Gravity Ventilation

COOK

GRAVITY VENTILATION

Gravity Vents

Page

INTRODUCTION

LOREN COOK COMPANY Gravity Ventilation units are designed for industrial and commercial applications requiring building ventilation, either natural or mechanical. All units are produced in an ISO 9001 certified facility.

GI / GR

GI / GR

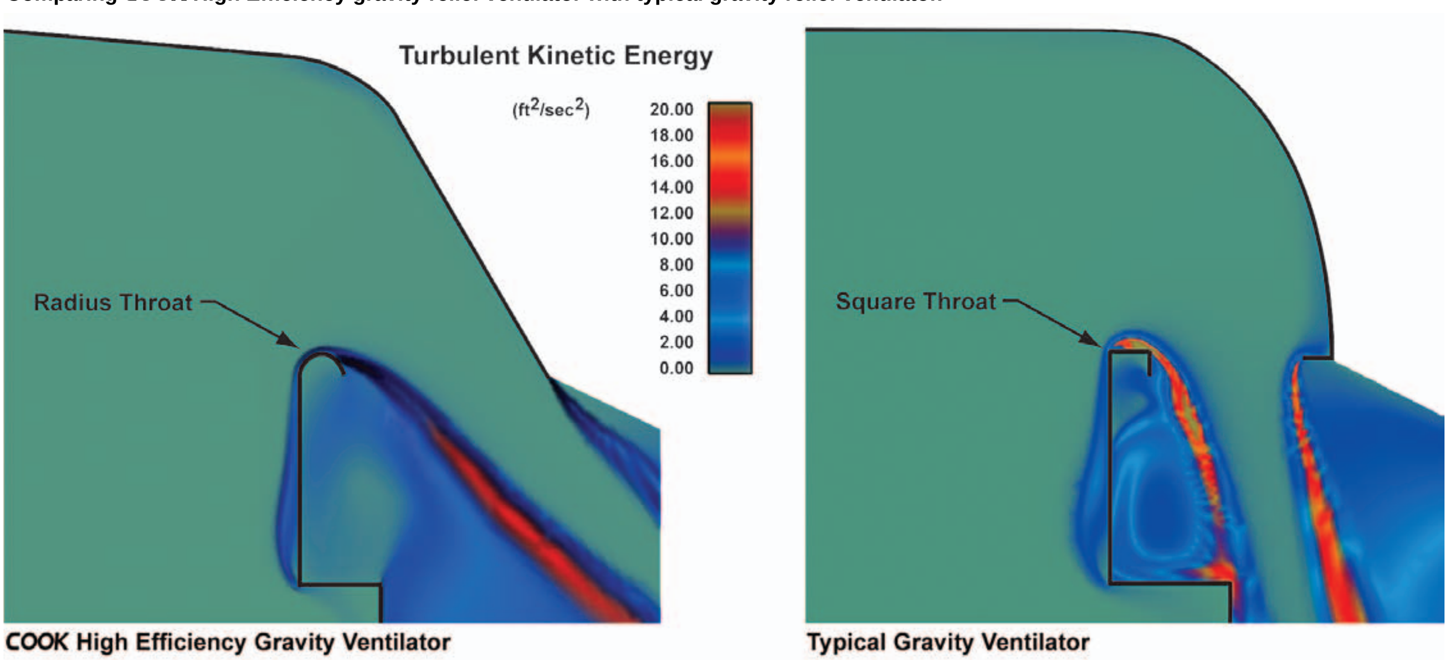
- GI and GR are high efficiency gravity roof ventilators designed using the latest Computational Fluid Dynamic (CFD) and Finite Element Analysis (FEA) software packages.
- GI and GR bases are manufactured with a rounded flange around the throat that decreases pressure losses due to turbulence. (See CFD Models Below)
- GI and GR units are available with throats in widths from 12” to 72” and unlimited length starting at 12”.
- GI and GR units come standard with integral lifting lugs.
- Tie down points are standard to allow for additional restraints to be added in the field as required.
- Rain gutters are standard to help eliminate rain infiltration.
- Roll formed hood panels provide excellent strength characteristics as well as creating a unit that is architecturally pleasing.
- GI and GR units are designed to exceed 30 lbs./ft^2 snowload rating.
- Hinged hoods are standard on GR units with less than a 73” throat length and GI units with less than a 61” throat length.

Designed with the latest in computer aided engineering software.

The new **COOK** GI and GR Gravity Ventilators were designed using the latest Computational Fluid Dynamics (CFD) and Finite Element Analysis (FEA) software. This allowed our engineers to optimize the geometry of the throat and hood to reduce pressure losses and increase efficiency, while maintaining structural integrity. Once the design was optimized, physical prototypes verified the performance and durability of the design. **The result is the most efficient Gravity Ventilator in the industry.**

CFD Simulation

Comparing COOK High Efficiency gravity relief ventilator with typical gravity relief ventilator.



The figures above depict the relative turbulence of each unit and illustrate the improved airflow achieved by the new **COOK** design.
As can be seen in the figures, the radius throat design significantly reduces turbulence as compared to the typical square throat design.

PR

PR

- PR is a spun aluminum intake/relief ventilator designed for use in both gravity and mechanical ventilation systems.
- PR is compact, durable and efficient.
- PR bases are manufactured with a fully developed inlet to provide the most efficient and weather resistant path for both supply and exhaust applications.
- PR units are available in 9 sizes from 8 to 48 inches.

TR

TR

- TR is a spun aluminum ventilator designed for use in both gravity and mechanical ventilation systems.
- TR units provide an increased intake area by utilizing two spun aluminum tiers and therefore, provide lower intake velocities reducing the introduction of airborne particles or moisture into the building.
- TR bases are manufactured with a fully developed base venturi to provide the most efficient and weather resistant path.
- TR units are available in 9 sizes from 8 to 48 inches.

TRE

TRE

- TRE is a tiered aluminum intake/relief ventilator designed to be one of the most flexible designs on the market.
- TRE units can be tailored specifically to meet most building exhaust and intake applications.
- The tiers are constructed of high quality extruded aluminum and provide for clean lines that can meet the requirements for even the most demanding architectural applications.
- TRE units are available with throat dimensions from 12” x 12” to 60” x 120”.

LSUG

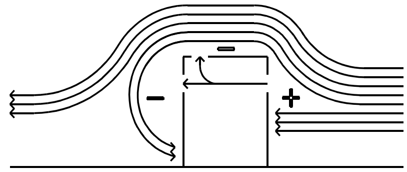
LSUG

- LSUG is a low silhouette, gravity relief, upblast ventilator designed for use on vertical high velocity exhaust systems.
- LSUG units include damper doors and a high volume rain gutter to prevent water infiltration.
- LSUG units are available in 7 sizes from 24 to 60 inches.

Gravity Ventilation (also known as natural ventilation) requires no powered ventilators to achieve air movement. It is most useful in buildings with open floor plans requiring no air conditioning, and where the primary motive for ventilation is heat removal or contaminant dilution. Gravity ventilation is achieved by strategically placing openings in the building to take advantage of prevailing winds and thermal buoyancy or stack effect.

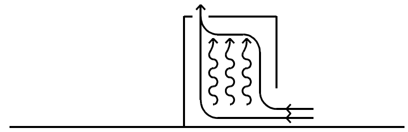
Wind Pressure

Wind moving past a building creates areas of high and low pressure. The windward side of the building is an area of high pressure and the leeward side and roof are areas of low pressure. Placing openings in both high and low pressure areas of the building envelope causes air movement through the building.



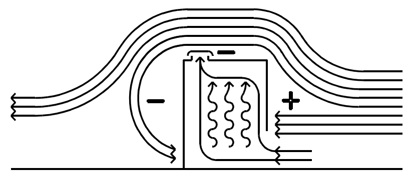
Thermal Buoyancy (Stack Effect)

Heat generated from within buildings rises to the upper part of the structure. In buildings where the structure is of significant height, this natural tendency of warm air to rise (known as thermal buoyancy or stack effect) can generate air movement in the building. By placing openings in both the highest and lowest levels of the building, hot air is allowed to rise out of the building and pull cooler air into the lower level of the building.



Placement of Openings

In order to take advantage of both wind pressure and stack effect, gravity ventilators are generally used in conjunction with doors and windows to ventilate the structure. Gravity ventilators are placed on the roof, being the highest part of the structure, to provide for exhaust of building air. Windows and doors at lower elevations provide the intake portals of the gravity ventilation system.



Gravity Ventilator Selection and Sizing

Gravity ventilators should be selected for appropriate architectural style, weather resistance, construction, and cost. When designing a gravity ventilation system it is important to allow ample intake area. The total area of doors, windows, and dampers used as intake points should be equal to or greater than the total throat area of the gravity ventilators selected. This will allow the gravity ventilators to operate as designed.

To determine the proper size and number of gravity ventilators, it is first necessary to calculate the amount of airflow required for the building.

Two of the most common parameters used to determine the required airflow in a gravity ventilation system are heat removal and contaminant dilution.

Designing For Heat Removal

Heat Load (from sunlight, lights, motors, people etc.) HL= [ ] (A) $\left(\frac{BTU}{HR}\right)$

Indoor Temperature T_i = [ ] (B) °F

Outdoor Temperature T_o = [ ] (C) °F

Temperature Difference (It is important to realize that the indoor temperature cannot be lowered below the outdoor temperature without tempering the air.) $T_i - T_o$ = [ ] (D) °F

$$\text{Air Flowrate} = \frac{HL}{1.10X(T_i - T_o)} = \frac{[\quad](A)}{1.10\ [\quad](D)} = [\quad](1)\ \text{CFM}$$

Designing For Dilution Of Contaminants

Building Volume BV = [ ] (E) CFM

Air Change Frequency (Typical values for common contaminants can be found in the ***LOREN COOK*** Engineering Cookbook.) ACF = [ ] (F) MIN./CHANGE

$$\text{Air Flowrate} = \frac{BV}{ACF} = \frac{[\quad](E)}{[\quad](F)} = [\quad](1)$$

Once the required air volume is known, the locations of gravity ventilators and intake openings need to be determined. It is wise to disperse gravity ventilators over the roof surface to provide even ventilation. If all intake openings are located on one side of the building, typically the gravity ventilators would be located on the opposite side of the building to provide a sweeping effect across the space.

Determining Size of Gravity Ventilators Required

1. Required Airflow (From heat removal or contaminate dilution on previous page.) Q= [ ] (1) CFM

2. Wind Velocity (Due to the fact that most wind velocity data is taken at 33 feet above ground level and that wind velocity decreases closer to the ground and with any disruption, design wind velocity should be less than meteorological data would suggest. Half of the average wind velocity is a good design value.) V= [ ] (2) MPH

3. Height Of Gravity Ventilator Above Neutral Pressure Level (The height above neutral pressure level can be assumed to be the distance above the centerline elevation of the largest opening in the side wall, usually an overhead door. If the side wall openings are evenly spaced along the height of the side wall, the height above neutral pressure level would be half the building height.) H= [ ] (3) FT

4. Indoor Dry Bulb Temperature To Be Maintained T_i = [ ] (4) °F

5. Outdoor Dry Bulb Temperature T_o = [ ] (5) °F

6. Difference Between Indoor and Outdoor Temperature $T_i - T_o$ = [ ] (6) °F

7. Gravity Ventilator Throat Velocity (TV)

$$TV = \sqrt{1936V^2 + \frac{57960H(T_i - T_o)}{(T_i + 460)}} = \sqrt{1936 \times {}^{(2)}[\ \ ]^2 + \frac{57960 \times {}^{(3)}[\ \ ] \times {}^{(6)}[\ \ ]}{({}^{(4)}[\ \ ] + 460)}} = [\ \ ]^{(7)} \frac{FT}{MIN}$$

8. Total Gravity Ventilator Throat Area (A)

$$A = \frac{Q}{TV} = \frac{[\ \ ]^{(1)}}{[\ \ ]^{(7)}} = [\ \ ]^{(8)} \text{ SQ FT}$$

9. Determine The Number of Ventilators That Is Required To Evenly Disperse The Airflow N = [ ] (9)

10. The Throat Area For Each Gravity Roof Unit

$$\text{Throat Area} = \frac{A}{N} = \frac{[\ \ ]^{(8)}}{[\ \ ]^{(9)}} = [\ \ ] \text{ SQ FT}$$

Example

156,000 BTU/Hr Heat Load
90×F Indoor Dry Bulb Temperature
80×F Outdoor Dry Bulb Temperature
15 ft Roof Elevation
10 ft Overhead Door (Primary Intake)
7 Gravity Ventilators
5 MPH Wind Velocity

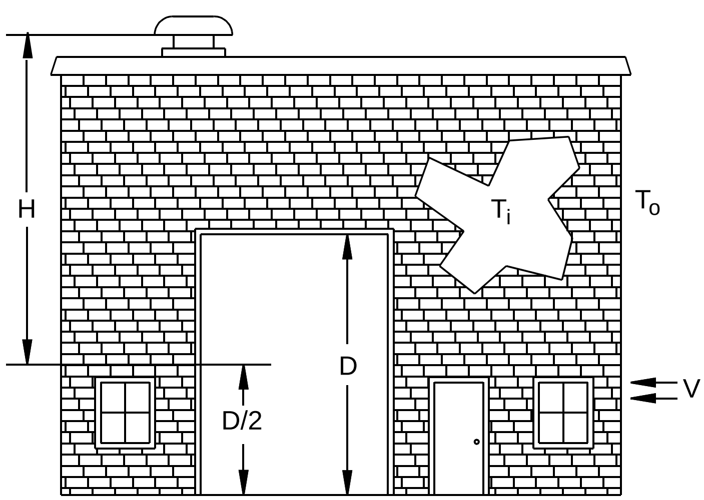
$$CFM = \frac{\frac{156,000\ BTU}{HR}}{1.10X(90 - 80)} = 14,181\ CFM$$

$$A = \frac{Q}{TV} = \frac{14181}{242.8} = 58.4\ SQ\ FT$$

$$TV = \sqrt{1936X\left(5^2 + \frac{57960X((15 - 5)X(90 - 80))}{90 + 460}\right)} = 242.8$$ FT PER MIN

$$\text{Throat Area} = \frac{A}{N} = \frac{58.4}{7} = 8.34\ SQ\ FT$$

Select (7) ***LOREN COOK*** Model GR 30 x 42 (8.75 ft^2 throat area).

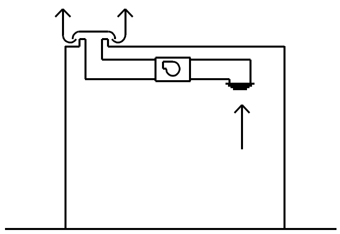


Aspect Ratio

Note that many selections are possible which will have an equivalent throat area. When making a decision on throat size, keep in mind that selections with an aspect ratio of 3:1 or less will perform the best. Aspect ratio is the ratio of the throat length to the throat width. (Example: 30 x 42 has an aspect ratio of 1.4:1 which is well below the 3:1 maximum.)

MECHANICAL VENTILATION

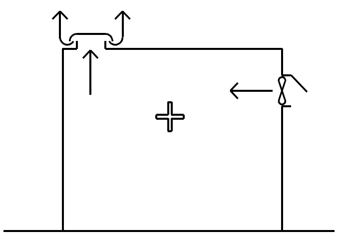
When selecting gravity ventilators for mechanical ventilation systems power ventilators will be forcing air in or out of the building through the gravity ventilators. The power ventilator may be directly connected to the gravity ventilator via ductwork or the building may constitute a plenum, the air induced to move through the gravity ventilator merely by the pressure differential created between the interior of the building and the ambient atmosphere.



Ducted Relief

Ducted Relief

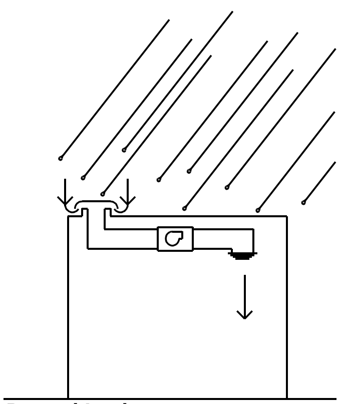
This application is the most simple of all gravity ventilator applications. The ventilators are selected based on the air volume and acceptable pressure drop along with any physical limitations which may affect the dimensions of the product.



Non-Ducted Relief

Non-Ducted Relief

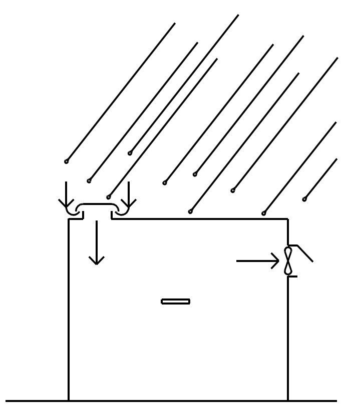
Non-ducted relief gravity ventilator applications are very similar to ducted relief applications with the exception that the pressure drop of the ventilator should be kept to a minimum. The building will be pressurized to approximately the selected pressure drop of the gravity ventilator. Selecting the ventilator for pressure drops in excess of 1/8” wg will result in problems with exit doors standing open and unwanted infiltration into any adjacent conditioned areas.



Ducted Intake

Ducted Intake

Ducted intake applications are similar to ducted relief with the additional consideration of intake velocity. Moisture carryover begins to occur at approximately 500 FPM intake velocity and gravity ventilator selections should, therefore, be kept below that threshold unless moisture containment measures are added to the system.

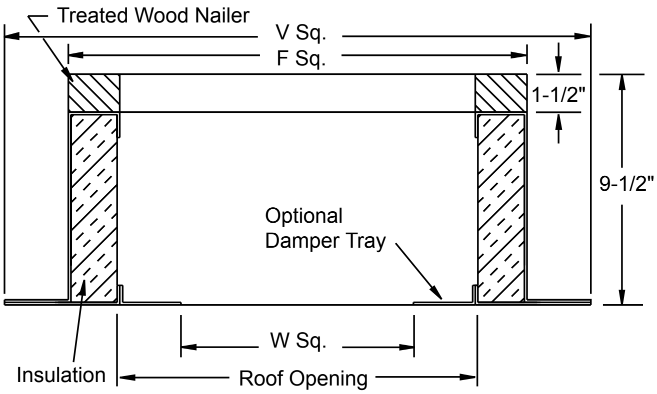


Non-Ducted Intake

Non-Ducted Intake

Although the 500 FPM intake velocity will usually limit the intake static pressure, the designer should double-check gravity ventilator pressure drop to ensure that it does not exceed 1/8” wg. If the negative pressure is excessive, it can result in difficulty opening exit doors and dangerous slamming of already open doors.

Curbs



Curb Construction Features

- Minimum 18 gauge galvanized steel (RCG) or .080 aluminum (RCA).
- 1-1/2", 3 lbs. density thermal and acoustical insulation.
- Continuously welded corners.
- Wood nailer.

Options

- Damper tray.
- No wood nailer (deduct 1-1/2" from height).
- 13-1/2" tall construction.
- 3" cant (add 4" to V Sq. dimension).

GI / GR / TRE Curb Sizing - The curb size for a unit is found by adding 4" to each dimension of the throat size. For a 24 x 30 GI, the appropriate galvanized curb would be a RCG 28 x 34. Additional information can be found in **LOREN COOK** submittals.

PR/TR/LSUG Curb Dimension Data

PR/ TR	LSUG	Catalog Number		F Sq.	V Sq.	W Sq.	Roof Opening
		Galv.	Alum.				
8	-	RCG-16	RCA-16	16-1/2	20-1/2	9-3/4	13-1/2
12	-	RCG-18	RCA-18	18-1/2	22-1/2	11-3/4	15-1/2
16	-	RCG-26	RCA-26	26-1/2	30-1/2	19-3/4	23-1/2
20	-	RCG-30	RCA-30	30-1/2	34-1/2	23-3/4	27-1/2
24	24	RCG-34	RCA-34	34-1/2	38-1/2	27-3/4	31-1/2
30	30	RCG-40	RCA-40	40-1/2	44-1/2	33-3/4	37-1/2
36	36	RCG-46	RCA-46	46-1/2	50-1/2	39-3/4	43-1/2
42	42	RCG-52	RCA-52	52-1/2	56-1/2	45-3/4	49-1/2
48	48	RCG-58	RCA-58	58-1/2	62-1/2	51-3/4	55-1/2
-	54	RCG-54	RCA-54	64-1/2	66-1/2	57-1/4	61-1/2
-	60	RCG-70	RCA-50	70-1/2	74-1/2	63-3/4	67-1/2

All dimensions in inches. When motor operated damper is used, a wood nailer is required. Sound curbs available for most sizes. Contact factory for dimensions.

Additional Accessories

- Aluminum Bird Screen
- 2" Washable Filters
- Hinged Base
- Magnetic Latches (LSUG)
- Discharge Guard (LSUG)
- Insect Screen
- Galvanized Construction (GI/GR)

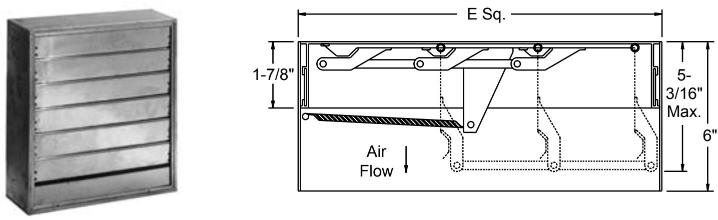
Available Coatings

- **LORENIZED**® - Standard on LSUG
- Epoxy
- Anti-condensate

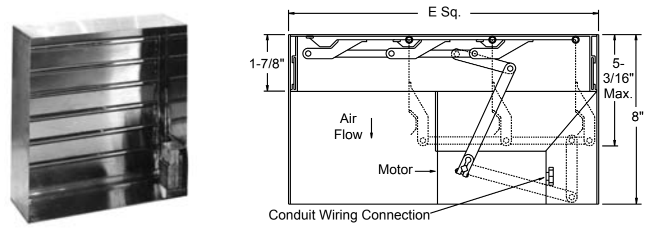
Dampers

Gravity dampers feature an extruded aluminum frame, aluminum blades and aluminum hinge pins with nylon bushings. Motorized dampers feature an extruded aluminum frame, aluminum blades and aluminum hinge pins with nylon bushings. Motors are shipped loose for field installation on motorized backdraft dampers (BDM). Motors are shipped installed on motorized intake backdraft dampers (BDMI). Available voltages include 115V, 220V and 440V.

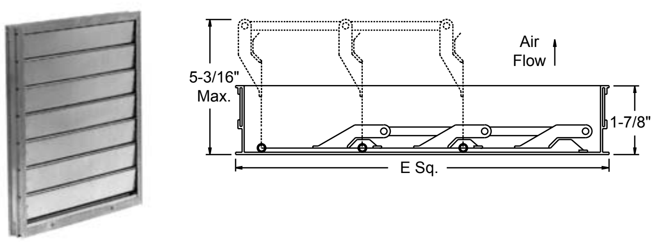
Intake Backdraft Damper



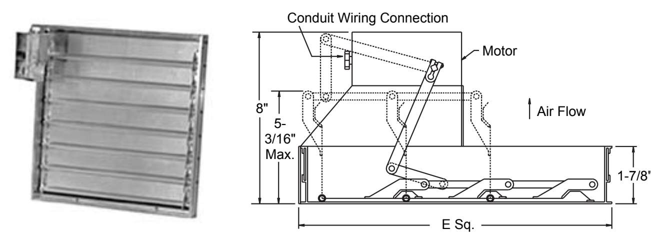
Motorized Intake Backdraft Damper



Gravity Backdraft Damper



Motorized Backdraft Damper



GI / GR Backdraft Damper Sizing - The length and width of the backdraft damper is 1/4” smaller than the length and width of the throat. The damper is designed to fit on the optional damper tray in the curb.

TRE Backdraft Damper Sizing - The length and width of the backdraft damper is 1-1/2” larger than the length and width of the TRE throat for dampers to be mounted in TRE unit. The damper is sized to fit on the integral damper tray located in the throat of the unit. The length and width of the backdraft damper is 1/4” smaller than the length and width of the throat for dampers to be curb mounted. On TRE Intake units with less than 4 tiers, TRE Relief units with less than 3 tiers, or TRE Intake units with 2” filters, a Backdraft Damper must be installed in a curb with tray. Dampers mounted in TRE for “knocked down” units require special consideration, consult factory.

PR/TR	Catalog Number				E Sq.
	BDI*	BDMI**	BD***	BDM$^{\Delta}$	
8	BDI-12	BDMI-12	BD-12	BDM-12	11-3/4
12	BDI-14	BDMI-14	BD-14	BDM-14	13-3/4
16	BDI-22	BDMI-22	BD-22	BDM-22	21-3/4
20	BDI-26	BDMI-26	BD-26	BDM-26	25-3/4
24	BDI-30	BDMI-30	BD-30	BDM-30	29-3/4
30	BDI-36	BDMI-36	BD-36	BDM-36	35-3/4
36	BDI-42	BDMI-42	BD-42	BDM-42	41-3/4
42	BDI-48	BDMI-48	BD-48	BDM-48	47-3/4
48	BDI-54	BDMI-54	BD-54	BDM-54	53-3/4

All dimensions in inches.

*BDI - Maximum operating temperature is 200° F (95° C).

**BDMI - Motors are available in 110V, 220V, or 440V, single phase. BDMI-36 and larger use two motors. Maximum operating temperature is 130° F (50° C). Wood nailer must be supplied on 9-1/2” tall curb.

***BD - Maximum operating temperature is 200° F (95° C). BD-36 to BD-66 are shipped as two panels. BD-78 is shipped as three panels.

$^{\Delta}$BDM - Maximum operating temperature is 130° F (50° C). Wood nailer must be supplied on 9-1/2” tall curb. Motors are available in 110V, 220V, or 440V, single phase. BDM-36 and larger use two motors.

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