34.74 | 538 | -     | -   | -     |     |
|            | 50000 | 19.32                         | 362 | 21.59 | 389 | 23.94 | 416 | 26.37 | 442 | 28.87 | 467 | 31.45 | 492 | 34.12 | 516 | 36.86 | 540 | -     | -   | -     |     |

# Direct Fired Make-Up Air Units

## Manifold Arrangements

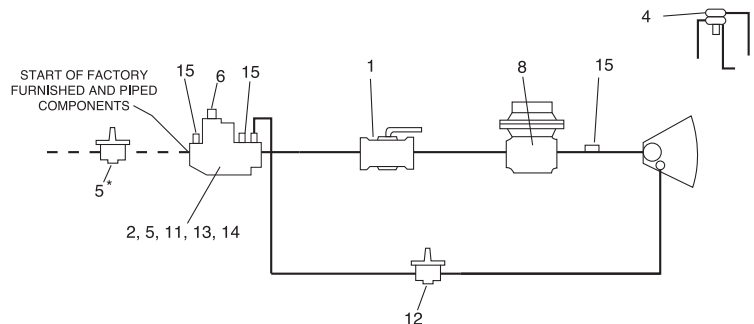
### Component Listing

- 1 Auxiliary Gas Shut-Off Valve
- 2 Combination Main Gas Valve
- 3 High and Low Gas Pressure Switch
- 4 Main Air Flow Proving Switch
- 5 Main Gas Pressure Regulator
- 6 Main Gas Shut-Off Valve
- 7 Main Gas Valve
- 8 Modulating Valve
- 9 Motorized Main Gas Valve
- 10 N/A
- 11 Orificed Pilot Needle Valve
- 12 Pilot Gas Pressure Regulator
- 13 Pilot Gas Shut-Off Valve
- 14 Pilot Gas Valve
- 15 Plugged Test Port
- 16 Redundant Main Gas Valve

The manifold arrangements shown are typical and may not match the unit selected. Refer to AccuSpec for actual arrangement.

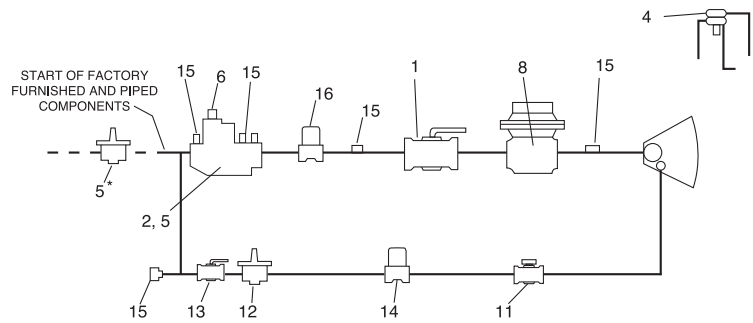
**Figure 22.1 - Typical Manifold Component Arrangements**

#### Standard, IRI, & FM Arrangement - Up to 400,000 Btu/Hr



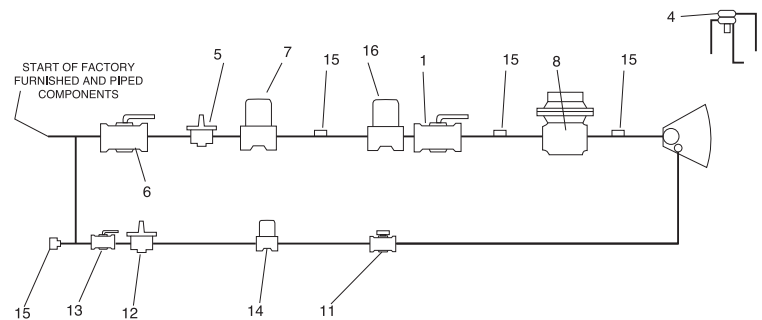
\* Required and field installed when gas pressure exceeds 14" wc (1/2 psi)

#### Standard, IRI, & FM Arrangement - Over 400,000 Btu/h and up to 720,000 Btu/Hr

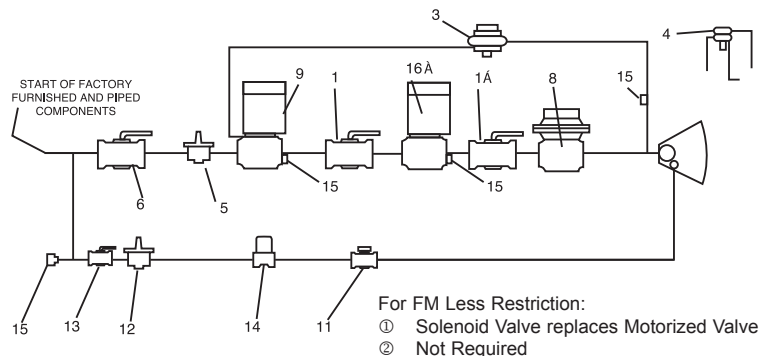


\* Required and field installed when gas pressure exceeds 14" wc (1/2 psi)

#### Standard & IRI Arrangement - Over 720,000 Btu/Hr FM (Less & With Restriction) - Up to 2,500,000 Btu/Hr



#### FM (Less & With Restriction) - Over 2,500,000 BTU/HR



**Table 22.1 - Field Gas Supply Connections**

| MBH<br>Digit 9-12 | Natural                  |                        | Propane                   |                        |
|-------------------|--------------------------|------------------------|---------------------------|------------------------|
|                   | 8-14" W.C.<br>Digit 13=A | 1-5 psig<br>Digit 13=B | 11-14" W.C.<br>Digit 13=C | 1-5 psig<br>Digit 13=D |
| 275-400           | 3/4"                     | n/a                    | 3/4"                      | n/a                    |
| 550-720           | 1"                       | n/a                    | 1"                        | n/a                    |
| 825               | 1-1/4"                   | 1"                     | 1"                        | 3/4"                   |
| 1000              | 1-1/4"                   | 1"                     | 1"                        | 1"                     |
| 1100              | 1-1/4"                   | 1-1/4"                 | 1-1/4"                    | 1"                     |
| 1375              | 1-1/2"                   | 1-1/4"                 | 1-1/4"                    | 1"                     |
| 1650              | 2"                       | 1-1/4"                 | 1-1/2"                    | 1-1/4"                 |
| 1925-2200         | 2"                       | 1-1/2"                 | 2"                        | 1-1/4"                 |
| 2475              | 2-1/2"                   | 1-1/2"                 | 2"                        | 1-1/4"                 |
| 2750-3575         | 2-1/2"                   | 2"                     | 2"                        | 1-1/2"                 |
| 3850-4950         | n/a                      | 2"                     | n/a                       | 2"                     |
| 5225-7425         | n/a                      | 2-1/2"                 | n/a                       | n/a                    |

## Unit and Accessory Weights

Figure 23.1 - Unit and Accessories

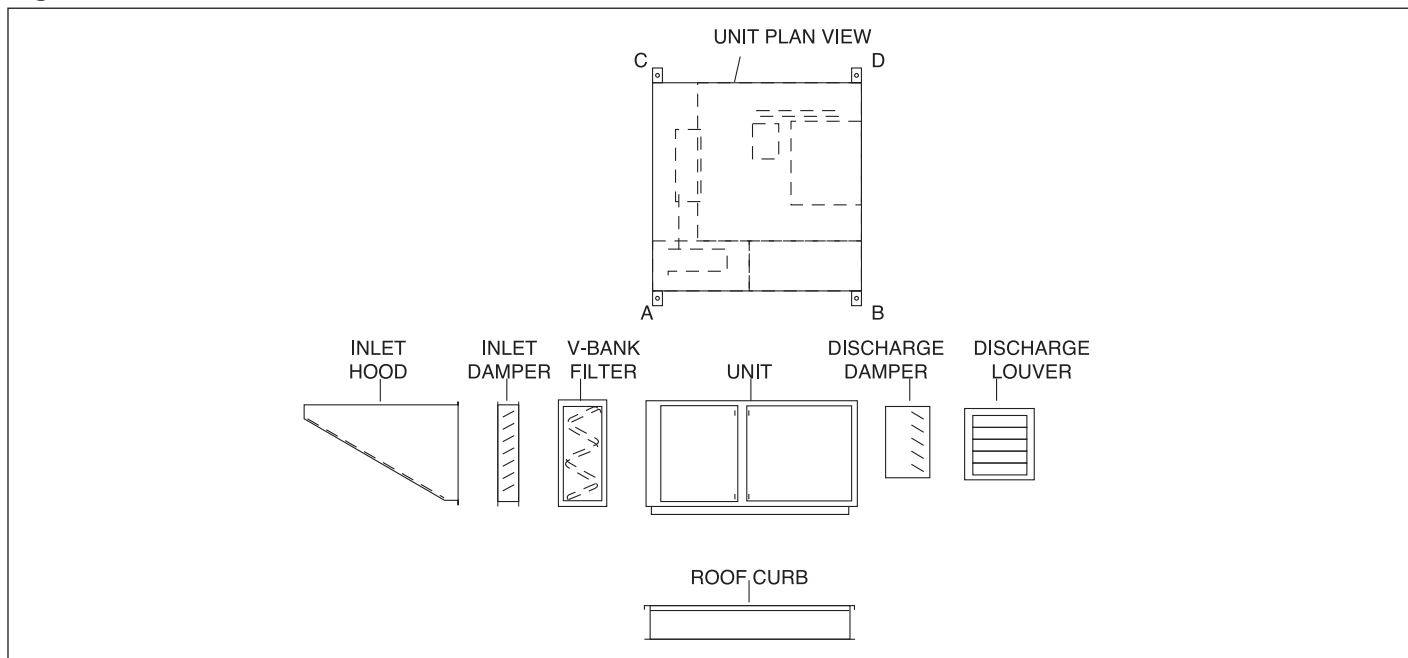


Table 23.1 - Unit Weights (all weight in pounds)

| Model Type          | Digit 7 | Digit 19 | 110 | 112 | 115 | 118 | 120  | 122  | 124  | 125  | 127  | 130  | 220  | 222  | 225  | 230  |
|---------------------|---------|----------|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|
| MDB                 | A-F     | A or B   | 440 | 500 | 800 | 850 | 1200 | 1275 | 1300 | 1655 | 1725 | 1805 | 1850 | 2050 | 2620 | 2795 |
|                     |         | C        | 475 | 535 | 850 | 900 | 1260 | 1335 | n/a  | 1730 | 1800 | 1880 | 2100 | 2300 | 2895 | 3070 |
|                     | G-J     | A or B   | 480 | 540 | 850 | 900 | 1350 | 1425 | n/a  | 1905 | 1975 | 2055 | n/a  | n/a  | n/a  | n/a  |
| MRB                 | A-F     | A or B   | 555 | 615 | 885 | 935 | 1345 | 1420 | n/a  | 1880 | 1950 | 2030 | 2070 | 2270 | 2925 | 3100 |
|                     |         | C        | 590 | 650 | 935 | 985 | 1405 | 1480 | n/a  | 1955 | 2025 | 2105 | 2320 | 2520 | 3200 | 3375 |
| Weight Distribution |         | A        | 125 | 140 | 220 | 235 | 325  | 345  | 350  | 445  | 465  | 490  | 510  | 570  | 725  | 780  |
|                     |         | B        | 100 | 120 | 200 | 210 | 300  | 315  | 325  | 400  | 415  | 430  | 395  | 435  | 610  | 645  |
|                     |         | C        | 90  | 100 | 160 | 170 | 250  | 265  | 270  | 365  | 380  | 395  | 435  | 475  | 560  | 590  |
|                     |         | D        | 125 | 140 | 220 | 235 | 325  | 345  | 350  | 445  | 465  | 490  | 510  | 570  | 725  | 780  |

Table 23.2 - Accessory Weights (all weight in pounds)

| Accessory                          | Model Size |          |               |               |          |          |
|------------------------------------|------------|----------|---------------|---------------|----------|----------|
|                                    | 110, 112   | 115, 118 | 120, 122, 124 | 125, 127, 130 | 220, 222 | 225, 230 |
| Inlet Hood                         | 80         | 125      | 165           | 220           | 235      | 385      |
| Inlet Damper                       | 70         | 95       | 170           | 230           | 260      | 380      |
| V-Bank Filter Section              | 120        | 160      | 245           | 325           | 365      | 505      |
| Discharge Damper                   | 60         | 80       | 95            | 135           | 210      | 285      |
| Discharge Louver                   | 80         | 95       | 115           | 150           | 225      | 310      |
| 14" Roof Curb                      | 115        | 140      | 220           | 240           | 285      | 315      |
| 24" Roof Curb                      | 180        | 215      | 375           | 410           | 485      | 540      |
| 24" High Vertical Unit Inlet Stand | 55         | 70       | 180           | 225           | -        | -        |
| 48" High Vertical Unit Inlet Stand | 75         | 90       | 220           | 265           | -        | -        |

Table 23.3a - Approximate Motor Weights (all weight in pounds)

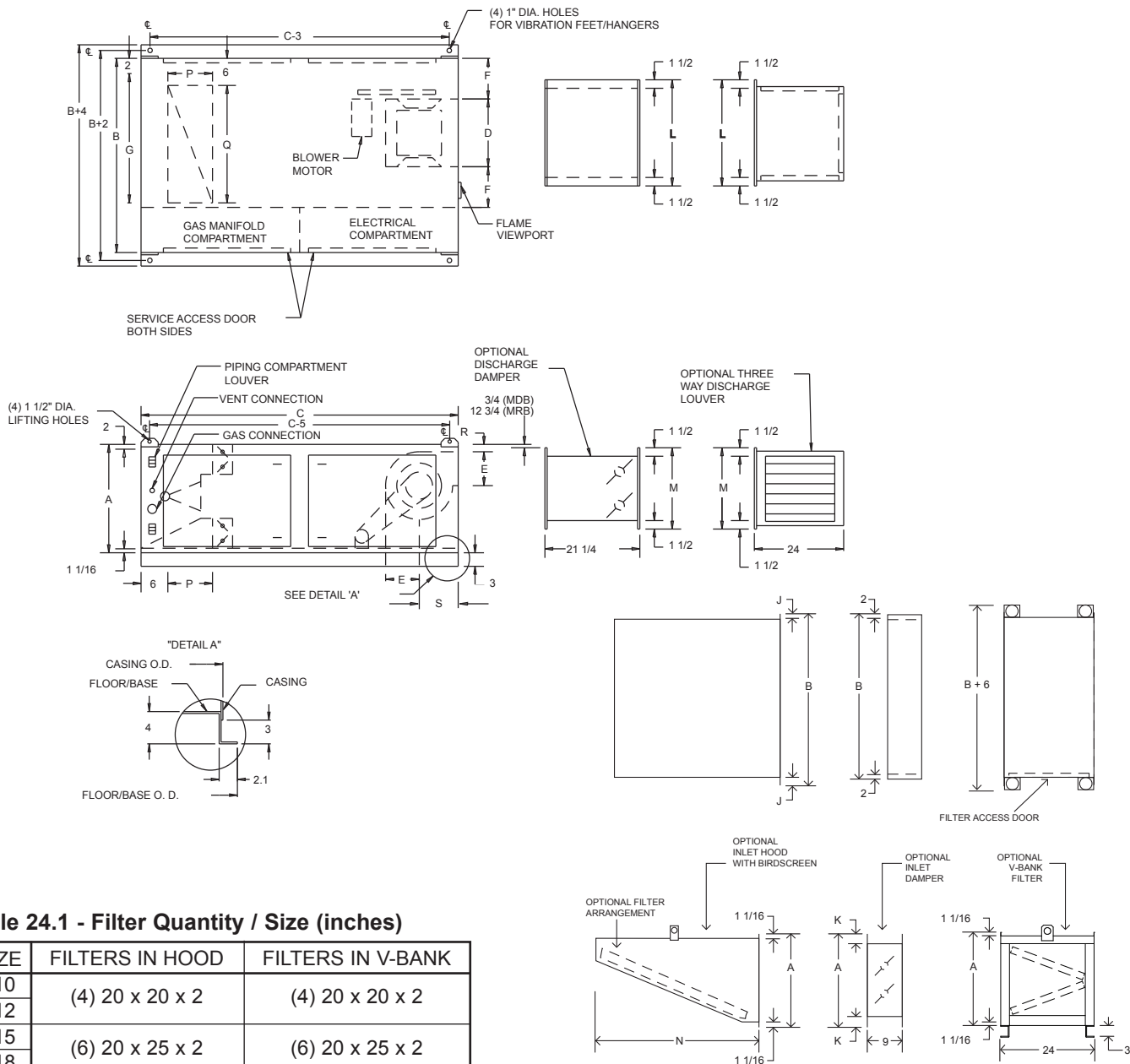
| HP         | 3/4 |    | 1   |    | 1-1/2 |    | 2   |    | 3   |    | 5   |     | 7-1/2 |     |
|------------|-----|----|-----|----|-------|----|-----|----|-----|----|-----|-----|-------|-----|
| Motor Type | ODP | TE | ODP | TE | ODP   | TE | ODP | TE | ODP | TE | ODP | TE  | ODP   | TE  |
| Weight     | 25  | 25 | 40  | 40 | 40    | 45 | 50  | 50 | 78  | 80 | 90  | 100 | 150   | 145 |

Table 23.3b - Approximate Motor Weights (all weight in pounds)

| HP         | 10  |     | 15  |     | 20  |     | 25  |     | 30  |     | 40  |     | 50  |     |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Motor Type | ODP | TE  | ODP | TE  | ODP | TE  | ODP | TE  | ODP | TE  | ODP | TE  | ODP | TE  |
| Weight     | 220 | 160 | 310 | 240 | 360 | 250 | 425 | 500 | 485 | 525 | 580 | 510 | 710 | 775 |

# Direct Fired Make-Up Air Units

## Dimensions - MDB/MRB 110-118 Units



**Table 24.1 - Filter Quantity / Size (inches)**

| SIZE | FILTERS IN HOOD | FILTERS IN V-BANK |
|------|-----------------|-------------------|
| 110  | (4) 20 x 20 x 2 | (4) 20 x 20 x 2   |
| 112  | (4) 20 x 20 x 2 | (4) 20 x 20 x 2   |
| 115  | (6) 20 x 25 x 2 | (6) 20 x 25 x 2   |
| 118  | (6) 20 x 25 x 2 | (6) 20 x 25 x 2   |

**Table 24.2 - MDB/MRB Unit Dimensions (All dimensions in inches)**

| SIZE | A       | B  | C  | D      | E       | F      | G  | H     | J     | K             | L      | M      | N      | P  | Q  | R      | S       |
|------|---------|----|----|--------|---------|--------|----|-------|-------|---------------|--------|--------|--------|----|----|--------|---------|
| 110  | 24/36 ① | 43 | 71 | 13 1/4 | 11 1/2  | 9 7/8  | 30 | 1 1/8 | 1 1/2 | 3/4 / 1 1/4 ③ | 21     | 20     | 38 1/2 | 10 | 26 | 2 1/4  | 6 1/4   |
| 112  | 24/36 ① | 43 | 71 | 15 3/4 | 13 9/16 | 8 5/8  | 30 | 1 1/8 | 1 1/2 | 3/4 / 1 1/4 ③ | 21     | 20     | 38 1/2 | 10 | 26 | 14 1/4 | 7 3/16  |
| 115  | 36      | 52 | 82 | 18 3/4 | 16      | 11 5/8 | 39 | 7/8   | 1     | 1 1/4         | 26 1/2 | 25 1/2 | 54 3/8 | 12 | 35 | 2 1/4  | 8 5/8   |
| 118  | 36      | 52 | 82 | 22     | 19      | 10     | 39 | 7/8   | 1     | 1 1/4         | 26 1/2 | 25 1/2 | 54 3/8 | 12 | 35 | 2 1/4  | 10 9/16 |

Note: All accessories shipped completely assembled for easy installation. Some accessories shipped separately. All data subject to change.  
All dimensions subject to manufacturing tolerances.

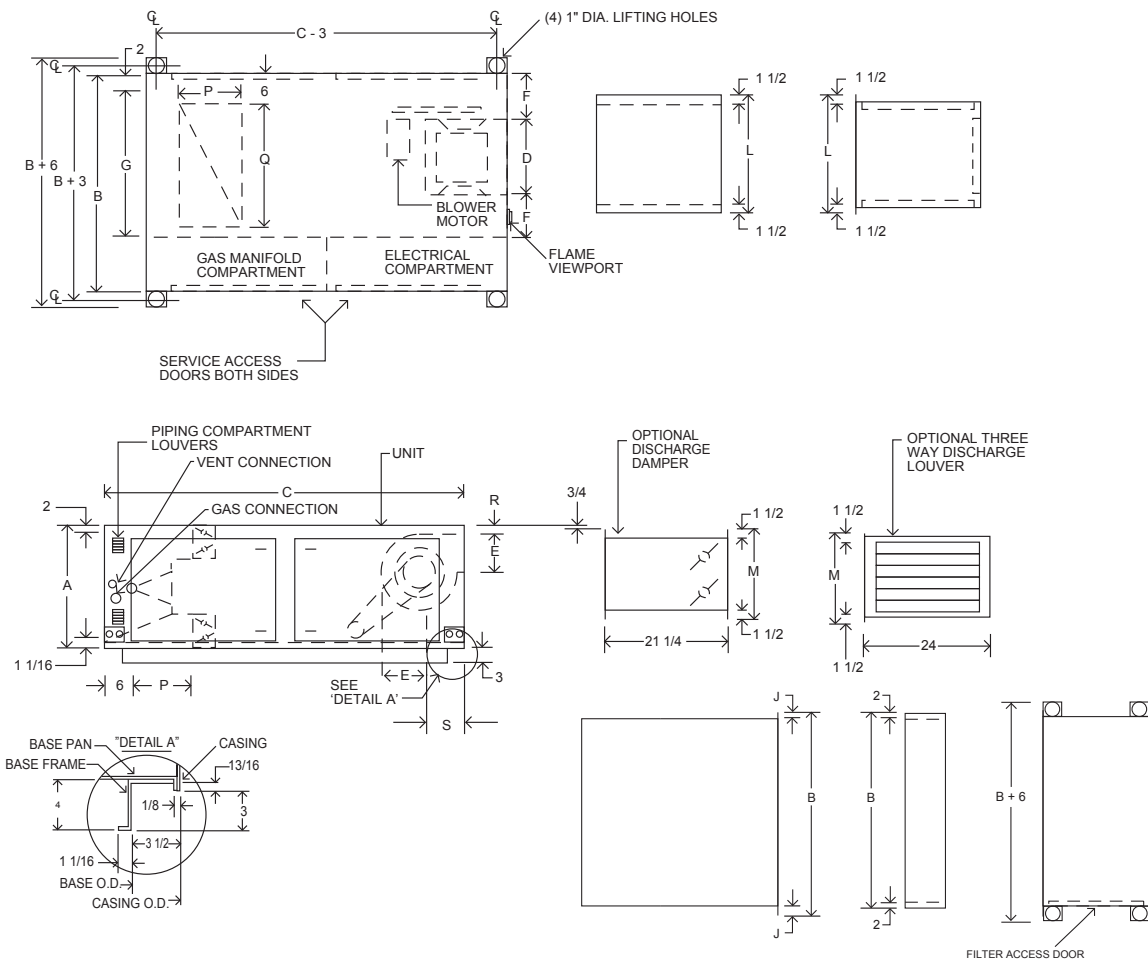
① 24" for MDB models, 36" for MRB models.

② 2 1/4" for MDB models, 14 1/4" for MRB models.

③ 3/4" for MDB models, 1 1/4" for MRB models.

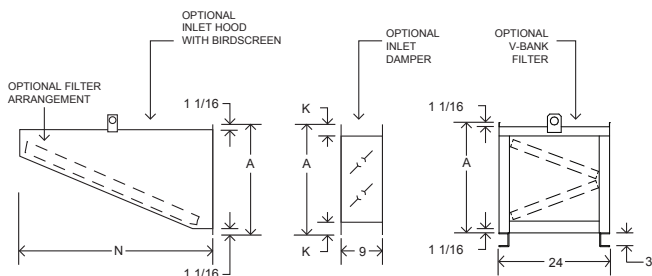
# Direct Fired Make-Up Air Units

## Dimensions - MDB/MRB 120-130 Units



**Table 25.1 - Filter Quantity / Size (inches)**

| Model Size | Filter Location                    |                                      |
|------------|------------------------------------|--------------------------------------|
|            | Inlet Hood                         | V-Bank Section                       |
| 120        | (9) 20 x 25 x 2                    | (12) 20 x 25 x 2                     |
| 122        |                                    |                                      |
| 124        |                                    |                                      |
| 125        | (6) 20 x 25 x 2<br>(9) 16 x 25 x 2 | (10) 20 x 20 x 2<br>(10) 20 x 25 x 2 |
| 127        |                                    |                                      |
| 130        |                                    |                                      |



**Table 25.2 - MDB / MRB Unit Dimensions (All dimensions in inches)**

| Model Size | A  | B  | C   | D      | E      | F        | G  | H      | J     | K     | L      | M  | N      | P  | Q  | R     | S      |
|------------|----|----|-----|--------|--------|----------|----|--------|-------|-------|--------|----|--------|----|----|-------|--------|
| 120        | 48 | 78 | 96  | 24 7/8 | 24 7/8 | 18 9/16  | 59 | 1 5/16 | 1 1/2 | 1 3/4 | 31 1/2 | 31 | 45 3/8 | 14 | 55 | 2 1/4 | 11 1/4 |
| 122        | 48 | 78 | 96  | 27 3/8 | 27 3/8 | 17 5/16  | 59 | 1 5/16 | 1 1/2 | 1 3/4 | 31 1/2 | 31 | 45 3/8 | 14 | 55 | 2 1/4 | 12 1/4 |
| 124        | 48 | 78 | 96  | 28 3/8 | 31 3/8 | 16 13/16 | 59 | 1 5/16 | 1 1/2 | 1 3/4 | 31 1/2 | 31 | 45 3/8 | 14 | 55 | 2 1/4 | 13 1/4 |
| 125        | 60 | 92 | 110 | 31 3/8 | 31 3/8 | 22 5/16  | 73 | 1 1/16 | 1     | 2 1/4 | 41 1/2 | 42 | 56     | 20 | 69 | 2 1/4 | 13 1/4 |
| 127        | 60 | 92 | 110 | 34 3/8 | 34 3/8 | 20 13/16 | 73 | 1 1/16 | 1     | 2 1/4 | 41 1/2 | 42 | 56     | 20 | 69 | 2 1/4 | 15 1/4 |
| 130        | 60 | 92 | 110 | 36 7/8 | 36 7/8 | 19 9/16  | 73 | 1 1/16 | 1     | 2 1/4 | 41 1/2 | 42 | 56     | 20 | 69 | 2 1/4 | 16 1/4 |

Note: All accessories shipped completely assembled for easy installation. Some accessories shipped separately. All data subject to change.  
All dimensions subject to manufacturing tolerances.

MATERIAL GAUGES: Unit Casing: 18 gauge galvanized. • Unit Channel Base: (120-130) 12 gauge galvanized.  
Rain Hood: 18 gauge galvanized. • V-Bank: 14 and 18 gauge galvanized. • Damper Blades: 18 gauge galvanized.  
Damper Frame: 14 gauge galvanized. • Discharge Louvers: 14 and 18 gauge galvanized.

# Direct Fired Make-Up Air Units

## Dimensions - MDB/MRB 220-230 Units

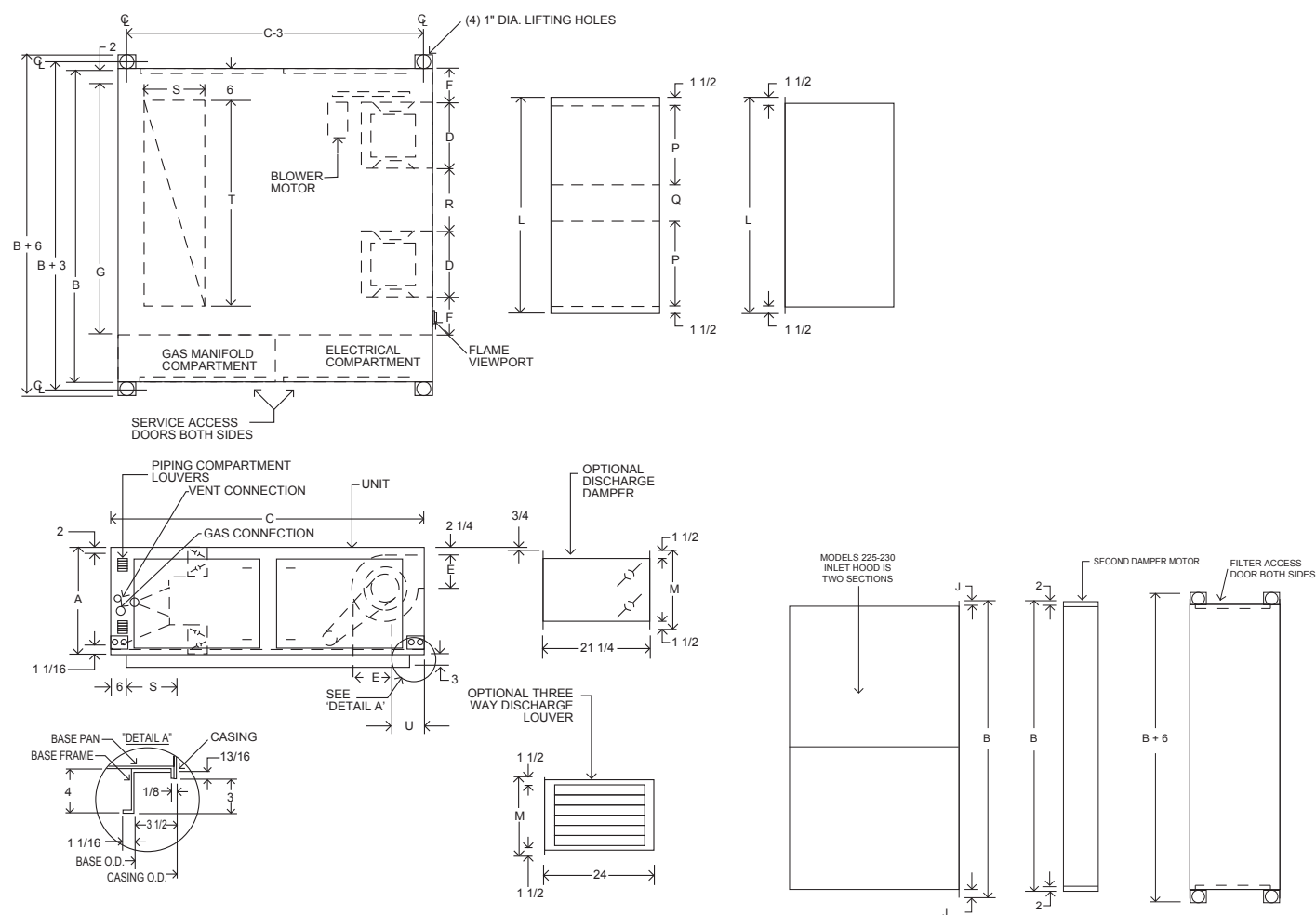


Table 26.1 - Filter Quantity / Size (inches)

| Model Size | Filter Location  |                  |
|------------|------------------|------------------|
|            | Inlet Hood       | V-Bank Section   |
| 220        | (15) 20 x 25 x 2 | (20) 20 x 25 x 2 |
| 222        |                  |                  |
| 225        | (6) 16 x 25 x 2  | (36) 20 x 20 x 2 |
| 230        | (18) 20 x 25 x 2 |                  |

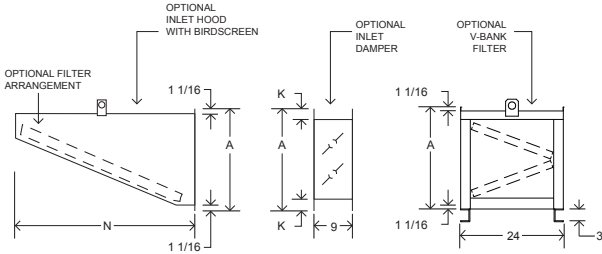
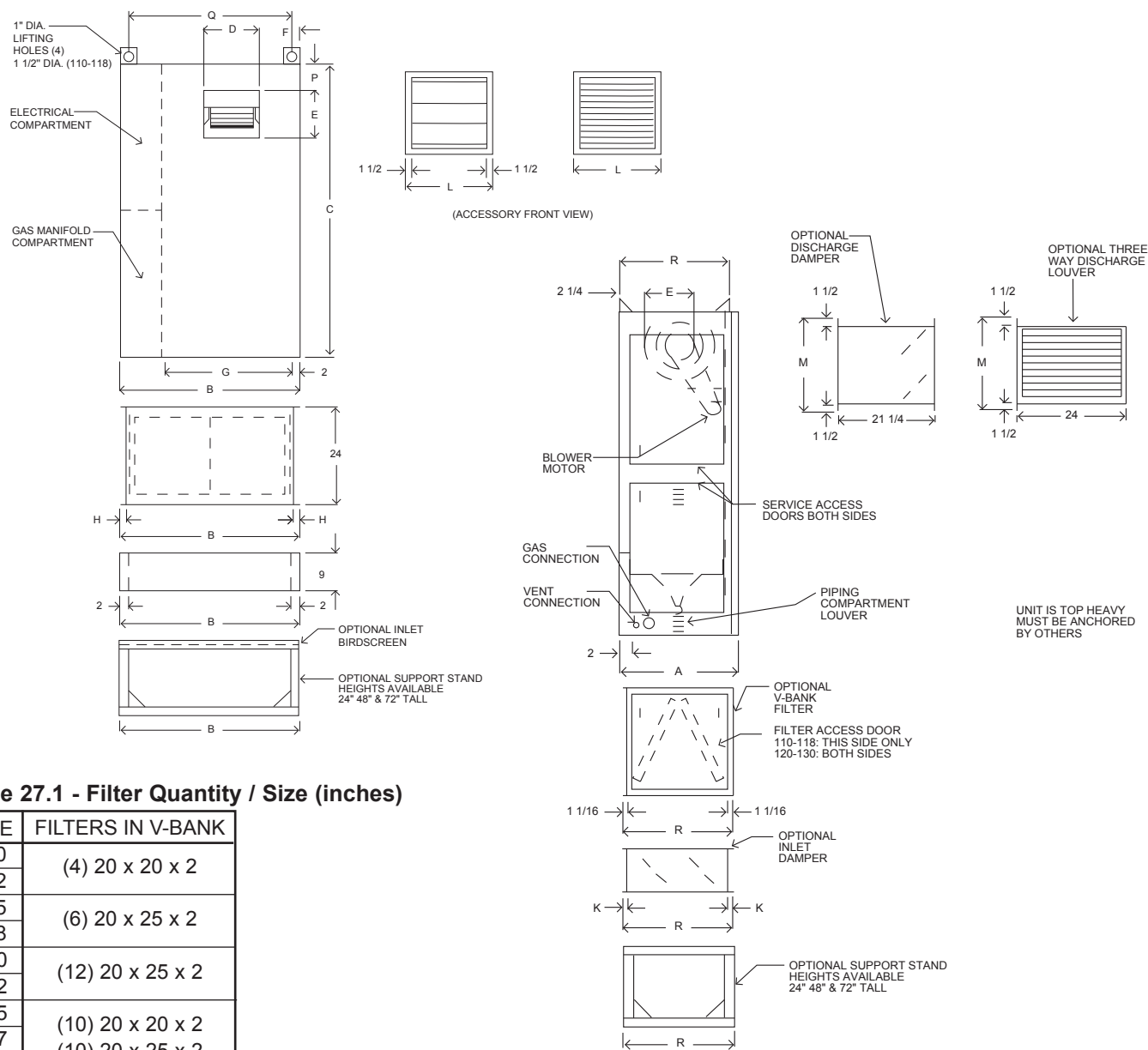


Table 26.2 - MDB / MRB Unit Dimensions (All dimensions in inches)

| Model Size | A  | B   | C   | D      | E      | F        | G   | H       | J     | K     | L   | M  | N      | P      | Q  | R      | S  | T   | U      |
|------------|----|-----|-----|--------|--------|----------|-----|---------|-------|-------|-----|----|--------|--------|----|--------|----|-----|--------|
| 220        | 48 | 130 | 96  | 24 7/8 | 24 7/8 | 16 1/16  | 111 | 2 11/16 | 2 1/2 | 1 3/4 | 88  | 31 | 45 3/8 | 28 1/2 | 28 | 32 1/8 | 14 | 107 | 11 1/4 |
| 222        | 48 | 130 | 96  | 27 3/8 | 27 3/8 | 14 13/16 | 111 | 2 11/16 | 2 1/2 | 1 3/4 | 88  | 31 | 45 3/8 | 28 1/2 | 28 | 29 5/8 | 14 | 107 | 12 1/4 |
| 225        | 60 | 154 | 110 | 31 3/8 | 31 3/8 | 18 13/16 | 135 | 2 3/8   | 2     | 2 1/4 | 110 | 42 | 56     | 38 1/2 | 30 | 37 5/8 | 20 | 131 | 13 1/2 |
| 230        | 60 | 154 | 110 | 36 7/8 | 36 7/8 | 16 1/16  | 135 | 2 3/8   | 2     | 2 1/4 | 110 | 42 | 56     | 38 1/2 | 30 | 32 1/8 | 20 | 131 | 16 3/4 |

Note: All accessories shipped completely assembled for easy installation. Some accessories shipped separately. All data subject to change.  
All dimensions subject to manufacturing tolerances.

## Dimensions - MDB 110-130 Units (Vertical Units)



**Table 27.1 - Filter Quantity / Size (inches)**

| SIZE | FILTERS IN V-BANK |
|------|-------------------|
| 110  | (4) 20 x 20 x 2   |
| 112  |                   |
| 115  | (6) 20 x 25 x 2   |
| 118  |                   |
| 120  | (12) 20 x 25 x 2  |
| 122  |                   |
| 125  | (10) 20 x 20 x 2  |
| 127  |                   |
| 130  | (10) 20 x 25 x 2  |

**Table 27.2 - MDB Vertical Unit Dimensions (all dimensions in inches)**

| SIZE | A  | B  | C   | D      | E       | F        | G  | H      | K     | L      | M      | P       | Q  | R  |
|------|----|----|-----|--------|---------|----------|----|--------|-------|--------|--------|---------|----|----|
| 110  | 24 | 43 | 71  | 13 1/4 | 11 1/2  | 9 7/8    | 30 | 1 1/8  | 3/4   | 21     | 20     | 6 1/4   | 38 | 24 |
| 112  | 24 | 43 | 71  | 15 3/4 | 13 9/16 | 8 5/8    | 30 | 1 1/8  | 3/4   | 21     | 20     | 7 3/16  | 47 | 24 |
| 115  | 36 | 52 | 82  | 18 3/4 | 16      | 11 5/8   | 39 | 7/8    | 1 1/4 | 26 1/2 | 25 1/2 | 8 5/8   | 47 | 36 |
| 118  | 36 | 52 | 82  | 22     | 19      | 10       | 39 | 7/8    | 1 1/4 | 26 1/2 | 25 1/2 | 10 9/16 | 47 | 36 |
| 120  | 51 | 78 | 96  | 24 7/8 | 24 7/8  | 18 9/16  | 59 | 1 5/16 | 1 3/4 | 31 1/2 | 31     | 11 1/4  | 75 | 48 |
| 122  | 51 | 78 | 96  | 27 3/8 | 27 3/8  | 17 5/16  | 59 | 1 5/16 | 1 3/4 | 31 1/2 | 31     | 12 1/4  | 75 | 48 |
| 125  | 63 | 92 | 110 | 31 3/8 | 31 3/8  | 22 5/16  | 73 | 1 1/16 | 2 1/4 | 41 1/2 | 42     | 13 1/4  | 89 | 60 |
| 127  | 63 | 92 | 110 | 34 3/8 | 34 3/8  | 20 13/16 | 73 | 1 1/16 | 2 1/4 | 41 1/2 | 42     | 15 1/4  | 89 | 60 |
| 130  | 63 | 92 | 110 | 36 7/8 | 36 7/8  | 19 9/16  | 73 | 1 1/16 | 2 1/4 | 41 1/2 | 42     | 16 1/4  | 89 | 60 |

Note: All accessories shipped completely assembled for easy installation. Some accessories shipped separately. All data subject to change. All dimensions subject to manufacturing tolerances.

# Direct Fired Make-Up Air Units

## Dimensions - Roof Curb

Figure 28.1 - Roof-Curb Dimensions - Size 110-130

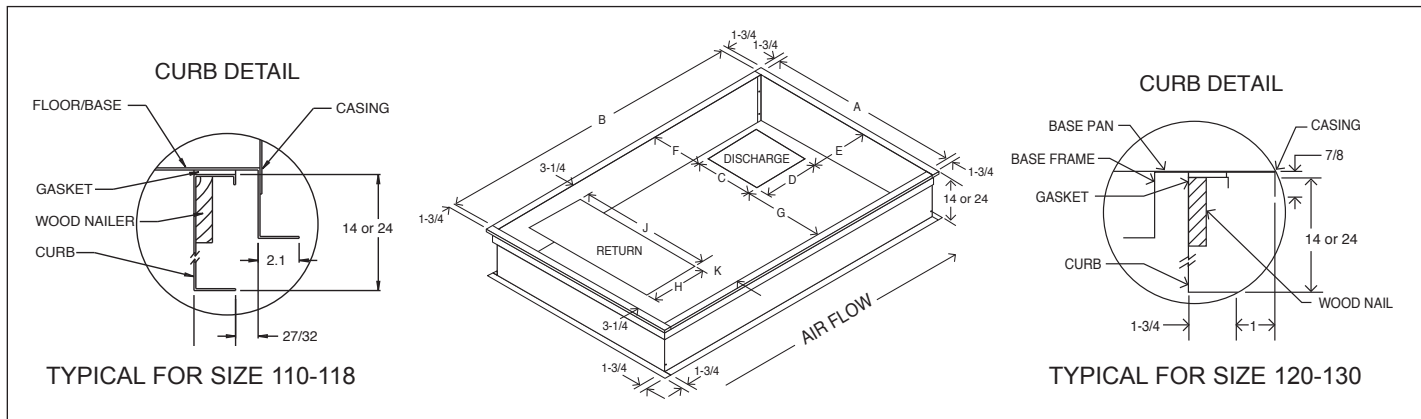


Table 28.1 - Roof-Curb Dimensions - Size 110-130 (inches)

| Model Size | Curb Inside Dimensions |         | Discharge Air Dimensions (optional) |         |         |          |          | Return Air Dimensions (optional) |     |        | Gasket Length (Feet) | Curb Weight (lbs) |          |
|------------|------------------------|---------|-------------------------------------|---------|---------|----------|----------|----------------------------------|-----|--------|----------------------|-------------------|----------|
|            | A                      | B       | C                                   | D       | E       | F        | G        | H                                | J   | K      |                      | 14" High          | 24" High |
| 110        | 37 1/2                 | 65 1/2  | 13 1/4                              | 11 1/2  | 3 1/2   | 7 1/8    | 17 1/8   | 10                               | 26  | 8 1/4  | 19                   | 115               | 180      |
| 112        | 37 1/2                 | 65 1/2  | 15 3/4                              | 13 9/16 | 4 7/16  | 5 7/8    | 15 7/8   |                                  |     |        |                      |                   |          |
| 115        | 46 1/2                 | 76 1/2  | 18 3/4                              | 16      | 5 7/8   | 8 7/8    | 18 7/8   | 12                               | 35  | 8 1/4  | 23                   | 140               | 215      |
| 118        | 46 1/2                 | 76 1/2  | 22                                  | 19      | 7 13/16 | 7 1/4    | 17 1/4   |                                  |     |        |                      |                   |          |
| 120        | 72 1/2                 | 90 1/2  | 24 7/8                              | 24 7/8  | 8 1/2   | 16 13/16 | 30 13/16 | 14                               | 55  | 14 1/4 | 29                   | 220               | 375      |
| 122        | 72 1/2                 | 90 1/2  | 27 3/8                              | 27 3/8  | 9 1/2   | 14 9/16  | 30 9/16  |                                  |     |        |                      |                   |          |
| 124        | 72 1/2                 | 90 1/2  | 28 3/8                              | 31 3/8  | 10 1/2  | 14 1/16  | 30 1/16  | n/a                              | n/a | n/a    |                      |                   |          |
| 125        | 86 1/2                 | 104 1/2 | 31 3/8                              | 31 3/8  | 10 1/2  | 19 9/16  | 35 9/16  | 20                               | 69  | 14 1/4 | 34                   | 240               | 410      |
| 127        | 86 1/2                 | 104 1/2 | 34 3/8                              | 34 3/8  | 12 1/2  | 18 1/16  | 34 1/16  |                                  |     |        |                      |                   |          |
| 130        | 86 1/2                 | 104 1/2 | 36 7/8                              | 36 7/8  | 13 1/2  | 16 13/16 | 32 13/16 |                                  |     |        |                      |                   |          |

Figure 28.2 - Roof-Curb Dimensions - Size 220-230

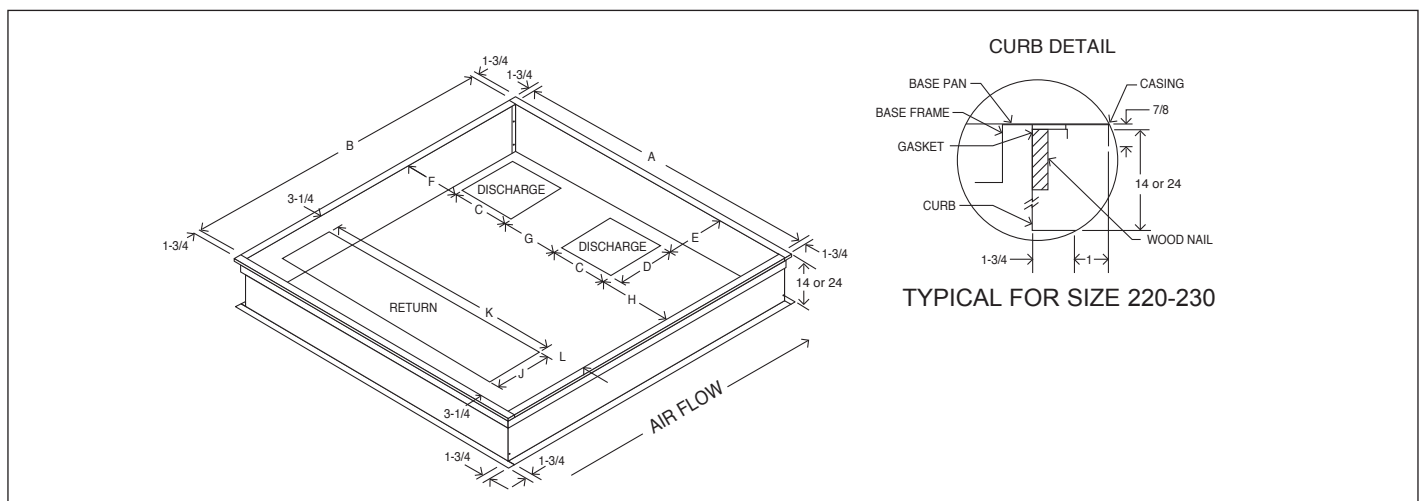


Table 28.2 - Roof-Curb Dimensions - Size 220-230 (inches)

| Model Size | Curb Inside Dimensions |         | Discharge Air Dimensions (optional) |        |        |         |        | Return Air Dimensions (optional) |    |     |    | Gasket Length (Feet) | Curb Weight (lbs) |          |
|------------|------------------------|---------|-------------------------------------|--------|--------|---------|--------|----------------------------------|----|-----|----|----------------------|-------------------|----------|
|            | A                      | B       | C                                   | D      | E      | F       | G      | H                                | J  | K   | L  |                      | 14" High          | 24" High |
| 220        | 124 1/2                | 90 1/2  | 24 7/8                              | 24 7/8 | 8 1/2  | 13 5/16 | 32 1/8 | 29                               | 14 | 107 | 14 | 38                   | 285               | 485      |
| 222        | 124 1/2                | 90 1/2  | 27 3/8                              | 27 3/8 | 9 1/2  | 12 1/16 | 29 5/8 |                                  |    |     |    |                      |                   |          |
| 225        | 148 1/2                | 104 1/2 | 31 3/8                              | 31 3/8 | 10 1/2 | 16 1/16 | 37 5/8 | 32                               | 20 | 131 | 14 | 44                   | 315               | 540      |
| 230        | 148 1/2                | 104 1/2 | 36 7/8                              | 36 7/8 | 14     | 13 5/16 | 32 1/8 |                                  |    |     |    |                      |                   |          |

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# Direct Fired Make-Up Air Units

## Evaporative Cooling

### Evaporative Cooling Module

All outdoor models can be provided with a field installed evaporative cooling module. When applicable, evaporative cooling is one of the most economical means of supplying conditioned air to a space.

Evaporative cooling works on the principle of exchanging sensible heat from the entering warm air to latent heat of vaporization of the cooling water. A special wetting media is placed in the entering air stream of the cooling unit and water is fed down the media. As the air passes through the media, sensible heat from the air is simply transferred to the water in the cooling media, causing the water to evaporate. Because the sensible heat from the air is simply transferred to the water, and both the water vapor and cooled air remain in the system, there is no net energy change in the system. However, the dry bulb temperature of the air has been lowered and provides cooling for the space.

The temperature of the cooling air will be dependent on three criteria. These criteria are:

1. The design dry bulb temperature
2. The design wet bulb temperature
3. The percent effectiveness of the cooling media

The design dry and wet bulb temperatures can be obtained from the climatic table of the ASHRAE fundamentals. The percent effectiveness of the cooling media is determined from the media performance curve shown in Curve 30.1 for the 12" media based on the velocity across the media. The velocity can be determined by dividing the desired cfm of the unit by the face area of the cooling media for the unit. The media face areas are shown in the Evaporative Cooler Dimensional, Performance, and Weight Data Table 31.1. All evaporative coolers are designed with face velocities below the point of water carryover, thus eliminating the need for moisture elimination pads. For media pressure drops, refer to the evaporative cooling pressure drops included with the unit blower performance curves.

Evaporative coolers are available with 2 types of media:

1. Munters CELdek® Cellulose 12" media providing brand name media performance.
2. Munters GLASdek® Fiberglass 12" media which is a fiberglass media material for applications requiring UL 900, Class 2 fire rating and complies with NFPA codes. .

### Standard Features

- 12" Munters CELdek® evaporative cooling media
- 304 stainless steel water reservoir and casing
- 2" permanent aluminum mesh washable pre-filters
- Internal thermal overload protected 115V/1ph motor
- Front access to pump motor, media, and water connections
- Float switch - Prevents the pump motor from operating if the water level in the reservoir is below the switch.
- Float valve and bleed line
- Adjustable leveling screws
- Water inlet, drain, overflow connections (1/2" NPT)

### Optional Features - Factory Installed

- 12" Munters 12" GLASdek® media
- 1" polyester cleanable pre-filter
- Rainhood with 2" permanent aluminum mesh washable pre-filters

### Accessory Fill and Drain Kits - Field Installed ①

- Manual remote operated fill and drain kit
- Manual remote operated fill and drain kit with freeze protection
- Automatic remote operated fill and drain kit
- Automatic remote operated fill and drain kit with freeze protection

① Valves rated for 50 psi maximum water pressure.

### Evaporative Cooling Performance Example

Determine the final dry bulb temperature for a model size 130 with a rated air capacity of 30,000 cfm with 12" GLASdek media. The unit is to be installed in Phoenix, Arizona. The ASHRAE guide shows a design dry bulb temperature of 109°F and a design wet bulb temperature of 71°F. Also determine the apparent cooling capacity of the evaporative cooler.

1. Determine the face velocity across the media located in Table 31.1. Find the model size of the selected unit and then find the corresponding media face area (For the model size 130, the media face area is 54 ft² of media. To calculate the face velocity:

$$\text{FPM} = \text{CFM} / \text{Media Face Area}$$

$$\text{or } 30,000 \text{ CFM} / 54 \text{ ft}^2 = 556 \text{ FPM}$$

2. Determine the media percent effectiveness. Enter Figure 30.1 at 556 FPM and follow up the graph until the FPM line intersects with the 12" media % curve. At the point of intersection, read across to the left and find the percent effectiveness. For this example, the effectiveness is 88%.
3. Determine final dry bulb temperature of conditioned air.

$$\text{LAT} = \text{EAT DB} - (\% \text{ Eff.} \times (\text{EAT DB} - \text{EAT WB}))$$

$$\text{LAT} = 109^\circ\text{F} - (0.88 \times (109^\circ\text{F} - 71^\circ\text{F})) = 76^\circ\text{F DB}$$

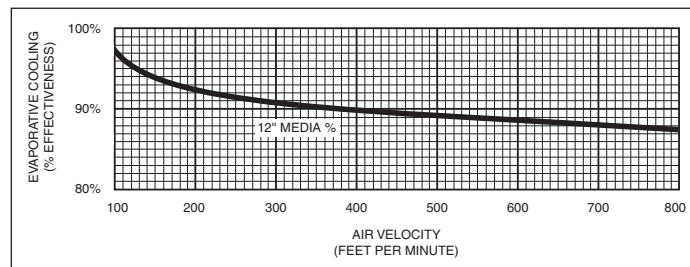
Once the final dry bulb temperature has been determined, the point of operation can be plotted on the psychrometric chart. The LAT dry bulb is 76°F and the wet bulb remains constant so it is 71°F.

4. Determine the cooling capacity of the unit. The cooling capacity of the unit is defined as the apparent cooling capacity because it is dependent on a specific set of temperature conditions. As these conditions change, so will the apparent cooling capacity.

$$Q = 1.08 \times (\text{EAT DB} - \text{LAT DB}) \times \text{CFM}$$

$$Q = 1.08 \times (109^\circ\text{F} - 76^\circ\text{F}) \times 30,000 \text{ CFM} = 1,069,200 \text{ Btu/Hr}$$

**Figure 30.1 - Evaporative Cooling Effectiveness Curve**



### Definition of Terms

|        |   |                           |
|--------|---|---------------------------|
| EAT    | = | Entering Air Temperature  |
| LAT    | = | Leaving Air Temperature   |
| DB     | = | Dry Bulb                  |
| WB     | = | Wet Bulb                  |
| % Eff. | = | Percent Effectiveness     |
| Q      | = | Apparent Cooling Capacity |

## Evaporative Cooling

Figure 31.1 - Evaporative Cooling Module

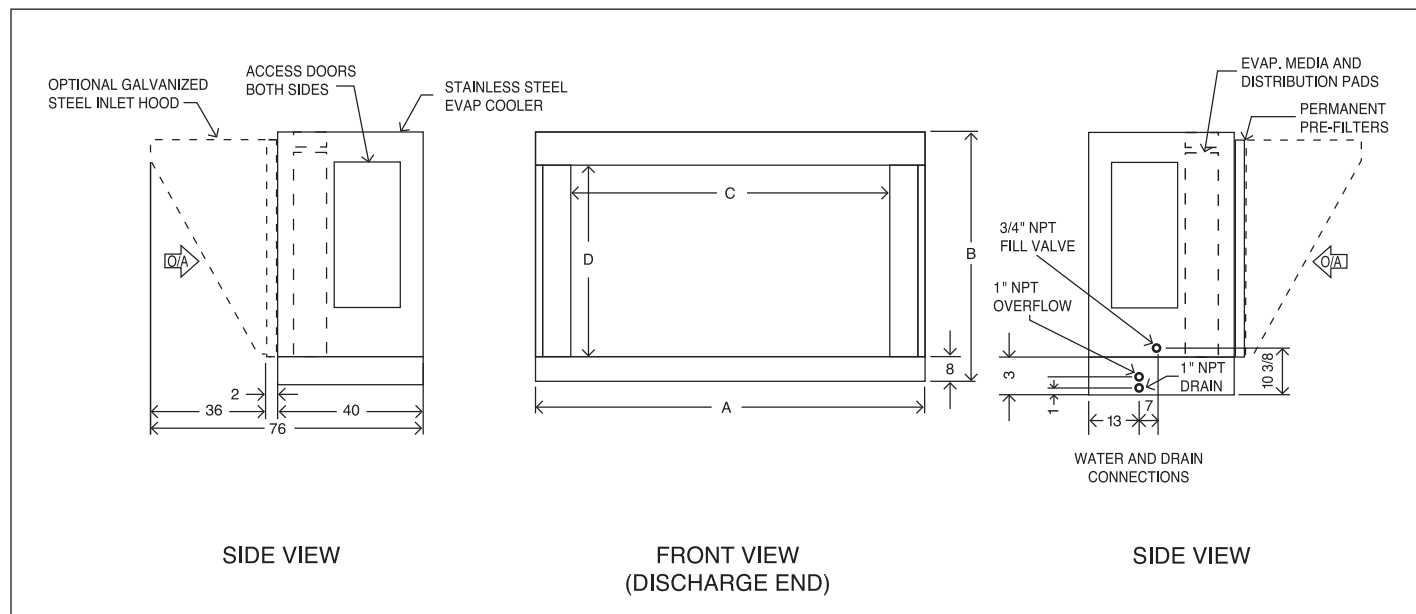


Table 31.1 - Evaporative Cooling Specifications

| Model Size | Evaporative Cooler |    |     |    |           |        | 2" Pre-Filters |              |                   |                 | 12" Evaporative Media |              |                   |                | 2" Dist. Pad |              | Weight (Lbs.) |      |      |
|------------|--------------------|----|-----|----|-----------|--------|----------------|--------------|-------------------|-----------------|-----------------------|--------------|-------------------|----------------|--------------|--------------|---------------|------|------|
|            | A                  | B  | C   | D  | CFM Range |        | Qty            | Size (L x H) | Face Area (sq ft) | Max. Vel. (FPM) | Qty                   | Size (W x H) | Face Area (sq ft) | Max Vel. (FPM) | Qty          | Size (W x H) | Ship          | Oper | Hood |
|            |                    |    |     |    | Min       | Max    |                |              |                   |                 |                       |              |                   |                |              |              |               |      |      |
| 110        | 48                 | 47 | 39  | 17 | 1,600     | 3,300  | 6              | 16 x 20      | 13.33             | 248             | 4                     | 12 x 36      | 12.00             | 275            | 1            | 12 x 48      | 265           | 525  | 62   |
| 112        | 48                 | 47 | 39  | 17 | 2,000     | 4,700  | 6              | 16 x 20      | 13.33             | 353             | 4                     | 12 x 36      | 12.00             | 392            | 1            | 12 x 48      | 265           | 525  | 62   |
| 115        | 60                 | 59 | 48  | 29 | 3,000     | 6,500  | 6              | 20 x 25      | 20.83             | 312             | 5                     | 12 x 36      | 15.00             | 433            | 1            | 12 x 48      | 395           | 720  | 75   |
| 118        | 60                 | 59 | 48  | 29 | 3,500     | 10,000 | 6              | 20 x 25      | 20.83             | 480             | 5                     | 12 x 48      | 20.00             | 500            | 1            | 12 x 48      | 395           | 720  | 75   |
| 120        | 84                 | 71 | 74  | 41 | 6,000     | 13,500 | 3              | 20 x 20      | 35.00             | 386             | 7                     | 12 x 60      | 35.00             | 386            | 1            | 12 x 60      | 610           | 1065 | 105  |
|            |                    |    |     |    |           |        | 12             | 16 x 20      |                   |                 |                       |              |                   |                | 1            | 12 x 24      |               |      |      |
| 122        | 84                 | 71 | 74  | 41 | 8,000     | 16,500 | 3              | 20 x 20      | 35.00             | 471             | 7                     | 12 x 60      | 35.00             | 471            | 1            | 12 x 60      | 610           | 1065 | 105  |
|            |                    |    |     |    |           |        | 12             | 16 x 20      |                   |                 |                       |              |                   |                | 1            | 12 x 24      |               |      |      |
| 124        | 84                 | 71 | 74  | 41 | 10,000    | 21,500 | 3              | 20 x 20      | 35.00             | 614             | 7                     | 12 x 60      | 35.00             | 614            | 1            | 12 x 60      | 610           | 1065 | 105  |
|            |                    |    |     |    |           |        | 12             | 16 x 20      |                   |                 |                       |              |                   |                | 1            | 12 x 24      |               |      |      |
| 125        | 108                | 71 | 88  | 53 | 10,000    | 21,500 | 9              | 20 x 20      | 45.00             | 478             | 9                     | 12 x 60      | 45.00             | 478            | 1            | 12 x 48      | 755           | 1340 | 110  |
|            |                    |    |     |    |           |        | 9              | 16 x 20      |                   |                 |                       |              |                   |                | 1            | 12 x 60      |               |      |      |
| 127        | 108                | 83 | 88  | 53 | 12,000    | 26,000 | 9              | 20 x 25      | 56.25             | 462             | 9                     | 12 x 72      | 54.00             | 481            | 1            | 12 x 48      | 835           | 1420 | 125  |
|            |                    |    |     |    |           |        | 9              | 16 x 25      |                   |                 |                       |              |                   |                | 1            | 12 x 60      |               |      |      |
| 130        | 108                | 83 | 88  | 53 | 14,000    | 30,000 | 9              | 20 x 25      | 56.25             | 533             | 9                     | 12 x 72      | 54.00             | 556            | 1            | 12 x 48      | 835           | 1420 | 125  |
|            |                    |    |     |    |           |        | 9              | 16 x 25      |                   |                 |                       |              |                   |                | 1            | 12 x 60      |               |      |      |
| 220        | 144                | 71 | 126 | 41 | 18,000    | 27,000 | 12             | 16 x 20      | 60.00             | 450             | 12                    | 12 x 60      | 60.00             | 450            | 2            | 12 x 72      | 1065          | 1845 | 140  |
|            |                    |    |     |    |           |        | 12             | 20 x 20      |                   |                 |                       |              |                   |                |              |              |               |      |      |
| 222        | 144                | 71 | 126 | 41 | 25,000    | 33,000 | 12             | 16 x 20      | 60.00             | 550             | 12                    | 12 x 60      | 60.00             | 550            | 2            | 12 x 72      | 1065          | 1845 | 140  |
|            |                    |    |     |    |           |        | 12             | 20 x 20      |                   |                 |                       |              |                   |                |              |              |               |      |      |
| 225        | 180                | 95 | 150 | 53 | 30,000    | 46,000 | 9              | 20 x 25      | 106.25            | 433             | 15                    | 12 x 72      | 105.00            | 438            | 3            | 12 x 60      | 1735          | 2710 | 175  |
|            |                    |    |     |    |           |        | 27             | 20 x 20      |                   |                 | 15                    | 12 x 12      |                   |                |              |              |               |      |      |
| 230        | 180                | 95 | 150 | 53 | 36,000    | 60,000 | 9              | 20 x 25      | 106.25            | 565             | 15                    | 12 x 72      | 105.00            | 571            | 3            | 12 x 60      | 1735          | 2710 | 175  |
|            |                    |    |     |    |           |        | 27             | 20 x 20      |                   |                 | 15                    | 12 x 12      |                   |                |              |              |               |      |      |

# Direct Fired Make-Up Air Units

## Specifications

### A. Specifications

#### General

Contractor is to install units according to manufacturers published installation instructions, ANSI Z223.1 (also known as NFPA 54 National Fuel Gas Code), and in accordance with all local codes. After installation, installer is to perform a complete start-up check as required by the manufacturer. A copy of the start-up report shall be left with the owner.

### B. Standards

- B.1 The unit(s) shall include ETL design certification for use in:  
\_\_\_\_\_ the U.S. and Canada to ANSI Z83.4 - latest revision, standard for "Non-Recirculating Direct Gas-Fired Industrial Air Heaters" for safe operation, construction, and performance (Model MDB only).  
\_\_\_\_\_ the U.S. only to ANSI Z83.18 - latest revision, standard for "Recirculating Direct Gas-Fired Industrial Air Heaters" for safe operation, construction, and performance (Model MRB only).

### C. Mechanical Configuration

- C.1. The unit(s) shall have right side gas and electrical controls access (left hand access optional) as viewed when looking into the inlet of the unit. Blower/motor compartment access will be on the opposite side as viewed when looking into the inlet of the unit.
- C.2. The unit(s) shall be provided with a 14" high (24" high optional), prefabricated 14 gauge, unpainted G90 Galvanized steel roof curb with assembly hardware for field assembly (Unit sizes 110-118 only).
- C.2. The unit(s) shall be provided with a 14" high (24" high optional), prefabricated 12 gauge, unpainted G90 Galvanized steel roof curb with assembly hardware for field assembly (Unit sizes 120-130 and 220-230 only).
- C.4.a. The unit(s) shall be provided with four (4) rubber-in-shear double deflection vibration isolation feet with support mounting for unit.
- C.4.b. The unit(s) shall be provided with two (2) rubber-in-shear double deflection vibration isolation feet with support mounting for V-Bank filter section.
- C.4.c. The unit(s) shall be provided with four (4) rubber-in-shear double deflection vibration isolation hangers with support mounting for unit.
- C.4.d. The unit(s) shall be provided with two (2) rubber-in-shear double deflection vibration isolation hangers with support mounting for V-Bank filter section.

### D. Unit Casing

- D.1. The unit(s) casing shall be constructed from minimum 18 gauge steel and designed for:  
\_\_\_\_\_ Outdoor installation, with unpainted G90 Galvanized steel.  
\_\_\_\_\_ Indoor installation, with unpainted G90 Galvanized steel.  
\_\_\_\_\_ Outdoor installation, with gray-green, prepainted G90 Galvanized steel.  
\_\_\_\_\_ Indoor installation, with gray-green, prepainted G90 Galvanized steel.
- D.2. The unit(s) casing roof shall be designed with a rain drip edge to prevent water entry.
- D.3. The unit(s) base shall be constructed of minimum 14 gauge galvanized steel and shall be designed for rail, slab, or roof curb mounting.
- D.4. The burner section shall be insulated with 1 inch, 1-1/2 lb density acoustical and thermal insulation. The insulation shall be made of glass fibers bonded with a thermosetting resin and overlaid with a fire-resistant black acrylic coating for additional strength. The acrylic coating must meet the requirements of ASTM C 665 for fungi resistance.

- D.5. The unit(s) shall include four hinged service access doors (two on each side). Each door shall have a minimum of two tooled access draw tight fasteners. Gas piping and electrical controls shall be mounted in separate enclosures, isolated from the each other and the air stream and shall have independent service access doors. The blower motor and drives shall be accessible through an access service door.
- D.6. Each unit shall include a minimum of four factory installed lifting lugs for handling and installation. Each lug will include a 1" diameter hole for lifting hooks.

### E. Inlet/Discharge Options and/or Accessories:

- E.1. The unit(s) shall include a field installed V-Bank filter section (factory installed on horizontal, 110 through 124 size units) with:  
\_\_\_\_\_ 2" permanent aluminum filters.  
\_\_\_\_\_ 2" FARR® Aeropleat 3 pleated throwaway filters.  
\_\_\_\_\_ 2" FARR® 30/30 pleated throwaway filters.
- E.2. The V-Bank filter section shall be constructed from minimum 18 gauge:  
\_\_\_\_\_ Un-painted G90 Galvanized steel.  
\_\_\_\_\_ Gray-green, prepainted G90 Galvanized steel.
- The V-Bank section will be fully assembled. The maximum air velocity through the filters shall not exceed 520 fpm.
- E.3. The V-Bank filter section shall be insulated with 1 inch, 1-1/2 lb density acoustical and thermal insulation. The insulation shall be made of glass fibers bonded with a thermosetting resin and overlaid with a fire-resistant black acrylic coating for additional strength. The acrylic coating must meet the requirements of ASTM C 665 for fungi resistance.
- E.4. The unit(s) shall include an optional field installed motorized 2-position inlet damper (factory installed on horizontal, 110 through 124 size units).
- E.5. Inlet damper frame shall be constructed from minimum 14 gauge steel and blades shall be a minimum of 18 gauge steel. Material shall be:  
\_\_\_\_\_ Un-painted G90 Galvanized steel.  
\_\_\_\_\_ Gray-green, prepainted G90 Galvanized steel.
- E.6. The unit(s) shall include an optional field installed Inlet Rain Hood with Bird Screen without filters (with 2" permanent filters optional) (factory installed on horizontal, 110 through 124 size units). The maximum inlet air velocity shall not exceed 720 fpm (520 fpm with optional filters).
- E.7. Inlet Rain Hood with Bird Screen shall be fully assembled and constructed of minimum 18 gauge:  
\_\_\_\_\_ Un-painted G90 Galvanized steel.  
\_\_\_\_\_ Gray-green, prepainted G90 Galvanized steel.
- E.8. The unit(s) shall include Inlet Rain Hood and/or V-Bank Filter Section Support Kits.
- E.9. The unit(s) shall include a field installed motorized 2-position discharge damper.
- E.10. Discharge damper frame shall be constructed from minimum 14 gauge steel and damper blades shall be a minimum of 18 gauge steel. Material shall be:  
\_\_\_\_\_ Un-painted G90 Galvanized steel.  
\_\_\_\_\_ Gray-green, prepainted G90 Galvanized steel.
- E.11. The unit(s) shall include field installed discharge louvers. Each louver shall have field horizontally adjustable air deflection blades. Direction of airflow shall be:  
\_\_\_\_\_ 3-Way  
\_\_\_\_\_ 4-Way
- E.12. Discharge louver shall be constructed from minimum 18 gauge:  
\_\_\_\_\_ Un-painted G90 Galvanized steel.  
\_\_\_\_\_ Gray-green, powdercoat painted G90 Galvanized steel.
- E.13. The unit(s) shall include 24" high (48" high) field installed, factory assembled vertical inlet stand without inlet screen (with inlet screen optional). Inlet stand shall be constructed from minimum 18 gauge painted Galvanized steel.

## Specifications

### F. Blower Section

- F.1.a. The unit(s) shall include one \_\_\_\_\_" diameter, forward curved, double width, double inlet (DWDI) belt driven blower, to supply \_\_\_\_\_ cfm against a total static pressure of \_\_\_\_\_" W.C. using a \_\_\_\_\_ hp motor. The minimum blower to internal side wall clearance (including insulation if applicable) shall not be less than one half of the blower wheel diameter.
- F.1.b. The unit(s) shall include two \_\_\_\_\_" diameter, forward curved, double width, double inlet (DWDI) belt driven blowers, to supply \_\_\_\_\_ cfm against a total static pressure of \_\_\_\_\_" W.C. using a \_\_\_\_\_ hp motor. The minimum blower to internal side wall clearance (including insulation if applicable) shall not be less than one half of the blower wheel diameter, and the distance between the blowers shall be not less than one blower diameter.
- F.2. The total static pressure shall include allowances for a minimum pressure drop of \_\_\_\_\_" W.C. for field connected ductwork, and \_\_\_\_\_" W.C. for factory/field installed options/accessories.
- F.3. The blower bearings shall be:  
\_\_\_\_\_ Permanently lubricated spider ball bearings.  
\_\_\_\_\_ Greaseable, heavy duty pillow block ball bearings.
- F.4. The unit(s) shall include extended blower bearing grease lines with externally mounted grease fittings on the exterior of the unit casing.
- F.5. The blower and motor assembly shall be fully spring isolated with flexible duct connection to unit casing to allow for vibration isolation.
- F.6. The blower section shall be insulated with 1 inch, 1-1/2 lb density acoustic and thermal insulation. The insulation shall be made of glass fibers bonded with a thermosetting resin and overlaid with a fire-resistant black acrylic coating for additional strength. The acrylic coating must meet the requirements of ASTM C 665 for fungi resistance.
- F.7. The blower motor horsepower shall be \_\_\_\_\_
- F.8. The blower motor shall be rated for:  
\_\_\_\_\_ 115V/60Hz/1Ph  
\_\_\_\_\_ 208V/60Hz/1Ph  
\_\_\_\_\_ 230V/60Hz/1Ph  
\_\_\_\_\_ 208V/60Hz/3Ph  
\_\_\_\_\_ 230V/60Hz/3Ph  
\_\_\_\_\_ 460V/60Hz/3Ph  
\_\_\_\_\_ 575V/60Hz/3Ph
- F.9. The blower motor type shall be:  
\_\_\_\_\_ Single-speed, open drip proof (ODP).  
\_\_\_\_\_ Single-speed, open drip proof, NEMA Premium efficiency (ODP HE).  
\_\_\_\_\_ Single-speed, totally enclosed (TE).  
\_\_\_\_\_ Single-speed, totally enclosed, NEMA Premium efficiency (TE HE).
- F.10. The motor wiring shall be in metal conduit.
- F.11. The unit(s) shall be provided with an adjustable motor sheave and fixed blower sheave to allow for minor adjustment of the blower RPM at the jobsite.
- F.12. The unit(s) shall be provided with:  
\_\_\_\_\_ A factory installed and wired motor starter.  
\_\_\_\_\_ A field installed variable frequency drive for blower motor control.  
\_\_\_\_\_ A factory installed variable frequency drive for blower motor control.

### G. Gas Controls/Manifold Assembly

- G.1. The unit(s) gas controls shall be designed for use with:  
\_\_\_\_\_ Natural gas with an inlet gas pressure of 8-14" W.C.  
\_\_\_\_\_ Natural gas with an inlet gas pressure of 1-5 psig.  
\_\_\_\_\_ Propane gas with an inlet gas pressure of 11-14" W.C.  
\_\_\_\_\_ Propane gas with an inlet gas pressure of 1-5 psig.
- G.2. The gas controls and manifold assembly shall meet insurance requirements of:  
\_\_\_\_\_ Industrial Risk Insurers (IRI).  
\_\_\_\_\_ Factory Mutual (FM) Less Restriction.  
\_\_\_\_\_ Factory Mutual (FM) With Restriction.

- G.3.a. The standard gas controls and manifold assembly shall include, at a minimum, a main gas hand shut-off valve, auxiliary hand shut-off valve, pilot gas hand shut-off valve, main gas regulator, pilot gas regulator, main gas solenoid valve, redundant main gas solenoid valve, pilot gas solenoid valve, modulating gas valve, and three gas pressure test ports. See "Ignition and Safety Controls" for additional optional components" (non-FM units and FM units up to 2500MBH).
- G.3.b. The standard gas controls and manifold assembly shall include, at a minimum, a main gas hand shut-off valve, two auxiliary hand shut-off valves, pilot gas hand shut-off valve, main gas regulator, pilot gas regulator, main gas motorized valve, redundant main gas motorized valve, pilot gas solenoid valve, modulating gas valve, four gas pressure test ports and combination high and low gas pressure switches (FM with restriction above 2500).
- G.3.c. The standard gas controls and manifold assembly shall include, at a minimum, a main gas hand shut-off valve, auxiliary hand shut-off valve, pilot gas hand shut-off valve, main gas regulator, pilot gas regulator, main gas motorized valve, redundant main gas solenoid valve, pilot gas solenoid valve, modulating gas valve, four gas pressure test ports and combination high and low gas pressure switches (FM less restriction above 2500).

### H. Ignition and Safety Controls

- H.1. The unit(s) shall be supplied with intermittent pilot ignition with 100% lockout on flame failure with a manual reset. These controls shall include, at a minimum, a flame safeguard ignition control, spark pilot ignition generator, manual reset high temperature limit control, primary and secondary electrical circuit fuses, low air flow proving switch, high air flow cutoff switch and a safety pre-purge timed delay relay.
- H.2. The pilot flame supervision method shall be:  
\_\_\_\_\_ Flame rod.  
\_\_\_\_\_ Flame rod and shall also include main flame sensing via a secondary flame rod (1925MBH and above)
- H.3. The unit(s) shall include a combination high and low gas pressure switch to prevent the unit from firing if the gas pressure is below the minimum gas pressure or above the maximum gas pressure. The switch is a manual reset type.

### I. Temperature Controls

- I.1.a. The unit(s) shall be provided with a Maxitrol System 14 Electronic Modulation Discharge Air Temperature control system. This system shall include a remote temperature dial for adjusting the set point of the discharge air temperature sensor. The discharge air sensor shall monitor the discharge air temperature and modulate the firing rate of the main burner to maintain the desired discharge air temperature. The temperature range of the remote temperature dial shall be 55-90°F.
- I.1.b. The unit(s) shall be provided with a room temperature override thermostat to override the discharge air temperature setting by 15°F.
- I.1.c. The unit(s) shall be provided with a Maxitrol System 44 Electronic Modulation Room Air Temperature control system. This system shall include a modulating room thermostat to regulate the firing rate of the main burner based on space temperature thermostat demand. The temperature set point range of the room thermostat shall be 55-90°F. This system also includes a discharge air sensor to provide high and low discharge air temperature limits. The discharge air sensor will prevent make-up air from being delivered to the space at temperatures which are below its set point, even if the room thermostat is satisfied, and will prevent the room thermostat from over-firing the burner when mild outdoor temperatures exist and the maximum firing capacity of the burner is not required to achieve the desired winter design discharge air temperature.
- I.1.d. The unit(s) shall be provided with a Maxitrol Electronic Modulation SC11 Signal Conditioner to provide DCC compatible controls. This system shall include a signal conditioner that utilizes an external 0-10Vdc or 4-20 mA control signal (by others) to control the discharge air temperature. The control signal to the electronic modulating gas valve is controlled by a discharged air sensor (by others) that is compatible with the building management system. An increase or decrease in input signal modulates the main burner gas flow to maintain the desired discharged air temperature. Also included with this system is a discharge air sensor which is used as a high temperature limit control. The discharge air sensor will prevent make-up air from being delivered above the unit discharge operating limit (set for 105°F).

# Direct Fired Make-Up Air Units

## Specifications

- I.2.a. The unit(s) shall be supplied with a remote control panel having main valve and alarm lights, a Summer/Off/Winter Switch and a general purpose NEMA 1 enclosure.

The remote panel shall be compatible with the temperature controls and unit configuration.

- I.2.b. The remote panel shall include:  
\_\_\_\_ No additional lights  
\_\_\_\_ An optional blower on light and a clogged filter light. A clogged filter switch will be mounted on the unit.

### J. Electrical

- J.1. The unit(s) shall be completely factory wired to provide for single point wiring for the main power supply to the unit. The main control panel shall include a numbered terminal strip for all factory wiring and field wiring connections. Units which must be split shipped because of their physical size shall have electrical wire connections tagged and numbered for ease of reconnection during installation.

- J.2. The supply voltage to the unit shall be:

\_\_\_\_ 115V/60Hz/1Ph  
\_\_\_\_ 208V/60Hz/1Ph  
\_\_\_\_ 230V/60Hz/1Ph  
\_\_\_\_ 208V/60Hz/3Ph  
\_\_\_\_ 230V/60Hz/3Ph  
\_\_\_\_ 460V/60Hz/3Ph  
\_\_\_\_ 575V/60Hz/3Ph

- J.3. The unit(s) shall be provided with a factory mounted and wired control transformer to reduce the supply voltage to 115V/60Hz/1Ph.

- J.4. The unit(s) shall be provided with:  
\_\_\_\_ 115V main controls and 24V Maxitrol temperature controls.  
\_\_\_\_ 24V main controls and 24V Maxitrol temperature controls.

Included is a factory mounted and wired control transformer to reduce the main control voltage from 115V to 24V.

- J.5. The unit(s) shall be provided with:  
\_\_\_\_ A field mounted fusible general purpose disconnect switch.  
\_\_\_\_ An indoor/outdoor factory mounted dead front main non-fusible disconnect switch.

### K. Optional Factory Installed Controls

- K.1. The unit(s) shall be provided with factory installed timed freeze protection discharge air thermostat used to prevent building freeze up in the event of a burner ignition failure. The timer is typically set for 180 seconds.
- K.2. The unit(s) shall be provided with factory installed mild temperature inlet on/off duct stat to automatically lockout the gas controls when the outdoor air temperature reaches the desired set point.
- K.3. The unit(s) shall be provided with an exhaust fan interlock contact to initiate a customer exhaust fan starter circuit. The interlock is an auxiliary motor starter contact that closes when the main motor starter contacts close.
- K.4. The unit(s) shall be provided with an exhaust fan interlock relay to initiate a customer exhaust fan starter circuit. The exhaust fan interlock relay contacts close when main airflow is proven.
- K.5. The unit(s) shall be provided with a 10 point circuit analyzer (12 point analyzers optional) that steps through the unit sequence of operation to provide unit operation status for service personnel.
- K.6. The unit(s) shall be provided with service door electrical interlock switch that breaks power in the control circuit if the door is opened. The switch can be overridden for servicing.
- K.7. The unit(s) shall be provided with a convenience outlet with a 115V GFCI service receptacle mounted in the electrical controls section. Outlet requires separate 115V power supply by others.

### L. Accessory Field Installed Controls

- L.1. The unit(s) shall be provided with a manual reset duct mounted fire stat to disable power to the unit if the temperature sensed by the stat exceeds the desired setting.
- L.2. The unit(s) shall be provided with:  
\_\_\_\_ A 7-Day mechanical time clock to operate the unit on user programmed time intervals.  
\_\_\_\_ A 7-Day electronic programmable time clock to operate the unit on user programmed time intervals.
- L.3. The unit(s) shall be provided with a night setback thermostat. The night setback thermostat only enables the unit in the unoccupied mode. The standard unit temperature controls control firing rate.

## Model Nomenclature

| 1,2 | 3  | 4  | 5,6 | 7  | 8  | 9,10,11,12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|-----|----|----|-----|----|----|------------|----|----|----|----|----|----|----|----|----|----|----|
| PT  | DS | BQ | BS  | UC | CF | MBTU       | GT | GC | I  | MO | AC | SV | BT | HP | MT | SA | PA |

### 1,2 - Product Type (PT)

MD - 100% Make Up Air  
MR - Return Air

### 3 - Design Sequence (DS)

B - Internally Assigned

### 4 - Blower Quantity (BQ)

1 - Single Blower Unit  
2 - Twin Blower Unit

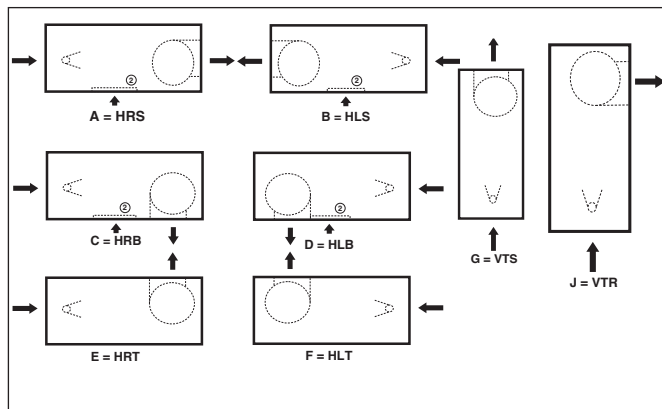
### 5,6 - Blower Size (in.) (BS)

10 - 10"      20 - 20"  
12 - 12"      22 - 22"  
15 - 15"      24 - 25" x 22" (single blower only)  
18 - 18"      25 - 25"  
20 - 20"      27 - 27"  
                30 - 30"

### 7 - Unit Configuration (UC)

A - Horizontal, right access, straight discharge (bottom return on MR)  
B - Horizontal, left access, straight discharge (bottom return on MR)  
C - Horizontal, right access, bottom discharge (bottom return on MR)  
D - Horizontal, left access, bottom discharge (bottom return on MR)  
E - Horizontal, right access, top discharge (not available on MR)  
F - Horizontal, left access, top discharge (not available on MR)  
G - Vertical, right access, top discharge (not available on MR)  
J - Vertical, right access, top-right discharge (not available on MR)

Figure 39.1 - Unit Configurations ①



① Configurations are shown facing the side of the unit with the gas and electrical controls.  
② For models with return air (Series MRB).

### 8 - Cabinet Finish and Location of Installation (CF)

A - Unpainted, Outdoor Installation  
B - Unpainted, Indoor Installation  
C - Painted, Outdoor Installation  
D - Painted, Indoor Installation

### 9, 10, 11, 12 - Maximum Burner Input (MBH) (MBTU)

|      |      |
|------|------|
| 0275 | 3850 |
| 0550 | 4125 |
| 0825 | 4400 |
| 1000 | 4675 |
| 1100 | 4950 |
| 1375 | 5225 |
| 1650 | 5500 |
| 1925 | 5775 |
| 2200 | 6050 |
| 2475 | 6325 |
| 2750 | 6600 |
| 3025 | 6875 |
| 3300 | 7150 |
| 3575 | 7425 |

### 13 - Gas Type and Inlet Pressure (GT)

A - Natural Gas (8-14")  
B - Natural Gas (1-5 psi)  
C - Propane Gas (11-14") (Model MDB only)  
D - Propane Gas (1-5 psi) (Model MDB only)

### 14 - Gas Control System (GC)

A - Maxitrol 14  
B - Maxitrol 44  
C - SC11 DDC (4-20 mA)  
D - SC11 DDC (0-10 VDC)

### 15 - Insurance (I)

1 - IRI (standard ETL)  
2 - FM less Restriction  
3 - FM with Restriction

### 16 - Additional Manifold Options (MO)

C - High & Low Gas Pressure Switch  
N - None

### 17 - Air Control Option (AC)

A - 100% MUA - Single Speed  
B - 100% MUA - Two Speed (VFD) - Type A  
C - 100% MUA - Two Speed (VFD) - Type B  
D - 100% MUA - DDC Control (VFD) - Type A  
E - 100% MUA - DDC Control (VFD) - Type B  
F - Space Pressure Control (MD with VFD or MR) - Type A  
G - Space Pressure Control (MD with VFD or MR) - Type B  
H - Space Pressure Control (MD with VFD or MR) - Type C  
I - Return Air - Fixed 75/25 Dampers - Type A  
J - Return Air - Fixed 75/25 Dampers - Type B  
K - Return Air - Fixed 75/25 Dampers - Type C  
L - Return Air - Fixed 70/30 Dampers - Type A  
M - Return Air - Fixed 70/30 Dampers - Type B  
N - Return Air - Fixed 70/30 Dampers - Type C

### 18 - Supply Voltage (SV)

|              |              |
|--------------|--------------|
| 1 - 115/60/1 | 4 - 208/60/3 |
| 2 - 208/60/1 | 5 - 230/60/3 |
| 3 - 230/60/1 | 6 - 460/60/3 |

### 19 - Bearings and Vibration Isolation (BT)

A - Spider Bearings - No Vibration Isolation  
B - Pillow Block Bearings - No Vibration Isolation  
C - Pillow Block Bearings - With Spring Vibration Isolation

### 20 - Motor HP (HP)

|         |        |
|---------|--------|
| A - 3/4 | H - 10 |
| B - 1   | I - 15 |
| C - 1.5 | J - 20 |
| D - 2   | K - 25 |
| E - 3   | L - 30 |
| F - 5   | M - 40 |
| G - 7.5 | N - 50 |

### 21 - Motor Type (MT)

1 - ODP  
2 - ODP - High Efficiency  
5 - TE  
6 - TE - High Efficiency

### 22 - Sheave Arrangement (SA)

A - (see Sheave Tables)

### 23 - Profile Assembly (PA)

A - (Internally assigned)

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*Products from Modine are designed to provide indoor air-comfort and ventilation solutions for residential, commercial, institutional and industrial applications. Whatever your heating, ventilating and air conditioning requirements, Modine has the product to satisfy your needs, including:*

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- *Unit Heaters:*
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  - *Hydronic*
  - *Electric*
  - *Oil*
- *Ceiling Cassettes*
- *Duct Furnaces*
- *Hydronic Cabinet Unit Heaters, Fin Tube, Convectors*
- *Infrared Heaters*
- *Make-up Air Systems*
- *Unit Ventilators*

#### *Ventilation*

- *Packaged Rooftop Ventilation*

#### *School Products*

- *Vertical Packaged Classroom HVAC:*
  - *DX Cooling/Heat Pump*
  - *Water/Ground Source Heat Pump*
  - *Horizontal/Vertical Unit Ventilators*

#### *Geothermal*

- *Water-to-Water*
- *Water-to-Air*
- *Combination*

*Specific catalogs are available for each product. Catalogs 75-136 and 75-137 provide details on all Modine HVAC equipment.*



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