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Date: 7/12/2023

Return Request: 7/22/2023

Project: LRSD – Rockefeller Early Childhood

Supplier: CaptiveAire

Manufacturer: CaptiveAire

Submittal: Centrifugal HVAC Fans

Submittal Number: 23 34 16-01

Drawing # and Installation: Mechanical Drawings

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N. Little Rock, AR 72118
501-376-6681

ENGINEER

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201 S. Chester St.
Little Rock, AR 72201
501-237-3077

GENERAL CONTRACTOR

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LITTLE ROCK, ARKANSAS

JOB NAME: LRSD ROCKEFELLER

JOB #: 23.1004

SUBMITTAL #: 23 34 16-1

VENDOR: COMFORT SYSTEMS

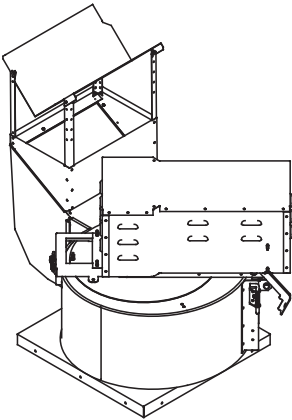
SPEC SECTION: 23 34 16

BY: ANDREW MCCARTY **DATE:** 7/19/23

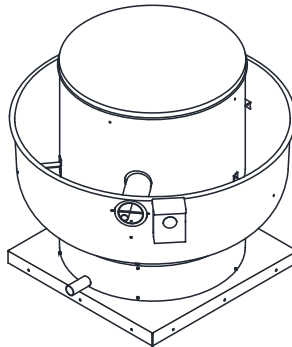
COMMENTS:

Kinco's review indicates that general conformity to the contract drawings, specifications and addenda to the best of our technical knowledge has been met by the vendor. This review does not in any way relieve the vendor of its obligation to perform or supply their product in strict accordance with the aforementioned contract documents. This submittal is certified to be in conformance with contract documents unless noted of herein.

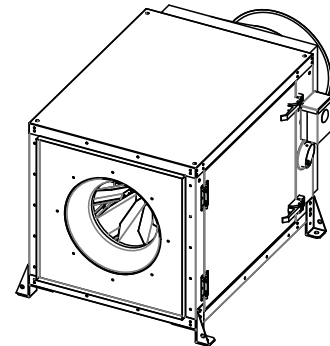
Installation, Operation, and Maintenance Manual



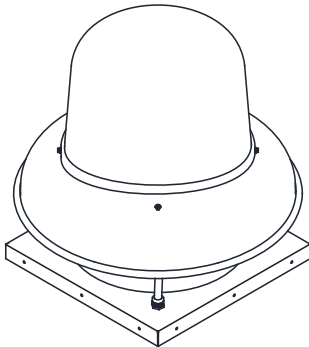
Curb Mount Utility Set



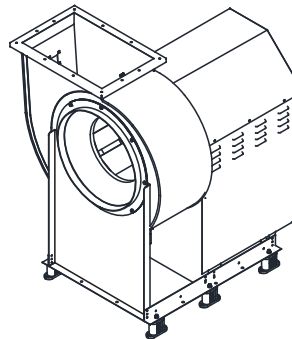
Up-blast Centrifugal Fan



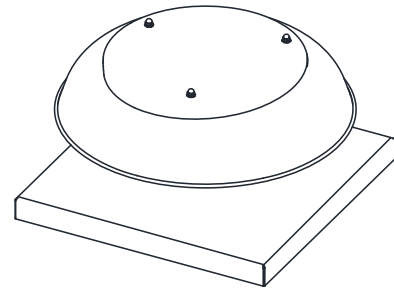
Square Inline



Down-blast Centrifugal Fan



Utility Set



Axial Fan

RECEIVING AND INSPECTION

Upon receiving unit, check for any interior and exterior damage, and if found, report it immediately to the carrier. Check that all accessory items are accounted for and free of damage. Turn the blower wheel by hand to verify free rotation and check the damper (if supplied) operates freely.

WARNING!!

Installation of this ventilator should only be performed by a qualified professional who has read and understands these instructions and is familiar with proper safety precautions. Improper installation poses serious risk of injury due to electric shock, contact with rotating equipment, and other potential hazards. Read this manual thoroughly before installing or servicing this equipment. **ALWAYS** disconnect power prior to working on fan.

Save these instructions: This document is the property of the owner of this equipment and is required for future maintenance. Leave this document with the owner when installation or service is complete.

Table of Contents

WARRANTY	4
INSTALLATION	5
Mechanical	5
Site Preparation	5
Roof Mounting	6
Wall Mounting	6
Curb and Ductwork	7
Duct Routing	10
Up-blast Wall Mount Details	11
Up-blast Through Wall Mount Details	12
Up-blast Roof Mount Installation	13
Down-blast Installation	13
Typical Hinge Kit - Centrifugal Up-blast	14
Heavy Duty (HD) Hinge Kit Installation	16
Heavy Duty (HD)/Extended Locking Hinge Kit Installation	18
Typical Grease Box Installation	20
Up-blast Utility Set Installation	21
Up-blast Utility Set Inlet Options	22
Inlet Service Duct Option	23
Up-blast Utility Set	24
Curb Mounted Sled Options (DD Only)	25
Up-blast Utility Set Indoor Installation	27
Up-blast Curb Mounted Utility Set Hinging Instructions	28
Up-blast Curb Mounted Utility Set Discharge Extension Option	29
Up-blast Curb Mounted Utility Set Rain Cap Option	29
Square Inline Mounting Configurations	30
Square Inline Mounting Bracket Detail	30
Square Inline Fan Drain	31
Square Inline Filter Bank Option	31
Square Inlet Discharge Options	31
Square Inline Discharge Configurations	32
Electrical	33
Permanent Split Capacitor (PSC) Motor Speed Control	34
Motorized Intake Damper	34
Electronically Commutated Motor (ECM) Speed Control	35
Unit Mount Controller	35
External PWM Signal	36
Fan to Building Wiring Connection	37
Motor Speed Controller (MSC) Installation	38
MSC Controls Overview	39
MSC Menu	39
Input Threshold	41
MSC Menu Tree	42
Variable Frequency Drive (VFD)	43
VFD Installation	44
Input AC Power	44
VFD Output Power	44
VFD Programming	45
ACTECH SMV VFD	46
START-UP OPERATION	47
Unit Start-up Procedure	47
Pulley Adjustment	48
Pulley Alignment/Proper Belt Tension	49
Bushing Information	50
Removing Fan Wheel	50
Installing Fan Wheel	51
Pulley Combination Chart	52
TROUBLESHOOTING	53
Airflow Troubleshooting Chart	53
MSC Troubleshooting	54
MAINTENANCE	55
General Maintenance	55
2 Weeks After Start-up	55
Every 3 Months	55
Yearly	55
Start-up and Maintenance Documentation	56

WARRANTY

This equipment is warranted to be free from defects in materials and workmanship, under normal use and service, for a period of 2-years from date of shipment. This warranty shall not apply if:

1. The equipment is not installed by a qualified installer per the MANUFACTURER'S installation instructions shipped with the product.
2. The equipment is not installed in accordance with Federal, State, and Local codes and regulations.
3. The equipment is misused, neglected, or not maintained per the MANUFACTURER'S maintenance instructions.
4. The equipment is not installed and operated within the limitations set forth in this manual.
5. The invoice is not paid within the terms of the sales agreement.

The MANUFACTURER shall not be liable for incidental and consequential losses and damages potentially attributable to malfunctioning equipment. Should any part of the equipment prove to be defective in material or workmanship within the 2-year warranty period, upon examination by the MANUFACTURER, such part will be repaired or replaced by MANUFACTURER at no charge. The BUYER shall pay all labor costs incurred in connection with such repair or replacement. Equipment shall not be returned without MANUFACTURER'S prior authorization, and all returned equipment shall be shipped by the BUYER, freight prepaid to a destination determined by the MANUFACTURER.

NOTE: To receive warranty coverage for this product, copy and print out the "Start-up and Maintenance Documentation" on page 56. Fill in all required details. Fax the page to 1-919-516-8710 or call 1-866-784-6900 for email information.

INSTALLATION

It is imperative that this unit is installed and operated with the designed airflow and electrical supply in accordance with this manual. If there are any questions about any items, please call the service department at **1-866-784-6900** for warranty and technical support issues.

Mechanical

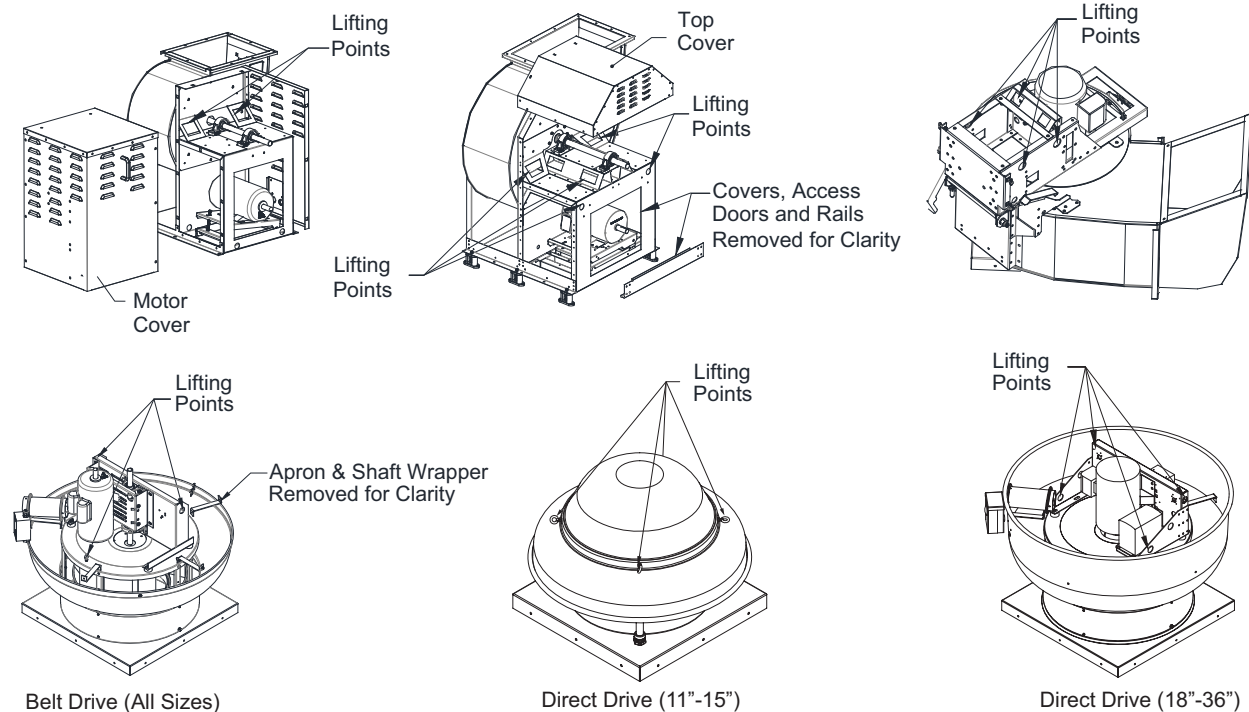
WARNING: DO NOT RAISE VENTILATOR BY THE HOOD, BLOWER OR MOTOR SHAFT, OR BEARINGS – USE LIFTING POINTS PROVIDED OR A SLING.

Site Preparation

1. Provide clearance around installation site to safely rig and lift equipment into its final position. Refer to **Figure 1** for lifting point locations. Supports must adequately sustain equipment. Refer to manufacturer's estimated weights.
2. Consider general service and installation space when locating unit.
3. Locate unit close to the space it will serve to reduce long, twisted duct runs.
4. The fan discharge must be located at least 10 feet away from any supply intakes. The fan discharge shall be in accordance with the applicable building code provisions.
5. Inline fans can be interior mounted, motors shall be located outside of the exhaust air-stream.
6. Interior mounted fans must have a grease drain that is piped to an approved grease reservoir.
7. Interior mounted fans are considered part of the duct system. Clearance to combustibles must always be maintained. If necessary, the fan may be wrapped to maintain the duct system fire rating.

NOTE: Never Lift Fans From Shafts and Bearings.

Figure 1 - Recommended Lifting Points



Refer to **“Curb Mounted Sled Options (DD Only)”** on page 25 and page 26 for lifting points.

Roof Mounting

Ventilators are designed for installation on top of a prefabricated or factory-built roof curb. If an up-blast fan is used for kitchen hood exhaust, ensure discharge is at least 40" above the roof surface in accordance with NFPA 96. Refer to Authority Having Jurisdiction (AHJ) requirements prior to installation. Follow manufacturer's instructions for proper curb installation.

1. If a backdraft damper is required, it should be secured within the curb using sheet metal screws to the bottom of a damper box or damper support flanges located below the roof deck.

CAUTION: NFPA 96 RECOMMENDS THAT DAMPERS SHOULD NOT BE INSTALLED WHEN EXHAUSTER IS USED FOR REMOVAL OF SMOKE AND GREASE LADEN VAPORS FROM COMMERCIAL KITCHEN EQUIPMENT. CONSULT STATE AND LOCAL CODES FOR DETAILED REQUIREMENTS.

2. On an up-blast fan, normally the power cord is brought through the conduit tube located on the top skirt on the outside of the unit.
3. Curb to substrate installation: Secure curb flange to substrate using suitable hardware (not furnished). Refer to **Table 1** and **Table 2** for hardware details.
4. Fan to curb installation: Use 1/4"-14 x 2" galvanized self-drilling screws. 19" through 40" fan bases use a minimum of 12 screws (3 per side). 44" fan bases use a minimum of 16 screws (4 per side).
5. Before connecting power source to the fan motor, verify power line wiring is de-energized. Check that the power source is compatible with the requirements of your equipment.
6. Connect power supply wiring to the motor as indicated on the motor nameplate or terminal box cover.
7. Before powering up fan, check ventilator wheel for free rotation.
8. Re-install motor cover. Check all fasteners for tightness.
9. A drain pipe is provided for single-point drainage of water and residue on up-blast fans. The drain pipe should be positioned towards the roof slope. Some means for collection of this residue must be provided, either a container directly under the trough or use of an adapter and pipe to carry the residue to a remote collection point. An optional downspout and grease collection box is available as an accessory item for up-blast fans.

Wall Mounting

Refer to Authority Having Jurisdiction (AHJ) requirements prior to installation. Follow manufacturer's instructions for proper curb installation.

1. The same instructions, warnings, and notes found under Roof Mounting section will apply. Follow steps 1-9 from above, with additional mounting information below.
2. **Masonry Wall/Steel Studs:** Around the wall opening, install an angle iron frame at least 2" x 2" x 1/4". Frame should be approximately 1/2" smaller than the inside base dimension of the ventilator. For masonry, secure the lead cinch type anchors with non-ferrous bolts (3 per side). For steel, use self-drilling screws (3) per side. The ventilator should be mounted to the mounting angle iron frame with self-tapping sheet metal screws (3 per side).
3. **Wood Sidings:** Around the wall opening, install a wooden frame 2" high x 2" wide. Frame should be approximately 1/2" smaller than the inside base dimension of the ventilator. Secure with counter-sunk expansion type lag bolts (3 per side). The ventilator should then be mounted to the mounting frame with square head wood screws (3 per side) 3/8" minimum.
4. Steel wall mount brackets are also available as a factory option for the fan.
5. The mounting flange connections should be coated with a suitable caulking compound or an approved waterproof mastic sealer.
6. Wall mount application is not recommended for fans greater than 24" wheel with 2 HP motor (1 or 3 phase); 24" wheel with 3 HP motor (3 phase only).

IMPORTANT: OSHA REGULATIONS REQUIRE THE VENTILATOR TO BE MOUNTED AT LEAST EIGHT (8) FEET ABOVE GROUND OR FLOOR LEVEL.

Curb and Ductwork

This fan was specified for a specific CFM and static pressure. The ductwork attached to this unit will significantly affect airflow performance. Flexible ductwork and square elbows should not be used. Also, transitions and turns in ductwork near the fan inlet will cause system effect and will drastically increase the static pressure and reduce airflow. **Follow SMACNA guides and recommendations for the remaining duct run.** Fans designed for rooftop installation should be installed on a prefabricated or factory-built roof curb. Follow curb manufacturer's instructions for proper curb installation.

An example of a curb installation: Curbs should be secured to structural members, such as wooden studs, steel studs, or concrete. The curb should be installed to the roof and/or wall using appropriate type and size fasteners. Refer to **Table 1** for minimum hardware requirements, refer to **Table 2** for quantity per curb flange. Always use suitable fasteners (not furnished) and quantity recommendations.

Refer to **Figure 2** and **Figure 3** for installation details. The fan should be installed on a curb and/or rail. Caulking, flashing, and sealing of wall/roof penetration done by contractor or installer.

Verify that the duct connection and fan inlet are properly aligned and sealed. The fan base is secured to the curb with 1/4"-14 x 2" galvanized self-drilling screws. Use a minimum of 12 screws (3 per side) for units with base sizes 19" through 40". Use a minimum of 16 screws (4 per side) for units with a base size of 44". Shims may be required depending upon curb installation and wall/roofing material. Check all fasteners for tightness.

Figure 2 - Curb Mount Details

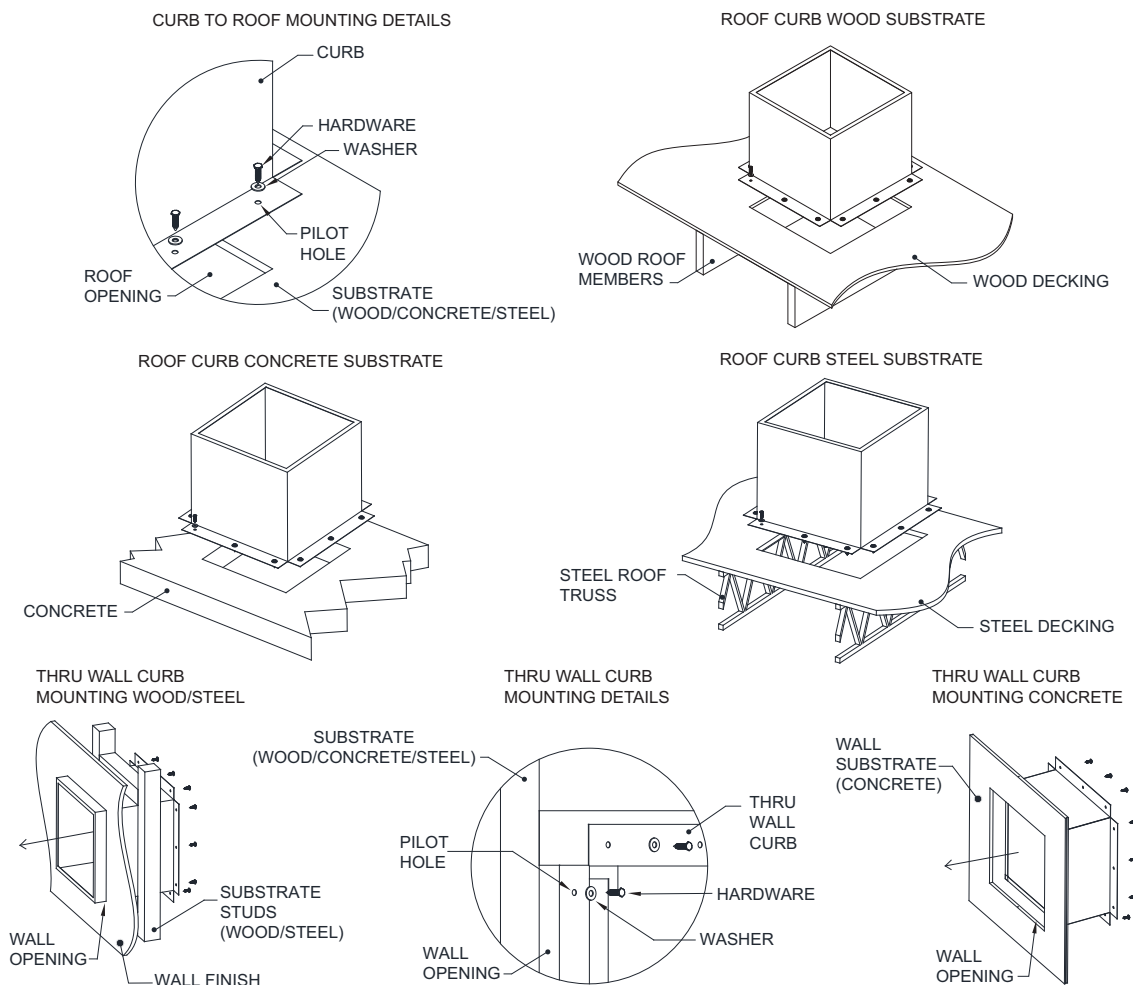


Figure 3 - Minimum Edge Distance and Penetration Details

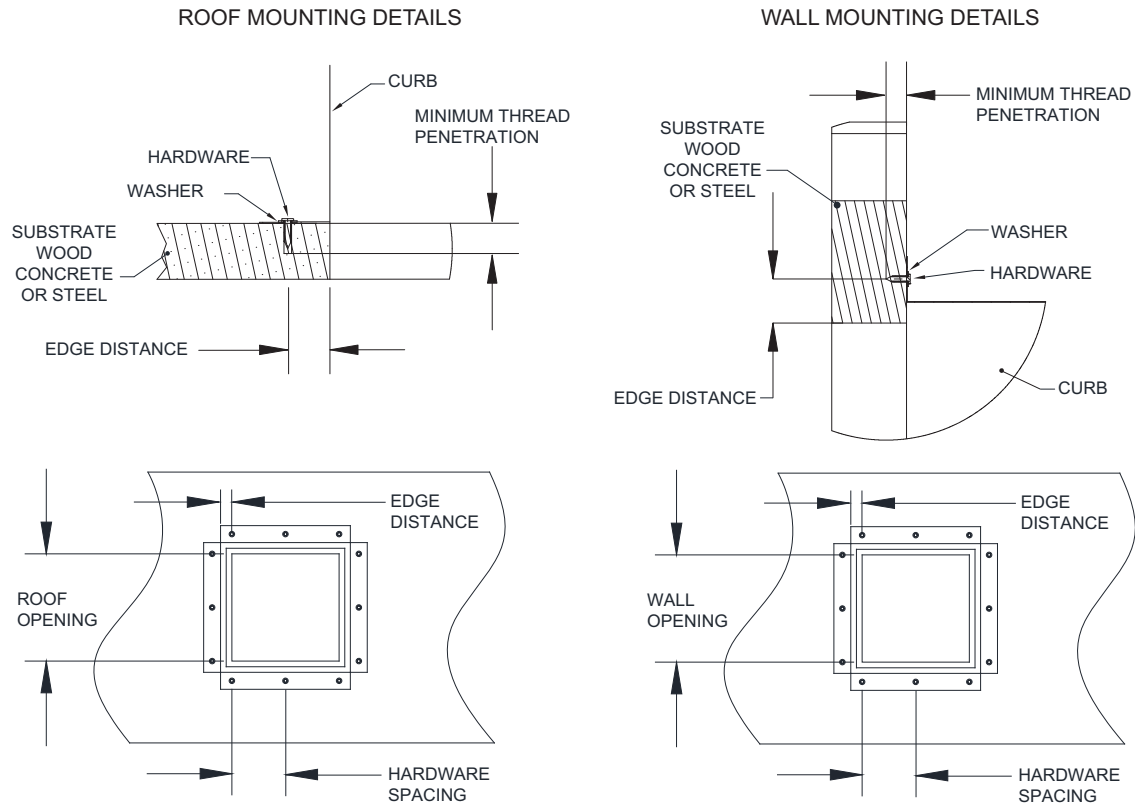


Table 1 - Minimum Hardware Requirements

Material	Minimum Hardware Specifications	Minimum Thread Penetration	Minimum Edge Distance
Wood - Minimum G.42	Zinc Plated Steel Hex Head Lag Screw 3/8" x 2-1/2" with 3/8" washer	2"	1-1/2"
Concrete - 2500 Minimum PSI	Hilti Kwik Bolt 3/8" Diameter TZ2 Expansion Anchor with 3/8" washer	2-5/16"	3"
Steel (Studs/Roof Truss)	Dril-Flex Self-Drilling Screws 1/4"-14 Min. 1/2" Through with 1/4" washer	12 Gauge or 1/8" Thick	3/8"

Table 2 - Curb to Deck Minimum Fastener Quantity

Fan Base Size	Hardware Quantity Wood	Hardware Quantity Concrete	Hardware Quantity Steel
19"	12 (3 per side)	12 (3 per side)	12 (3 per side)
21"	12 (3 per side)	12 (3 per side)	16 (4 per side)
24-3/4"	16 (4 per side)	16 (4 per side)	20 (5 per side)
26"	20 (5 per side)	20 (5 per side)	24 (6 per side)
28"	20 (5 per side)	20 (5 per side)	24 (6 per side)
33"	24 (6 per side)	24 (6 per side)	28 (7 per side)
40"	28 (7 per side)	28 (7 per side)	36 (8 per side)
44"	40 (10 per side)	36 (9 per side)	44 (11 per side)

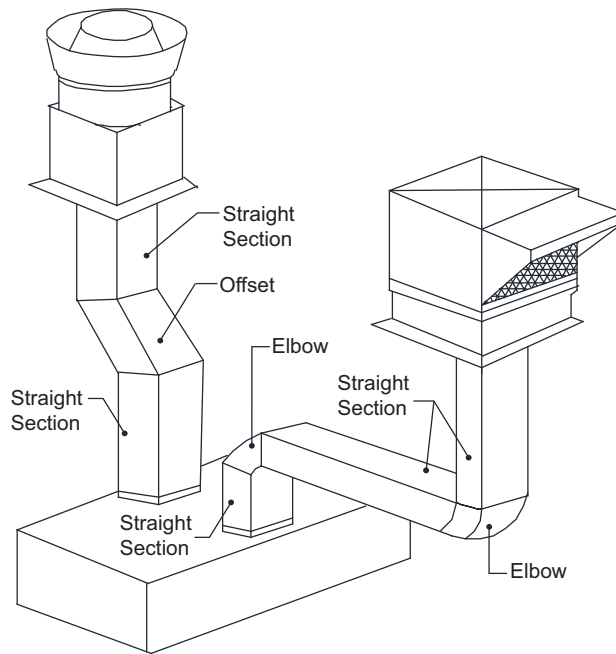
Fan Base Size	Hardware Quantity Wood	Hardware Quantity Concrete	Hardware Quantity Steel
41" x 27"	Long Side 14 (7 per side) Short Side 10 (5 per side)	Long Side 14 (7 per side) Short Side 10 (5 per side)	Long Side 16 (8 per side) Short Side 12 (6 per side)
59" x 27"	Long Side 22 (11 per side) Short Side 10 (5 per side)	Long Side 20 (10 per side) Short Side 10 (5 per side)	Long Side 20 (10 per side) Short Side 12 (6 per side)
61" x 27"	Long Side 22 (11 per side) Short Side 10 (5 per side)	Long Side 20 (10 per side) Short Side 10 (5 per side)	Long Side 20 (10 per side) Short Side 12 (6 per side)
64" x 27"	Long Side 24 (12 per side) Short Side 10 (5 per side)	Long Side 20 (10 per side) Short Side 10 (5 per side)	Long Side 20 (10 per side) Short Side 12 (6 per side)
45" x 31"	Long Side 20 (10 per side) Short Side 12 (6 per side)	Long Side 18 (9 per side) Short Side 12 (6 per side)	Long Side 22 (11 per side) Short Side 14 (7 per side)
74" x 31"	Long Side 28 (14 per side) Short Side 12 (6 per side)	Long Side 24 (12 per side) Short Side 12 (6 per side)	Long Side 24 (12 per side) Short Side 14 (7 per side)
52" x 42.5"	Long Side 22 (11 per side) Short Side 20 (10 per side)	Long Side 20 (10 per side) Short Side 18 (9 per side)	Long Side 22 (11 per side) Short Side 22 (11 per side)
94" x 42.5"	Long Side 28 (14 per side) Short Side 20 (10 per side)	Long Side 24 (12 per side) Short Side 18 (9 per side)	Long Side 24 (12 per side) Short Side 22 (11 per side)
62" x 51"	Long Side 22 (11 per side) Short Side 20 (10 per side)	Long Side 20 (10 per side) Short Side 20 (10 per side)	Long Side 20 (10 per side) Short Side 20 (10 per side)
108" x 51"	Long Side 34 (17 per side) Short Side 20 (10 per side)	Long Side 28 (14 per side) Short Side 20 (10 per side)	Long Side 28 (14 per side) Short Side 20 (10 per side)

NOTE: Fan to Curb Installation: Use 1/4"-14 x 2" self-drilling screws. Use a minimum of 12 screws (3 per side) for 19" through 40" fan bases. Use a minimum of 16 screws (4 per side) for 44" fan bases.

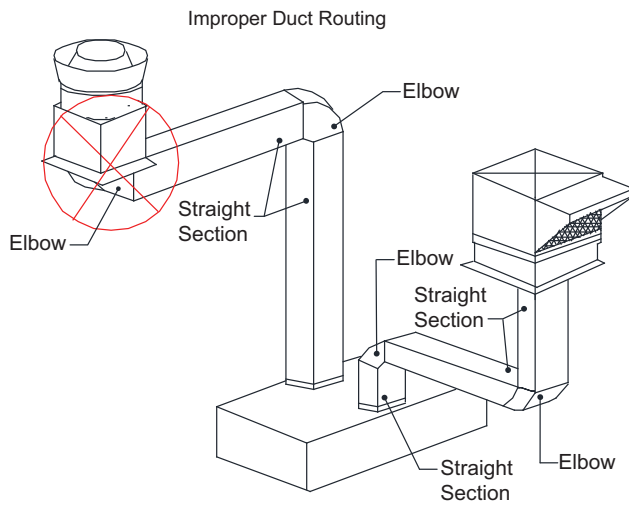
Duct Routing

Figure 4 - Examples of Duct Routing

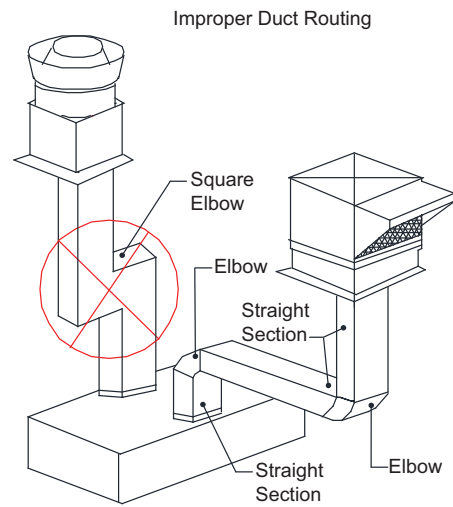
Proper Duct Routing



Use offsets if the duct cannot be routed straight up.



DO NOT connect elbow directly to fan inlet.



DO NOT use square elbows.

Up-blast Wall Mount Details

Drill pilot holes into the bracket.

Secure wall mount bracket to the wall. Refer to **Table 1** for hardware details.

Use at least (3) suitable fasteners (not furnished) per side.

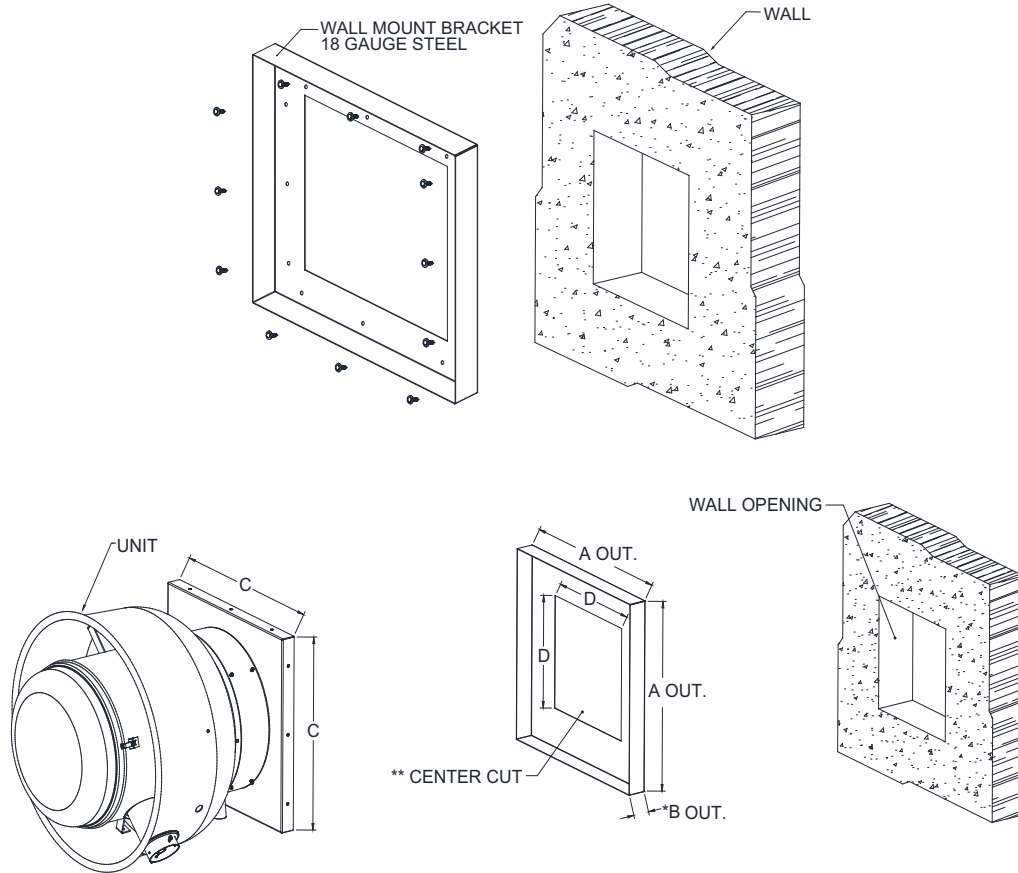
Wall bracket fits into base of fan.

Use self-drilling screws to attach unit to the wall mount bracket.

* "B" dimension = 5" when used with damper.

** Centered in wall mount.

Figure 5 - Wall Mount Bracket



A Outer	B Outer	C	D
18-1/2"	2"	19"	13"
20-1/2"	2"	21"	16"
21-1/2"	2"	22"	16"
24-1/4"	2"	24-3/4"	20"
25-1/2"	2"	26"	20"
27-1/2"	2"	28"	24"
32-1/2"	2"	33"	28"

Up-blast Through Wall Mount Details

Standard curb fits into base of fan.

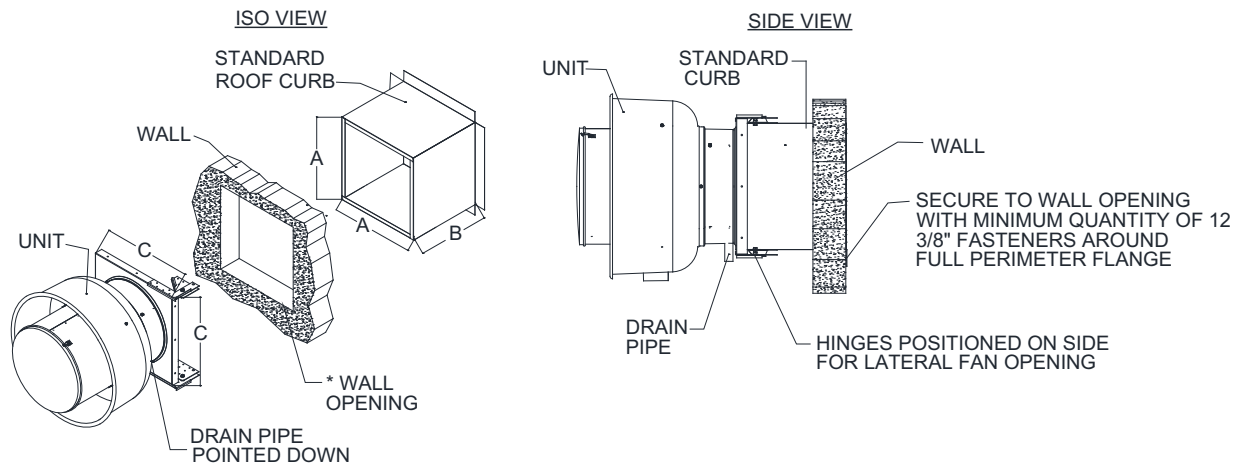
Refer to “Curb and Ductwork” on page 7 for curb installation details.

Use self-drilling screws when attaching unit to curb.

Flashing and sealing of wall penetration done by contractor or installer.

For use with fans up to: 24” Wheel 2 HP - 1 Phase Maximum; 24” Wheel 3 HP - 3 Phase Maximum

Figure 6 - Through Wall Mount Details



*Contractor or installer must flash wall to curb.

A Dimension	B Dimension	C Dimension
19-1/2"	22"	21"
19-1/2"	20"	21"
23"	20"	24-3/4"
26-1/6	20"	28"
26-1/2"	20"	28"
31-1/2"	20"	33"

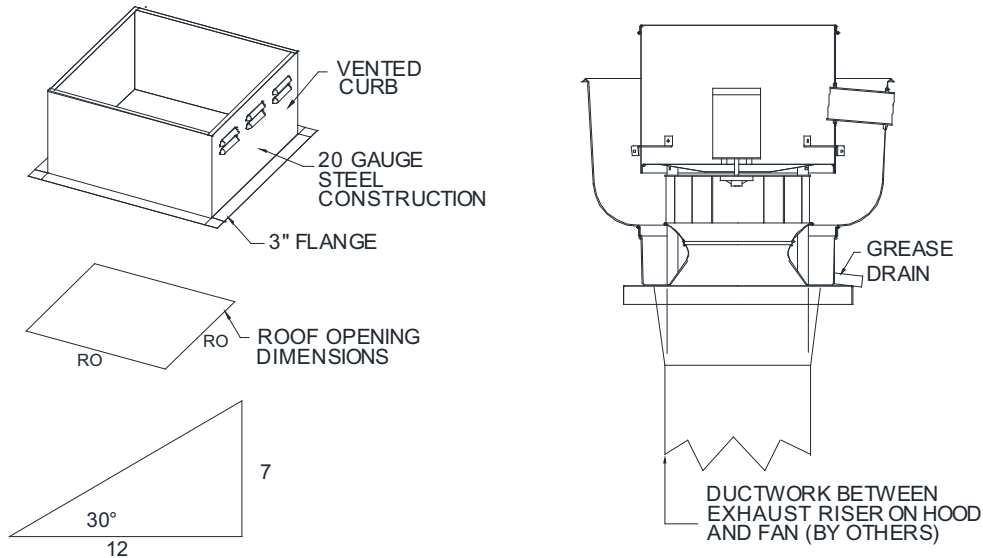
Up-blast Roof Mount Installation

Normal temperature test – The exhaust fan must operate continuously while exhausting air at 300°F (149°C) until all fan parts have reached thermal equilibrium, and without any deteriorating effects to the fan which would cause unsafe operation.

Abnormal flare-up test – The exhaust fan must operate continuously while exhausting burning grease vapors at 600°F (316°C) for a period of 15 minutes without the fan becoming damaged to any extent that could cause an unsafe condition.

Pitched curbs are available. Specify pitch when ordering, for example: 7/12 Pitch = 30° Slope

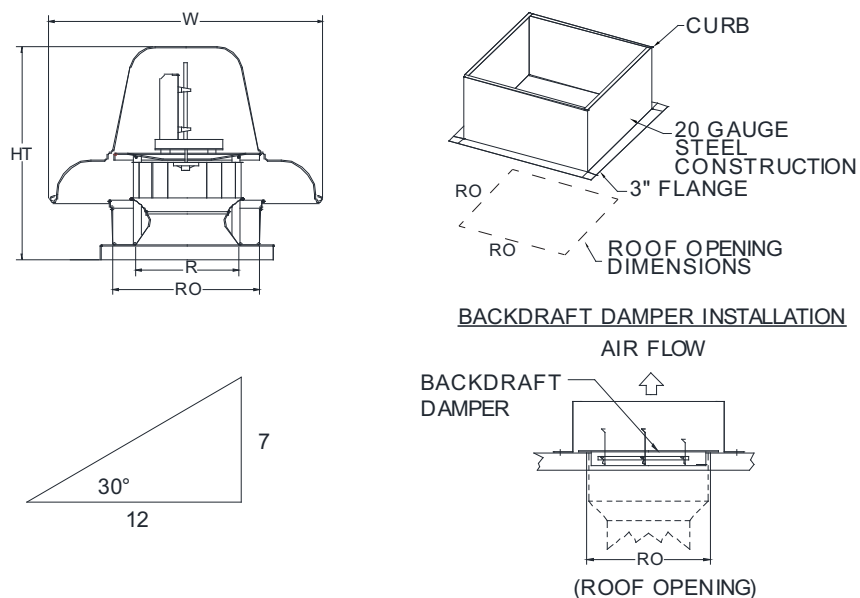
Figure 7 - Up-blast Roof Mount Details



Down-blast Installation

Pitched curbs are available. Specify pitch when ordering, for example: 7/12 Pitch = 30° Slope

Figure 8 - Down-Blast Details



Typical Hinge Kit - Centrifugal Up-blast

Hinge Kit Field Installation

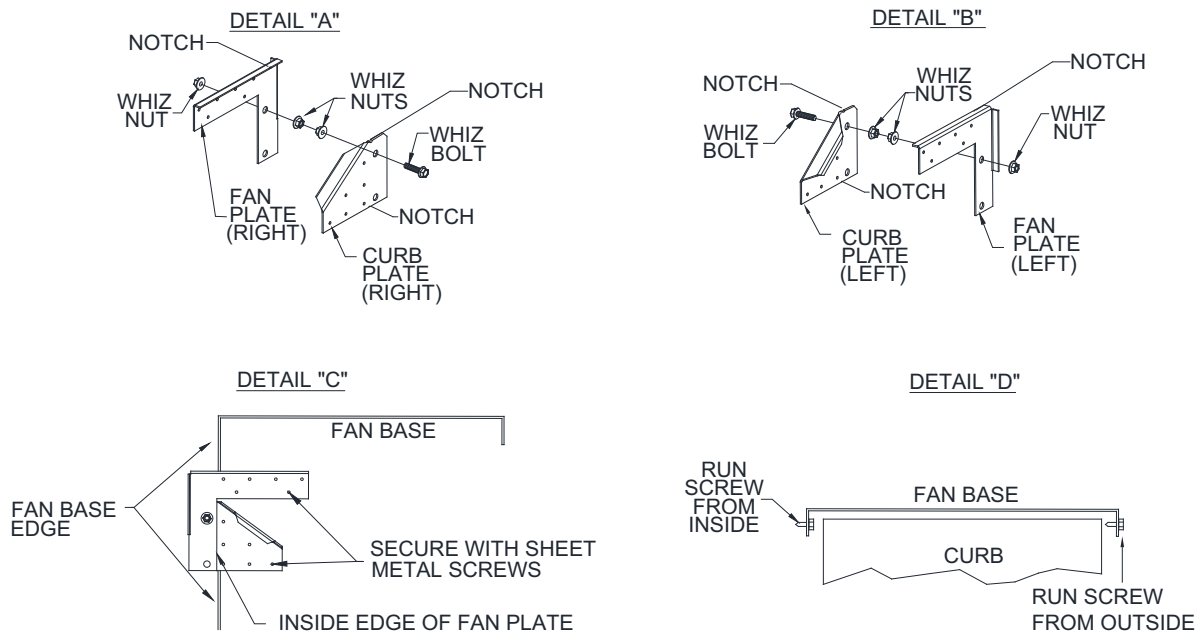
Attention: Installer Must Supply Enough Electrical Cord to Allow the Fan to Swing Open.

1. If parts are not already assembled, refer to **Figure 9** for assembly instructions. Assemble the fan plate and curb plate with hardware, as shown in **Figure 9** Detail "A" and Detail "B".
2. Line up fan base edge to inside edge of fan plate, as shown in **Figure 9** Detail "C". Refer to **Figure 10** for positioning fan plate on fan base. Use provided notches.
3. Secure the fan plate to the fan base using sheet metal screws (#14 x 3/4" – qty 12). **If the screws interfere with the curb, run the screws from the inside of the fan base. Refer to Figure 9 Detail "D". Verify hardware does not interfere with curb when fan swings open or closed.**
4. Secure the curb plate to the curb using sheet metal screws (#14 x 3/4" – qty 12), **Figure 9** Detail "C". Verify all parts and hardware are secure and tight. Verify that the fan and base swings open properly, see **Figure 10**.

Parts List

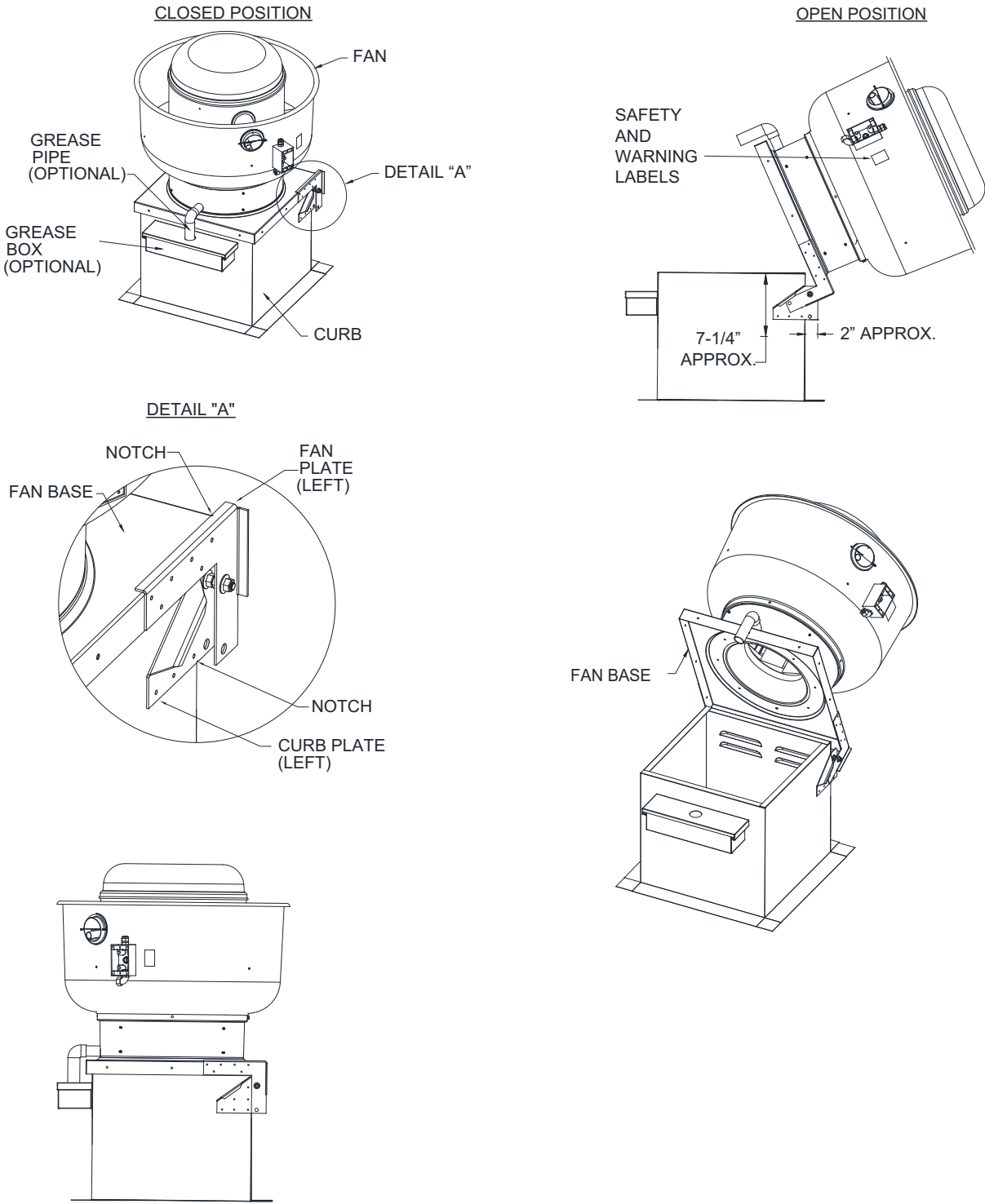
- Left/Right Fan Plates - Qty 2
- Left/Right Curb Plates - Qty 2
- Whiz Nuts - Qty 6
- Whiz Bolts - Qty 2
- Sheet Metal Screws (#14 x 3/4") - Qty 24

Figure 9 - Typical Hinge Kit Fan Plate and Curb Plate Details



Attention! Installer Must Supply Enough Electrical Cord to Allow the Fan to Swing Open.

Figure 10 - Centrifugal Up-blast Hinge Kit Installation Details



Heavy Duty (HD) Hinge Kit Installation

Hinge Kit Field Installation

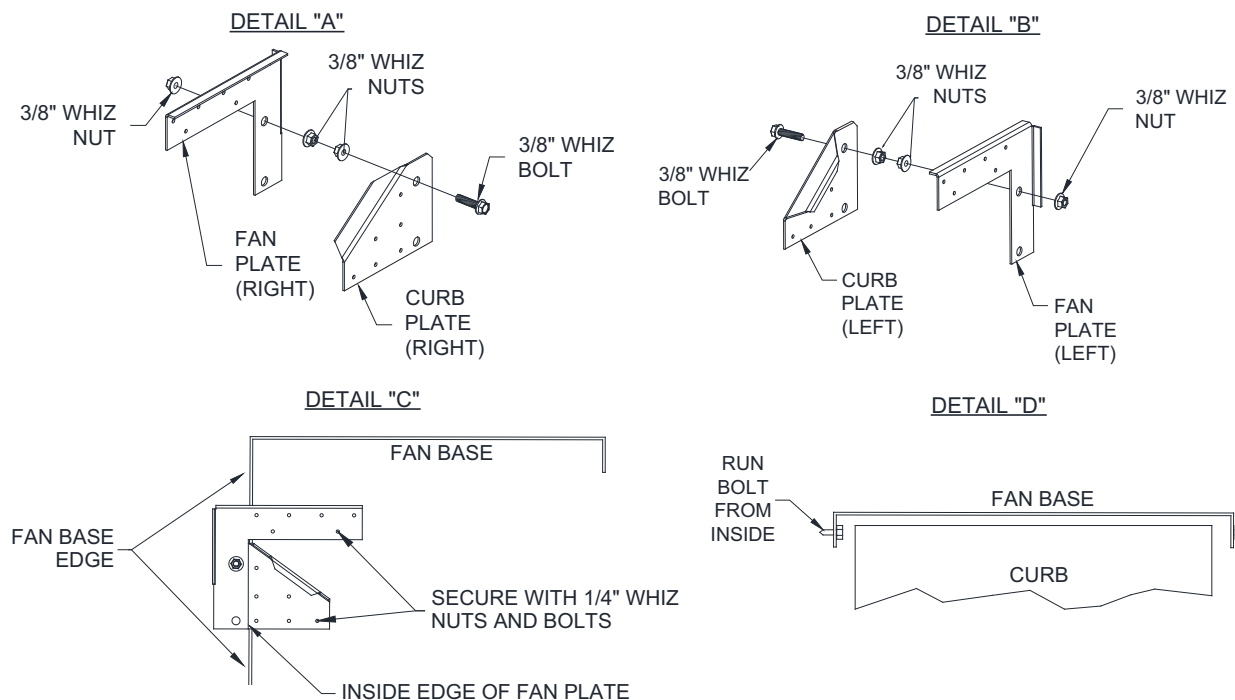
Attention: Installer Must Supply Enough Electrical Cord to Allow the Fan to Swing Open.

1. If parts are not already assembled, refer to **Figure 11** for assembly instructions. Assemble the fan plate and curb plate with hardware, as shown in **Figure 11** Detail "A" and Detail "B".
2. Secure the hinged backplate to the curb with provided hardware, refer to **Figure 12** Detail "B".
3. Line up fan base edge to inside edge of fan plate, as shown in **Figure 11** Detail "C". Refer to **Figure 12** detail "A" for positioning fan plate on fan base.
4. Secure the fan plate to the fan base using provided hardware (1/4"-20 – qty 11). **If the screws interfere with the curb, run the screws from the inside of the fan base. Refer to Figure 11 Detail "D". Verify hardware does not interfere with curb when fan swings open or closed.**
5. Secure the curb plate to the curb using provided hardware (1/4"-20 – qty 9), **Figure 11** Detail "C". Verify all parts and hardware are secure and tight. Verify that the fan and base swings open properly, see **Figure 12**.

Parts List

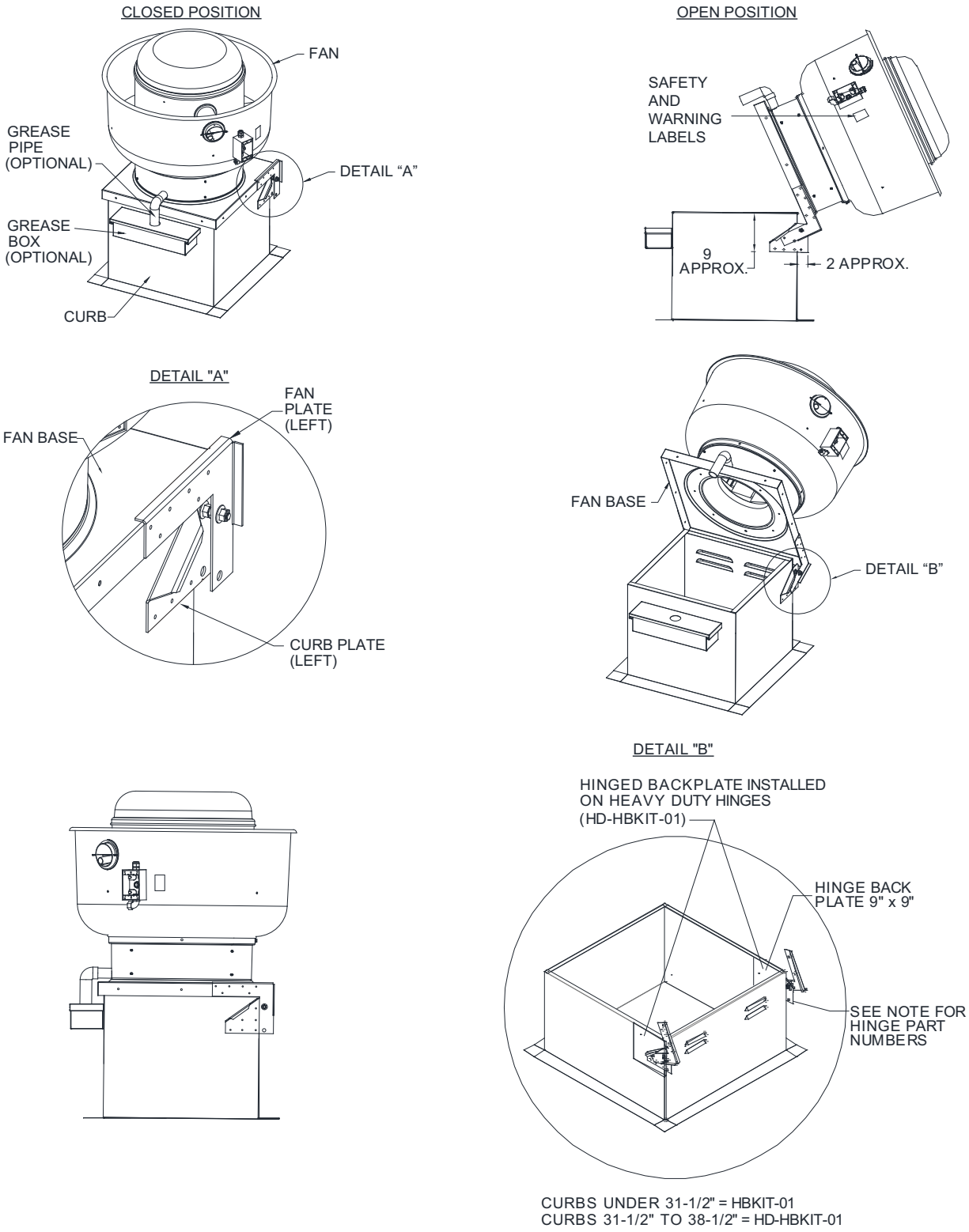
- Left/Right Fan Plates - Qty 2
- Left/Right Curb Plates - Qty 2
- 3/8"-16 Whiz Nuts - Qty 6
- 3/8"-16 Whiz Bolts - Qty 2
- 1/4"-20 Whiz Bolts - Qty 20
- 1/4"-20 Whiz Nuts - Qty 20

Figure 11 - HD Hinge Kit Fan Plate and Curb Plate Details



Attention! Installer Must Supply Enough Electrical Cord to Allow the Fan to Swing Open.

Figure 12 - Heavy Duty (HD) Hinge Kit Installation Details



Heavy Duty (HD)/Extended Locking Hinge Kit Installation

Hinge Kit Field Installation

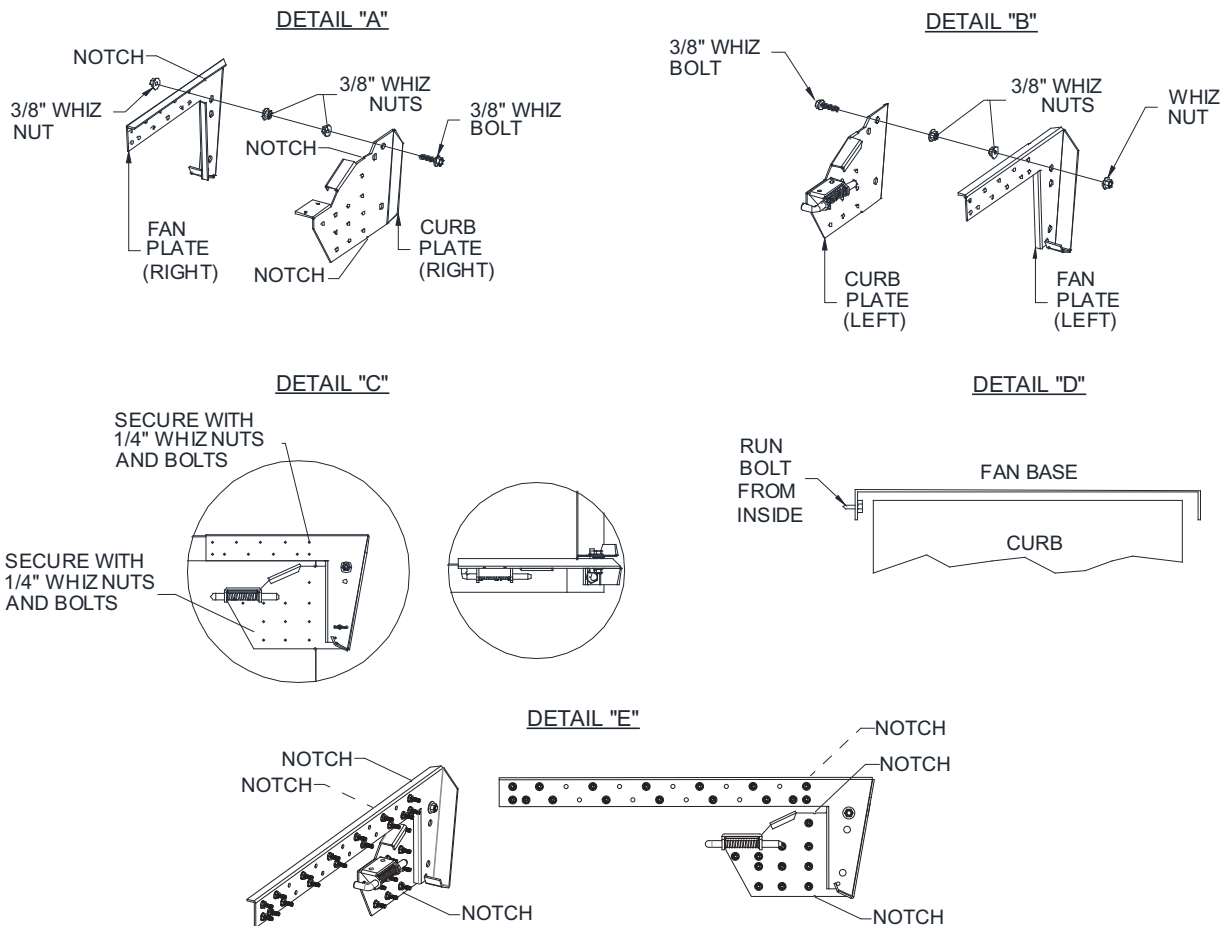
Attention: Installer Must Supply Enough Electrical Cord to Allow the Fan to Swing Open.

1. If parts are not already assembled, refer to **Figure 13** for assembly instructions. Assemble the fan plate and curb plate with hardware, as shown in **Figure 13** Detail "A" and Detail "B".
 2. Secure the hinged backplate to the curb with provided hardware, refer to **Figure 14** Detail "B".
 3. Line up fan base edge to inside edge of fan plate, as shown in **Figure 13** Detail "C". Refer to **Figure 14** detail "A" for positioning fan plate on fan base. Use provided notches.
 4. Secure the fan plate to the fan base using provided hardware (see parts list). **If the screws interfere with the curb, run the screws from the inside of the fan base. Refer to Figure 13 Detail "D". Verify hardware does not interfere with curb when fan swings open or closed.**
 5. Secure the curb plate to the curb using provided hardware (see parts list), **Figure 13** Detail "C". Verify all parts and hardware are secure and tight. Verify that the fan and base swings open properly, see **Figure 14**.
 6. For the extended locking hinge kit, follow the recommended mounting pattern in **Figure 13** Detail "E".
- * The HD kit requires 22 whiz nuts and bolts. The Extended kit requires 27 whiz nuts and bolts.

Parts List

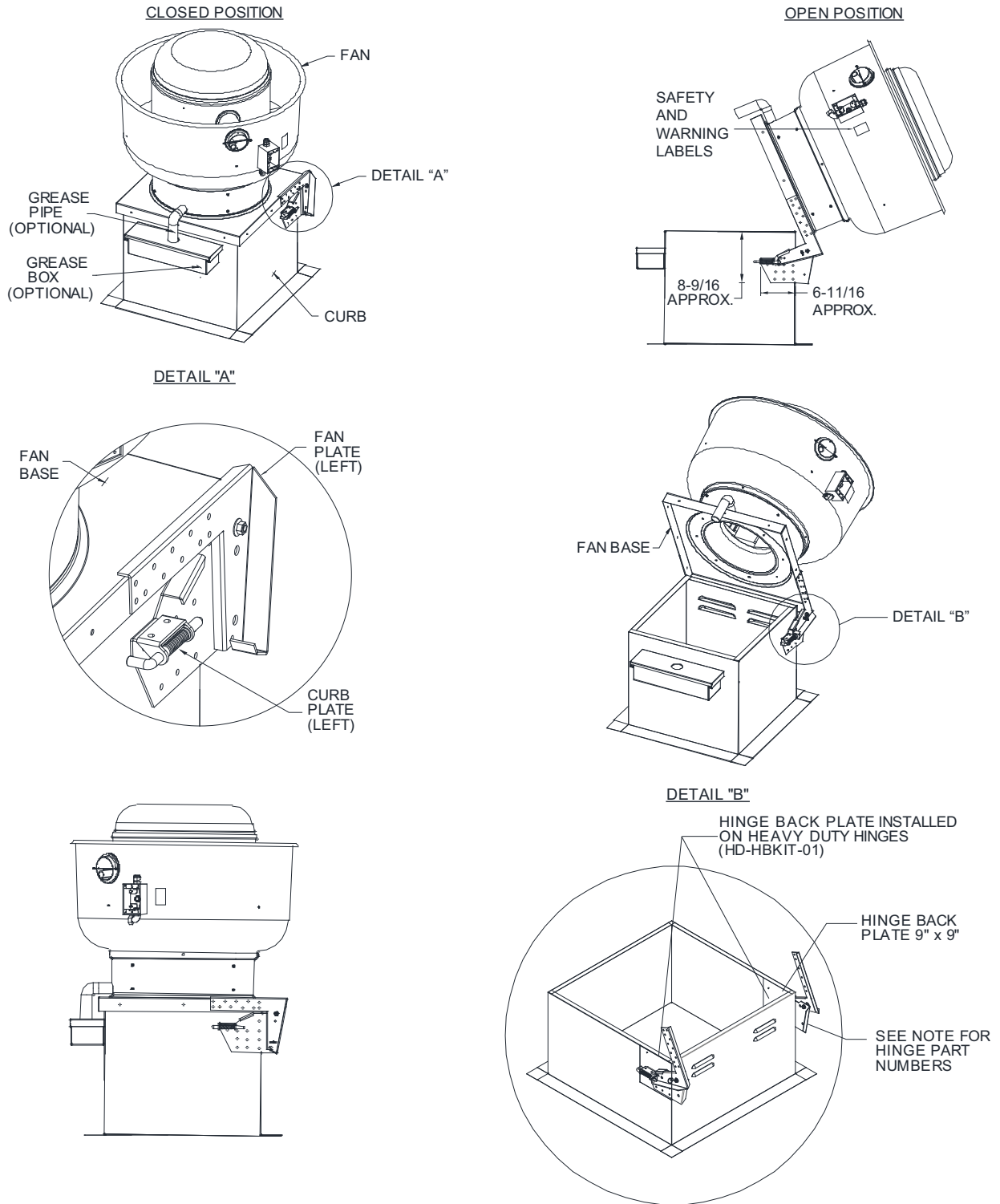
- Left/Right Fan Plates - Qty 2
- Left/Right Curb Plates - Qty 2
- 3/8"-16 Whiz Nuts - Qty 6
- 3/8"-16 Whiz Bolts - Qty 2
- 1/4"-20 Whiz Bolts* - Qty 22/27
- 1/4"-20 Whiz Nuts* - Qty 22/27

Figure 13 - HD/Extended Locking Hinge Kit Fan Plate and Curb Plate Details



Attention! Installer Must Supply Enough Electrical Cord to Allow the Fan to Swing Open.

Figure 14 - Heavy Duty (HD) Locking Hinge Kit Installation Details



Typical Grease Box Installation

Grease Box Field Installation

1. Mark a mounting location 3" from the top of the curb for the grease box cover. Refer to **Figure 15** Detail "A".
2. Secure grease box cover to the curb using provided sheet metal screws (qty 3). Refer to **Figure 15** Detail "B".
3. Slide the grease box into the grease box cover lip. Refer to **Figure 15** Detail "C".
4. Install grease pipe into grease box cover. Refer to **Figure 15** Detail "D".

Figure 15 - Typical Grease Box Installation

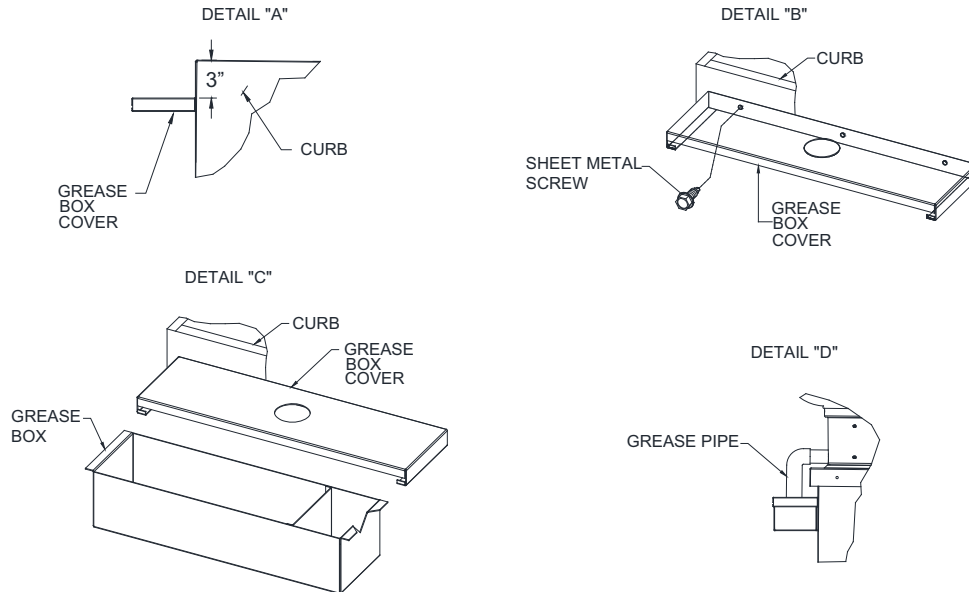
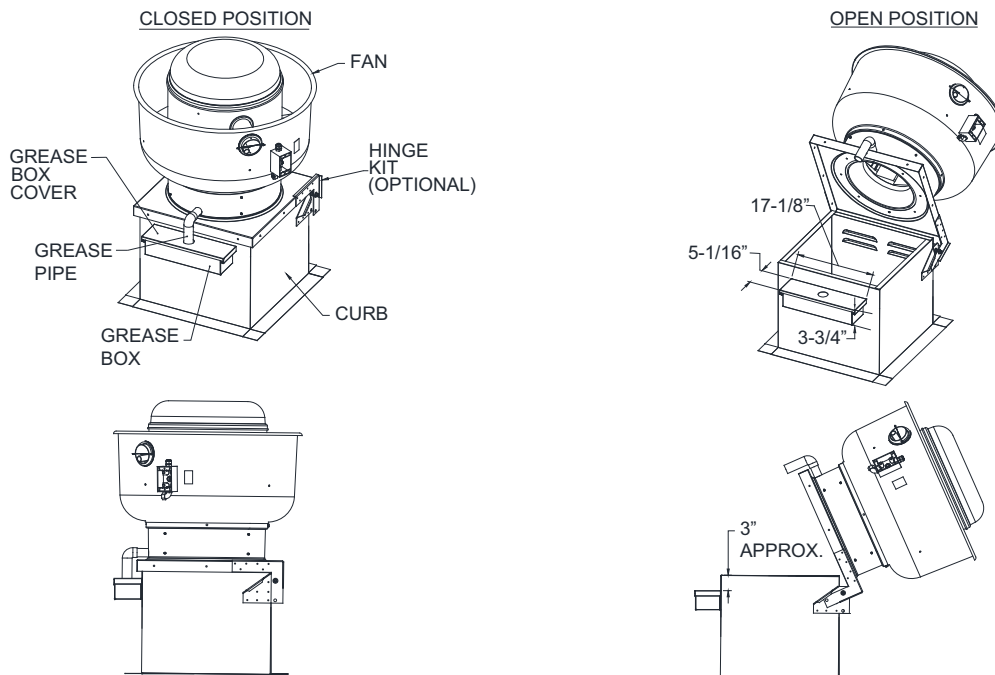


Figure 16 - Grease Box Installed



Up-blast Utility Set Installation

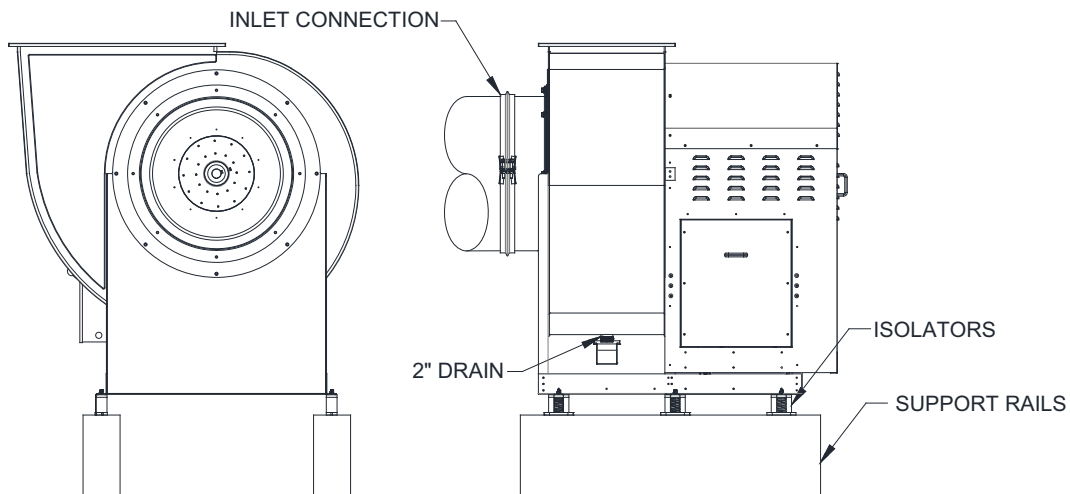
Normal temperature test belt drive – The exhaust fan must operate continuously while exhausting air at 350°F (176°C) until all fan parts have reached thermal equilibrium, and without any deteriorating effects to the fan which would cause unsafe operation.

Normal temperature test direct drive – The exhaust fan must operate continuously while exhausting air at 350°F (176°C) until all fan parts have reached thermal equilibrium, and without any deteriorating effects to the fan which would cause unsafe operation.

Direct driveshaft diameter may change due to motor selected Horsepower (HP)/frame size.

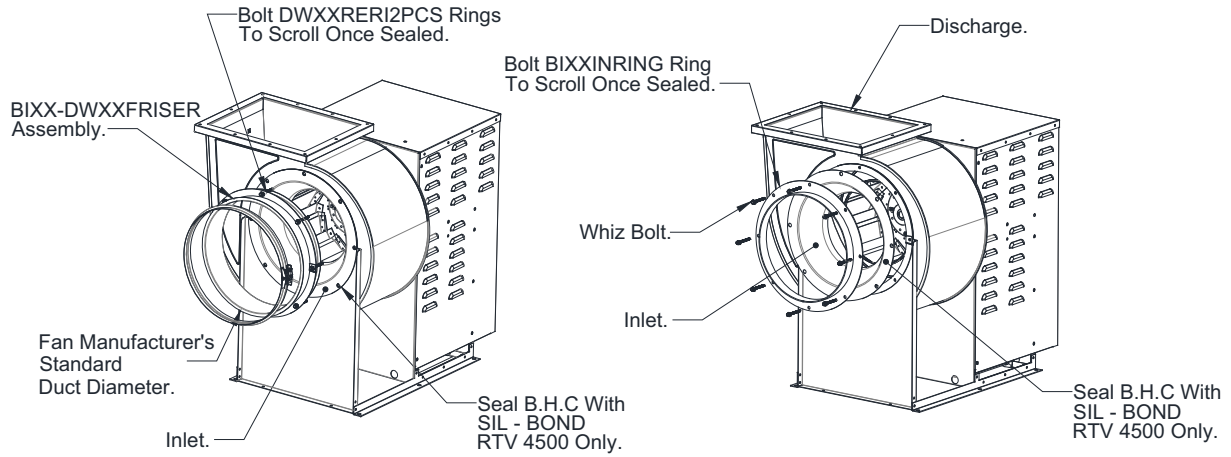
<u>Features</u>	<u>Options</u>
Roof Mounted Fans	Grease Box
Restaurant Model	Shaft Seal
UL705	Vibration Isolators
High Heat Operation Direct Drive 350°F (176°C)	Extension
High Heat Operation Belt Drive 350°F (176°C)	Inlet Adapters
Heat Slinger	Inlet Riser
Grease Classification Testing	Support Rails
2" Drain	Rain Cap
Motor Weather Cover	Curb Mounted Sled with
Fully Sealed Scroll Housing	Vibration Isolators (DD only)
Scroll Access Door	Curb Mounted Sled with Vibration Isolator
Flange 1 = 1/4"-11 through 20"	and Down Oriented Starter Duct (DD Only)
Flange 2 = 2"-24 through 36"	

Figure 17 - Up-blast Utility Set Installation



Up-blast Utility Set Inlet Options

Figure 18 - Up-blast Utility Set Inlet Options



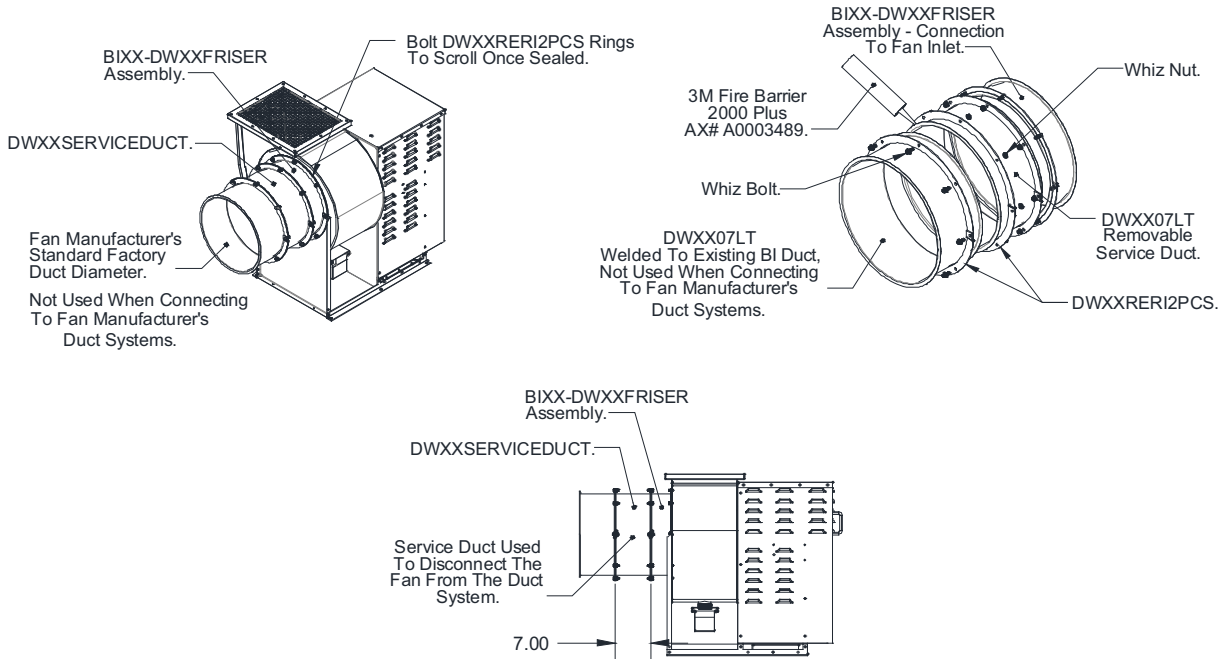
Fan Size	Duct Diameter	Inlet Connection	Inlet Rings	Quantity	Duct Riser	Quantity	Whiz Bolt	Quantity
11	12"	BI11-DW12FRISER	A0028896/ DW12RERI2PCS	2	DW12RISER	1	A0005696/ 1/4"-20 x 1-1/2"	8
13	14"	BI13-DW14FRISER	A0028897/ DW14RERI2PCS	2	DW14RISER	1	A0005696/ 1/4"-20 x 1-1/2"	8
15	16"	BI15-DW16FRISER	A0028898/ DW16RERI2PCS	2	DW16RISER	1	A0005696/ 1/4"-20 x 1-1/2"	8
18	20"	BI18-DW20FRISER	A0028900/ DW20RERI2PCS	2	DW20RISER	1	A0005696/ 1/4"-20 x 1-1/2"	8
20	20"	BI20-DW20FRISER	A0028901/ DW20RERIUSBI202PCS	2	DW20RISER	1	A0005696/ 1/4"-20 x 1-1/2"	8
24	24"	BI24-DW24FRISER	A0028904/ DW24RERIUSBI242PCS	2	DW24RISER	1	A0005678/ 3/8"-16 x 1-1/2"	8
30	24"	BI30-DW24FRISER	A0028905/ DW24RERIUSBI302PCS	2	DW24RISER	1	A0005678/ 3/8"-16 x 1-1/2"	8
36	30"	BI36-DW30FRISER	A0030879/ DW30RERIUSBI362PCS	2	DW30RISER	1	A0005678/ 3/8"-16 x 1-1/2"	8
11	12"	A0023766/BI11INRING	N/A		N/A		A0005696/ 1/4"-20 x 1-1/2"	8
13	14"	A0023767/BI13INRING	N/A		N/A		A0005696/ 1/4"-20 x 1-1/2"	8
15	16"	A0023768/BI15INRING	N/A		N/A		A0005696/ 1/4"-20 x 1-1/2"	8
18	20"	A0023769/BI18INRING	N/A		N/A		A0005696/ 1/4"-20 x 1-1/2"	8
20	20"	A0023770/BI20INRING	N/A		N/A		A0005696/ 1/4"-20 x 1-1/2"	8
24	24"	A0023771/BI24INRING	N/A		N/A		A0005678/ 3/8"-16 x 1-1/2"	8
30	24"	A0023772/BI30INRING	N/A		N/A		A0005678/ 3/8"-16 x 1-1/2"	8
36	30"	A0023773/BI36INRING	N/A		N/A		A0005678/ 3/8"-16 x 1-1/2"	8

Inlet Service Duct Option

Service duct kits allow a quick disconnect between the fan inlet and duct system.

1. Service duct kits come with (2) 7" long duct sections, (8) riser rings, and installation hardware.
2. Service duct flanges must be sealed with 3M Barrier 2000+.
3. Once sealed, the service duct is secured using bolt together riser rings.
4. The first 7" long duct section can be welded directly to existing duct systems.
5. If connecting to fan Manufacturer's factory duct, the first 7" long duct section may or may not be used. You may connect fan Manufacturer's standard duct directly to service duct using V-bands.

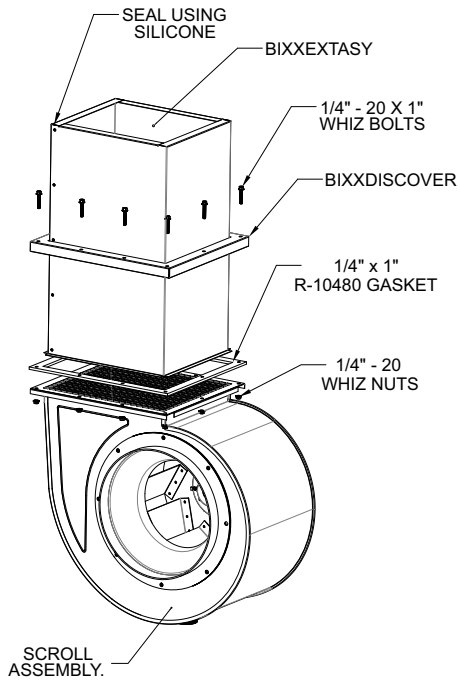
Figure 19 - Inlet Service Duct Option



Fan Size	Duct Diameter	Inlet Connection Assembly	Duct LT	Quantity	Riser Rings	Quantity	Whiz Bolt (Inches)	Quantity	Whiz Nut (Inches)	Quantity
11	12"	12SERVICEDUCTKIT	DW1207LT	2	A0028896/ DW12RERI2PCS	8	A0023684/ 1/4"-20 x 1"	16	A005690/ 1/4"-20	16
13	14"	14SERVICEDUCTKIT	DW1407LT	2	A0028897/ DW14RERI2PCS	8	A0023684/ 1/4"-20 x 1"	16	A005690/ 1/4"-20	16
15	16"	16SERVICEDUCTKIT	DW1607LT	2	A0028898/ DW16RERI2PCS	8	A0023684/ 1/4"-20 x 1"	16	A005690/ 1/4"-20	16
18	20"	20SERVICEDUCTKIT	DW2007LT	2	A0028900/ DW20RERI2PCS	8	A0023684/ 1/4"-20 x 1"	16	A005690/ 1/4"-20	16
20	20"	20SERVICEDUCTKIT	DW2007LT	2	A0028900/ DW20RERI2PCS	8	A0023684/ 1/4"-20 x 1"	16	A005690/ 1/4"-20	16
24	24"	24SERVICEDUCTKIT	DW2407LT	2	A0028903/ DW24RERI2PCS	8	A0023684/ 1/4"-20 x 1"	16	A005690/ 1/4"-20	16
30	24"	24SERVICEDUCTKIT	DW2407LT	2	A0028903/ DW24RERI2PCS	8	A0023684/ 1/4"-20 x 1"	16	A005690/ 1/4"-20	16
36	30"	30SERVICEDUCTKIT	DW3007LT	2	A0030878/ DW36RERI2PCS	8	A0024297/ 3/8"-16 x 1"	16	A005688/ 3/8"-16	16

Up-blast Utility Set

Figure 20 - Discharge Extension Options

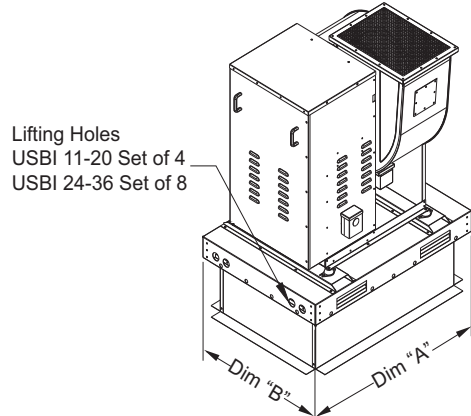
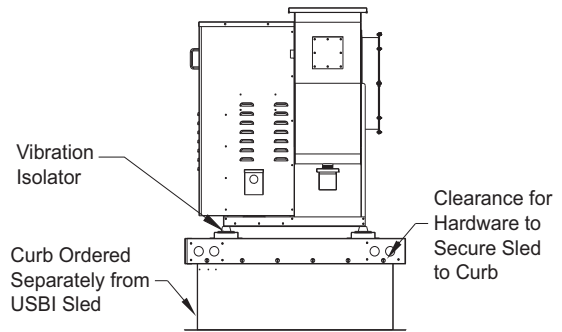
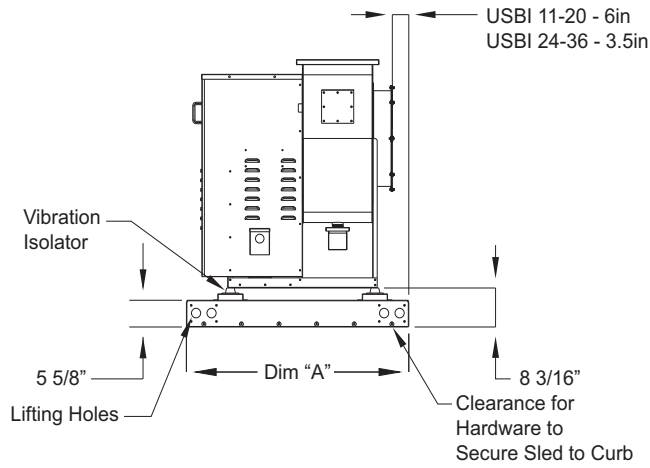


Hardware Counts		
Hardware # Bolt/Nut	Hardware Quantity	
1/4"-20 x 1" (92323A518)/1/4"-20 (94831A029)	8	
1/4"-20 x 1" (92323A518)/1/4"-20 (94831A029)	8	
1/4"-20 x 1" (92323A518)/1/4"-20 (94831A029)	8	
1/4"-20 x 1" (92323A518)/1/4"-20 (94831A029)	12	
1/4"-20 x 1" (92323A518)/1/4"-20 (94831A029)	12	
1/4"-20 x 1" (92323A518)/1/4"-20 (94831A029)	12	
1/4"-20 x 1" (92323A518)/1/4"-20 (94831A029)	12	
1/4"-20 x 1" (92323A518)/1/4"-20 (94831A029)	14	

BI - Discharge Extension					
Fan Size	Extension #	L	W	H	Cover #
11	BI11EXTASY	12"	11"	24"	BI11DISCOVER
13	BI13EXTASY	14"	12"	24"	BI13DISCOVER
15	BI15EXTASY	16"	13"	24"	BI15DISCOVER
18	BI18EXTASY	19"	15"	24"	BI18DISCOVER
20	BI20EXTASY	21"	15"	24"	BI20DISCOVER
24	BI24EXTASY	26"	17"	24"	BI24DISCOVER
30	BI30EXTASY	32"	19"	24"	BI30DISCOVER
36	BI36EXTASY	39"	23"	24"	BI26DISCOVER

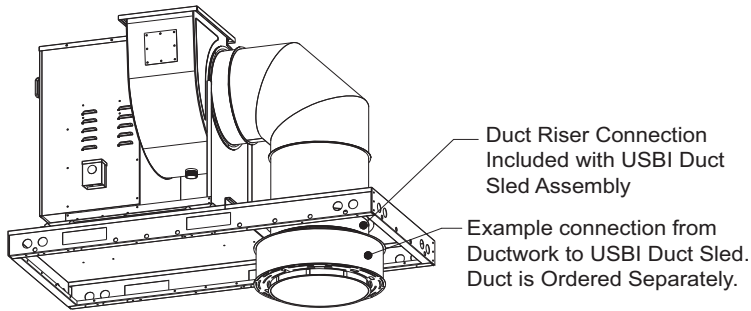
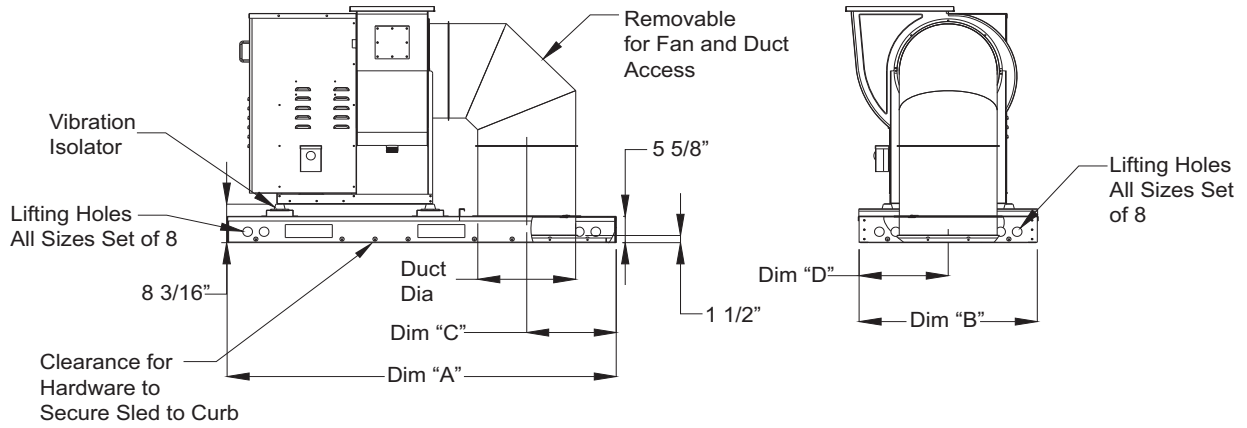
Curb Mounted Sled Options (DD Only)

Figure 21 - Vibration Isolators Option



Fan Size	Dim "A"	Dim "B"	Curb Size
11	46 3/4"	32 3/4"	41" x 27"
13	46 3/4"	32 3/4"	41" x 27"
15	46 3/4"	32 3/4"	41" x 27"
18	50 3/4"	36 3/4"	45" x 31"
20	50 3/4"	36 3/4"	45" x 31"
24	57 3/4"	47 3/4"	52" x 42.5"
30	60 3/4"	47 3/4"	52" x 42.5"
36	67 3/4"	56 1/4"	62" x 51"

Figure 22 - Vibration Isolator and Down Oriented Starter Duct Option



Fan Size	Dim "A"	Dim "B"	Curb Size	Dim "C"	Dim "D"	Duct Dia.
11	63 3/4"	32 1/4"	59" x 27"	16 3/8"	16 3/8"	12
13	63 3/4"	32 1/4"	61" x 27"	16 3/8"	16 3/8"	14
15	69 3/4"	32 1/4"	64" x 27"	16 3/8"	16 3/8"	16
18	79 3/4"	36 1/4"	74" x 31"	18 3/8"	18 1/4"	20
20	79 3/4"	36 1/4"	74" x 31"	18 7/8"	18 1/4"	20
24	99 3/4"	47 3/4"	94" x 42.5"	23 1/4"	23 7/8"	24
30	99 3/4"	47 3/4"	94" x 42.5"	24 1/8"	24"	24
36	113 3/4"	56 1/4"	108" x 51"	27 7/8"	28 1/4"	30

Up-blast Utility Set Indoor Installation

Some situations prevent the installation of exhaust fans on the roof or other outdoor location. An indoor installation may be the only alternative.

Of the various types of fans that might be employed, utility sets seem most appropriate because they readily accommodate the inlet and outlet duct connections. Fans designed for curb mounting would present outlet duct connection difficulties.

Most Authority Having Jurisdictions (AHJs) comply with IMC and UL 705 standards. Standard UL 705, "Power Roof Ventilators for Restaurant Exhaust Appliances", covers the utility set high temperature and grease fire testing.

Testing to UL Standards:

The exhaust fan moves air for several hours at the maximum temperature the manufacturer wishes to list the fan, such as 300°F. Another test imitates a grease fire by igniting grease in a pan near an inlet duct. If the fan keeps running and does not display any unsafe results, it passes those tests. Testing also examines the fan for any characteristics that might be unsuitable.

In the scope of section 1.1, it states, "these requirements cover roof or wall-mounted ventilators for restaurant exhaust appliances." It would seem at first that the phrase "roof or wall mounted" would preclude applicability of the label indoors. However, in the very next paragraph it goes on to say, "Power ventilators...covered by these requirements are intended for installation in accordance with ... NFPA 96". NFPA 96 clearly defines how to install a traditional ventilator indoors.

Standard NFPA 96 – 8.1.4* Utility Set Exhaust Fans.

8.1.4.2 Utility set exhaust fans installed within the building shall be located in an accessible area of adequate size to allow for service or removal.

8.1.4.3 Where the duct system connected to the fan is in an enclosure, the space or room in which the exhaust fan is located shall have the same fire resistance rating as the enclosure.

8.1.4.4 The fan shall be connected to the exhaust duct by flanges securely bolted, as shown in Figure 8.1.3.2 (a) through Figure 8.1.3.2 (d) or by a system specifically listed for such use, such as UL 1978 or UL 2221 listed duct systems.

8.1.4.5 Flexible connectors shall not be used.

8.1.4.6 Exhaust fans shall have a drain directed to a readily accessible and visible grease receptacle not to exceed 3.8 L (1 gallon).

Manufacturer Recommendations for Indoor Installation:

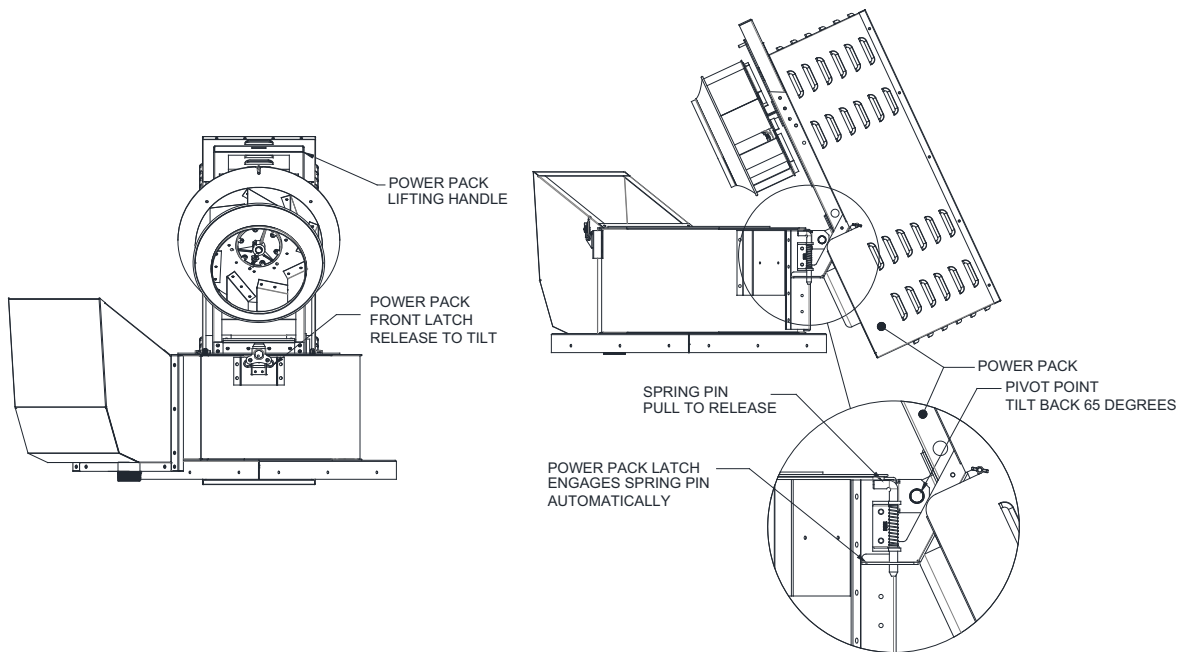
1. The fan inlet and outlet must be connected to the ducts using companion flanges and high temperature (1500F) gaskets or by a system specifically listed for such use, such as UL 1978 or UL 2221 listed duct systems.
2. Install the fan where there is room for service and removal.
3. Usually, the duct to the fan is in a shaft, and the shaft walls have a fire resistance rating. The space where the fan is located must have the same fire resistance rating as the shaft.
4. Flexible connectors are not allowed.
5. There must be a drain in the fan that is directed to a readily accessible and visible grease receptacle, ideally piped to the building grease trap.
6. The exhaust housing constructed of carbon steel not less than 1.52 mm (.060 in.), unless listed in accordance with the terms of the listing.
7. Inlet and outlet ducts will have access doors installed 3 feet from the fan for service and maintenance.
8. Minimum clearances are 18" inches to combustible, 3" inches to limited, 0" inches to non-combustibles.
9. All wiring and electrical equipment must comply with NFPA 70, National Electrical Code.

Up-blast Curb Mounted Utility Set Hinging Instructions

1. Turn the disconnect switch to the off position.
2. Turn and release the latch from the power pack handle.
3. Lift the power pack using the front handle.
4. The power pack will tilt back 65 degrees.
5. The power pack latch will automatically engage the spring pin.
6. To close the power pack, hold the lifting handle and pull the spring pin up.
7. Lower the power pack down.
8. Engage the front latch into the lifting handle and twist to lock.
9. Inspect the power pack. Top plate should be sealed with top gasket.
10. Turn the wheel to make sure there is not any interference.

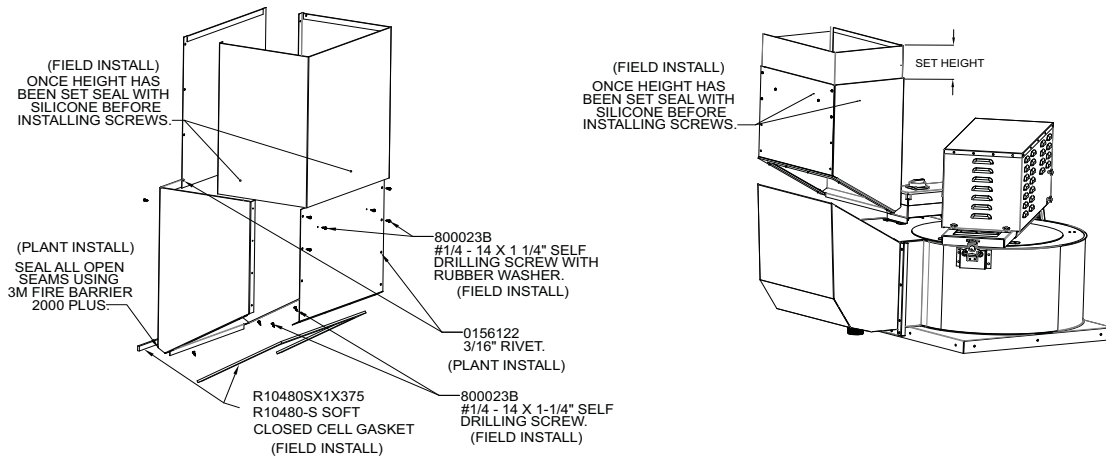
NOTE: Utility sets may not be wall mounted.

Figure 23 - Up-blast Curb Mounted Utility Set Hinge



Up-blast Curb Mounted Utility Set Discharge Extension Option

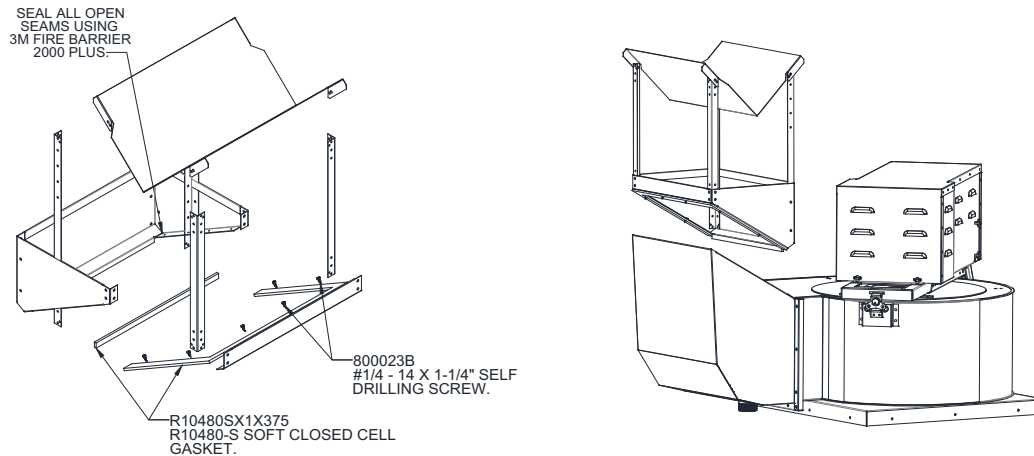
Figure 24 - Discharge Extension Option



Utility Set Option - Extension Assembly	
Part Number	Description
RE13ADJEXTASY	RE13 - Extension Assembly Option
RE15ADJEXTASY	RE15 - Extension Assembly Option
RE18ADJEXTASY	RE18 - Extension Assembly Option
RE20ADJEXTASY	RE20 - Extension Assembly Option
RE24ADJEXTASY	RE24 - Extension Assembly Option

Up-blast Curb Mounted Utility Set Rain Cap Option

Figure 25 - Rain Cap Option

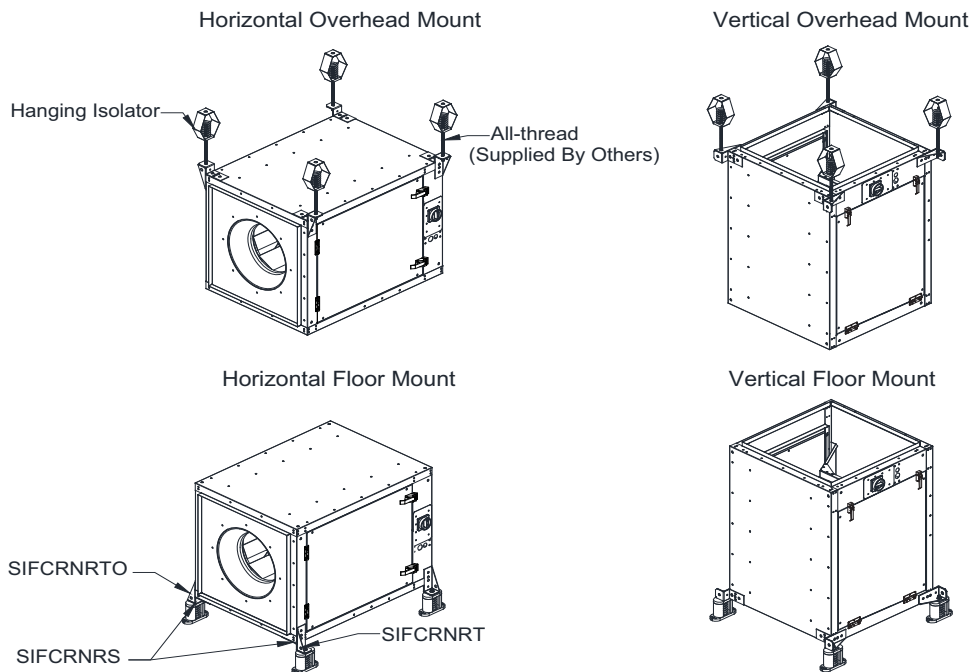


Utility Set Option - Rain Cap Assembly	
Part Number	Description
RE11RAINCAP ASSY	RE11 - Extension Assembly Option
RE13RAINCAP ASSY	RE13 - Extension Assembly Option
RE15RAINCAP ASSY	RE15 - Extension Assembly Option
RE18RAINCAP ASSY	RE18 - Extension Assembly Option
RE20RAINCAP ASSY	RE20 - Extension Assembly Option
RE24RAINCAP ASSY	RE24 - Extension Assembly Option

Square Inline Mounting Configurations

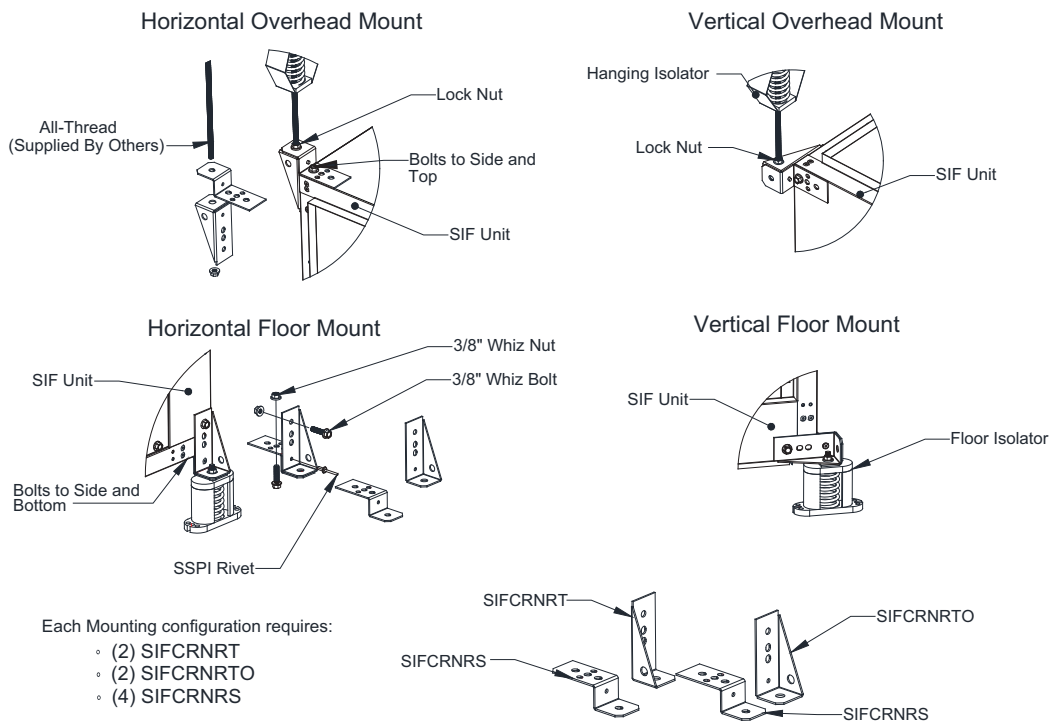
IMPORTANT: Models containing cooling tubes and drains should not be mounted vertically. Drains must be oriented in the 6 o'clock position.

Figure 26 - Mount Configurations



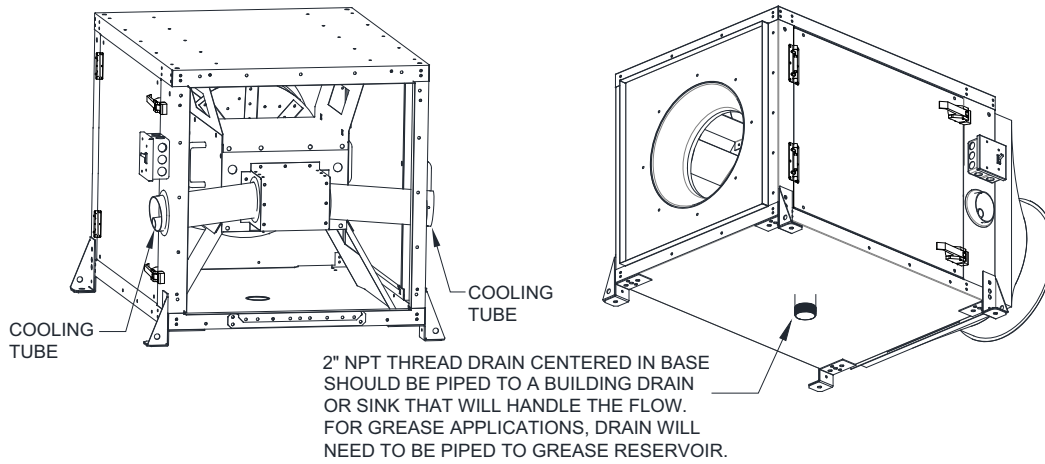
Square Inline Mounting Bracket Detail

Figure 27 - Square Inline Mount Details



Square Inline Fan Drain

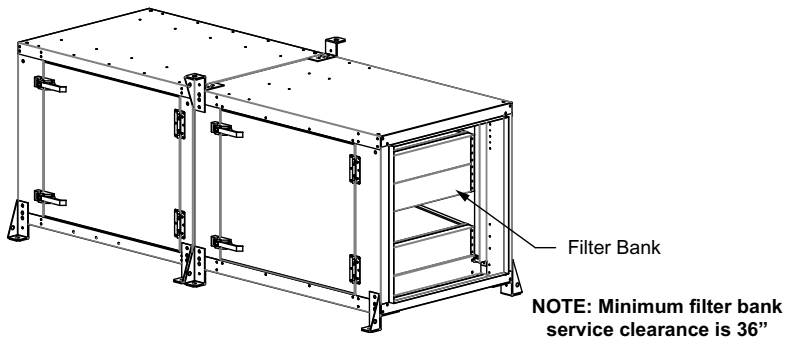
Figure 28 - Direct Drive Stainless Steel Inline Fans



*FAN MUST BE INSTALLED WITH DRAIN POINTING DOWN.

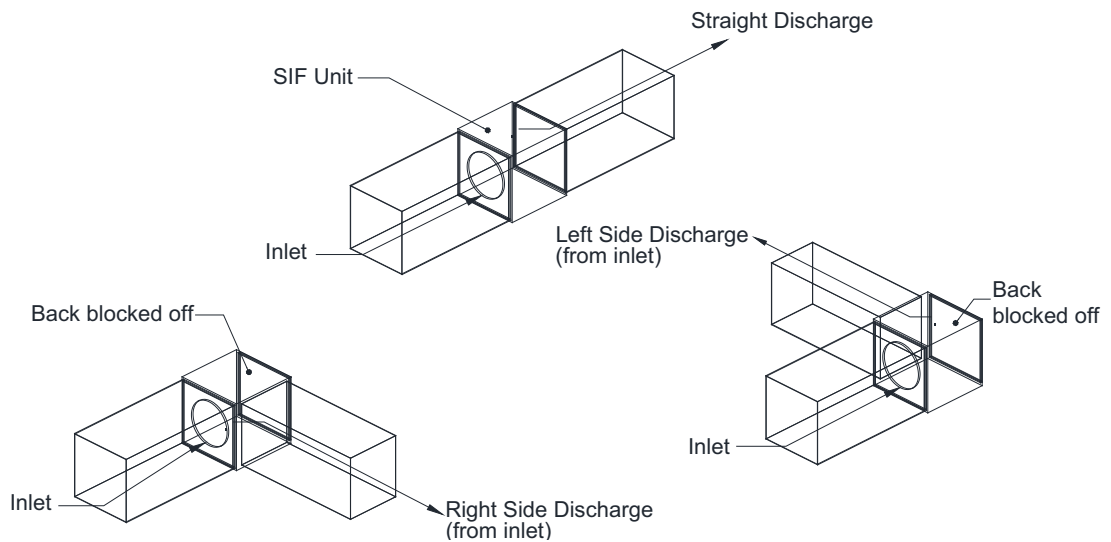
Square Inline Filter Bank Option

Figure 29 - Filter Bank Option



Square Inlet Discharge Options

Figure 30 - Square Inlet Discharge

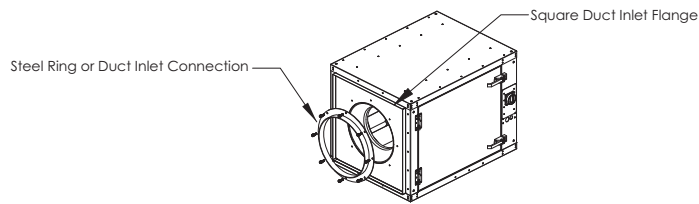


Side Discharge is not available for UL762 rated fans.

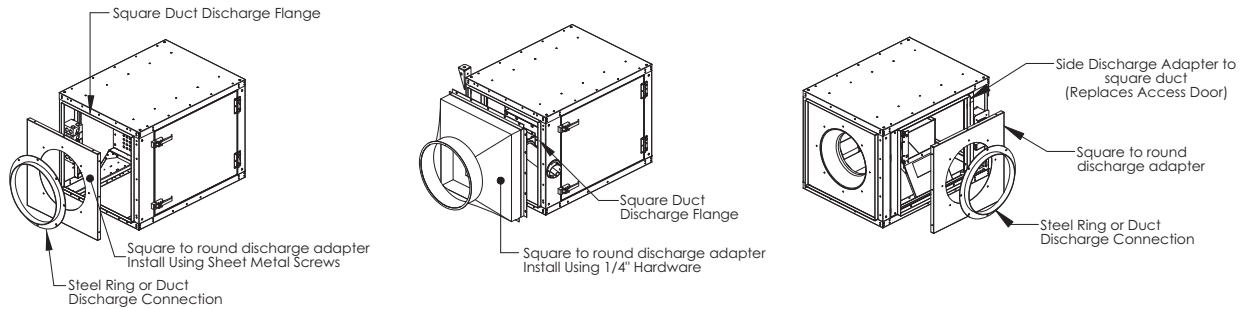
Square Inline Discharge Configurations

Figure 31 - Square Inline Discharge Details

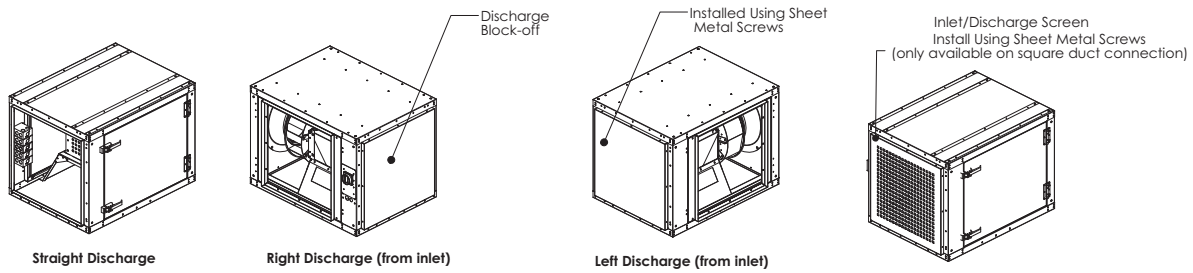
Inlet Options



Discharge Options



Discharge Configurations



Side Discharge is not available for UL762 rated fans.

NOTE: If the fan manufacturer's duct is not used, black iron grease duct will need to be welded directly to the unit.

Inlet/Outlet Connections			
Fan Size	Square Duct Dimension	Duct Diameter	Steel Ring O.D.
9-10	12" x 12"	10"	N/A
11	16" x 16"	12"	12.5"
13	18" x 18"	14"	13.5"
15	23" x 23"	16"	15.25"
18	24" x 24"	20"	18.5"
20	28" x 28"	20"	19.625"
24	35" x 35"	24"	25.375"
30	42" x 42"	24"	24.375"
36	48" x 48"	30"	30.5"

Electrical

WARNING!

Disconnect power before installing or servicing unit. High voltage electrical input is needed for this equipment. A qualified electrician should perform this work.

Before connecting power to the fan, read and understand the entire section of this document. As-built wiring diagrams are furnished with each unit by the factory and are attached to the fan or provided with paperwork packet. Electrical wiring and connections must be made in accordance with local ordinances and the National Electric Code, ANSI/NFPA 70. Verify the voltage and phase of the power supply. Confirm the wire amperage capacity is in accordance with the unit nameplate. For additional safety information, refer to AMCA publication 410-96, *Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans*.

1. **Always disconnect power before working on or near this equipment. Lock and tag the disconnect switch and/or breaker to prevent accidental power-up.**
2. A dedicated branch circuit should supply the motor circuit with short circuit protection according to the National Electric Code. This dedicated branch should run to the junction box. Every branch circuit should include a properly sized ground connection.
3. A disconnect switch is shipped with every fan. The switch may be located on the exterior of the fan or in the interior of the fan. On down-blast direct drive fans, the disconnect function is built into the speed controller.
4. Verify that the power source is compatible with the requirements of your equipment. The nameplate identifies the **proper phase and voltage** of the equipment.
5. Before connecting the unit to the building's power source, verify that the power source wiring is de-energized. Refer to schematics.
6. Secure the power cable to prevent contact with sharp objects. Verify ground connection is secure.
7. Do not kink power cable and never allow the cable to encounter oil, grease, hot surfaces, or chemicals.
8. Before powering up the unit, make sure that the fan rotates freely. Make sure that the interior of the unit is free of loose debris or shipping materials.
9. If any of the original wire supplied with the unit must be replaced, it must be replaced with type THHN wire or equivalent.

IMPORTANT: FANS WITH HINGE KITS REQUIRE ENOUGH SLACK IN THE WIRING TO THE FAN TO ALLOW FAN TO TILT BACK TO THE OPEN POSITION. ELECTRICIAN MUST CHECK THIS AND ACCOUNT FOR THE RANGE OF MOTION OF THE FAN.

Table 3 - Copper Wire Ampacity

Wire Size AWG	Maximum Amps
14	15
12	20
10	30
8	50
6	65
4	85
3	100
2	115
1	130

Motorized Intake Damper

On units shipped with the optional motorized damper, power must be supplied to the damper according to the damper nameplate. The damper motor is controlled external to the fan. External wiring to the damper motor is required.

NOTE: Some installations may require the use of a step-up or step-down transformer.

Permanent Split Capacitor (PSC) Motor Speed Control

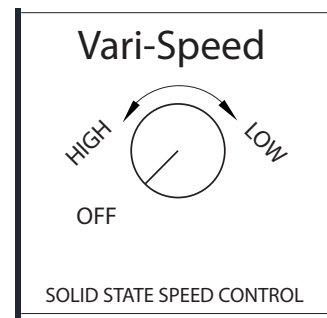
Some single-phase direct-drive fans contain speed controls that regulate the amount of voltage going to the motor. Specific PSC motors must be used in conjunction with speed controls. The speed control has a knob (**Figure 32**) with an off position along with high to low range. At high speed, the speed control allows all of the line voltage to pass directly to the motor.

A minimum speed adjustment is provided to allow independent control of the minimum speed setting. Minimum speed adjustment ensures the motor runs with sufficient torque to prevent stalling. To adjust this:

1. Motor must be in actual operating conditions to achieve proper speed adjustment. Motor will not slow down unless proper load is applied.
2. Turn main control knob to lowest speed position.
3. Locate and adjust minimum speed setting. This can be found under the speed control faceplate. Use a small screwdriver to adjust. Rotate clockwise to decrease minimum speed; counter-clockwise to increase minimum speed.
4. Motor will now operate from this preset minimum speed to full speed.

The lowest minimum voltage that may be applied to these motors is 65V AC. Running lower voltages to the motor can cause premature failure and overheating problems.

Figure 32 - PSC Motor Speed Control



Electronically Commutated Motor (ECM) Speed Control

An Electrically Commutated Motor (ECM) with speed control allows for an accurate manual adjustment of the fan's speed. The benefits of using an EC motor is exceptional efficiency, performance, and motor life.

Unit Mount Controller

The RTC speed controller features a 4 digit LED display with a five button interface. All parameters can be accessed through the user menu. The percent of run speed can be changed by using the **Up** and **Down** buttons followed by pressing **Enter** (middle button) to save changes. Every **ten seconds** the display will toggle between current percentage of run speed and current RPMs. The flow index has a range of **0-100%** and is typically linear with motor RPM.

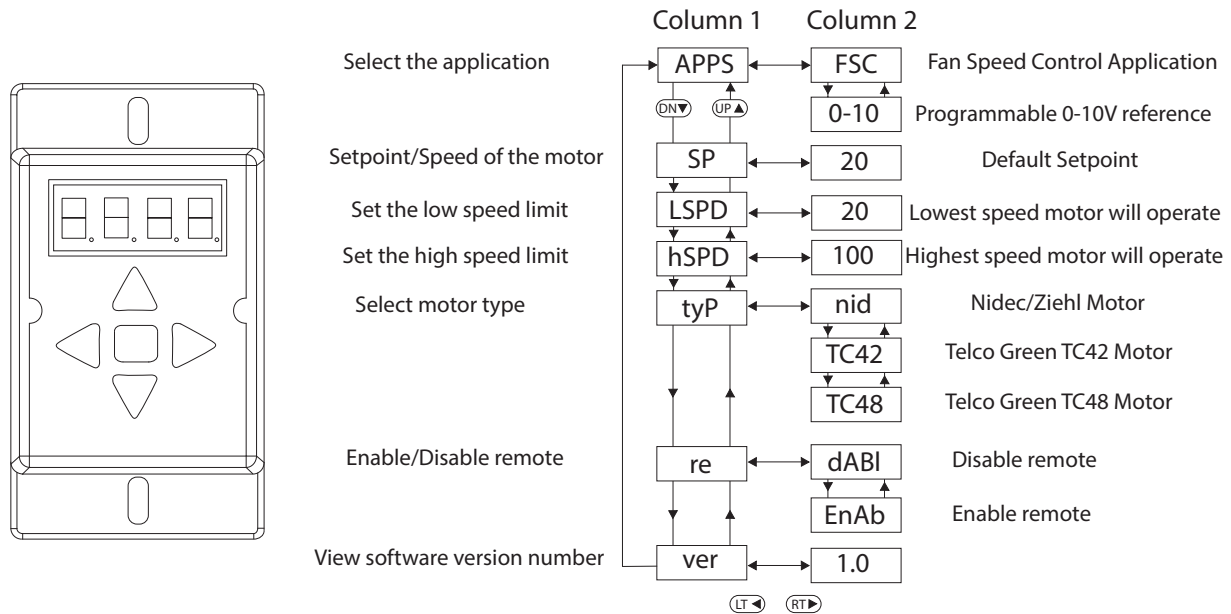
If the remote function (re) is enabled, the speed is controlled through a **0-10V** input. **0V = 0%** and **10V = 100%**, unless overridden by the low speed and high speed limits.

The speed controller requires a **24V AC** input and can locally turn the motor on and off. The motor RPM range is fully adjustable between the minimum and maximum setpoints, see LSPD and HSPD on the programming display. For more information, see the RTC control operating manual.

For all motors except 16Z, 18Z, 20Z, 22Z, 25Z, 28Z: If "oFF" is being displayed, and the speed is set above 300 RPM, the ECM is not receiving RPM feedback. Check that the ECM is wired correctly. Check that the motor "tyP" in the settings matches the motor manufacturer. 16Z, 18Z, 20Z, 22Z, 25Z, 28Z do not send RPM feedback.

NOTE: A Variable Frequency Drive (VFD) is required to adjust the speed control of a non-electrically commutated 3-phase direct-drive motor.

Figure 33 - RTC Speed Controller and Menu

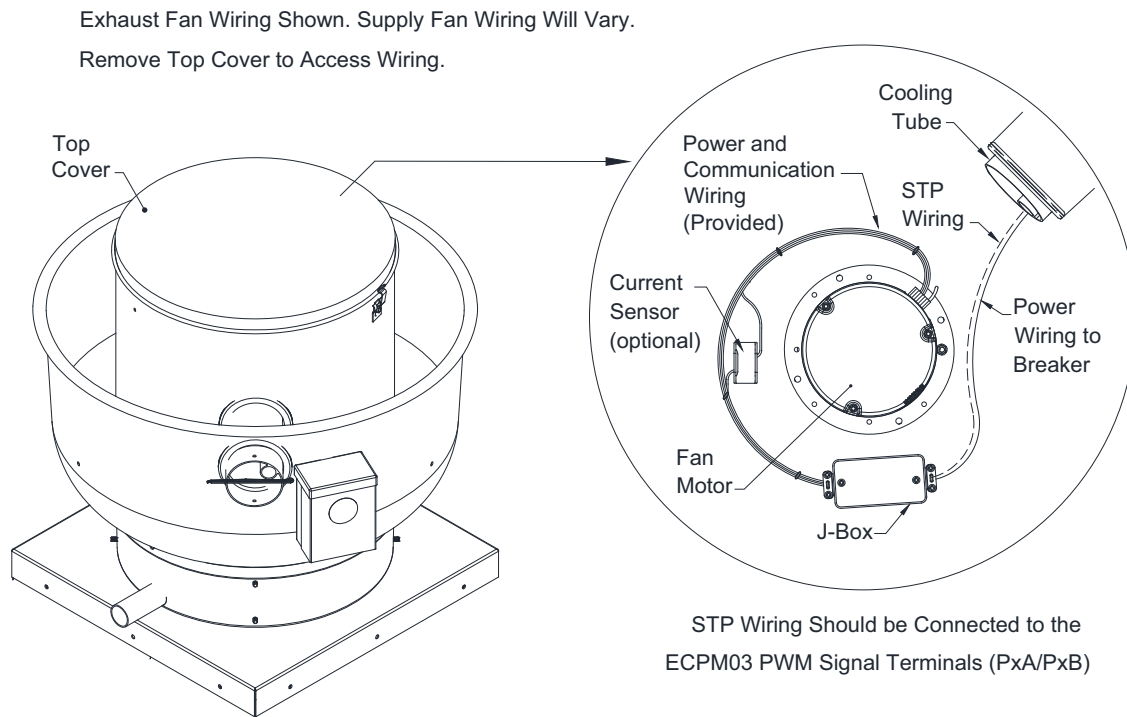


External PWM Signal

Figure 34 illustrates ECM fan wiring. The fan unit will be shipped with power wiring and communication wiring fed to an internal junction box (J-Box). The fan is shipped with Shielded Twisted Pair (STP) wire, which is used for wiring to a remote PWM signal. Power the unit off. Remove top cover from fan. Remove J-Box cover to access wiring connections.

- The STP wire is connected to the communication wiring of the motor using wire nuts in the junction box. If a preset length of STP is provided, it will be connected to wiring located in junction box from the factory.
- If wiring is not connected from the factory, connect the red wire to the positive PWM signal and the black wire to the negative PWM signal. Reference schematics for all wiring connections (PxA and PxB).
- Run STP wiring through the cooling tube and along the power wiring of the fan, secure the two together with zip ties. Ensure there is enough slack for the fan to hinge open and close freely.
- Refer to wiring schematics to verify wiring and connections.

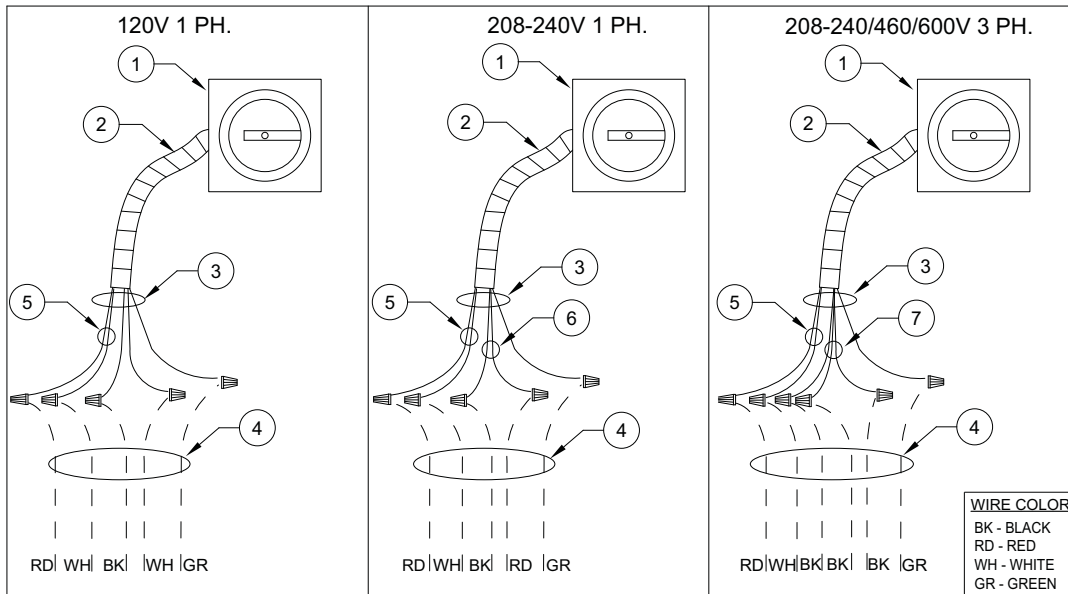
Figure 34 - ECM Fan Wiring



Fan to Building Wiring Connection

Figure 35 - Wiring Connection Details

120V Optional



1. Disconnect Switch
2. Galflex Conduit (In Unit)
3. Factory Wiring
4. Field Supplied Wiring - From building power or pre-wired control panel.
5. 120V Single Phase Standing Power
6. 208-240 Single Phase
7. Three Phase

Motor Speed Controller (MSC) Installation

The Motor Speed Controller (MSC) is a versatile device able to output various signal types to many different Electrically Commutated Motors (ECMs). The MSC signal output types can be selected under the 'Motor Type' section of the MSC menu. The MSC may be installed in a fan, remotely in a kitchen space, or in a mechanical room. While this device can be mounted remotely and powered using 24V, it may also be mounted with the fan where it will be exposed to higher voltages. If installed in the fan, the electrical installation must be carried out according to the appropriate regulations (e.g., cable cross-sections, circuit breaker, protective earth [PE] connection). National and local codes must be followed during the installation process.

The MSC board may be powered through a 120VAC/24VAC CLASS 2 transformer, 120V AC/24V DC CLASS 2 power supply, or through MODBUS connections.

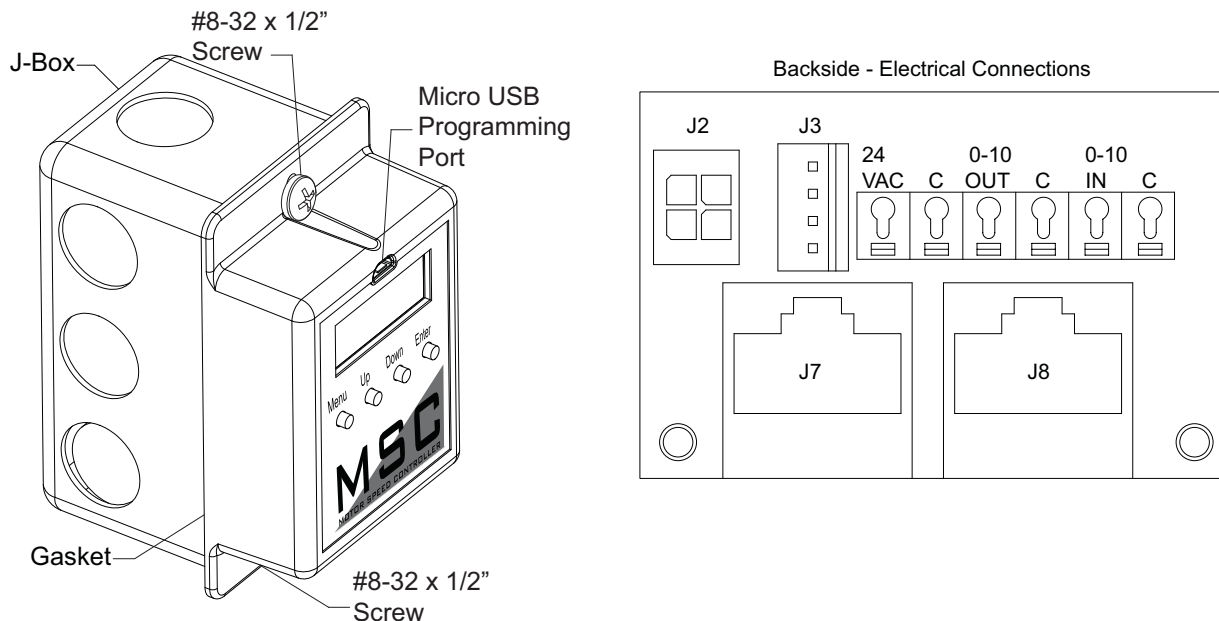
The MSC contains static sensitive components. Therefore, you must handle with care to avoid damage to these components. All operations concerning installation, commissioning, and maintenance must be carried out by qualified, skilled personnel who are familiar with the installation, assembly, commissioning, and operation of the electronic board and the application for which it is being used.

Ensure proper handling and avoid excessive mechanical stress. Do not bend any components when handling or installing component. **Do not touch any electronic components or contacts.**

Precautions must be adhered to during installation, testing, servicing, and repairing of this board. Component damage may result if proper procedures are not followed.

Do not install the MSC where it is subjected to adverse environmental conditions such as combustibles, oils, hazardous vapors, corrosive chemicals, excessive dust, moisture, direct sunlight, or extreme temperatures. When removing or installing the MSC to the j-box, verify the gasket is present. All electrical connections for the MSC are located on the backside of the controller. Refer to **Figure 36** for details on installation and electrical connections. When the micro USB programming port is not in use, place the weather-seal plug into the port location.

Figure 36 - Installation/Electrical Connections



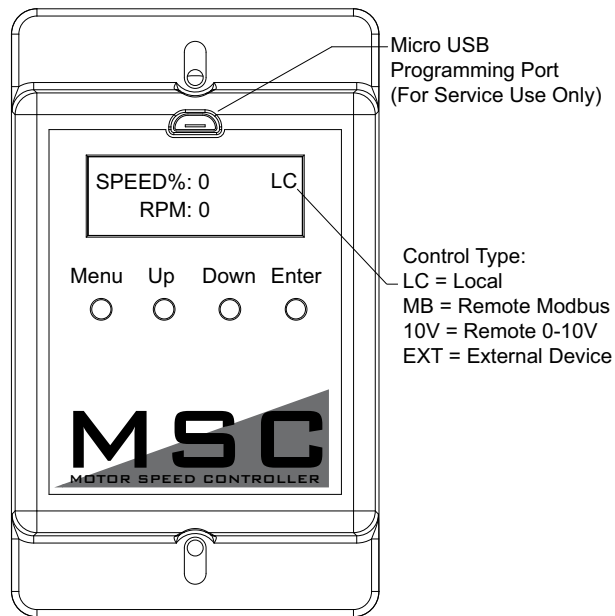
MSC Controls Overview

There are four buttons to navigate through the menu screens, refer to **Figure 37**.

Press the **MENU** button to access menu settings/parameters, pressing **MENU** will also back out of the current menu screen. To scroll through menus, use **UP** and **DOWN** buttons. Press the **ENTER** button to change setting/parameter selection.

To enter password, press MENU, then press **ENTER** when "Board Config" is displayed. Use **UP** and **DOWN** to scroll through numbers, press **ENTER** to advance to the next numerical setting. To save changes, press **MENU** until the screen displays "SAVE CHANGES? [ENTER] TO SAVE." Press the **ENTER** button to save changes.

Figure 37 - MSC Front Detail View



MSC Menu

Board Config - Password (default is 0225)

- **Motor Type** - User may change motor type between Nidec, Telco 42, Telco 48, Ziehl, 0-10V, Other.
- **Control Type** - This setting adjusts how the fan will be controlled.
 - **Local** - The fan will be controlled by the MSC.
 - **Remote Modbus** - The fan will be controlled by another master board through the MSC. A connection between the 0-10V Out to 0-10V In must be made for start command.
 - **Remote 0-10V** - The fan will be controlled by an external 0-10V signal.
- **Speed Settings** - Provides access to speed and voltage settings.
 - **Low Speed** - Adjustable speed from 20% up to high speed setting, or 0-10V. Setting cannot go above High Speed parameter.
 - **High Speed** - Adjustable speed from 100% down to low speed setting, or 0-10V. Setting cannot go below Low Speed parameter.
 - **Set Speed%** - Adjustable speed range is dependent on Low Speed and High Speed settings. This controls the output of the motor.
 - **Voltage Range** - Only available when Motor Type "OTHER" is selected. Default setting is 24V. 5V, and 10V are also available.

- **Modbus #** - Adjustable Modbus ID. Exhaust Fan range 11-18, Supply Fan range 21 or 22. **A VFD and MSC cannot use the same Modbus #.**
- **Options**
 - **Feedback Fault** - If set to ENABLED, the MSC will monitor RPM feedback. If the MSC does not receive data for 30 seconds or 70% of the expected RPM, this fault will be displayed. **Ziehl motors do not provide feedback.**
 - **2 Speed** - The 0-10V output cannot be used when the 2 Speed or Manual Speed options are On, or if the "Control Type" is set to Modbus. When the 0-10V OUT and 0-10V IN terminals are **not** jumped together, the fan will operate at low speed. When 0-10V OUT and 0-10V IN terminals are jumped together, the fan will operate at high speed.
 - **Analog Speed** - The user may enable/disable the option, and calibrate a potentiometer for proper operation that is connected between the 0-10V OUT and 0-10V IN terminals. When enabled, you must calibrate the potentiometer. Follow the MSC's on-screen instructions. The speed will be adjustable between 0V (low speed) to 10V (high speed).
 - **Input Threshold** - When control type is set to Remote 0-10V, an input threshold will be created for motor control. Refer to **Figure 38 on page 41** for threshold examples.
 - **Zero Operation** - The user may select how the motor will operate when the 0-10V input is at 0V. The options will be Off or Low Speed (default).
 - **Threshold** - Increasing the threshold value will allow for the device to hold its voltage/RPM output while the input is between the 0 - threshold value.
 - **Restore Settings** - Provides access to restore factory settings, and test & balance settings.
 - **Factory Settings** - This will reset all values back to factory settings.
 - **T & B Settings** - This will reset all values back to last saved test & balance settings.
 - **Change Password** - Users may update the password setting to their own. Password 0225 will also be stored for backup. Both passwords will allow users to enter "Board Config" settings.

Software Version - Displays the current software version installed on the board.

Faults - This provides access to "Fault History," "Fault Totals," and "Clear Faults."

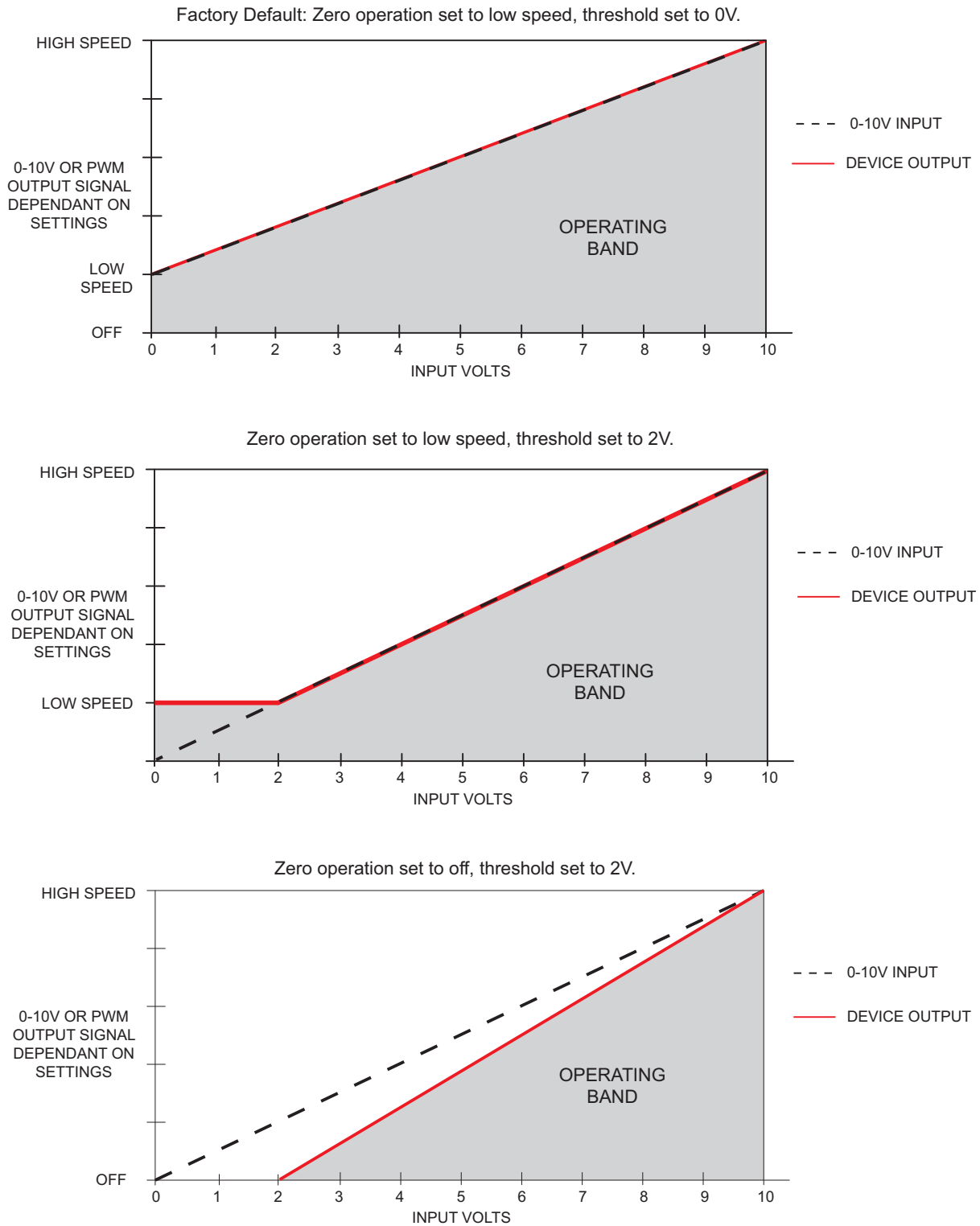
- **Fault History** - Displays fault history and board reboots in chronological order. Possible displayed faults are:
 - **No Faults** - There are no active faults with the system.
 - **Feedback Fault** - Only displayed for motors with feedback capabilities.
 - **Reboot** - Any time the fan goes from OFF to ON, this "fault" will be logged. This fault will only display in "Fault History."
 - **Modbus** - Issue with Modbus communication between the MSC and master board.
 - **Variable Device Fault** - When "Analog Speed" is selected and a potentiometer is connected, if the voltage drops below 1V, this fault will be displayed.
- **Fault Totals** - Displays amount of faults for Modbus, Feedback, Var Device, Reboot, and Total Faults.
- **Clear Faults** - Users may clear all faults from the board.

Service - This provides access to service settings. Password: 1234

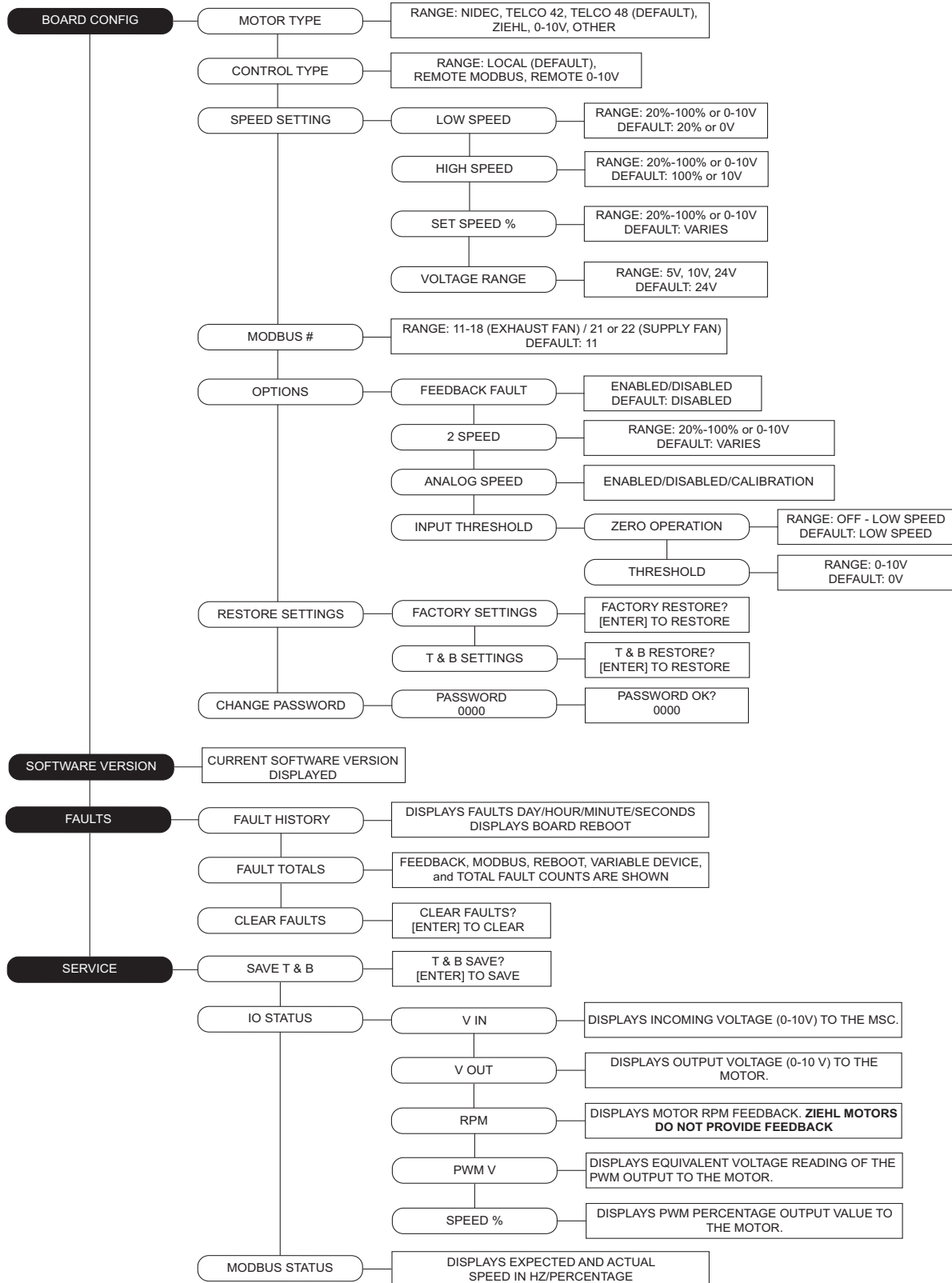
- **Save T & B** - After the test & balance process has been completed, save adjustments under this menu.
- **IO Status** - Provides access to information about the inputs and outputs of the MSC board.
 - **V In** - Displays the incoming voltage (0-10V) to the MSC.
 - **V Out** - Displays the output voltage (0-10V) to the motor.
 - **RPM** - Displays motor RPM feedback. **Ziehl motors do not provide feedback.**
 - **PWM V** - Displays equivalent voltage reading of the PWM output to the motor.
 - **Speed%** - Displays PWM percentage output value to the motor.

Input Threshold

Figure 38 - Input Threshold Examples



MSC Menu Tree



Variable Frequency Drive (VFD)

WARNING!

- Before installing the VFD drive, ensure the input power supply to the drive is OFF.
- The power supply and motor wiring of the VFD must be completed by a qualified electrician.
- The VFD is factory programmed, only change if replaced or ordered separately.

Consult the VFD manual and all documentation shipped with the unit for proper installation and wiring of the VFD. The VFD has been programmed by the factory with ordered specific parameters. Use **Table 4** as a guide during installation.

Table 4 - VFD Installation Check List

Check Off	Description
	The installation environment conforms to the VFD manual.
	The drive is mounted securely.
	Space around the drive meets the drive's specification for cooling.
	The motor and driven equipment are ready to start.
	The drive is properly grounded.
	The input power voltage matches the drive's nominal input voltage.
	The input power connections at L1, L2, and L3 are connected and tight. Verify correct size crimp fitting is used.
	The input power protection is installed.
	The motor's power connection at U, V, and W are connected and tight. Verify correct size crimp fitting is used.
	The input, motor, and control wiring are run in separate conduit runs.
	The control wiring is connected and tight.
	NO tools or foreign objects (such as drill shavings) are in the drive.
	NO alternative power source for the motor (such as a bypass connection) is connected - NO voltage is applied to the output of the drive.

VFD Installation

Input AC Power

- Circuit breakers feeding the VFDs are recommended to be thermal-magnetic and fast-acting. They should be sized based on the VFD amperage. Refer to “**ACTECH SMV VFD**” on page 46. See installation schematic for exact breaker sizing.
- Every VFD should receive power from its own breaker. If multiple VFDs are to be combined on the same breaker, each drive should have its own protection measure (fuses or miniature circuit breaker) downstream from the breaker.
- Input AC line wires should be routed in conduit from the breaker panel to the drives. AC input power to multiple VFDs can be run in a single conduit if needed. **Do not combine input and output power cables in the same conduit.**
- The VFD should be grounded on the terminal marked PE. A separate insulated ground wire must be provided to each VFD from the electrical panel. This will reduce the noise being radiated in other equipment.

ATTENTION: Do not connect incoming AC power to output terminals U, V, W. Severe damage to the drive will result. Input power must always be wired to the input L terminal connections (L1, L2, L3).

VFD Output Power

- Motor wires from each VFD to its respective motor **MUST** be routed in a **separate steel** conduit away from control wiring and incoming AC power wiring. This is to avoid noise and crosstalk between drives. An insulated ground must be run from each VFD to its respective motor. Do not run different fan output power cables in the same conduit.
- VFD mounted in ECP: A load reactor should be used and sized accordingly when the distance between the VFD and motor is greater than specified below. The load reactor should be installed within 10 feet of the VFD output:
 - 208/230V** - Load reactor should be used when distance exceeds 250 feet.
 - 460/480V** - Load reactor should be used when distance exceeds 50 feet.
 - 575/600V** - Load reactor should be used when distance exceeds 25 feet.
- VFD mounted in fan: The load reactor should be sized accordingly when the VFD is mounted in the fan.
 - 208/230V** - Load reactor is optional but recommended for 15 HP and above motors.
 - 460/480V** - Load reactor is optional but recommended for 7.5 HP and above motors.
 - 575/600V** - Load reactors are required for all HP motors.
- If the distance between the VFD and the motor is extremely long, up to 1000 FT, a dV/dT filter should be used, and the VFD should be increased by 1 HP or to the next size VFD. The dV/dT filter should be sized accordingly and installed within 10 feet of the output of the VFD.
 - 208/230V** – dV/dT filter should be used when distance exceeds 400 feet.
 - 460/480V** – dV/dT filter should be used when distance exceeds 250 feet.
 - 575/600V** – dV/dT filter should be used when distance exceeds 150 feet.
- Do not install a contactor between the drive and the motor. Operating such a device while the drive is running can potentially cause damage to the power components of the drive.
- When a disconnect switch is installed between the drive and motor, the disconnect should only be operated when the drive is in a STOP state.

VFD Programming

Programming

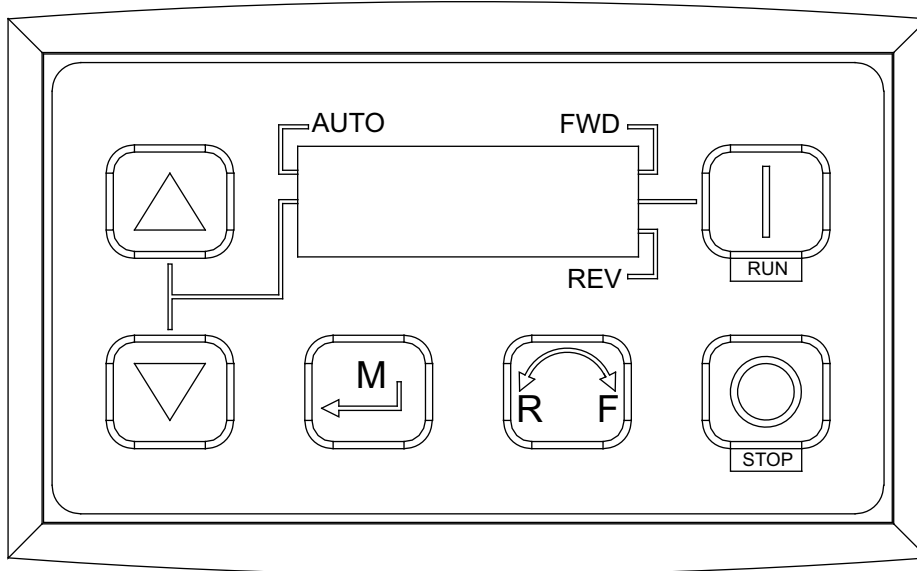
1. The Drive should be programmed for the proper motor voltage. P107 is set to 0 (Low) if motor voltage is 120V AC, 208V AC or 400V AC. P107 is set to 1 (High) if the motor voltage is 230V AC, 480V AC, or 575V AC.
2. The Drive should be programmed for the proper motor overload value. P108 is calculated as Motor FLA x 100 / Drive Output Rating (refer to “**ACTECH SMV VFD**” on page 46).

To enter the PROGRAM mode to access the parameters:

1. Use the buttons on the VFD screen (**Figure 39**) to adjust VFD settings. Press the Mode (M) button. This will activate the password prompt (PASS).
2. Use the Up and Down buttons to scroll to the password value (the factory default password is “0225”) and press the Mode (M) button. Once the correct password is entered, the display will read “P100”, which indicates that the PROGRAM mode has been accessed at the beginning of the parameter menu.
3. Use the Up and Down buttons to scroll to the desired parameter number.
4. Once the desired parameter is found, press the Mode (M) button to display the present parameter setting. The parameter value will begin blinking, indicating that the present parameter setting is being displayed. The value of the parameter can be changed by using the Up and Down buttons.
5. Pressing the Mode (M) button will store the new setting and exit the PROGRAM mode. To change another parameter, press the Mode (M) button again to re-enter the PROGRAM mode. If the Mode button is pressed within 1 minute of exiting the PROGRAM mode, the password is not required to access the parameters. After one minute, the password must be re-entered to access the parameters again.

P500 parameter provides a history of the last 8 faults on the drive. It can be accessed without entering PROGRAM mode.

Figure 39 - VFD Screen



NOTE: When a parameter is changed in the drive, the drive should be de-energized. Wait for the display to go completely dark. Once the display is completely dark, the drive can be re-energized.

ACTECH SMV VFD

Table 5 - Cross-Reference

HP	Part Number	Volts	1Ø Input	3Ø Input	Input Amps 1Ø 120V AC	Input Amps 1Ø 240V AC	Output Amps	Breaker 1Ø 120V AC	Breaker 1Ø 240V AC
0.33	ESV251N01SXB	120/240V	X	-	6.8	3.4	1.7	15	15
0.5	ESV371N01SXB	120/240V	X	-	9.2	4.6	2.4	15	15
1	ESV751N01SXB	120/240V	X	-	16.6	8.3	4.2	25	15
1.5	ESV112N01SXB	120/240V	X	-	20	10	6	30	20

HP	Part Number	Volts	1Ø Input	3Ø Input	Input Amps 1Ø	Input Amps 3Ø	Output Amps	Breaker 1Ø	Breaker 3Ø
0.5	ESV371N02YXB	240V	X	X	5.1	2.9	2.4	15	15
1	ESV751N02YXB	240V	X	X	8.8	5	4.2	15	15
1.5	ESV112N02YXB	240V	X	X	12	6.9	6	20	15
2	ESV152N02YXB	240V	X	X	13.3	8.1	7	25	15
3	ESV222N02YXB	240V	X	X	17.1	10.8	9.6	30	20
5	ESV402N02TXB	240V	-	X	-	18.6	16.5	-	30
7.5	ESV552N02TXB	240V	-	X	-	26	23	-	40
10	ESV752N02TXB	240V	-	X	-	33	29	-	50
15	ESV113N02TXB	240V	-	X	-	48	42	-	80
20	ESV153N02TXB	240V	-	X	-	59	54	-	90
480V									
1	ESV751N04TXB	480V	-	X	-	2.5	2.1	-	15
1.5	ESV112N04TXB	480V	-	X	-	3.6	3	-	15
2	ESV152N04TXB	480V	-	X	-	4.1	3.5	-	15
3	ESV222N04TXB	480V	-	X	-	5.4	4.8	-	15
5	ESV402N04TXB	480V	-	X	-	9.3	8.2	-	15
7.5	ESV552N04TXB	480V	-	X	-	12.4	11	-	20
10	ESV752N04TXB	480V	-	X	-	15.8	14	-	25
15	ESV113N04TXB	480V	-	X	-	24	21	-	40
20	ESV153N04TXB	480V	-	X	-	31	27	-	50
25	ESV183N04TXB	480V	-	X	-	38	34	-	70
30	ESV223N04TXB	480V	-	X	-	45	40	-	80
600V									
1	ESV751N06TXB	600V	-	X	-	2	1.7	-	15
2	ESV152N06TXB	600V	-	X	-	3.2	2.7	-	15
3	ESV222N06TXB	600V	-	X	-	4.4	3.9	-	15
5	ESV402N06TXB	600V	-	X	-	6.8	6.1	-	15
7.5	ESV552N06TXB	600V	-	X	-	10.2	9	-	20
10	ESV752N06TXB	600V	-	X	-	12.4	11	-	20
15	ESV113N06TXB	600V	-	X	-	19.7	17	-	30
20	ESV153N06TXB	600V	-	X	-	25	22	-	40
25	ESV183N06TXB	600V	-	X	-	31	27	-	50
30	ESV223N06TXB	600V	-	X	-	36	32	-	60

START-UP OPERATION

Before starting up or operating the unit, verify all fasteners are secure and tight. Check the set screw in the wheel hub, bearings, and the fan sheaves (pulleys). With power **OFF** to the unit or before connecting the unit to power, turn the fan wheel by hand. Verify it is not striking the inlet or any obstructions. If necessary, re-center.

Special Tools Required: Standard Hand Tools, AC Voltage Meter, Tachometer

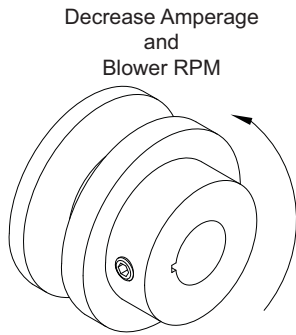
Unit Start-up Procedure

1. Check all electrical connections are secure and tight.
2. Check pulley alignment and belt tension. Refer to “**Pulley Alignment/Proper Belt Tension**” on page 49.
3. Inspect the condition of the intake damper and damper linkage, if applicable.
4. Inspect the air-stream for obstructions or debris in wheel.
5. Compare the supplied **motor voltage** with the fan’s nameplate voltage. If this does not match, correct the problem.
6. Place the external disconnect to the **ON** position to start the unit. Immediately place the disconnect switch off. **Check the rotation of the fan** with the directional arrow on the blower scroll. Reversed rotation will result in poor air performance, motor overloading and possible burnout. For units equipped with a single-phase motor, check the motor wiring diagram to change rotation. For 3-phase motors, any two power leads can be interchanged to reverse motor direction.
7. When the fan is started, observe the operation and check for any unusual noises.
8. Place the external disconnect switch back to the **ON** position. The system should be in full operation with all ducts attached. Measure the system airflow. The motor sheave (pulley) is variable pitch and allows for an increase or decrease of the fan RPM. If an adjustment is needed, refer to “**Pulley Adjustment**” on page 48. For adjustment specifications, refer to “**Pulley Combination Chart**” on page 52.
9. Once the proper airflow is achieved, measure and record the fan speed with a reliable tachometer. **Caution - Excessive speed will result in motor overloading or bearing failure. Do not set fan RPMs higher than specified in the maximum RPM chart.** Refer to “**TROUBLESHOOTING**” on page 53 for more information.
10. Measure and record the **voltage** and **amperage** to the motor. Compare with the motor’s nameplate to determine if the motor is operating under safe load conditions.
11. Once the RPM of the ventilator has been properly set, disconnect power. Re-check belt tension and pulley alignment, refer to “**Pulley Alignment/Proper Belt Tension**” on page 49.

Pulley Adjustment

The adjustable motor pulley is factory set for the RPM specified (**Table 6**). Speed can be increased by closing or decreased by opening the adjustable motor sheave. Two groove variable pitch pulleys must be adjusted to an equal number of turns open or closed. Any increase in speed represents a substantial increase in horsepower required by the unit. Motor amperage should always be checked to avoid serious damage to the motor when the speed is varied. Always torque set screws according to the torque specifications shown in **Figure 40**.

Figure 40 - Adjustable Pulley



Setscrew Thread Size	Torque (in-lbs)
No. 10 (bushing)	32
1/4" (bushing)	72
5/16"	130

Table 6 - Maximum RPM and HP Chart

Belt Drive		
Blower Size	Max. RPM	Max. HP
10"	1800	2
12"	1500	3
15"	1400	5
18"	1200	5
20"	1000	10
25"	900	20

Direct Drive		
Blower Size	Max. RPM	Max. HP
15D	1800	2
20D	1500	3
24D	1400	5
30D	1200	5
36D	1000	10
16Z	2400	4
18Z	3200	5
20Z	2300	5
22Z	1900	5
25Z	1800	8
28Z	1400	7

Pulley Alignment/Proper Belt Tension

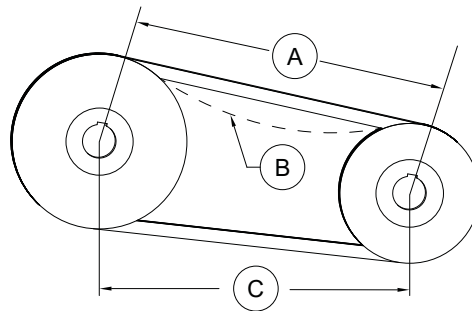
1. Belts tend to stretch and settle into pulleys after an initial start-up sequence. **Do not tension belts by changing the setting of the motor pulley**, this will change the fan speed and may damage the motor.
 - To re-tension belts, turn OFF power to the fan motor.
 - Loosen all fasteners that hold the blower motor plate to the blower housing.
 - Rotate the motor to the left or right to adjust the belt tension. Belt tension should be adjusted to allow 1/64" of deflection per inch of belt span. Use extreme care when adjusting V-belts as not to misalign pulleys. Any misalignment will cause a sharp reduction in belt life and produce squeaky noises. Over-tightening will cause excessive belt and bearing wear as well as noise. Too little tension will cause slippage at start-up and uneven wear.
 - **Whenever belts are removed or installed, never force belts over pulleys without loosening motor first to relieve belt tension.** When replacing belts, use the same type as supplied by the manufacturer. On units shipped with double groove pulleys, matched belts should always be used.
2. All fasteners should be checked for tightness each time maintenance checks are performed before restarting unit.

Belt tension examples:

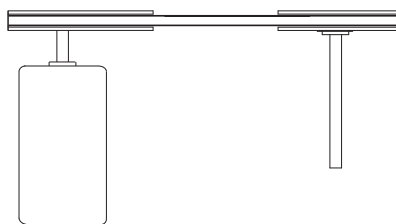
- Belt span 12" = 3/16" deflection
- Belt span 32" = 1/2" deflection

Figure 41 - Pulley Alignment/Belt Tension

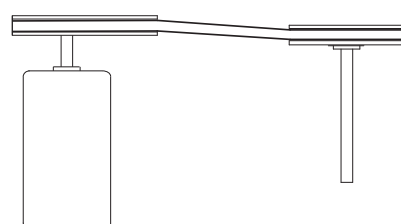
- A. Belt Span Length
- B. Deflection
- C. Center Distance



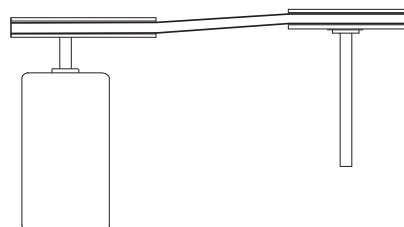
Correct



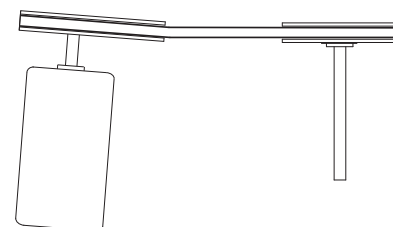
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Incorrect



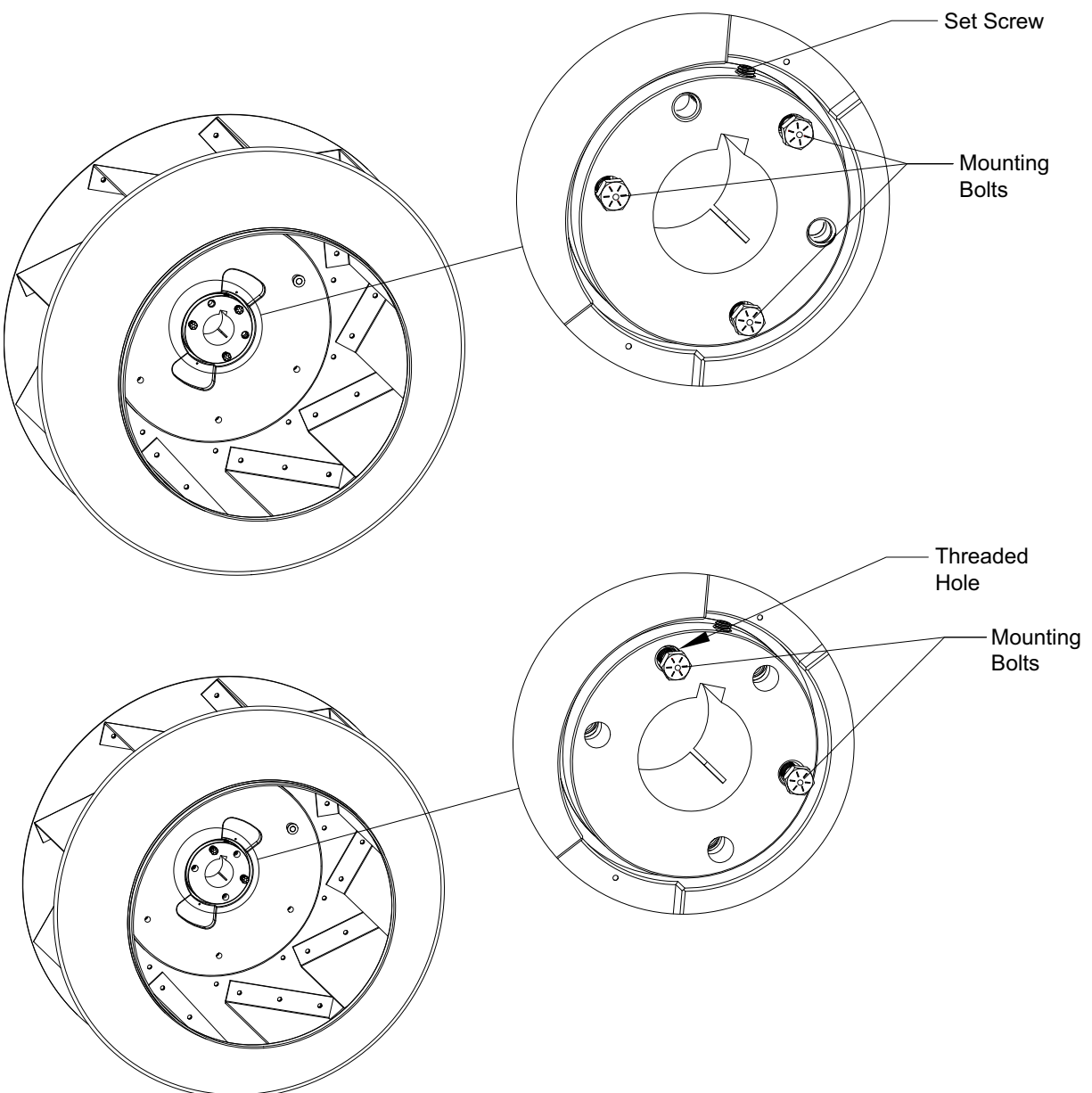
Bushing Information

Removing Fan Wheel

Location of hardware differs depending on hub configuration in **Figure 43 on page 51**. Refer to **Figure 42** for details on removing fan wheel from motor shaft.

1. Loosen set screw on bushing (excludes fan wheels that use H bushing).
2. Remove mounting bolts from bushing.
3. There are threaded holes provided on the bushing. These holes are used for removing the bushing. Using mounting bolts from previous step; slowly thread bolts into threaded holes in the bushing. Alternate tightening bolts after each full turn.
4. Continue until fan wheel can be removed by hand.
5. Remove mounting bolts on motor and remove motor shaft from fan wheel.

Figure 42 - Fan Wheel Removal from Motor Shaft



Installing Fan Wheel

Refer to **Figure 43** for fan bushing assembly details. **Bushing type is stamped on the face of the bushing.**

1. Place bushing key into bushing slot **(A)**, excludes H bushing.
2. Install bushing into wheel hub. Align bushing key with hub keyway **(B)**.
3. Use blue Loctite on the mounting bolts.
4. Install wheel assembly so that the bushing keyway **(C)** is aligned with the motor's shaft key **(D)**.
5. For Direct Drive motors, make sure the bushing is flush to the tip of the motor shaft.
6. For Belt Drive motors, make sure the wheel is properly aligned to the inlet.
7. Tighten set screw to lock shaft key in place. Install bolts and torque to proper setting listed in **Table 7**.

Figure 43 - Bushing Details

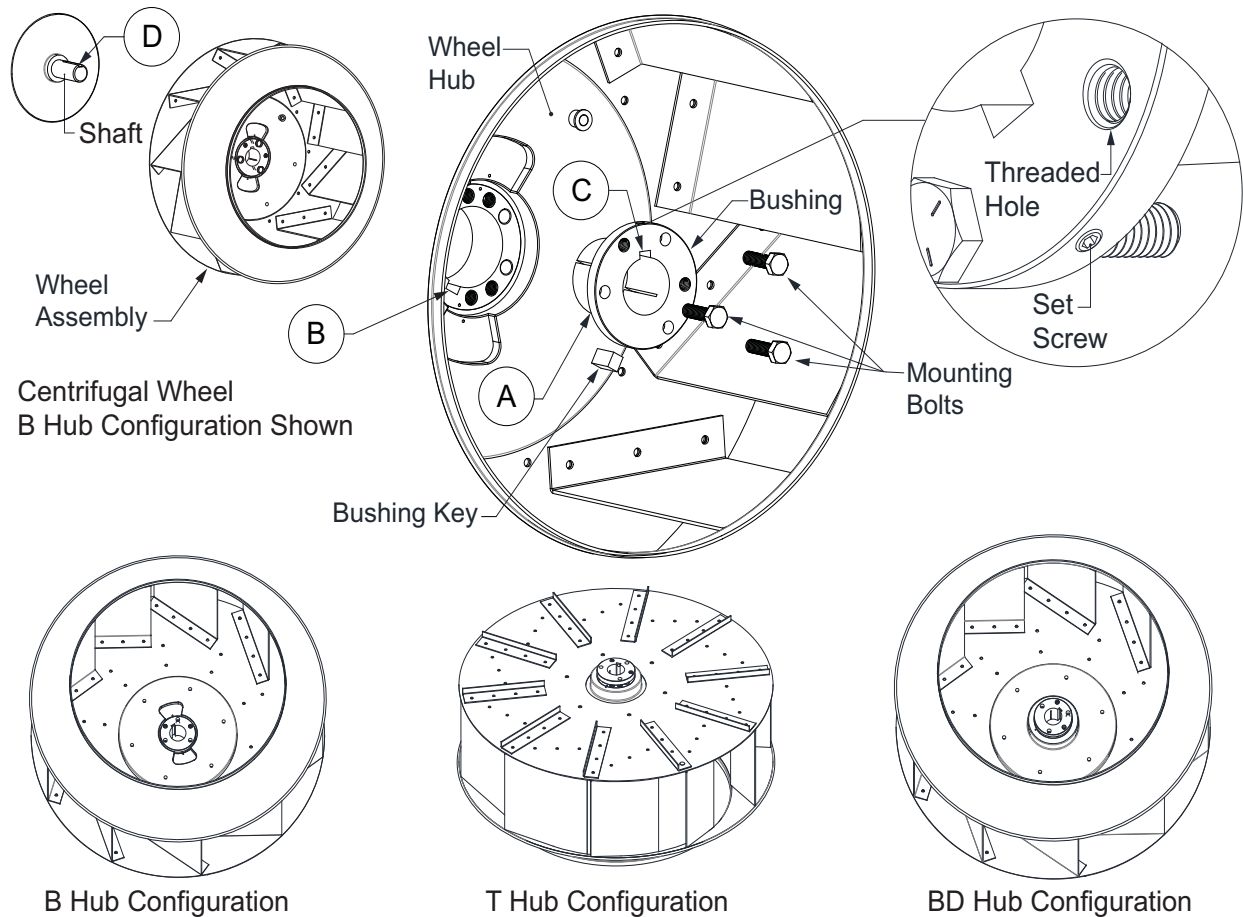


Table 7 - Bushing Specifications

Bushing Type	Outer Diameter	Bolt Size	Torque (In-lbs)	Set-Screw (in-lbs)
H	2-1/2"	1/4" X 3/4"	95	17
P1	3"	5/16" X 1"	192	65
Q1	4-1/8"	3/8" X 1-1/4"	348	115

Pulley Combination Chart

Motor RPM		1725													
1/3 to 1-1/2 HP AX BELTS			MOTOR PULLEY		Dd1	Dd2	Pd1	Pd2	TURNS ON MOTOR PULLEY						
			1VL34		1.9	2.9	2	3	2 1/2	2	1 1/2	1	1/2	0	
BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	Open												
AK114	11	11.2	308	323	339	354	370	385	400	416	431	447	462	477	

Motor RPM		1725													
1/3 to 1-1/2 HP AX BELTS			MOTOR PULLEY		Dd1	Dd2	Pd1	Pd2	TURNS ON MOTOR PULLEY						
			1VL40		2.4	3.4	2.6	3.6	3	2 1/2	2	1 1/2	1	1/2	0
BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	Open												
AK114	11	11.2	400	416	431	447	462	477	493	508	524	539	554	569	
AK94	9	9.2	488	506	525	544	563	581	600	619	638	656	675	694	
AK79	7.5	7.7	582	605	627	650	672	694	717	739	762	784	806	828	
AK66	6.2	6.4	701	728	755	782	809	836	863	889	916	943	970	997	
AK54	5	5.2	863	896	929	962	995	1028	1062	1095	1128	1161	1194	1227	
AK46	4.2	4.4	1019	1059	1098	1137	1176	1215	1255	1294	1333	1372	1411	1450	
AK39	3.5	3.7	1212	1259	1305	1352	1399	1445	1492	1539	1585	1632	1678	1725	
AK32	3	3.2	1402	1455	1509	1563	1617	1671	1725	1779	1833	1887	1941	1995	

Motor RPM		1725														
2 to 5 HP BX BELTS			MOTOR PULLEY		Dd1	Dd2	Pd1	Pd2	TURNS ON MOTOR PULLEY							
			2VP42		2.9	3.9	3	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0
BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	Open													
2BK160H	15.4	15.7	330	339	348	357	366	375	385	394	403	412	421	430	439	
2BK140H	13.4	13.7	378	388	399	409	420	430	441	451	462	472	483	493	504	
2BK120H	11.4	11.7	442	455	467	479	491	504	516	528	541	553	565	577	590	
2BK110H	10.4	10.7	484	497	511	524	537	551	564	578	591	605	618	631	645	
2BK100H	9.4	9.7	534	548	563	578	593	608	622	637	652	667	682	697	711	
2BK90H	8.4	8.7	595	611	628	644	661	677	694	710	727	744	760	777	793	
2BK80H	7.4	7.7	672	691	709	728	747	765	784	803	821	840	859	877	896	
2BK70H	6.4	6.7	772	794	815	837	858	880	901	923	944	965	987	1008	1030	
2BK60H	5.4	5.7	908	933	958	984	1009	1034	1059	1084	1110	1135	1160	1185	1211	
2BK55H	4.9	5.2	995	1023	1050	1078	1106	1133	1161	1189	1216	1244	1272	1299	1327	
2BK50H	4.4	4.7	1101	1132	1162	1193	1223	1254	1285	1315	1346	1376	1407	1438	1468	

Motor RPM		1725																
7-1/2 to 10 HP BX BELTS			MOTOR PULLEY		Dd1	Dd2	Pd1	Pd2	TURNS ON MOTOR PULLEY									
			2VP60		4.3	5.5	4.7	5.9	4 1/2	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0
BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	Open															
2BK160H	15.4	15.7	516	527	538	549	560	571	582	593	604	615	626	637	648			
2BK140H	13.4	13.7	592	604	617	630	642	655	667	680	693	705	718	730	743			
2BK120H	11.4	11.7	693	708	722	737	752	767	781	796	811	826	840	855	870			
2BK110H	10.4	10.7	758	774	790	806	822	838	854	871	887	903	919	935	951			
2BK100H	9.4	9.7	836	854	871	889	907	925	943	960	978	996	1014	1031	1049			
2BK90H	8.4	8.7	932	952	972	991	1011	1031	1051	1071	1091	1110	1130	1150	1170			
2BK80H	7.4	7.7	1053	1075	1098	1120	1143	1165	1187	1210	1232	1255	1277	1299	1322			

Motor RPM		1725														
3 to 5 HP BX BELTS			MOTOR PULLEY		Dd1	Dd2	Pd1	Pd2	TURNS ON MOTOR PULLEY							
			2VP42		2.9	3.9	3	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0
BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	Open													
2B5V278	27.8	28.1	184	189	194	200	205	210	215	220	225	230	235	240	246	
2B5V250	25	25.3	205	210	216	222	227	233	239	244	250	256	261	267	273	
2B5V234	23.4	23.7	218	224	230	237	243	249	255	261	267	273	279	285	291	
2B5V200	20	20.3	255	262	269	276	283	290	297	304	312	319	326	333	340	
2B5V184	18.4	18.7	277	284	292	300	307	315	323	331	338	346	354	361	369	
2B5V160	16	16.3	317	326	335	344	353	362	370	379	388	397	406	414	423	
2B5V154	15.4	15.7	330	339	348	357	366	375	385	394	403	412	421	430	439	
2B5V136	12.6	12.9	401	412	423	435	446	457	468	479	490	501	513	524	535	
2B5V124	12.4	12.7	407	419	430	441	453	464	475	487	498	509	521	532	543	
2B5V110	11	11.3	458	471	483	496	509	522	534	547	560	572	585	598	611	

Motor RPM		1725																
7-1/2 to 10 HP BX BELTS			MOTOR PULLEY		Dd1	Dd2	Pd1	Pd2	TURNS ON MOTOR PULLEY									
			2VP60		4.3	5.5	4.7	5.9	4 1/2	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0
BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	Open															
2B5V278	27.8	28.1	289	295	301	307	313	319	325	331	338	344	350	356	362			
2B5V250	25	25.3	320	327	334	341	348	355	361	368	375	382	389	395	402			
2B5V234	23.4	23.7	342	349	357	364	371	378	386	393	400	408	415	422	429			
2B5V200	20	20.3	399	408	416	425	433	442	450	459	467	476	484	493	501			
2B5V184	18.4	18.7	434	443	452	461	470	480	489	498	507	517	526	535	544			
2B5V160	16	16.3	497	508	519	529	540	550	561	571	582	593	603	614	624			
2B5V154	15.4	15.7	516	527	538	549	560	571	582	593	604	615	626	637	648			
2B5V136	12.6	12.9	628	642	655	669	682	695	709	722	735	749	762	776	789			
2B5V124	12.4	12.7	638	652	666	679	693	706	720	733	747	761	774	788	801			
2B5V110	11	11.3	717	733	748	763	779	794	809	824	840	855	870	885	901			

Motor RPM		1725																		
15 to 20 HP BX BELTS			MOTOR PULLEY		Dd1	Dd2	Pd1	Pd2	TURNS ON MOTOR PULLEY											
			2VP75		5.8	7	6.2	7.4	5 1/2	5	4 1/2	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0
BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	Open																	
2B5V278	27.8	28.1	381	387	393	399	405	411	417	424	430	436	442	448	454					
2B5V250	25	25.3	423	430	436	443	450	457	464	470	477	484	491	498	505					
2B5V234	23.4	23.7	451	459	466	473	480	488	495	502	509	517	524	531	539					
2B5V200	20	20.3	527	535	544	552	561	569	578	586	595	603	612	620	629					
2B5V184	18.4	18.7	572	581	590	600	609	618	627	636	646	655	664	673	683					
2B5V160	16	16.3	656	667	677	688	698	709	720	730	741	751	762	773	783					
2B5V154	15.4	15.7	681	692	703	714	725	736	747	758	769	780	791	802	813					
2B5V136	12.6	12.9	829	842	856	869	883	896	909	923	936	949	963	976	990					

TROUBLESHOOTING

The troubleshooting section lists causes and corrective actions for possible problems with the equipment. Review this section prior to consulting the manufacturer.

Airflow Troubleshooting Chart

Problem	Potential Cause	Corrective Action
Fan Inoperative	Blown fuse/Open circuit breaker	Check amperage.
		Check fuse, replace if needed.
		Check circuit breaker.
	Disconnect switch in "OFF" position	Place switch to the "ON" position.
	Incorrect wiring to motor	Inspect motor wiring. Verify connections with wiring diagram located on fan motor.
Motor starter overloaded	Check amperage.	
	Reset starter.	
Broken fan belt	Replace belt.	
Motor Overload	Incorrect fan rotation	Verify that the fan is rotating in the direction shown on rotation label.
	Fan speed is too high	Reduce fan RPM.
	Incorrect wiring to motor	Inspect motor wiring. Verify connections with wiring diagram located on fan motor.
	Overload in starter set too low	Set overload to motor's FLA value.
	Motor HP too low	Determine if HP is sufficient for job.
	Duct static pressure lower than design	Reduce fan RPM.
Insufficient Airflow	Incorrect fan rotation	Verify that the fan is rotating in the direction shown on rotation label.
	Poor outlet conditions	Check duct and connections. There should be a straight duct connection to the outlet.
	Intake damper not fully open	Inspect damper linkage. If the linkage is damaged, replace damper motor.
	Duct static pressure higher than design	Check ductwork. Adjust/resize to eliminate or reduce duct losses.
	Blower speed too low	Increase fan RPM. Do not overload motor.
	Supply grills or registers closed	Open/Adjust.
	Dirty/clogged filters	Clean filters. Replace filters if they cannot be cleaned or are damaged.
	Belt slippage	Adjust belt tension.
Excessive Airflow	Blower speed too high	Reduce fan RPM.
	Filters not installed	Install filters.
	Duct static pressure lower than design	Reduce fan RPM.
Excessive Vibration and Noise	Damaged/Unbalanced wheel	Replace wheel.
	Fan is operating in unstable region of fan curve	Refer to performance curve for fan.
	Bearings need lubrication/Damaged bearing	Lubricate bearings, replace if damaged.
	Fan speed is too high	Reduce fan RPM.
	Dirty/oily belt(s)	Clean belt(s).
	Belt(s) too loose	Adjust, replace if necessary.
	Worn belt(s)	Replace belt(s).
	Misaligned pulleys	Align pulleys.

MSC Troubleshooting

Fault	Problem	Potential Cause	Corrective Action
Feedback Fault	Feedback Fault on MSC Display	Disconnected/faulty wiring	Secure connections to fan. If faulty wiring is found, repair or replace as required.
		No feedback for 30 seconds	Check parameters.
		Less than 70% of RPM	Check duct/fan for obstructions.
Modbus	Modbus fault on MSC Display	Faulty Cat 5 connection/cable	Find and replace faulty cable.
		ECPM03 does not recognize device	Verify Modbus # on device is set correctly.
Variable Device Fault	Motor not responding to changes made on variable device (potentiometer)	Defective potentiometer	Replace potentiometer.
		Faulty wiring to motor	Find and replace faulty wiring.
Motor not responding	Motor not functioning as expected	2-Speed switch not working	Check switch and wiring.
		Wiring to motor defective	Find and replace faulty wiring.
		Check for other faults on MSC display	If no other faults are present, motor may be defective.

TURN OFF POWER TO THE MOTOR WHILE PROGRAMMING THIS DEVICE.

- If the device has a potentiometer or a 2-Speed switch, a jumper wire can be placed in between the 10V In and 10V Out terminals to rule out a defective device. This will cause the motor to go to HIGH SPEED.
- The IO STATUS menu can be used to verify the inputs and outputs of the device are functioning as expected.
- The FAULT HISTORY menu can be used to keep track of faults while working on the device.

MAINTENANCE

To guarantee trouble-free operation of this fan, the manufacturer suggests following these guidelines. Most problems associated with fan failures are directly related to poor service and maintenance.

Please record any maintenance or service performed on this fan in the documentation section located at the end of this manual.

General Maintenance

- Fan inlet and approaches to ventilator should be kept clean and free from any obstruction.
- All fasteners and electrical connections should be checked for tightness each time maintenance checks are performed before restarting unit.
- These units require very little attention when moving clean air. Occasionally oil and dust may accumulate, causing imbalance. If the fan is installed in a corrosive or dirty atmosphere, periodically inspect and clean the wheel, inlet, and other moving parts to ensure smooth and safe operation.
- Motors are normally permanently lubricated. Check bearings periodically. If they have grease fittings lubricate each season. Use caution when lubricating bearings. Wipe the fittings clean and lubricate the unit while rotating with your hand. **Caution: Use care when touching the exterior of an operating motor. Components may be hot enough to burn or cause injury.**
- If bearings require lubrication, very little is needed. A general rule is one-half pump from a grease gun for 1/2" to 1-7/16" shaft diameters and one full pump for 1-11/16" and large diameter shafts for every 1500 to 3000 hours of operation. A lithium-based grease should be used. Bearings should be rotated as they are lubricated to evenly distribute the grease, either by hand or via extended grease lines. Do not attempt to grease bearings from inside the enclosure while the motor is energized. **Caution: Bearings are sealed, over-greasing can cause damage to the bearings. Do not grease until grease comes out of seals. Only add the appropriate amount of grease.**

2 Weeks After Start-up

- All fasteners should be checked for tightness each time maintenance checks are performed before restarting unit.
- Belt tension should be checked after the first 2 weeks of fan operation. **See "Pulley Alignment/Proper Belt Tension" on page 49.**

Every 3 Months

- Filters need to be cleaned and/or replaced quarterly, and more often in severe conditions. Washable filters can be washed in warm soapy water. When re-installing filters, be sure to install with the **airflow in the correct direction** as indicated on the filter.
- All fasteners should be checked for tightness each time maintenance checks are performed before restarting unit.
- Belt tension should be checked quarterly. **See "Pulley Alignment/Proper Belt Tension" on page 49.** Over-tightening will cause excessive bearing wear and noise. Too little tension will cause slippage at start-up and uneven wear.

Yearly

- Inspect bolts and set screws for tightness. Tighten as necessary.
- Inspect motor for cleanliness. Clean exterior surfaces only. Remove dust and grease and grease from the motor housing to ensure proper motor cooling.
- Remove dirt and grease from the wheel and housing to prevent imbalance and damage.
- Inspect bearings for wear and deterioration. Replace if necessary.
- Inspect belt wear and replace torn or worn belts.

Start-up and Maintenance Documentation

START-UP AND MEASUREMENTS SHOULD BE PERFORMED AFTER THE SYSTEM HAS BEEN AIR BALANCED (Warranty will be void without completion of this form)

Job Information

Job Name		Service Company	
Address		Address	
City		City	
State		State	
Zip		Zip	
Phone Number		Phone Number	
Fax Number		Fax Number	
Contact		Contact	
Purchase Date		Start-up Date	

Fan Unit Information

Refer to the start-up procedure in this manual to complete this section.

Name Plate and Unit Information		Blower Rotation	
Model Number		Correct	
Serial Number		Incorrect	
Volts		Field Measure Information	
Hertz		Voltage	
Phase		Amperage**	
FLA		RPM	
HP			
Blower Pulley			
Motor Pulley			
Belt Number			

Cleaning and Maintenance

Date	Service Performed	Date	Service Performed

**If measured amps exceed the FLA rating on the nameplate, fan RPM must be reduced to decrease the measured amps below the nameplate FLA rating.

As a result of our dedication to constant improvements and quality, the MANUFACTURER reserves the right to update specifications without notice. Please refer to MANUFACTURER'S website for up to date documentation.

Scan for Online Manual





LETTER OF TRANSMITTAL

TO: *Kinco Constructors*

DATE: July 26, 2023

RE: *LRSD Rockefeller EC Center*

JOB NO.: 22-046

ATTN: Mr. Casey Sowell/ Mr. Andrew McCarty

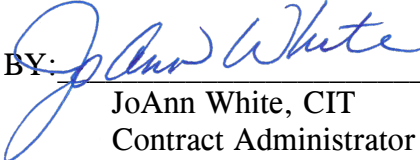
COPIES	DATE	NO.	DESCRIPTION
1 Emailed	07/20/23	23 34 16-1	Exhaust Fans

THESE ARE TRANSMITTED:

- For Approval As Requested Reviewed for General Compliance Resubmit ___ copies for approval
- For Your Use For Review and Comment Reviewed and Noted Submit ___ copies for distribution
- For Your Information Reject, Revise and Resubmit Comments Return ___ corrected prints

REMARKS:

COPY TO: Job File

BY: 

 JoAnn White, CIT
 Contract Administrator



201 S Chester
Little Rock, AR 72201
501.237.3077

Submittal Comment Sheet

Project Name: Rockefeller Pre-K Renovation

Project Number:22-050

Date Received: 07/20/2023

Date Returned:07/26/2023

Reviewed By: K. Koch

1. Exhaust Fans
 - a. EF-1 – Approved
 - b. EF-2 – Approved

End of Comments

THE CONSULTANTS OF RECORD FOR THIS PROJECT HAVE REVIEWED THESE SHOP DRAWINGS. THE CONSULTANTS' COMMENTS AND REVIEW STAMP ARE APPLICABLE FOR THEIR PORTION OF THE WORK. THE REVIEW AND CHECKING OF THE REFERENCED SUBMITTED DOCUMENTS IS FOR GENERAL CONFORMANCE WITH THE DESIGN INTENT OF THE PROJECT AND GENERAL COMPLIANCE WITH THE INFORMATION GIVEN IN THE CONTRACT DOCUMENTS. ANY ACTION SHOWN IS SUBJECT TO THE REQUIREMENTS OF THE PLANS AND SPECIFICATIONS. REVIEW IS NOT CONDUCTED FOR THE PURPOSE OF DETERMINING THE ACCURACY AND COMPLETENESS OF OTHER DETAILS, SUCH AS DIMENSIONS AND QUANTITIES, FOR SUBSTANTIATING INSTRUCTIONS FOR INSTALLATION OR PERFORMANCE OF EQUIPMENT OR SYSTEMS, OR FOR COORDINATION OF THE WORK OF ALL TRADES, ALL OF WHICH REMAIN THE RESPONSIBILITY OF THE CONTRACTOR AS REQUIRED BY THE CONTRACT DOCUMENTS. CONTRACTOR IS RESPONSIBLE FOR ALL QUANTITIES.





Submittal #23 34 16-1.0

23 34 16 - CENTRIFUGAL HVAC FANS

Central Arkansas
12600 Lawson Road
Little Rock, Arkansas 72210
Phone: (501) 225-7606
Fax: (501) 225-1028

Project: 23.1004 - 23.1004 LRSD Rockefeller Early Childhood Center
(WDD #22-046)
700 East 17th Street
Little Rock, 72206

Exhaust Fans

SPEC SECTION:	23 34 16 - CENTRIFUGAL HVAC FANS	SUBMITTAL MANAGER:	Andrew McCarty (Kinco Constructors, LLC)
STATUS:	Open	DATE CREATED:	07/20/2023
ISSUE DATE:	07/20/2023	REVISION:	0
RESPONSIBLE CONTRACTOR:	Comfort Systems USA Arkansas, Inc.	RECEIVED FROM:	Matt Aldridge
RECEIVED DATE:		SUBMIT BY:	
FINAL DUE DATE:	08/10/2023	LOCATION:	
TYPE:	Product Data	COST CODE:	
APPROVERS:	JoAnn White (Wittenberg, Delony & Davidson, Inc)		
BALL IN COURT:	JoAnn White (Wittenberg, Delony & Davidson, Inc)		
DISTRIBUTION:			
DESCRIPTION:	Exhaust fan product data		
ATTACHMENTS:	23 34 16-01 Centrifugal HVAC Fans.pdf		

SUBMITTAL WORKFLOW

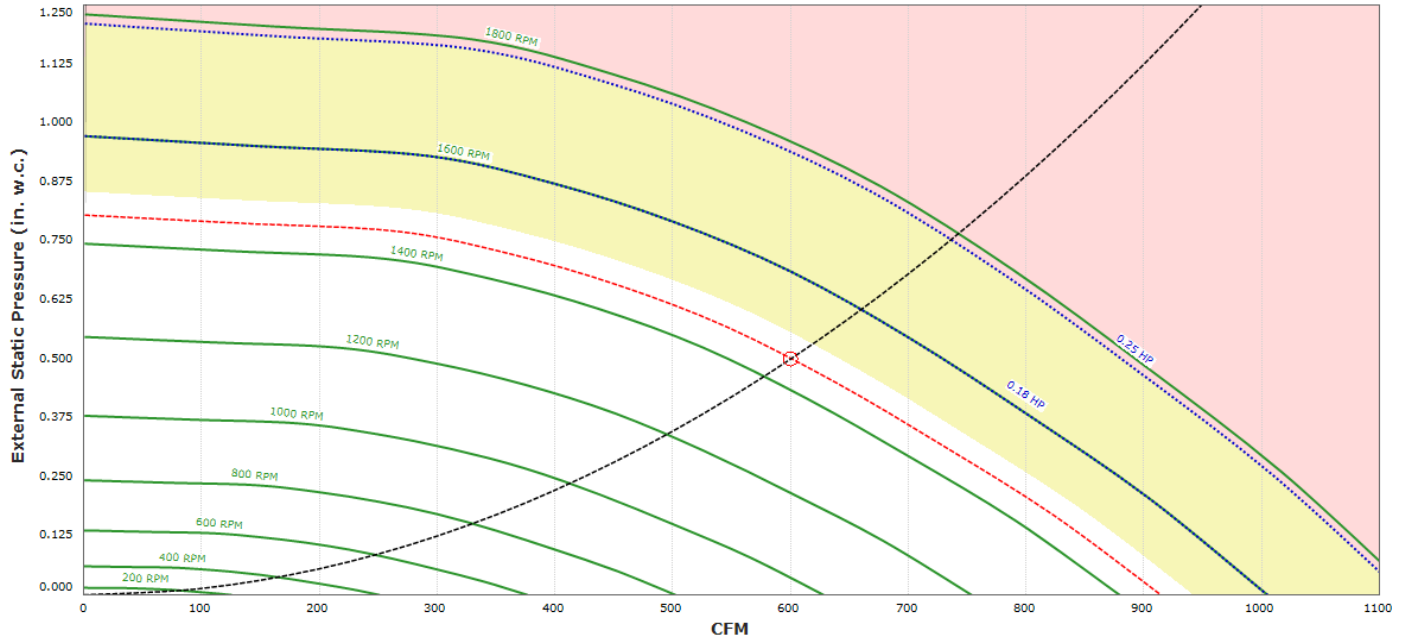
NAME	SUBMITTER/ APPROVER	SENT DATE	DUE DATE	RETURNED DATE	RESPONSE	ATTACHMENTS	COMMENTS
Andrew McCarty	Submitter		7/20/2023	7/20/2023	Submitted	23 34 16-1 Centrifugal HVAC Fans.pdf	Kinco Reviewed
JoAnn White	Approver	7/20/2023	8/10/2023		Pending		

BY _____ DATE _____ COPIES TO _____



DR12HFA (#1) **EF-1** Qty: 2, Weight: 47 lbs./16 curb each

High Speed Direct Drive Centrifugal Downblast Exhaust Fan with speed control (speed control included for single phase only), birdscreen, disconnect switch and 10-1/2" wheel



EXHAUST MOTOR

Model BMN42-18011-60-115 • 0.250 HP • 1 Phs • 115 V • 60Hz • 2.9 FLA • TEAO-ECM (Totally Enclosed Air Over Electronically Commutated Motor)

EXHAUST PERFORMANCE

Volume:	600 cfm	RPM:	1456	TS:	4002 ft/min
Static Pressure:	0.500" w.g.	BHP:	0.1360		
Altitude:	300'	Ambient Temp:	70°F		

VERIFY IF ACCEPTABLE

EXHAUST INSTALLATION INFORMATION

Unit Voltage:	1 phs 115 V 60Hz
Unit Main Input:	3.7 Amps MCA • 15 Amps MOP • 115 V
SCCR:	10 kAmp

CONSTRUCTION FEATURES

- Housing constructed of heavy gauge aluminum
- Centrifugal backward inclined, non-overloading wheel
- Weatherproof safety disconnect switch
- Speed control
- Heavy duty ball bearing motors permanently lubricated, rated for continuous operation, and thermally protected
- Integral electrical conduit runs from fan base to motor compartment
- Shaft precision ground & polished
- Fresh air channelled through motor to ensure long motor life
- Durable base with welded corners

CURB & SUPPORTS

- ROOF CURB - 17.5" Square X 12" High

CONFIGURED OPTIONS

- ECM Wiring Package and Manual or 0-10VDC Control for Exhaust EC motors. RTC Controller (No harness when ordered as a part).

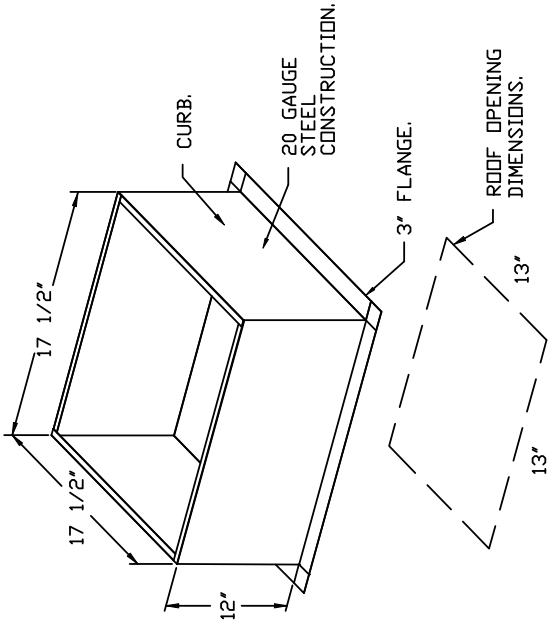
DR12HFA SOUND (1456 RPM) AT 5 FT. IN OCTAVES:

1	2	3	4	5	6	7	8
71	74	74.3	65.3	62.4	59.5	55.3	47.3
LWA:	69.7	Sones:	8.1	DBA:	58.2		

Note: Sound data across operational range. Tested in accordance to AHRI Standard 270/370.

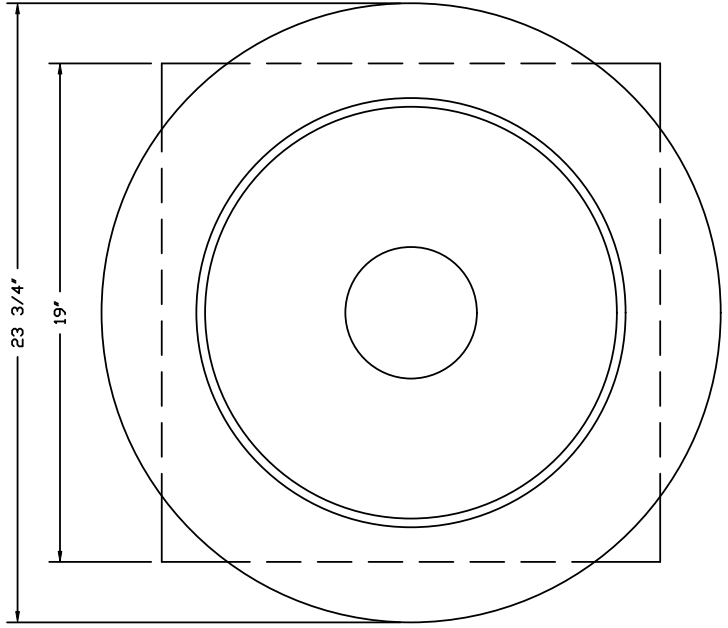
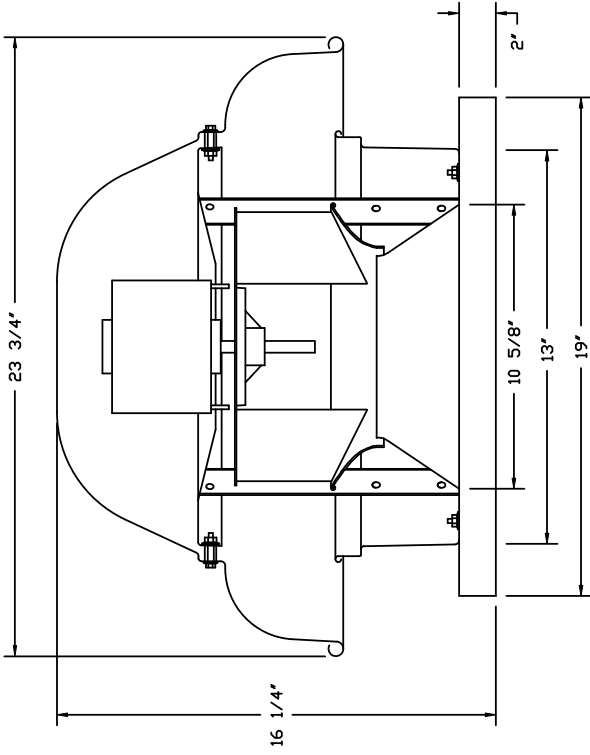
FEATURES:

- DIRECT DRIVE CONSTRUCTION (NO BELTS/PULLEYS).
- ROOF MOUNTED FANS.
- UL705.
- SAFETY DISCONNECT.
- STANDARD BIRD SCREEN.
- SPEED CONTROL.
- THERMAL OVERLOAD PROTECTION (SINGLE PHASE).



PITCHED CURBS ARE AVAILABLE FOR PITCHED ROOFS.

SPECIFY PITCH:
EXAMPLE: 7/12 PITCH = 30° SLOPE.



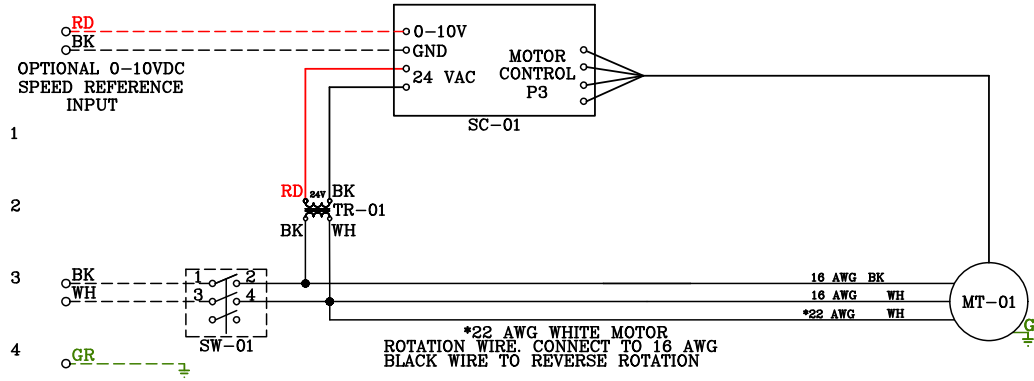
Exhaust Fan Wiring

JOB 6028337 - LRSO Rockefeller Early Childh...

DRAWING NUMBER EXH6028337-1

SHIP DATE 7/13/2023

MODEL DR12HFA



Installed Options

Component Identification		
Label	Description	Location
MT-01	Fan Motor	[3]
SC-01	RTC-FSC-1	[1]
SW-01	Main disconnect switch	[3]
TR-01	24VAC 20VA Transformer	[2]

MOTOR INFO
EXHAUST 0.25HP-115V-1P-2.9FLA

ELECTRICAL INFORMATION
MOTOR/CTRL MCA: 3.7A
MOTOR/CTRL MOP: 15A

NOTES
----- DENOTES FIELD WIRING
_____ DENOTES INTERNAL WIRING

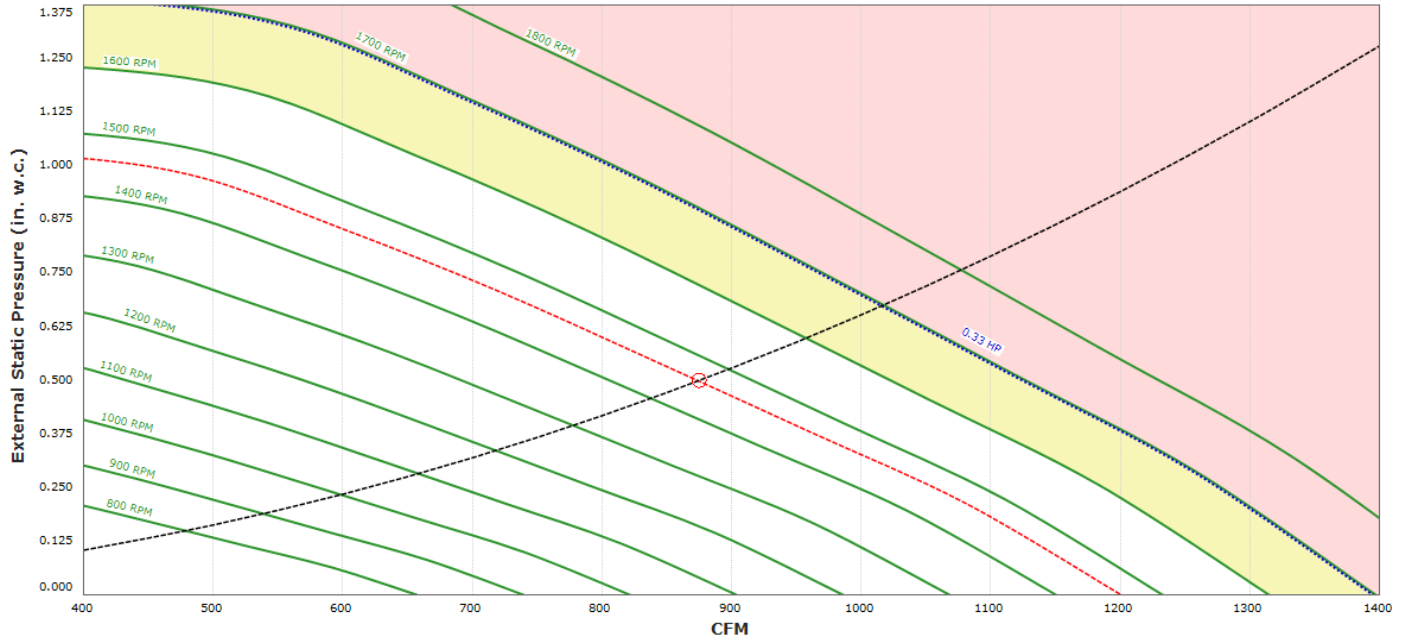
WIRE COLOR
BK - BLACK YW - YELLOW
BL - BLUE GR - GREEN
BR - BROWN GY - GRAY
OR - ORANGE PR - PURPLE
RD - RED PK - PINK
WH - WHITE

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DR33HFA (#2) EF-2 Weight: 54 lbs./18 curb

High Speed Direct Drive Centrifugal Downblast Exhaust Fan with speed control (speed control included for single phase only), birdscreen, disconnect switch and 11-3/4" wheel



EXHAUST MOTOR

Model BMN48-25011-60-115 • 0.333 HP • 1 Phs • 115 V • 60Hz • 4.3 FLA • TEAO-ECM (Totally Enclosed Air Over Electronically Commutated Motor)

EXHAUST PERFORMANCE

Volume:	875 cfm	RPM:	1461	TS:	4494 ft/min
Static Pressure:	0.500" w.g.	BHP:	0.2120	Discharge Velocity:	433 FPM
Altitude:	300'	Ambient Temp:	70°F		

EXHAUST INSTALLATION INFORMATION

Unit Voltage:	1 phs 115 V 60Hz
Unit Main Input:	5.4 Amps MCA • 15 Amps MOP • 115 V
SCCR:	10 kAmp

CONSTRUCTION FEATURES

- Housing constructed of heavy gauge aluminum
- Centrifugal backward inclined, non-overloading wheel
- Weatherproof safety disconnect switch
- Speed control
- Heavy duty ball bearing motors permanently lubricated, rated for continuous operation, and thermally protected
- Integral electrical conduit runs from fan base to motor compartment
- Shaft precision ground & polished
- Fresh air channelled through motor to ensure long motor life
- Durable base with welded corners

CURB & SUPPORTS

- ROOF CURB - 19.5" Square X 12" High

CONFIGURED OPTIONS

- ECM Wiring Package and Manual or 0-10VDC Control for Exhaust EC motors. RTC Controller (No harness when ordered as a part).

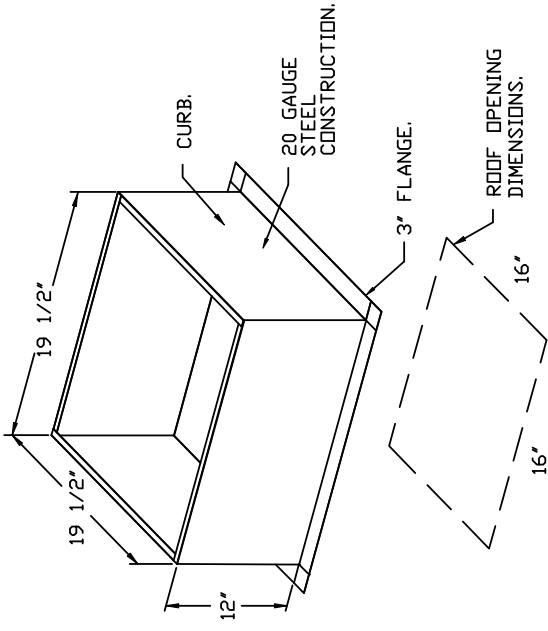
DR33HFA SOUND (1461 RPM) AT 5 FT. IN OCTAVES:

1	2	3	4	5	6	7	8
70.3	77.2	78	71	66.9	65.6	60.2	49.2
LWA:	74.3	Sones:	11.2	DBA:	62.8		

Note: Sound data across operational range. Tested in accordance to AHRI Standard 270/370.

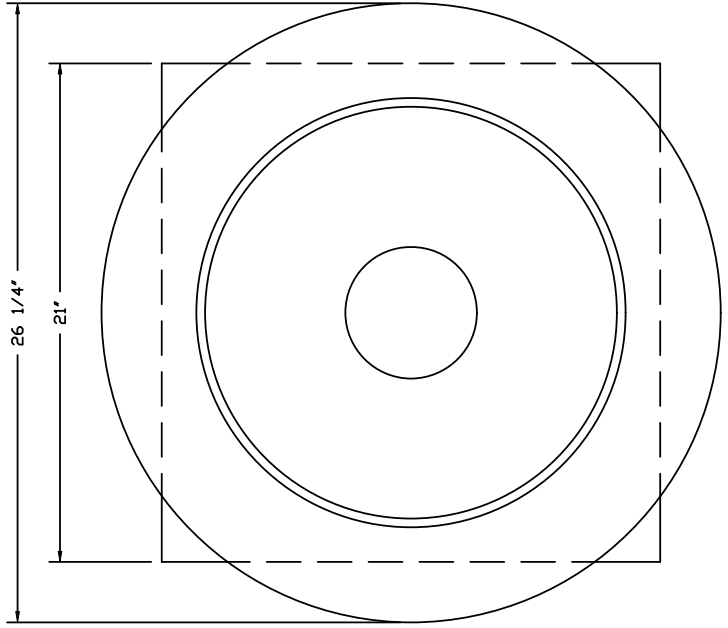
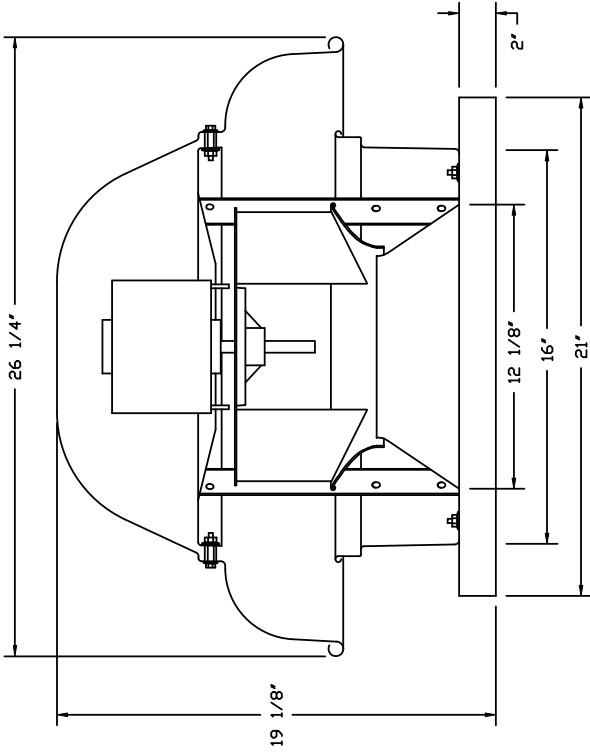
FEATURES:

- DIRECT DRIVE CONSTRUCTION (NO BELTS/PULLEYS).
- ROOF MOUNTED FANS.
- UL705.
- SAFETY DISCONNECT.
- STANDARD BIRD SCREEN.
- SPEED CONTROL.
- THERMAL OVERLOAD PROTECTION (SINGLE PHASE).



PITCHED CURBS ARE AVAILABLE FOR PITCHED ROOFS.

SPECIFY PITCH:
EXAMPLE: 7/12 PITCH = 30° SLOPE.



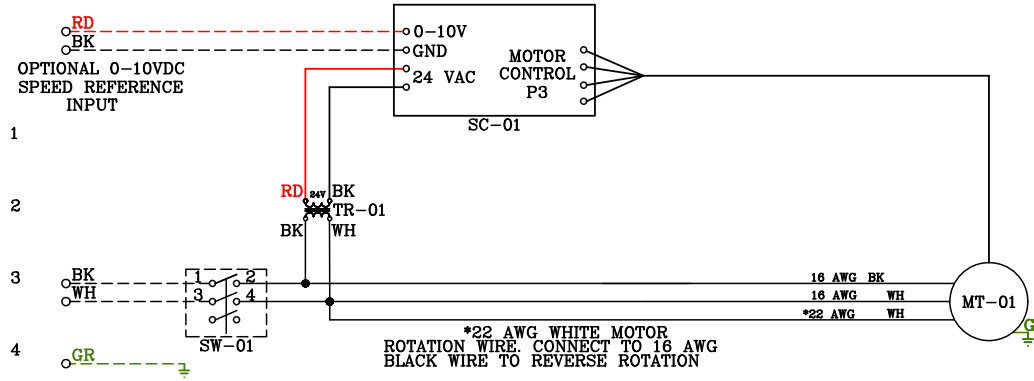
Exhaust Fan Wiring

JOB 6028337 - LRSO Rockefeller Early Childh...

DRAWING NUMBER EXH6028337-2

SHIP DATE 7/13/2023

MODEL DR33HFA



Installed Options

Component Identification		
Label	Description	Location
MT-01	Fan Motor	[3]
SC-01	RTC-FSC-1	[1]
SW-01	Main disconnect switch	[3]
TR-01	24VAC 20VA Transformer	[2]

MOTOR INFO
EXHAUST 0.333HP-115V-1P-4.3FLA

ELECTRICAL INFORMATION
MOTOR/CTRL MCA: 5.4A
MOTOR/CTRL MOP: 15A

NOTES
----- DENOTES FIELD WIRING
_____ DENOTES INTERNAL WIRING

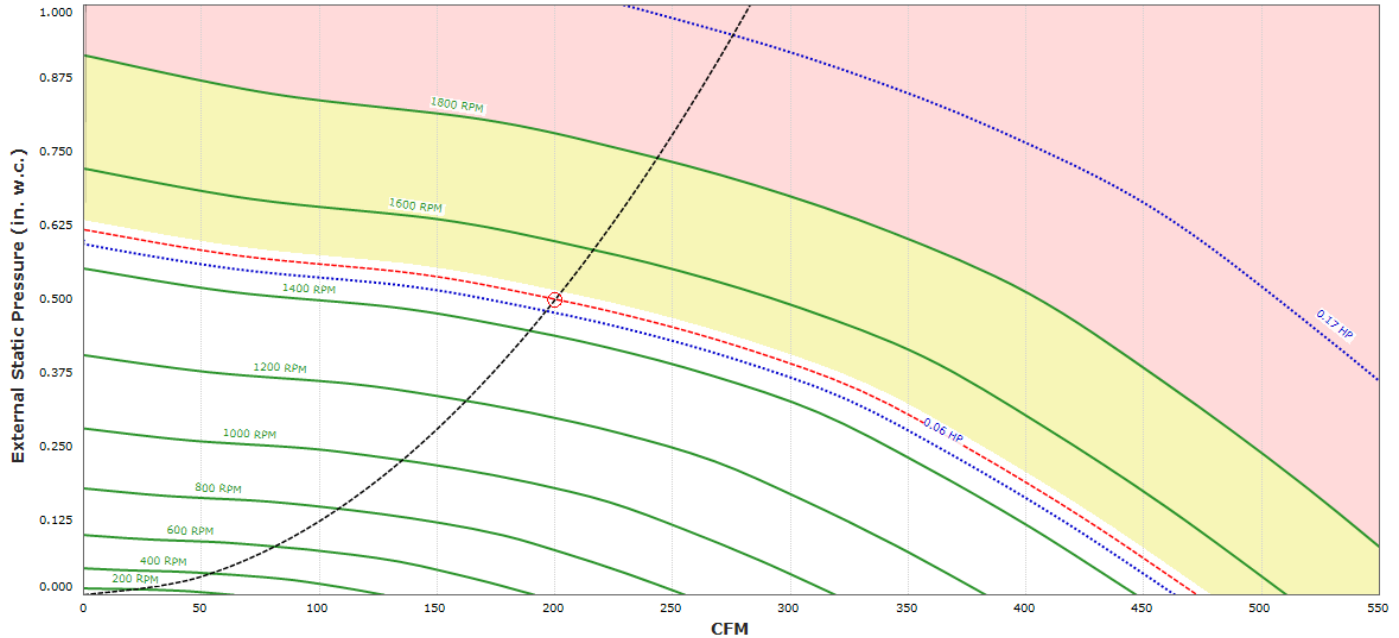
WIRE COLOR

BK - BLACK	YW - YELLOW
BL - BLUE	GR - GREEN
BR - BROWN	GY - GRAY
OR - ORANGE	PR - PURPLE
RD - RED	PK - PINK
WH - WHITE	



DR10HFA (#3) EF-3 Weight: 46 lbs./16 curb

High Speed Direct Drive Centrifugal Downblast Exhaust Fan with speed control (speed control included for single phase only), birdscreen, disconnect switch and 9" wheel



EXHAUST MOTOR

Model BMN42-12011-60-115 • 0.166 HP • 1 Phs • 115 V • 60Hz • 1.9 FLA • TEAO-ECM (Totally Enclosed Air Over Electronically Commutated Motor)

EXHAUST PERFORMANCE

Volume:	200 cfm	RPM:	1481	TS:	3490 ft/min
Static Pressure:	0.500* w.g.	BHP:	0.0640		
Altitude:	300'	Ambient Temp:	70°F		

EXHAUST INSTALLATION INFORMATION

Unit Voltage:	1 phs 115 V 60Hz
Unit Main Input:	2.4 Amps MCA • 15 Amps MOP • 115 V
SCCR:	10 kAmp

CONSTRUCTION FEATURES

- Housing constructed of heavy gauge aluminum
- Centrifugal backward inclined, non-overloading wheel
- Weatherproof safety disconnect switch
- Speed control
- Heavy duty ball bearing motors permanently lubricated, rated for continuous operation, and thermally protected
- Integral electrical conduit runs from fan base to motor compartment
- Shaft precision ground & polished
- Fresh air channelled through motor to ensure long motor life
- Durable base with welded corners

CURB & SUPPORTS

- ROOF CURB - 17.5" Square X 12" High

CONFIGURED OPTIONS

- ECM Wiring Package and Manual or 0-10VDC Control for Exhaust EC motors. RTC Controller (No harness when ordered as a part).

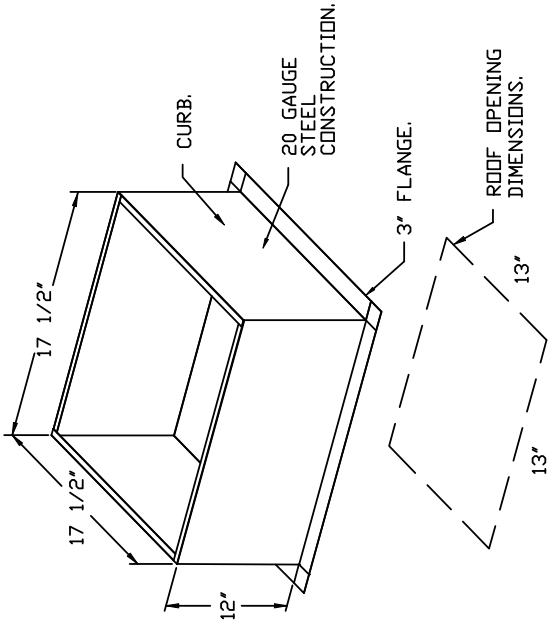
DR10HFA SOUND (1481 RPM) AT 5 FT. IN OCTAVES:

1	2	3	4	5	6	7	8
66	66.8	71.3	55.4	52.1	49.3	45.5	36.5
LWA:	63.9	Sones:	5.4	DBA:	52.4		

Note: Sound data across operational range. Tested in accordance to AHRI Standard 270/370.

FEATURES:

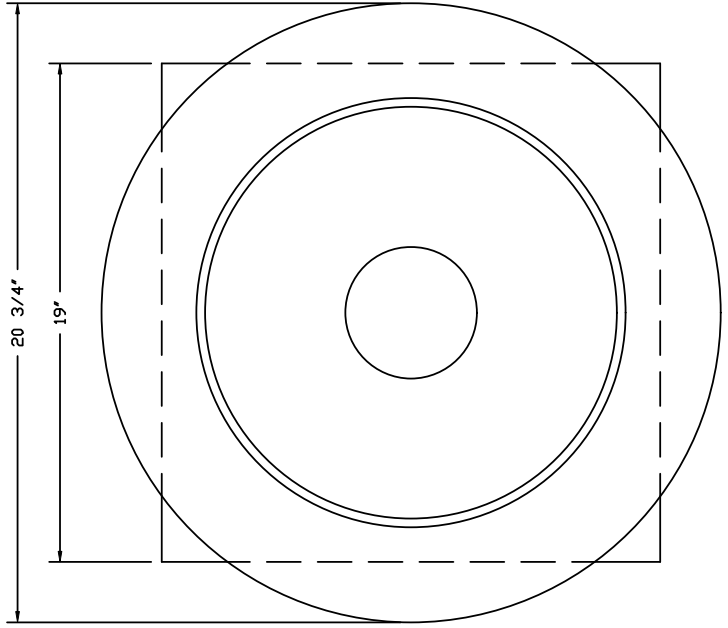
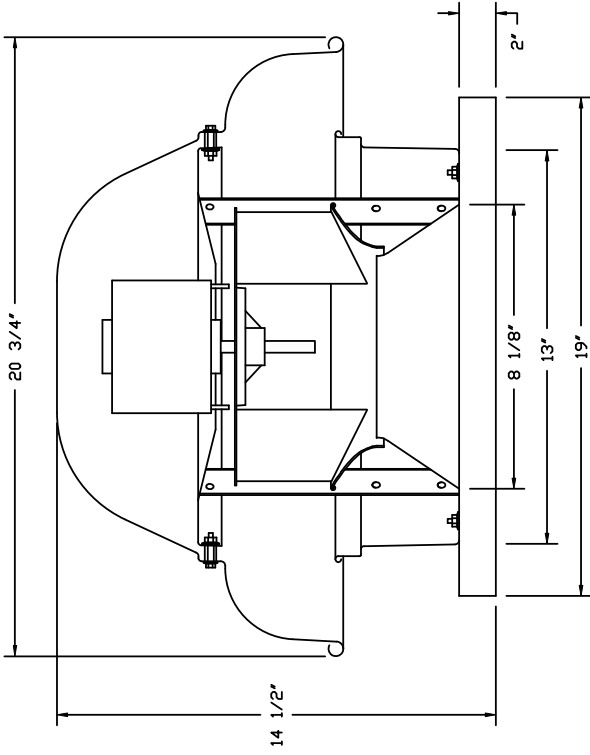
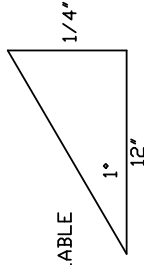
- DIRECT DRIVE CONSTRUCTION (NO BELTS/PULLEYS).
- ROOF MOUNTED FANS.
- UL705.
- SAFETY DISCONNECT.
- STANDARD BIRD SCREEN.
- SPEED CONTROL.
- THERMAL OVERLOAD PROTECTION (SINGLE PHASE).



PITCHED CURBS ARE AVAILABLE FOR PITCHED ROOFS.

SPECIFY PITCH:

EXAMPLE: 7/12 PITCH = 30° SLOPE.



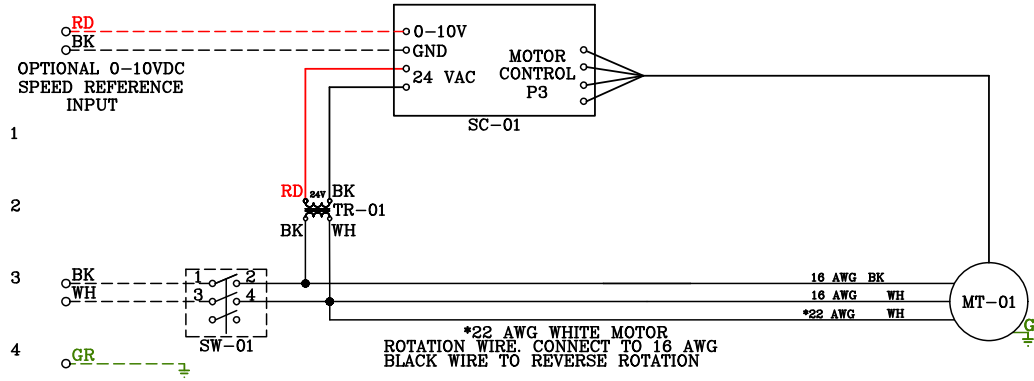
Exhaust Fan Wiring

JOB 6028337 - LRSO Rockefeller Early Childh...

DRAWING NUMBER EXH6028337-3

SHIP DATE 7/13/2023

MODEL DR10HFA



Installed Options

Component Identification		
Label	Description	Location
MT-01	Fan Motor	[3]
SC-01	RTC-FSC-1	[1]
SW-01	Main disconnect switch	[3]
TR-01	24VAC 20VA Transformer	[2]

MOTOR INFO
EXHAUST 0.166HP-115V-1P-1.9FLA

ELECTRICAL INFORMATION
MOTOR/CTRL MCA: 2.4A
MOTOR/CTRL MOP: 15A

NOTES
----- DENOTES FIELD WIRING
_____ DENOTES INTERNAL WIRING

WIRE COLOR
BK - BLACK YW - YELLOW
BL - BLUE GR - GREEN
BR - BROWN GY - GRAY
OR - ORANGE PR - PURPLE
RD - RED PK - PINK
WH - WHITE

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