

R Y T E C

# Powerhouse Model SD<sup>®</sup>

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## Installation Manual



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## INTRODUCTION

The information contained in this manual will allow you to install your Rytec Powerhouse SD<sup>®</sup> Door in a manner that will ensure maximum life and trouble-free operation.

Any unauthorized changes to these procedures, or failure to follow the steps as outlined, will automatically void the warranty. Any changes to the working parts, assemblies, or specifications as written, which are not authorized by Rytec Corporation, will also cancel the warranty. The responsibility for the successful operation and performance of this door lies with the owner.

**DO NOT INSTALL, OPERATE, OR PERFORM MAINTENANCE ON THIS DOOR UNTIL YOU READ AND UNDERSTAND ALL THE INSTRUCTIONS IN THIS MANUAL.**

If you have any questions, contact your Rytec representative or call the Rytec Technical Support Department at 1-800-628-1909. Always refer to the serial number of the door when calling your representative or Customer Support. The location of the serial number is on the left side of the head assembly.

The wiring connections and schematics in this manual are for general information purposes only. The actual schematic for your custom installation is located in the crate when the door is delivered.

## HOW TO USE MANUAL

Throughout this manual, the following key words are used to alert the reader to potentially hazardous situations, or situations where additional information to successfully perform the procedure is presented:

### **WARNING**

**WARNING** is used to indicate the potential for personal injury, if the procedure is not performed as described.

### **CAUTION**

**CAUTION** is used to indicate the potential for damage to the product or property damage, if the procedure is not followed as described.

**IMPORTANT: IMPORTANT** is used to relay information **CRITICAL** to the successful completion of the procedure.

**NOTE:** NOTE is used to provide additional information to aid in the performance of the procedure or operation of the door, but not necessarily safety related.

## DOOR SERIAL NUMBER

The door serial number is located halfway up the left side column.

**IMPORTANT:** When installing multiple doors of the same model, verify & match the serial numbers of all the components for each door/ kit (i.e. control panel, side columns, head assembly, wind bar, etc.).

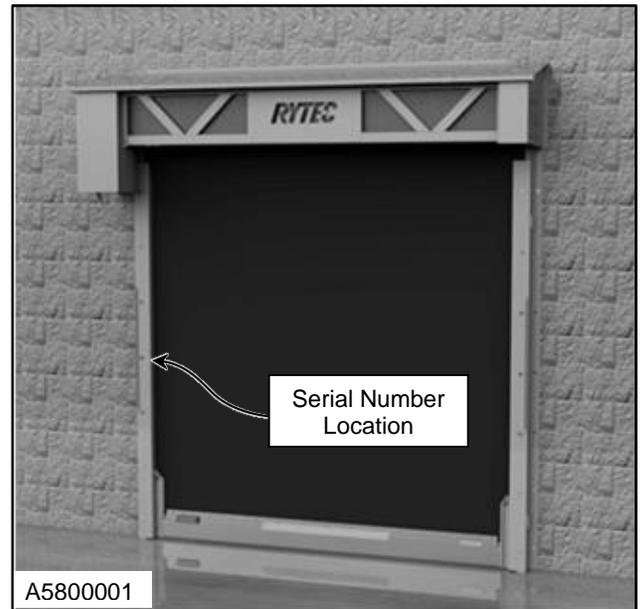


Figure 1

## ITEMS IN SHIPPING CRATE

- Header Assembly
- Left and Right Side Columns
- Spreader Bar
- Control Panel
- Installation Manual
- Owner's Manual
- Electrical Schematic (door specific)
- Windbar Assembly Kit-Front and/or Rear (Optional)
- Hood Assembly (Optional)
- Small Parts Carton

**IMPORTANT:** Some door assemblies are shipped in multiple crates. Every Powerhouse door comes with a door-specific electrical schematic. Since the doors come in different sizes and configurations, always use the electrical schematic that came with that door to install and/or trouble- shoot problems.

## INSTALLATION—ELECTRICAL

### ELECTRICAL

- When working with electrical or electronic controls, make sure that the power source has been locked out and tagged according to OSHA regulations and approved local electrical codes.
- Qualified electricians must do all electrical wiring. Wiring must meet all local, state, and federal codes.
- Please check the documentation to determine the specified voltage. Confirm that the power supply meets the voltage required: 208V, 230/240V, or 460/480/575V. Voltage and fuses or breakers should be checked before connecting to the main power supply.

### INSTALLATION

#### MATERIAL, TOOLS, AND EQUIPMENT

1. Threaded rod ( $\text{\O}1/2\text{-in.}$ ) and other various wall anchor hardware and material. Concrete anchor bolts ( $\text{\O}1/2\text{-in.}$ ). (See “ANCHORING METHODS” on page 3)
2. Assorted shim stock.
3. Steel fish tape.
4. Double-sided tape (for attaching shims to wall).
5. Clamps (9” Minimum).
6. Electric and Hammer Drills.
7. Masonry drill bits (for  $\text{\O}1/2\text{-in.}$  anchors).
8. Torx T40 Bit/Driver.
9. Carpenter’s level (4-ft. minimum length).
10. Carpenter’s square.
11.  $\text{\O}3/8\text{”}$ ,  $\text{\O}1/2\text{”}$ , & “J” size drill bits. (J drill bit required/ included for retro fit installations)
12.  $\text{\O}3/4\text{”}$  Step drill bit.
13. Hammer or mallet and block of wood.
14. Crowbar or pry bar.
15. Assorted hand tools (pliers, tape measure, etc.).
16. Socket and wrench sets.
17. Water level, line level, laser level, or transit.
18. Scissors lift and/or 2 ladders (taller than door opening).
19. Forklift (see “Forklift or Crane Requirements”).

#### GENERAL ARRANGEMENT OF DOOR COMPONENTS

Figure 2 shows the location of the major components of the door and the general placement of the associated sub-assemblies for a typical installation.

*NOTE: These illustrations are for informational purposes only. They should not be relied upon solely during the installation of your door and its sub-assemblies.*

**IMPORTANT:** The surface of the wall on which the door is to be installed must be free of any obstructions. Also, any existing door framing on the wall should be removed or the side panels will require shimming before installing.

*NOTE:* Figure 2 shows the front of the door. Left and right are determined when viewing the front of the door.

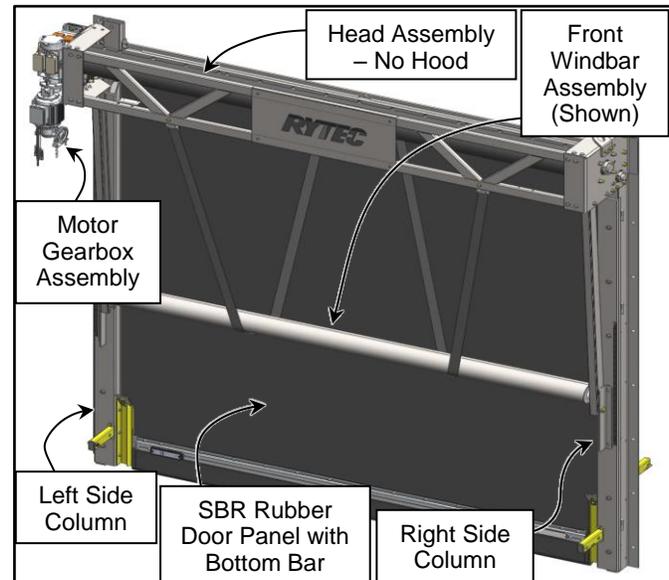


Figure 2

#### ADDITIONAL REQUIREMENTS

##### Labor and Site Requirements

1. Two installers.
2. An electrician is required for making all electrical connections.

**NOTE:** All electrical work must be performed in accordance with local, state, and all applicable building codes.

3. Unlimited accessibility to the door opening during the entire installation process. No traffic should be allowed to pass through the opening while the door windbar(s) is/are being installed.

##### Forklift or Crane Requirements

A forklift supplied by the customer, dealer, or installer are mandatory for the safe and proper installation of this door. Each forklift or crane should have:

- Sufficient lifting capacity.
- Minimum height ability — door height plus 12 in.
- Side-shift capability (desired).

## Electrician's Responsibilities

For complete details on the responsibilities of the electrician, refer to the wiring diagram and manual that were shipped with the control drive.

## ANCHORING METHODS

Correct anchoring of the side columns and head assembly to the wall is important for the smooth and safe operation of the door. The wall material should be strong enough to support the weight to lateral load of the door assembly and all wall anchors.

Figure 3 shows an anchoring method for various types of walls. Use the method that is best suited for your particular installation site.

All necessary anchoring hardware and material required for the installation of this door are the responsibility of the door owner. If you have any questions, call your Rytec representative or the Rytec Technical Support Department at 1-800-628-1909.

**NOTE:** Use  $\varnothing 1/2$ -in. threaded through bolts or threaded rods to anchor the door to all wall applications. Rytec does not recommend mounting the door to wood or insulated wall without additional structural reinforcements. Consult with structural engineer or architect.

### Block or Brick

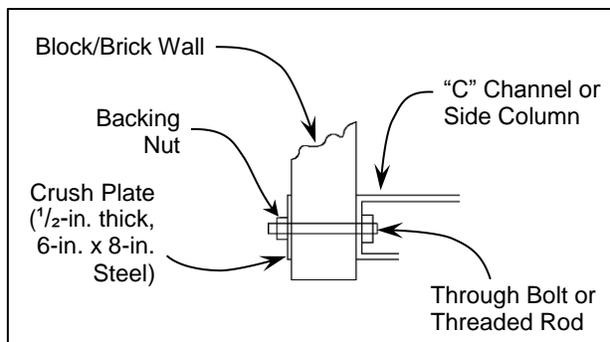


Figure 3

### Metal

When installing the Powerhouse SD door to a metal structure, use 4-in. welds every 16 inches on both sides of the side columns. A certified welding professional should perform this type of installation. (See Figures 4 and 5)

**NOTE:** The door assembly, walls, and building structure **MUST BE** properly grounded.

*Use bar clamps and simply use small tack welds to hold side column in position. DO NOT weld permanently into place until you've verified that the door is plumb.*



Figure 4

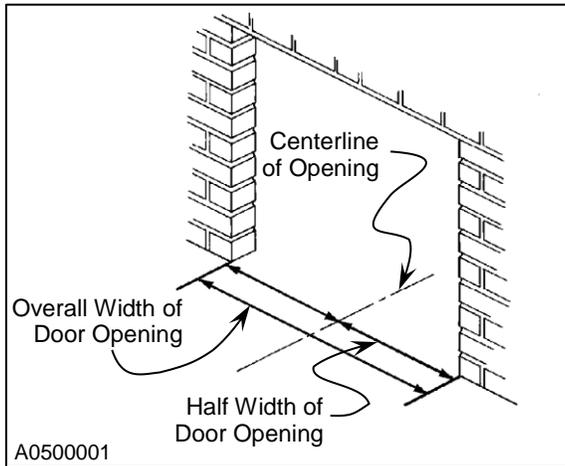


Figure 5

## LOCATING SIDE COLUMNS

1. Locate the layout drawing of the door. It should be attached to the small parts carton. This drawing identifies the production width of your door.
2. Using the centerline as a reference point, lay out and mark half of the door's production width along the floor. (See Figure 6)

## INSTALLATION—LOCATING SIDE COLUMNS

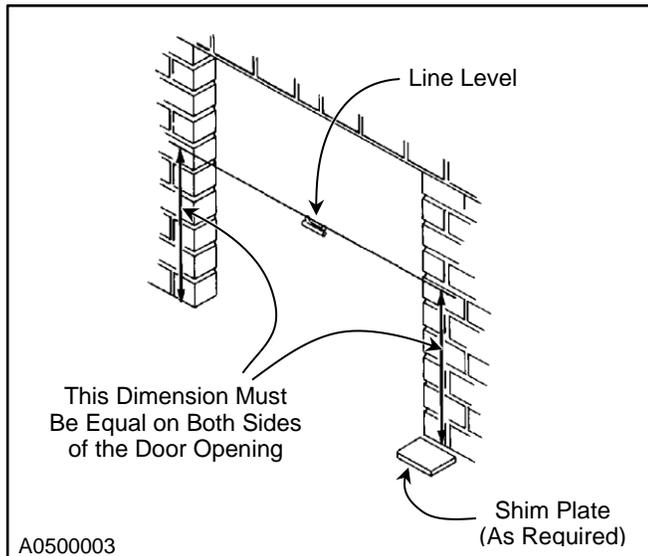


**Figure 6**

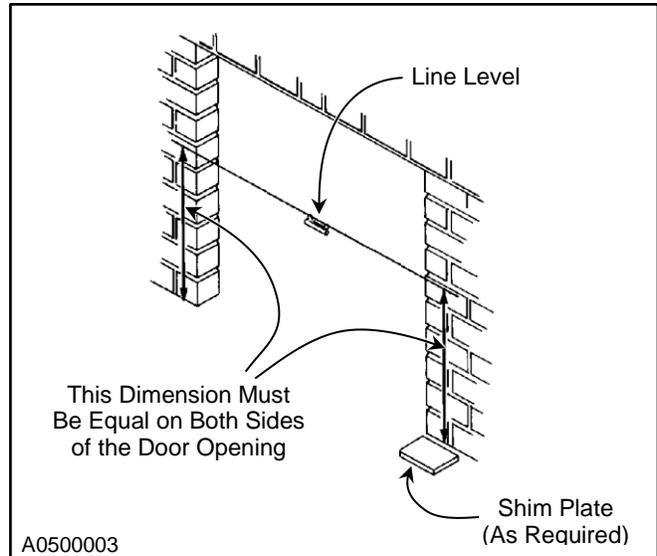
3. With a carpenter's square placed against the wall, mark both sides of the door along the floor. Extend the line along each edge.
4. Check the floor for level across the door opening. The floor must be level within 0.12 in. from side-to-side. If one side of the opening is higher than the other, a shim under the low side column will be required.

Figures 7 and 8 show two recommended methods that can be used to ensure level side column installation.

**NOTE:** Contact the Rytec Technical Department if the floor is more than 1 in. out of level.



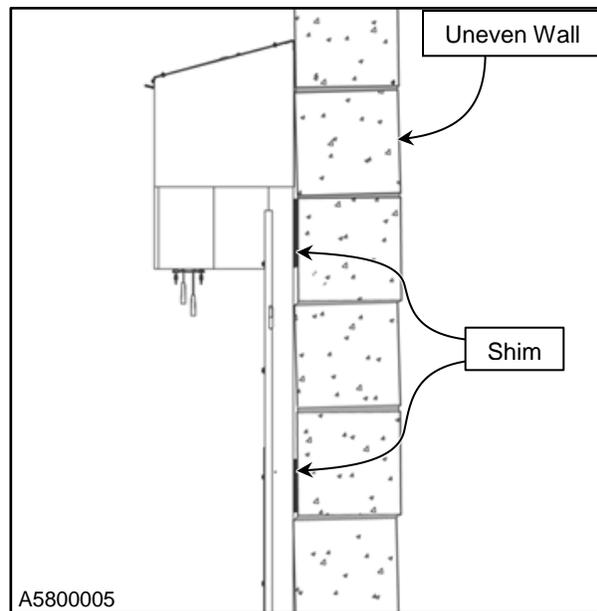
**Figure 7**



**Figure 8**

5. Use a plumb bob or carpenter's level to check the wall for plumb in the areas where the side columns are to be mounted. Also, inspect the wall for any obstructions.

If the wall is not plumb, use shims. If you find an obstruction, remove it or shim the column to avoid the obstruction. (See Figure 9)



**Figure 9**

**NOTE:** If the door requires more than 1/2 in. to shim around the wall obstruction, longer anchors will be required.

**SIDE COLUMNS AND HEAD ASSEMBLY**

The side columns come completely assembled. They are installed with LED and light curtain assemblies (optional) at the factory to make the routing and connecting of cables and wires more efficient.

*NOTE: The side columns come with preset anchor points for your custom door height. DO NOT add additional anchor points as this will void the door warranty. Contact the Rytec Technical Support Department at 1-800-628-1909 for engineering support.*

*Production width is measured from the inner side columns. The door must be installed centered on the opening and in most instances, flush with the wall jamb.*

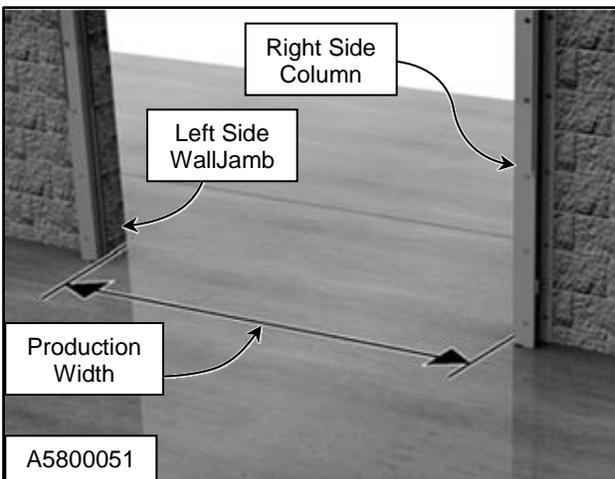


Figure 10

1. Remove the right side column from the shipping crate.

**IMPORTANT:** *It is critical that the side columns are mounted square and plumb with the wall, and level across the door opening. Using a 4-ft. level and carpenter's square will help ensure the columns are correctly set. Place shims where necessary. In addition, the use of bar clamps will allow you to temporarily secure the columns to the wall, while allowing you to make slight adjustments during the installation process.*

**⚠ WARNING**

**Before drilling any holes, ensure there are no electrical wires, water pipes, gas lines, etc., buried in the floor or hidden in the wall.**

2. Place the right side column against the wall and align with the marks on the floor.

*NOTE: In many instances the jamb may not be plumb, square or level.*

3. Once the side column is set plumb and square, bar clamp it to the wall. (See Figure 11)

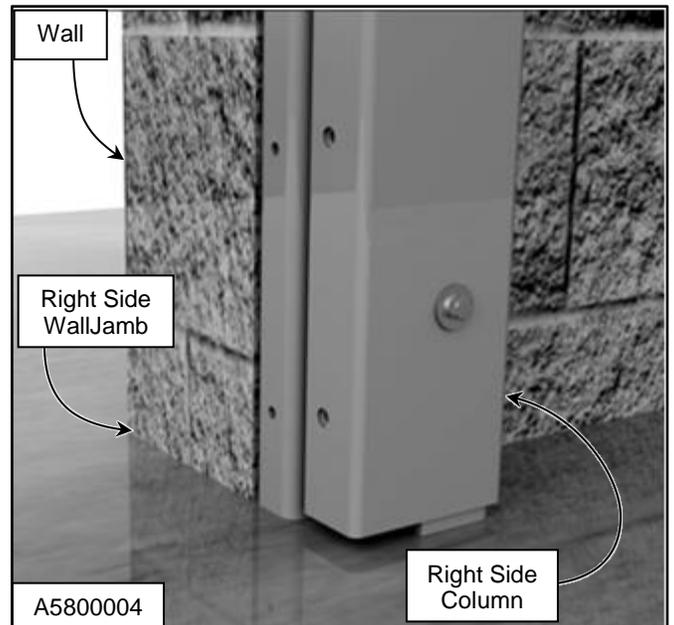


Figure 11

4. Anchor the side column (See "ANCHORING METHODS" on page 3). **DO NOT** tighten the anchors completely at this time - they will be tightened later on after the head assembly is installed. (See Figure 12)

## INSTALLATION—SIDE COLUMNS AND HEAD ASSEMBLY

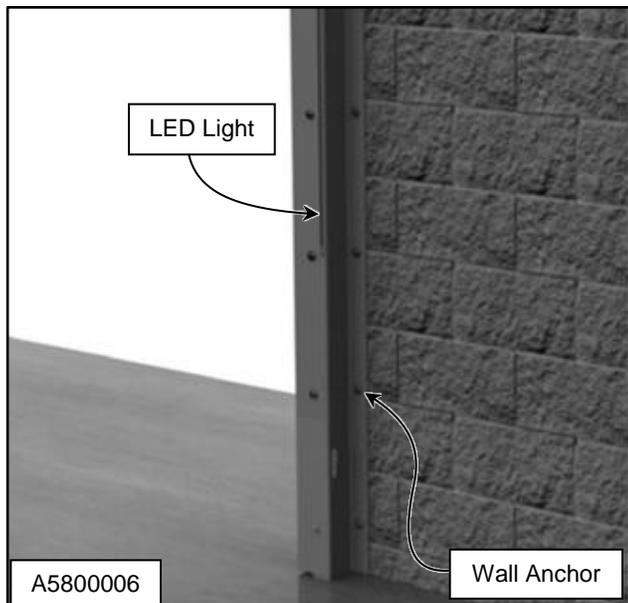


Figure 12

**NOTE:** Use all anchor holes to anchor the side columns to the wall.

**IMPORTANT:** Use  $\frac{1}{2}$ -in. epoxy-filled and/or vibration resistant anchors for concrete walls. Use through bolts or threaded rods for brick walls.

5. Install left side column in the same manner as the right.
6. Install rear spreader assembly between the two side columns using four  $\frac{1}{2}$  x 1-in. hex head cap screws and  $\frac{1}{2}$ -in. lock washers. (See Figure 13)

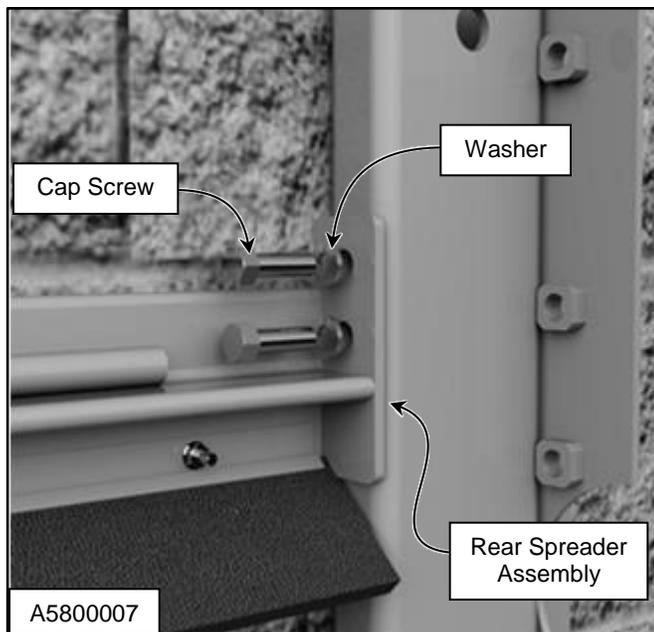


Figure 13

7. With both columns set, clamped down, and snugly anchored in place, check the overall squareness of each column.

Compare the diagonal measurements and the upper and lower horizontal measurements across the columns. The columns are square and parallel when the diagonal measurements are equal and the horizontal measurements are equal. (See Figure 14)

**NOTE:** If either column requires slight repositioning (when the difference of either comparison is greater than  $\frac{1}{4}$  in.), use a block of wood and a mallet to nudge the column into position.

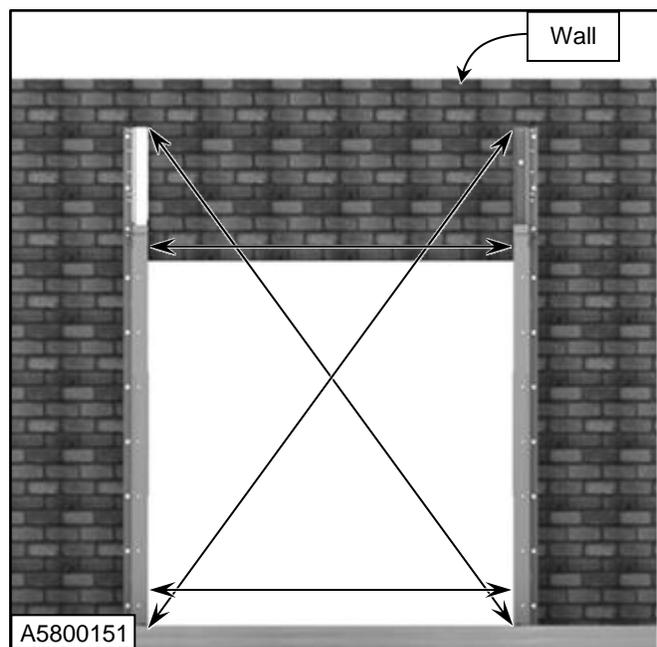


Figure 14

8. Install anchor into rear spreader assembly. (See Figure 15)

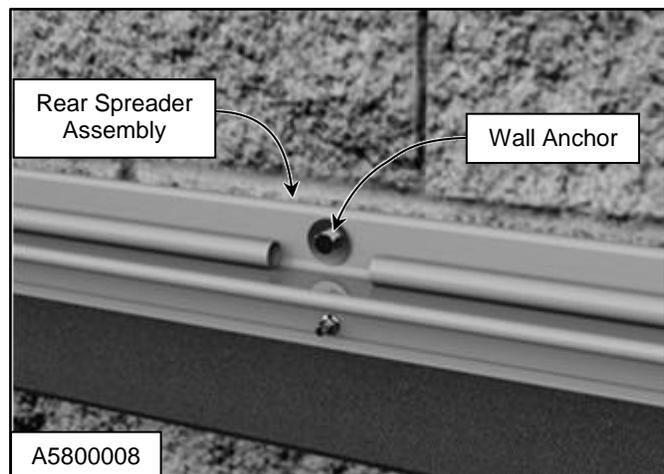


Figure 15

## INSTALLATION—SIDE COLUMNS AND HEAD ASSEMBLY

9. Attach head assembly to the lifting device:

- a. Attach an appropriate rated strap or chain to the lifting lugs of the head assembly. (See Figure 16)

**NOTE:** The lifting lugs are manufactured at a 45° angle and should not be modified. When using chains or straps to lift the head assembly into place, the angle cannot be less than 45°. Anything less than that will cause the assembly to bow, and improper alignment and fit will result.

Before fully lifting head assembly into position, test the strap angle on the head assembly. If end plates begin to bow inward, increase the strap angle.

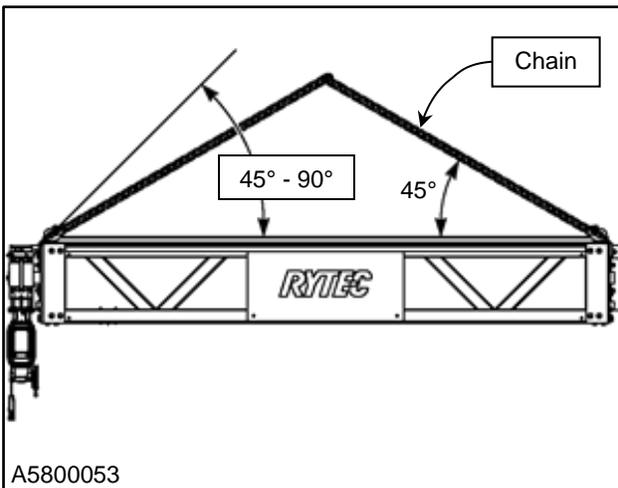


Figure 16

- b. Secure the head assembly to a forklift or other suitable lifting device. (See Figure 17)

**NOTE:** The wooden cradle supports the head assembly during shipping. The wooden cradle can be used to lift the head assembly into position when overhead clearance is unavailable. If the wooden cradle is used to lift the head assembly into position caution must be taken in lifting the assembly safely. The preferred method of lifting the head is from the top utilizing the lifting lugs.

**IMPORTANT:** When lifting from the bottom, the load is heavy and out in front away from the fork truck. Use caution when lifting.

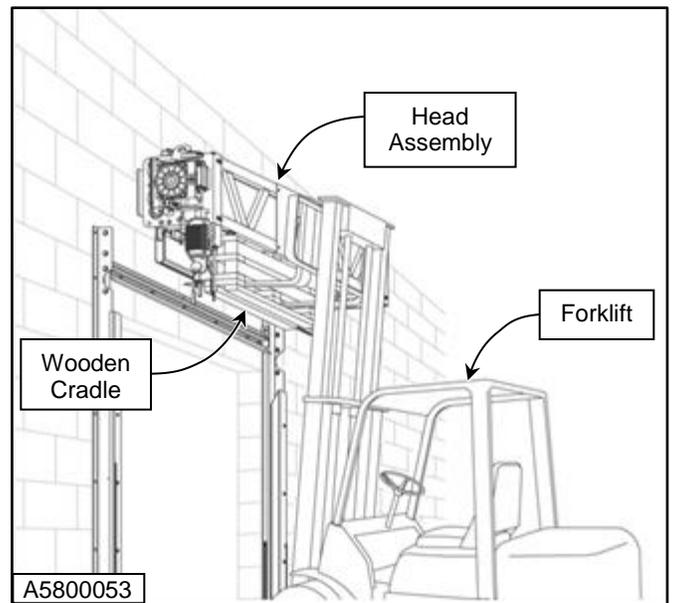


Figure 17

10. Lift into position and align head assembly with the side columns. Install washers, lock washers, and cap screws. (See Figure 18 and Figure 19)

**IMPORTANT:** There are three sizes of head assemblies for the Powerhouse SD door.

- A-Size (13.00 in.) Head
- B-Size (18.50 in.) Head
- C-Size (22.50 in.) Head

The A-Size requires six washers, lock washers, and cap screws to attach the head assembly to the side columns. The B-Size and C-Size require eight.

**NOTE:** The motor/gearbox is factory installed to the head assembly. Use extreme care when lifting and attaching the head assembly to the side columns.

## INSTALLATION—SIDE COLUMNS AND HEAD ASSEMBLY

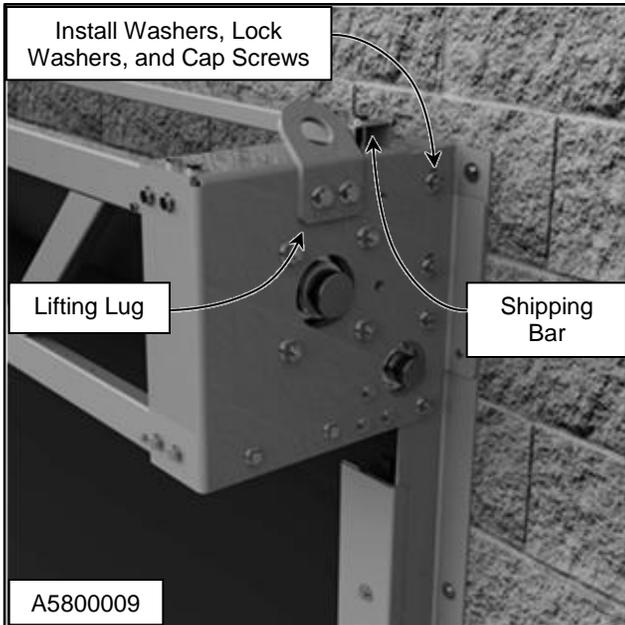


Figure 18

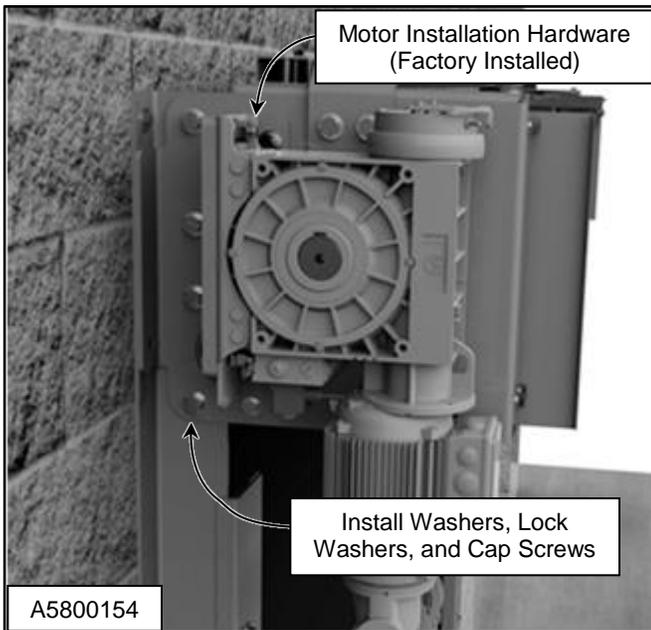


Figure 19

11. Using a carpenter's level (4-ft. minimum length), check that the head assembly is level and tighten all hardware and anchors.
12. Tighten all anchors and associated hardware.
13. **OPTIONAL:** The lifting lug and shipping bar are used to install the door. These pieces can be removed if there is a interference problem. (See Figure 18)

**NOTE:** See "HOOD (OPTIONAL)" on pages 13 and 28 regarding lifting lug and shipping bar.

14. Check and adjust the routing of the bottom bar and door panel over the idler roller. (See Figure 20)

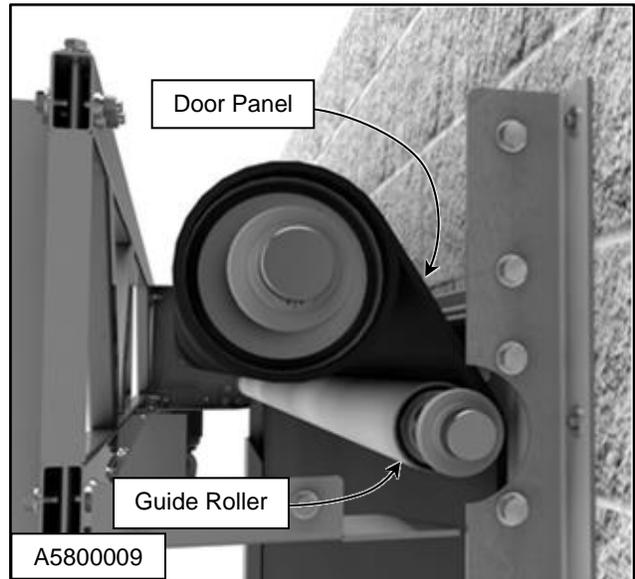


Figure 20

**IMPORTANT:** Prior to installing the hood assembly or switching power on for the first time, make sure all wires and cables are properly routed and secure. Wires and cables should not interfere with any moving parts.

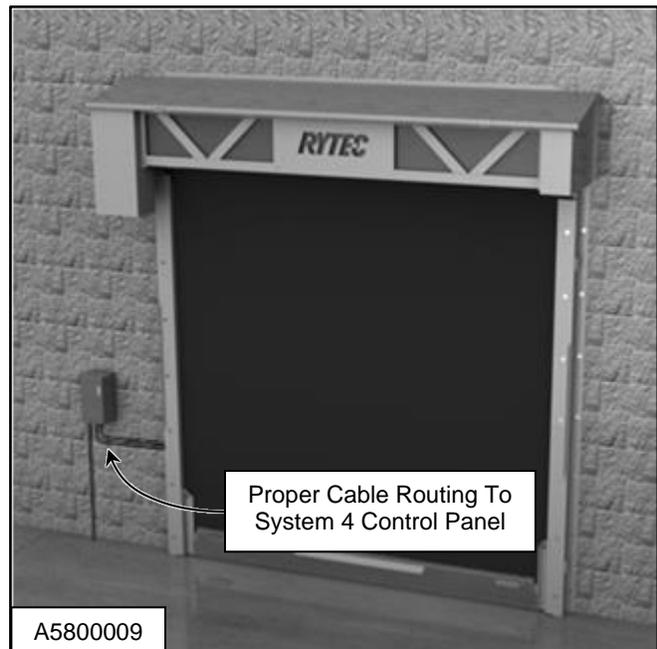


Figure 21

**LIGHT CURTAIN (OPTIONAL)**

**IMPORTANT:** Light curtains are standard on the Powerhouse SD model doors. Standard photo eyes are optional. (See “PHOTO EYES (optional)” on page 10)

The Powerhouse SD door is equipped with a set of light curtains. One side column will contain the transmitter module and the other contains the receiver module. The transmitter and receiver have both been factory installed and cabled in the side columns. The cables exit the side columns at the top. The purpose of the light curtains is to hold the door open if a vehicle, person, or any object is in the path of the light curtain beam.

The light curtain is not active when the door is closed.

This system consists of one pair of non-adjustable emitter and receiver module. There are no gain or sensitivity settings.

1. Gain access to light curtain(s) by removing all cap screws, lock washers, and washers on the front of the side column door.

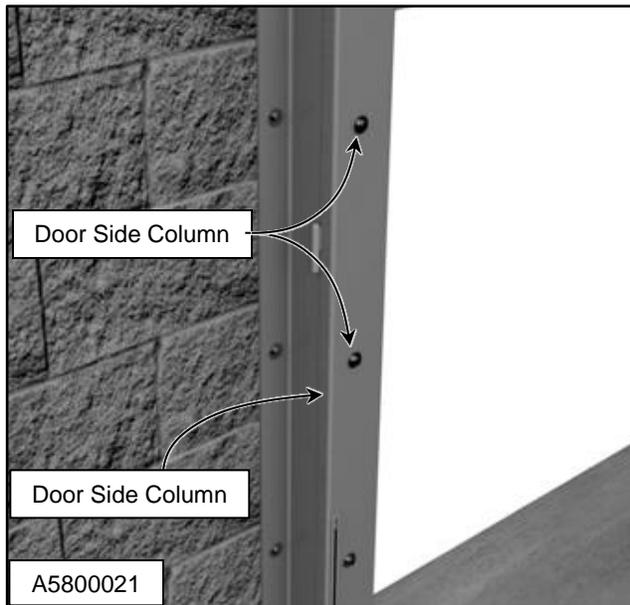


Figure 22

2. Connect cable to light curtain(s).

**NOTE:** Light curtain assemblies are factory installed. Cables are routed through the tube steel to the top of each side column.

**NOTE:** A fish tape may be required to route cables and wires.

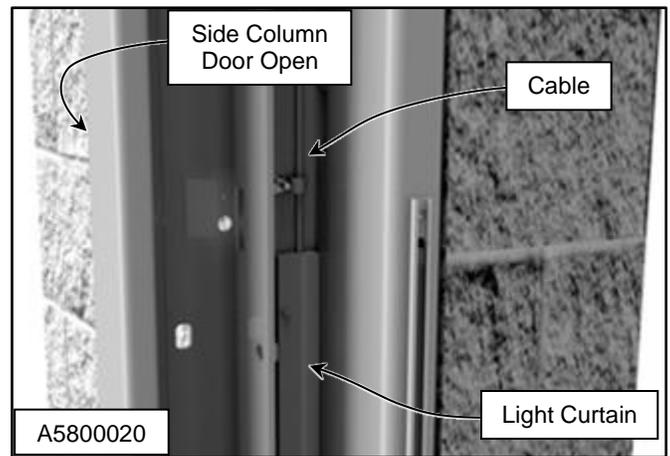


Figure 23

3. Route light curtain cables toward System 4 control panel. Use tubes on the rear spreader for routing all cables and wires to the control panel. Secure cables as neatly and cleanly as possible with an exposed head assembly.

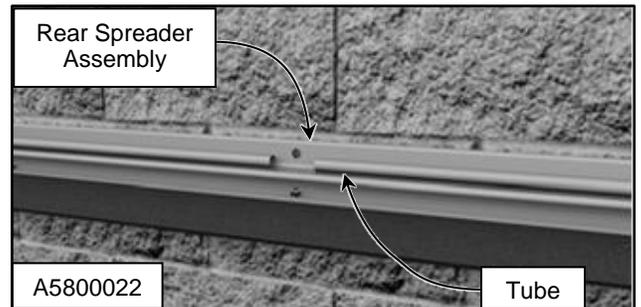


Figure 24

4. If the optional hood assembly is installed, route all cables and wires through prefabricated access holes. (See Figure 25)

**NOTE:** End of the hood assembly is removed for clarity.

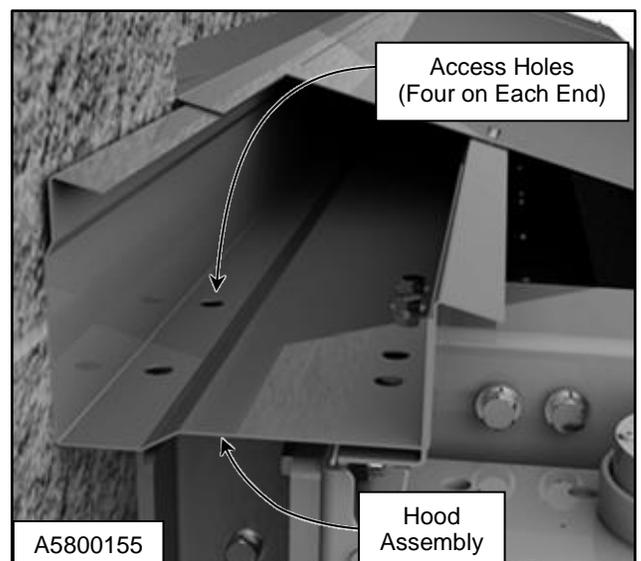


Figure 25

# INSTALLATION—PHOTO EYES

## PHOTO EYES

### **! WARNING**

The disconnect must be in the OFF position and properly locked and tagged before proceeding and performing the following procedures.

The photo eyes are provided as a safety feature. If the photo eyes are installed correctly, any object in the path of the photo eye beam while the door is closing will cause the door to reverse direction and remain in the fully open position until the obstruction is removed.

The transmitter and receiver can be identified in two ways. The transmitter is designated SMT 3000 on the white label or by a single green light that comes on at the clear end of the transmitter. (See Figure 26) The receiver is designated SMR 3215 on the white label or by a yellow light that illuminates only when it is in proper alignment with the transmitter. (See Figure 27)

*NOTE: When the cable is connected to the photo eye, there is only a 1/4-inch window to see the green or yellow LED light.*



Figure 26



Figure 27

The front and rear photo eyes, their required wire cables, and mounting brackets are located in the small parts carton. You must provide the hardware to install the brackets on your particular wall.

*NOTE: The front set of eyes is to be located on the wall, adjacent to the front side of the door. Each eye must be located 8–12 in. above the floor and as close to the door as possible. They must also be mounted directly across from each other. (See Figure 28)*

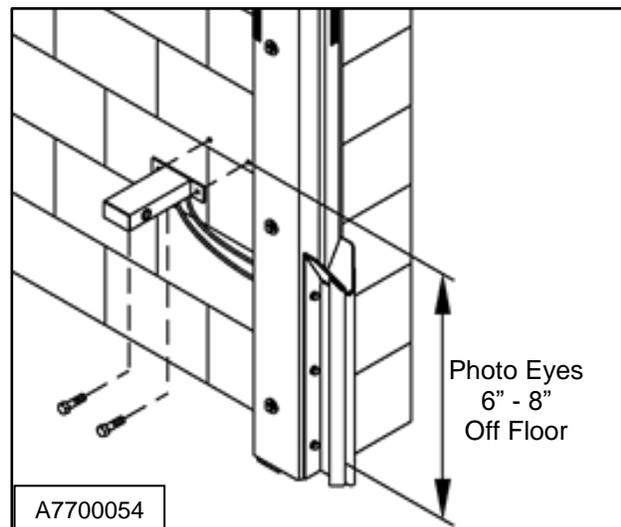
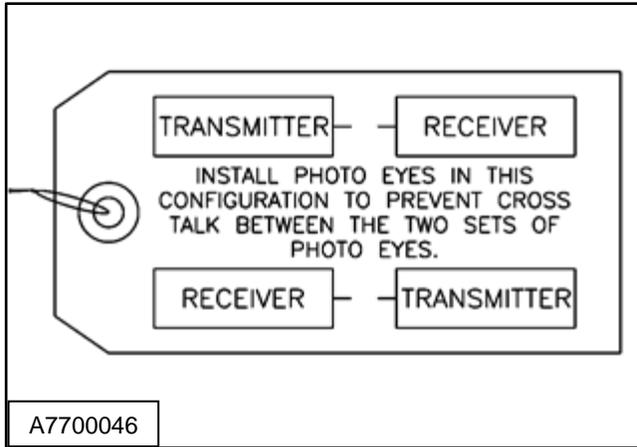


Figure 28

1. After the mounting brackets are in place, install the transmitter module in the left bracket and the receiver module in the right bracket.

**IMPORTANT:** *If installing two sets of photo eyes, the photo eyes MUST be installed as shown in Figure 29.*



**Figure 29**

2. Thread the connector found on the terminated end of each wire cable onto the end of the photo eyes.

**NOTE:** *Be sure the path through which the wire cables are routed hides and protects them from damage. If necessary, run conduit to each mounting bracket to protect the cables.*

3. Route the wire cables from the field-installed photo eyes to the control panel in a manner conforming to all applicable codes and regulations. Shielded cable is recommended for all photo eye wires.

**IMPORTANT:** *Remove excess cable before terminating the connections. DO NOT leave excess coils of cable in the control panel or junction box.*

4. Connect cable to junction box per schematic.
5. After all work is complete, clean the lens of each photo eye using window cleaner and a soft, clean cloth.

### Testing Photo Eyes

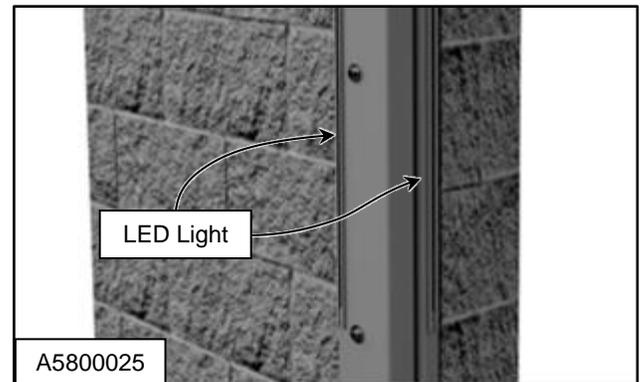
With the power on, the green light on the transmitter indicates that the photo eye module is powered up. When the yellow light on the receiver module is also lit, the transmitter and receiver modules are properly aligned.

Placing your hand in front of the receiver breaks the light path and causes the yellow light to go out. Removing your hand causes the yellow light to go back on.

### LED (LIGHT EMITTING DIODE)

Your door is equipped with four LED lights, two mounted in each side column. The purpose of these LEDs is to warn an approaching person or vehicle that the door panel is closing or getting ready to close.

Three yellow flashes is the factory default warning that the door is preparing to close. A solid red light indicates that the door panel is closing and on the way down. The LED lights can be custom set; see the System 4 Drive & Control RY-WI System Installation and Owner's Manual for settings. (See Figure 30)



**Figure 30**

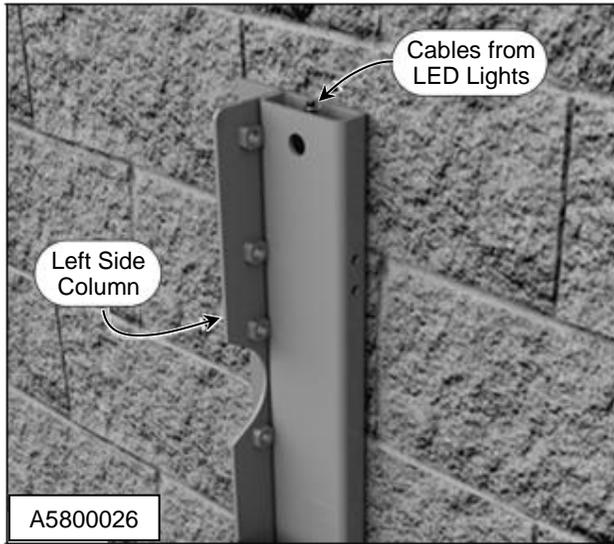
1. Connect cables to LED connectors. (See Figure 31)

**NOTE:** *Cables are routed at the factory. The tops of the side columns have cables zipped tied to the top of the side columns.*

*Cut all zip ties and route cables to control panel. Make sure to remove any excess cable, loops or coils left in the cable routing.*

## INSTALLATION—LED (LIGHT EMITTING DIODE)

*NOTE: Head assembly has been removed to show clarity of the LED connectors. (See Figure 31)*

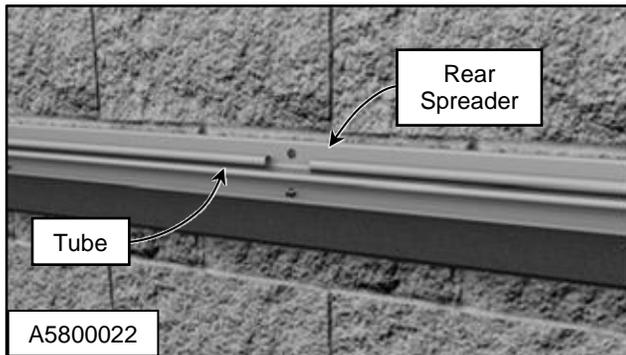


**Figure 31**

2. Route LED light cables toward the System 4 control panel. Use tubes on the rear spreader for routing all cables and wires to the control panel. (See Figure 32)

*NOTE: Secure cables as needed.*

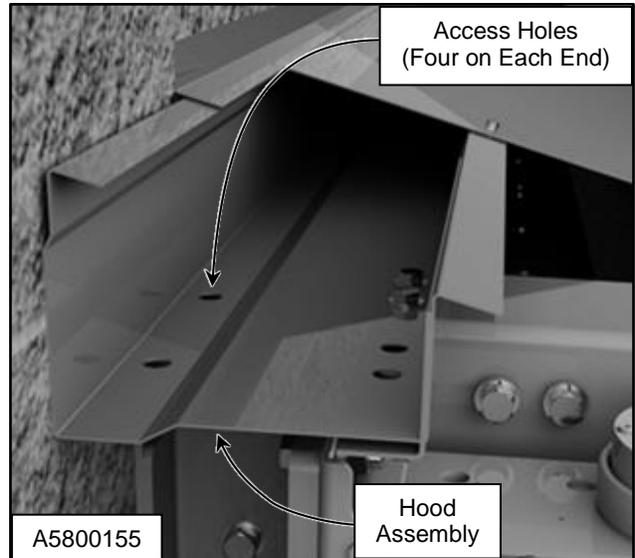
*NOTE: A fish tape may be required to route cables and wires.*



**Figure 32**

3. If the optional hood assembly is installed, route all cables and wires through prefabricated access holes. (See Figure 33)

*NOTE: End of the hood assembly is removed for clarity.*



**Figure 33**

## THERMOSTAT CONTROL (OPTIONAL)

An optional thermostat control is available for the Powerhouse SD door. The thermostat controls a trickle charge to the motor to heat the motor windings. Rytec part number #R00112019. Contacts close at 32°F (0°C), open at 50°F (10°C). When contacts are closed the trickle charge travels to the motor and keeps the windings warm. If the thermostat has been ordered at installation reference the electrical schematics for connections.

## HOOD (OPTIONAL)

The hood is an option for the Powerhouse SD door. It is built at the factory and delivered separately to the door site. The installer will have to assemble and install the hood assembly.

### **WARNING**

**The disconnect must be in the OFF position and properly locked and tagged before proceeding and performing the following procedures.**

1. Remove and discard the shipping bar and both lifting lugs from the head assembly if this hasn't already been done. Save the hardware from the shipping bar. (See Figure 34)

*NOTE: If these items were already discarded, then remove the hardware that attached the shipping bar to the head assembly.*

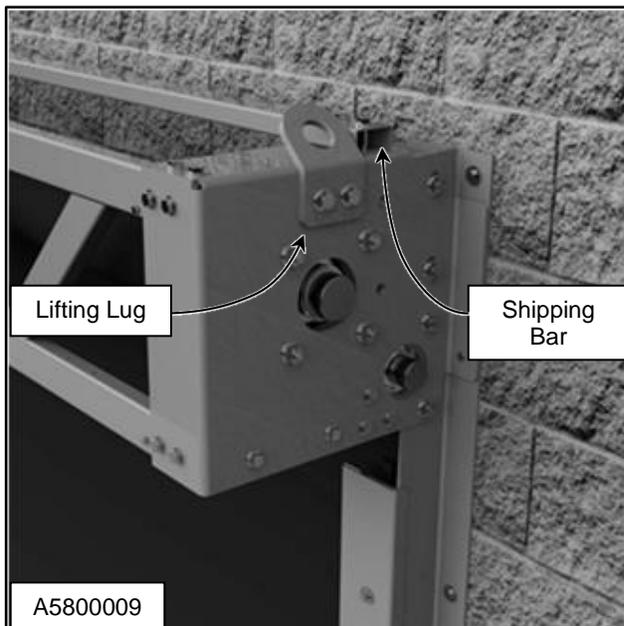


Figure 34

2. Install the hood spreader with the hardware that was removed from the shipping bar. (See Figure 35)

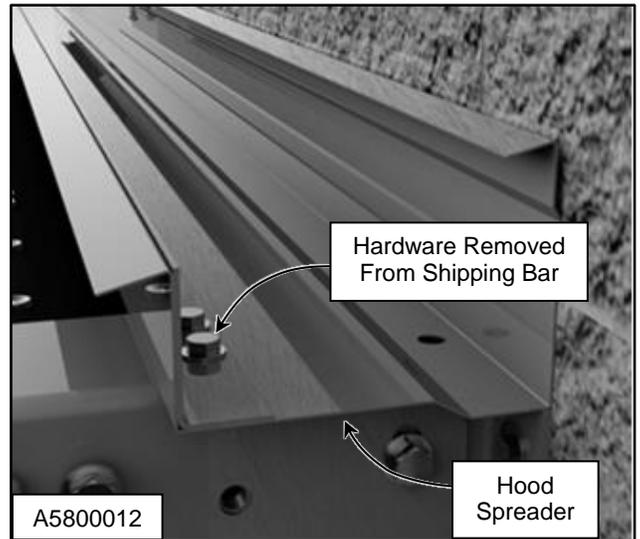


Figure 35

3. Install two front hood pieces onto the front truss assembly. Use 1/4-14 x 3/4-in. hex washer self-drilling screws. (See Figure 36)

*NOTE: The front hood pieces can vary in size, both in length and height. The quantity of hardware to do the assembly will vary, depending on the size of the head.*

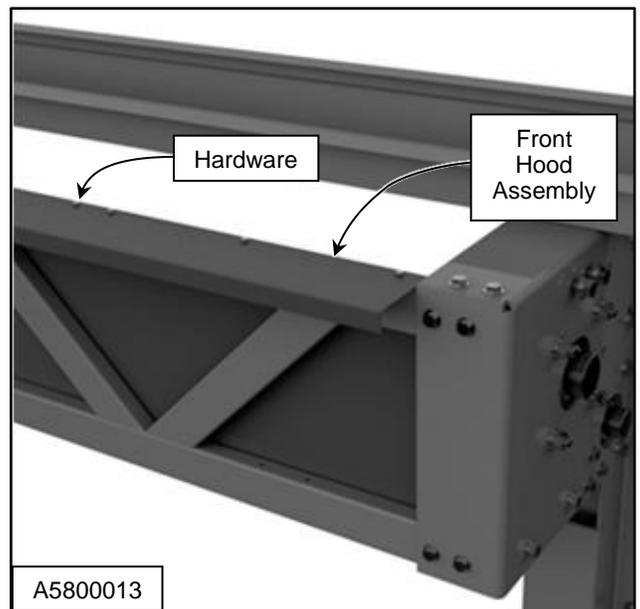


Figure 36

## INSTALLATION—HOOD (OPTIONAL)

4. Attach right head assembly end cover onto the front truss assembly. Use  $\frac{1}{4}$ -14 x  $\frac{3}{4}$ -in. hex washer self-drilling screws. (See Figure 37 and Figure 38)



Figure 37

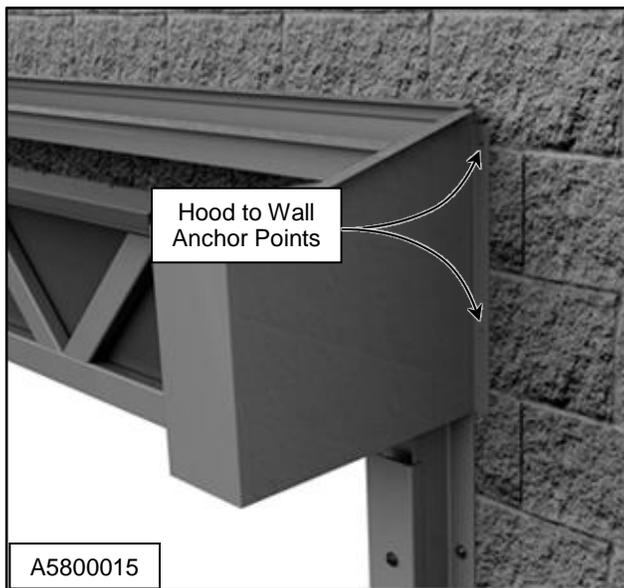


Figure 38

*NOTE: Right end cover wall anchor installation.*

5. Attach the left head assembly end cover onto the front truss assembly. Use  $\frac{1}{4}$ -14 x  $\frac{3}{4}$ -in. hex washer self-drilling screws. (See Figure 39 and Figure 40)

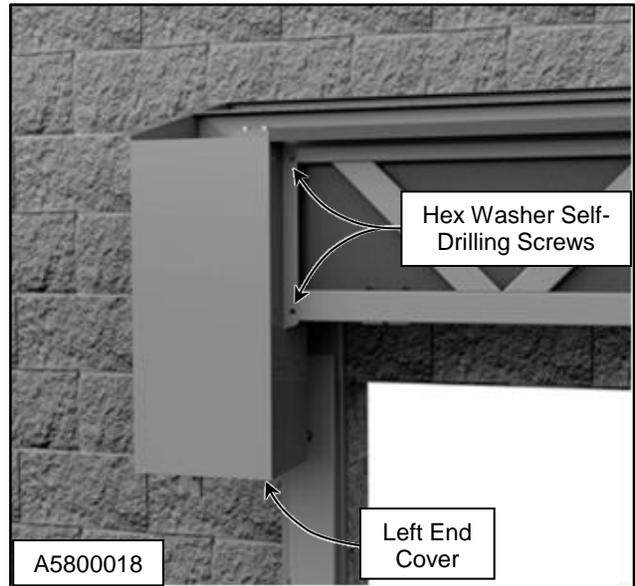


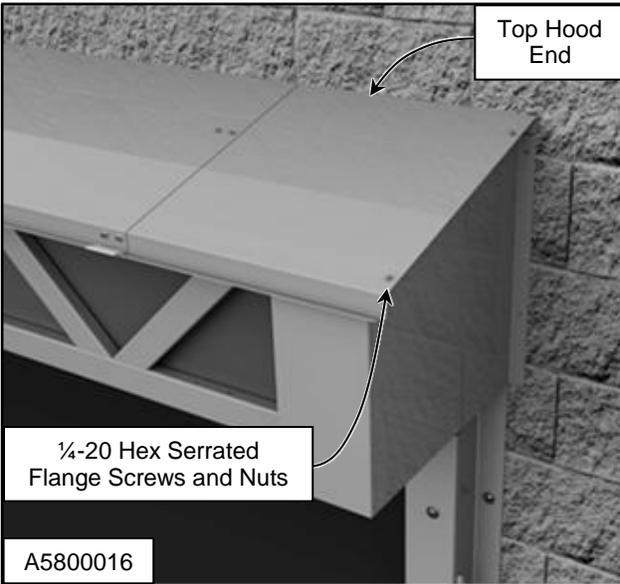
Figure 39



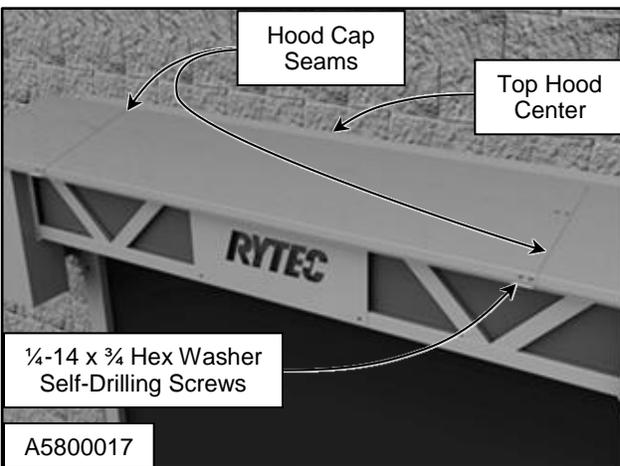
Figure 40

*NOTE: Left end cover wall anchor installation.*

6. Attach left and right top hood ends onto the head assembly. Use 1/4-20 x 1/2-in. hex serrated flange machine screws and 1/4-20-in. hex serrated flange lock nuts. (See Figure 41 and Figure 42)



**Figure 41**



**Figure 42**

## INSTALLATION—FRONT MOUNT WINDBAR ASSEMBLY (OPTIONAL)

### FRONT MOUNT WINDBAR ASSEMBLY (OPTIONAL)

#### Front Windbar Strap Clamp Assembly Mounting

All installation and operating instructions from the Powerhouse Model SD Installation Manual and Owner's Manual apply and must be followed when installing and operating your door with Front Mounted Windbar Assembly.

Front mounted Windbar assemblies are easily mounted on any Powerhouse SD model door. Whether mounting on a new installation or retrofitting to a currently installed door, the installation procedure is the same. New doors may not require all detailed procedures as listed.

1. Move the door panel/bottom bar to a convenient height for installation of the front windbar and turn off power. Closing the door will provide maximized room for this procedure.



The disconnect must be in the OFF position and properly locked and tagged before proceeding and performing the following procedures.

2. Mark the locations for the (2)  $\text{\O}1/2$ " holes required in the lower horizontal beam truss member for the Front Strap Clamp Assemblies as shown. 18" Horizontally from the front end plate inner edge and 1-1/2" Vertically to the centerline of the lower horizontal beam truss. (See Figures 43 & 44)
3. Making sure holes are perpendicular, drill the  $\text{\O}1/2$ " holes completely through the truss beam. Using a small pilot hole aids in maintaining hole location precision. (See Figures 43 & 44)
4. Clean and deburr the holes.
5. Mount the windbar strap clamp assemblies thru the drilled holes in the lower truss beam as shown. Install the bolts into the nuts so full thread engagement into the nut's nylock is achieved. The strap clamp must be able to swivel freely. DO NOT OVER TIGHTEN THE BOLTS! (See Figures 43 & 44)

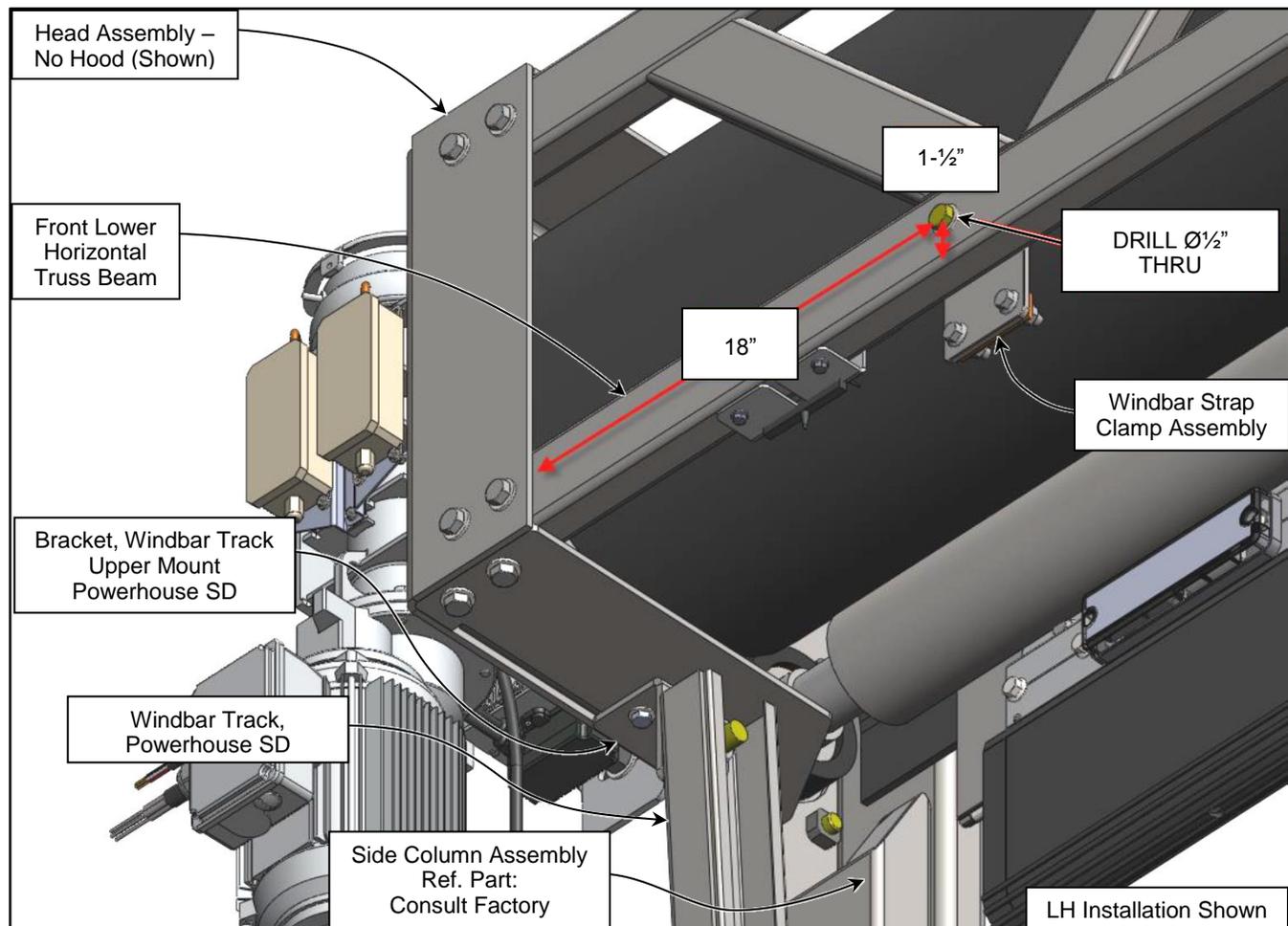


Figure 43

## INSTALLATION—FRONT WINDBAR STRAP CLAMP ASSEMBLY MOUNTING

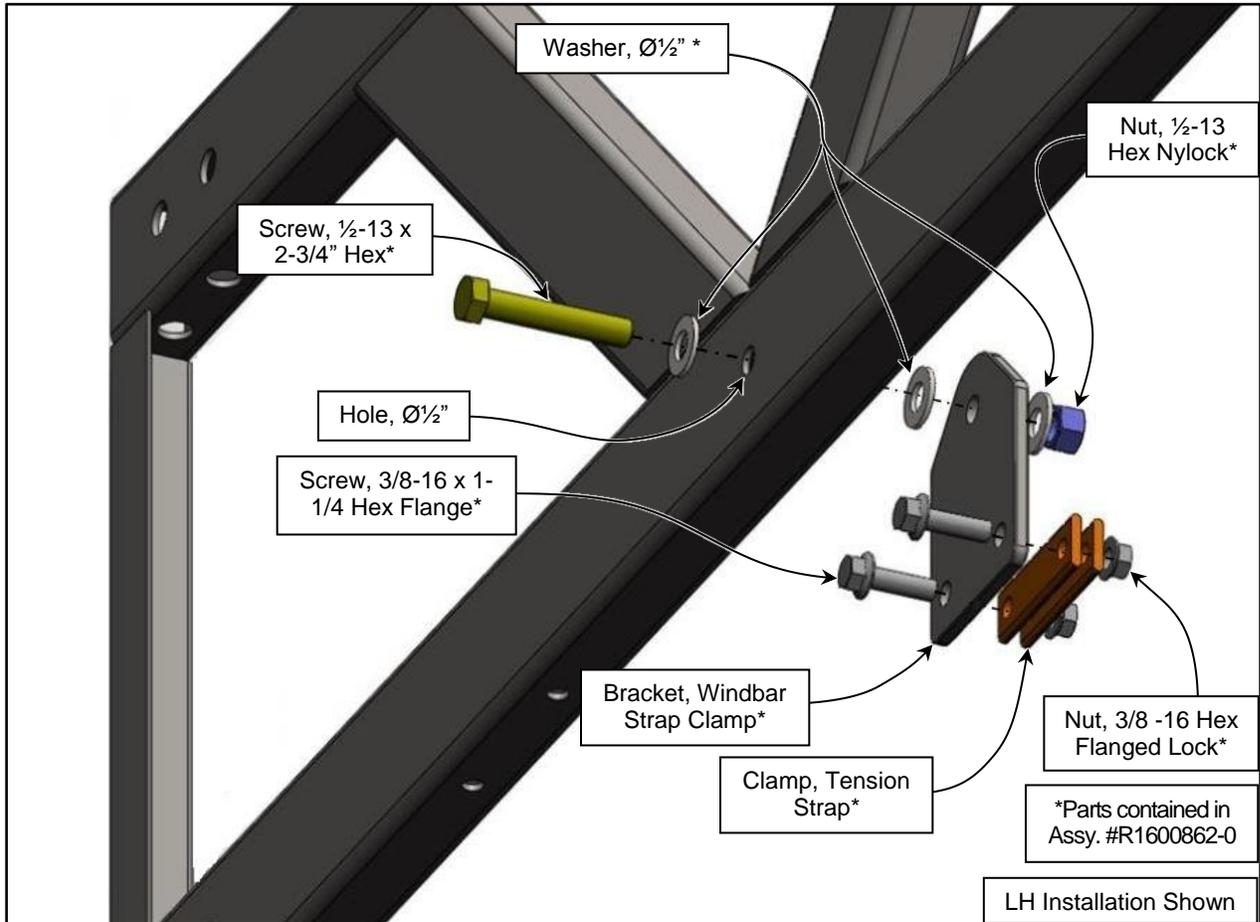


Figure 44

### Front Windbar Track Assembly Mounting

1. Move the door panel/bottom bar to the closed position for installation of the front windbar and turn off power. Closing the door will provide maximized room for the following procedures.

### **! WARNING**

**The disconnect must be in the OFF position and properly locked and tagged before proceeding and performing the following procedures.**

2. Mark the locations for the (4)  $\text{Ø}\frac{3}{8}$ " holes required in the Head Assembly Bottom Plates for the Upper Windbar Track Mounting Bracket as shown when necessary (retrofit installations). (See Figures 45 & 46)
3. Making sure holes are perpendicular and true to the plates, drill the  $\text{Ø}\frac{3}{8}$ " holes completely through the Bottom Plates. Using a small pilot hole aids in maintaining hole location precision.

4. Clean and deburr the holes.
5. Mount the Upper Windbar Track Mounting Bracket to the Head Assembly Bottom Plates as shown. Screw the bolts into the nuts so full thread engagement is achieved. Do not tighten the brackets in place yet. They will need adjustment later. (See Figure 46)
6. Hang and fasten the Windbar Tracks from the Upper Windbar Track Mounting Brackets with the hardware shown. (See Figure 46)

**IMPORTANT: The track must be oriented with the thick face of the track facing away from the door panel as shown.**

The track's inside face/edge must be mounted flush with the inside edge of the Side Column. Screw the bolts into the nuts so full thread engagement is achieved. Do not tighten the brackets in place yet. They will need adjustment later. (See Figures 45 and 47)

# INSTALLATION—FRONT WINDBAR TRACK ASSEMBLY MOUNTING

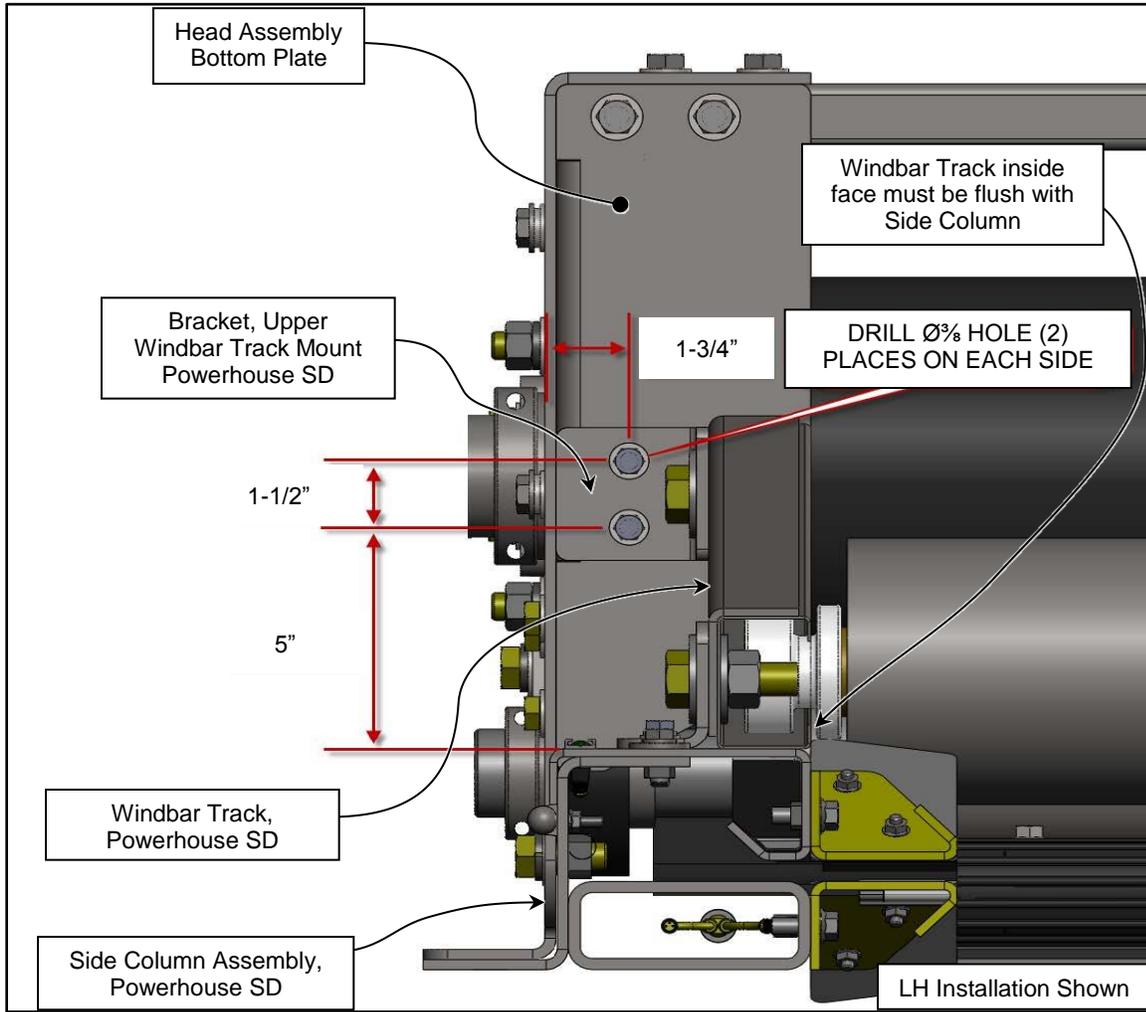


Figure 45

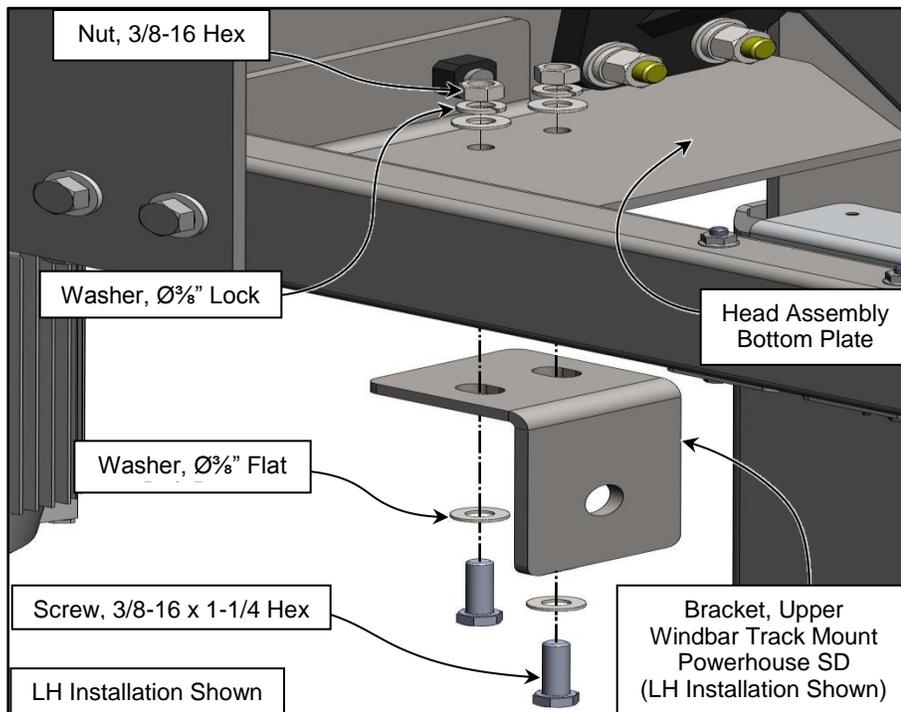


Figure 46

## INSTALLATION—FRONT WINDBAR TRACK ASSEMBLY MOUNTING

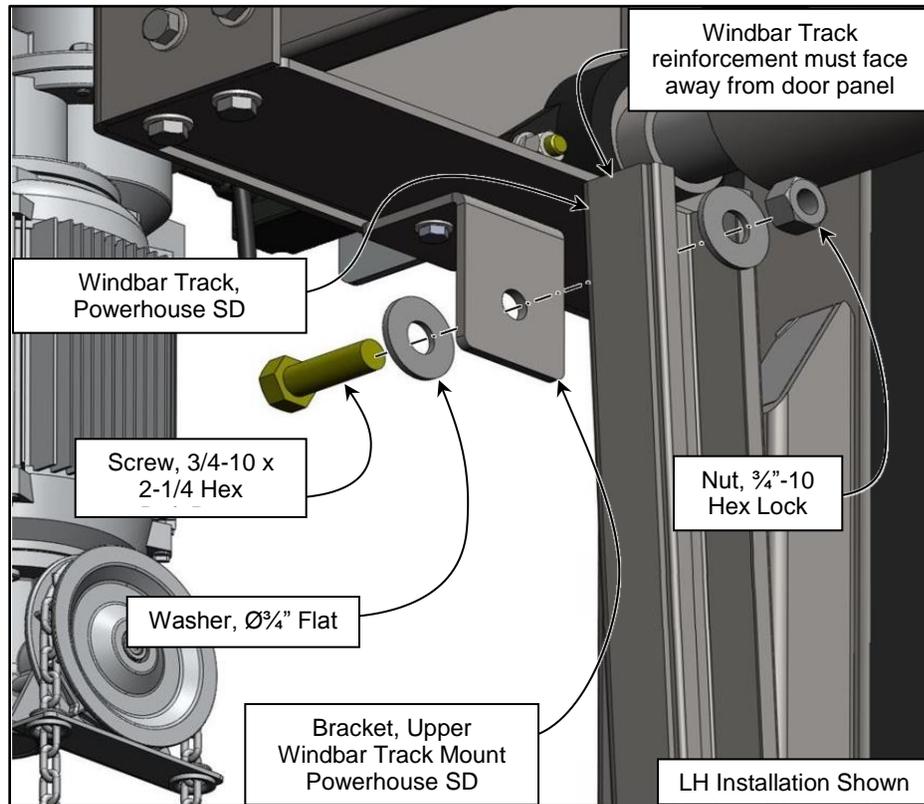


Figure 47

7. Remove and replace the  $\frac{3}{8}$ -16 x 1.00 Side Column Cover screws just above and below the ends of the windbar tracks with the 1-1/4" long screws supplied with the windbar assembly kit. Also replace the  $\frac{3}{4}$ " flat washers with the ones supplied in the windbar assembly kit. (See Figure 48)
8. Mount the Lower Windbar Track Brackets to the side column covers using the longer screws supplied from the kit. (See Figure 48)
9. Butt the windbar tracks up against the side column covers and the lower mounting bracket as shown. (See Figure 49)
10. Mark the center of the Track Bracket lower mounting hole and drill a  $\frac{3}{4}$ " hole thru the Lower Mounting Brackets as shown. (See Figures 48 & 49)
11. Fasten the Windbar Track to the Lower Mount with the fasteners as shown. The threaded portion of the  $\frac{3}{4}$ " bolts must be mounted toward the inside of the tracks. (See Figures 48, & 50)
12. Check the inside width between the Windbar Tracks. It should measure the same as the door width.

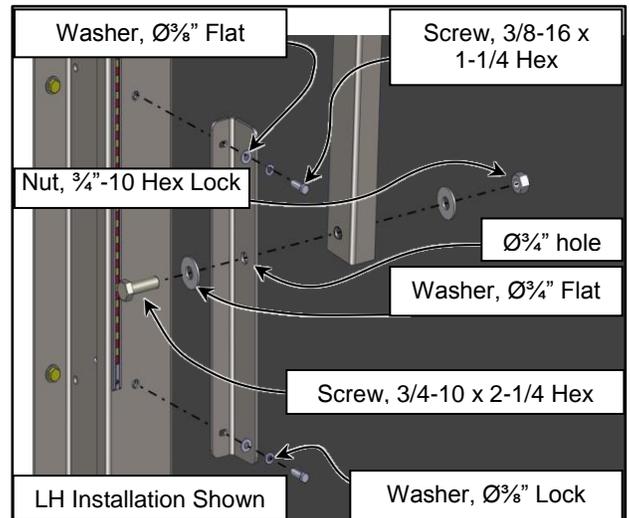


Figure 48

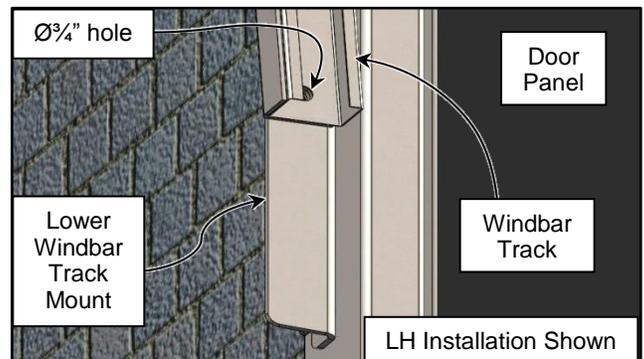


Figure 49

## INSTALLATION-FRONT AND REAR WINDBAR STRAP AND DRUM CLAMP MOUNTING

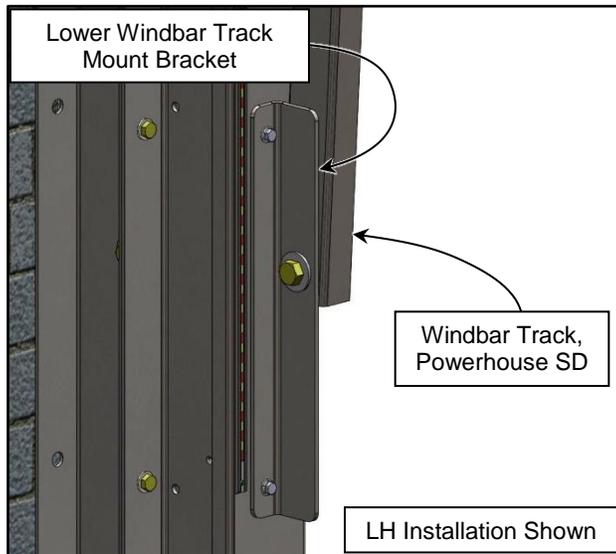


Figure 50

### Front and Rear Windbar Strap & Drum Clamp Mounting

1. Completely unroll the door panel/bottom bar so that you can gain full access to the drum for installation of the front windbar straps. Turn off the door's power. (See Figure 51)

### **⚠ WARNING**

The disconnect must be in the OFF position and properly locked and tagged before proceeding and performing the following procedures.

*NOTE: New doors may not need holes drilled in the field. Doors manufactured prior to this revision will require holes to be drilled per steps 2-4.*

2. Place a Windbar Strap Clamp directly against the panel drum just below the door panel edge (about  $\frac{1}{4}$ " ) as shown on either side of the drum center. Center the (2) strap clamps 4" on either side of the drum's center. If the clamp centers are the same distance as an existing panel mounting screw, each clamp must be moved out from the drum's center an additional 4". The Windbar Strap Clamps must straddle the panel mounting screws as shown. (See Figure 52)
3. Mark each of the Windbar Strap Clamp centers on the Panel Drum. Create a pilot hole for each hole on these center marks.
4. Using a "J" size drill bit, finish drill (4) true and perpendicular "J" size ( $\text{Ø}.277$ " ) holes for the strap clamps fasteners. (See Figure 52)

**IMPORTANT: Use only a "J" size drill bit. Do not tilt or angle the drill. Holes must be true formed.**

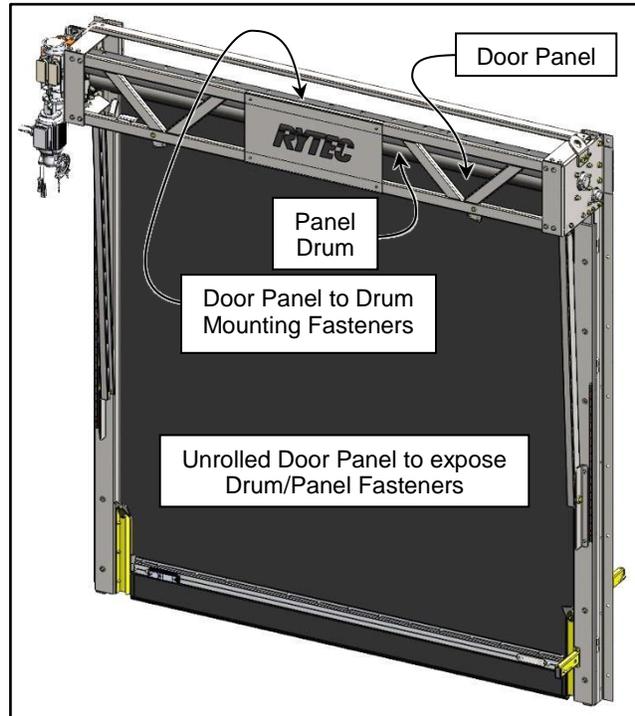


Figure 51

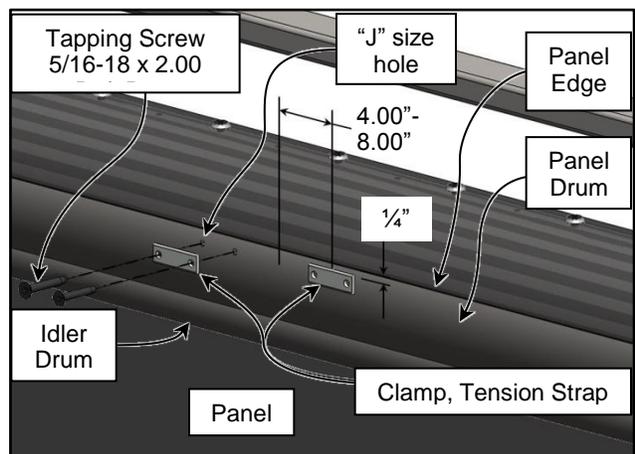


Figure 52

5. While aligning the screws perpendicular and true to the drum, use a drill w/ a Torx T40 driver bit to drive the 5/16-18 x 2.00 tapping screws into the "J" size drilled holes and tap the screw threads.

### **⚠ WARNING**

**Do not strip the tapped hole threads.**

6. After all the screw mounting holes have been tapped and threaded, remove the screws and clamps.
7. Stack the Windbar Strap Clamps over the mounting holes with the countersink of the holes in the outer strap clamp facing out and away from the drum. (See Figure 53)

## INSTALLATION-FRONT AND REAR WINDBAR STRAP AND DRUM CLAMP MOUNTING

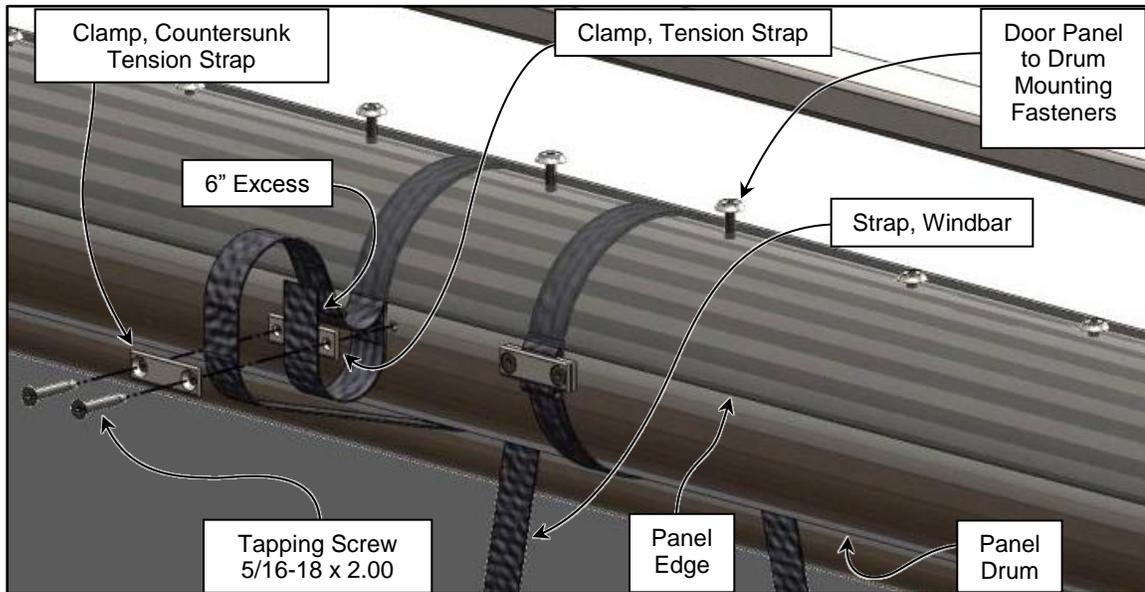


Figure 53

8. Insert the screws again through the clamps but do not tighten leaving some clearance for inserting the straps. (See Figure 53)
9. If both front and rear windbars are used, install the front as shown. The rear windbar straps must be installed between the next set of Panel-Drum Mounting Fasteners out from the drum center. (See Figures 52 and 53)

*NOTE: Windbar Strap(s) may be factory installed. If they are not, install them according to the following steps.*

### FRONT WINDBAR STRAP-DRUM INSTALLATION

- a. Loosen the existing panel/drum mounting fasteners (screws and washers) within the area of the mounting strap that is directly over, and adjacent to, the windbar straps as well as between the strap clamps. Loosen them just enough to allow installing the straps. (See Figure 53)
- b. Place a Windbar Strap on the front side of the door panel and pull one end up, between the panel and drum, **between** the two clamps. (See Figures 53 and 54)
- c. Wrap the strap one (1) full wrap around the drum, pulling the strap end **under** both clamps. (See Figures 53 and 54)
- d. Pull the strap end back **between** the two clamps in the opposite direction and **under** the strap. Leave approximately 6" of excess strap pulled through the clamps. (See Figures 53 and 54)

### REAR WINDBAR STRAP-DRUM INSTALLATION

- a. Loosen the existing panel/drum mounting fasteners (screws and washers) within the area of the mounting strap that is directly over, and adjacent to, the windbar straps as well as between the strap clamps. Loosen them just enough to allow installing the straps. (See Figure 53)

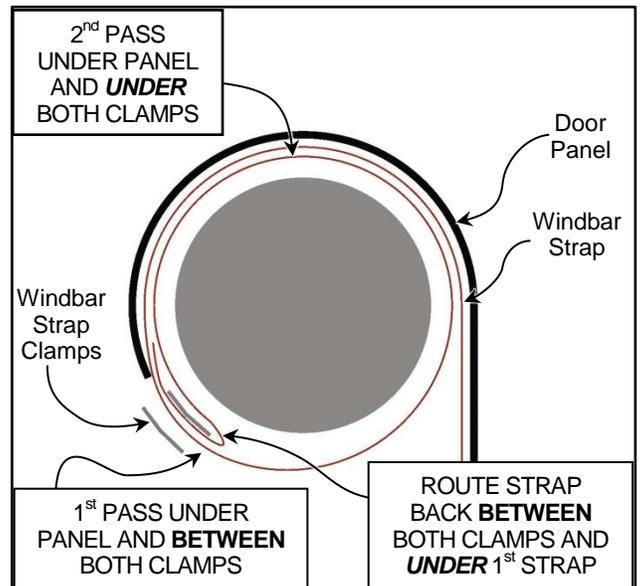


Figure 54

- b. Place a Windbar Strap on the rear side of the door panel and pull one end up and over the panel and drum, then **between** the two clamps. (See Figure 53)
- c. Wrap the strap one (1) additional full wrap around the drum, pulling the strap end under the panel and drum and **under** both clamps. (See Figures 53 and 55)

## INSTALLATION— FRONT WINDBAR and STRAP FINAL ASSEMBLY MOUNTING

- d. Pull the strap end back **between** the two clamps in the opposite direction and **under** the strap and panel. Leave approximately 6" of excess strap pulled through the clamps. (See Figures 53 and 55)

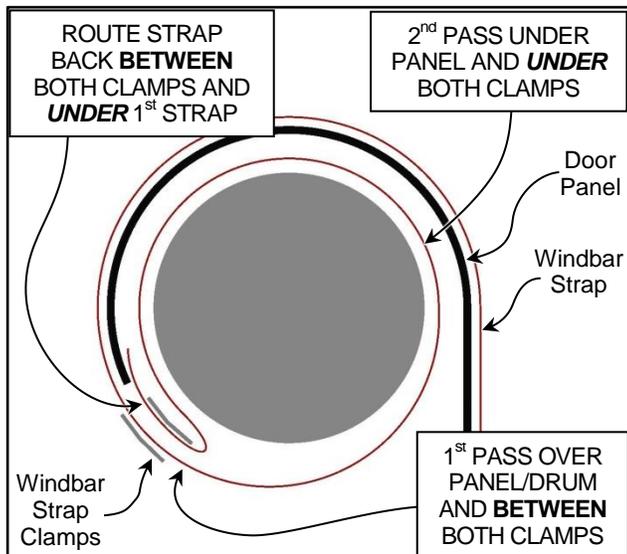


Figure 55

10. Adjust the straps so they are nearly straight. Also adjust them so they are evenly and symmetrically placed on the drum and in the clamps. (See Figures 53, 54, and 55)
11. Securely fasten the straps in the strap clamps by tightening the clamp screws. (See Figures 53, 54, and 55)
12. Retighten the panel/drum mounting screws. (See Figure 53)

### **⚠ WARNING**

**Do not strip the tapped hole threads.**

### Front Windbar and Strap Final Assembly Mounting

1. Close the door panel/bottom bar so the panel bottom bar is in full contact w/ the floor. Turn off the door's power. (See Figure 57)

### **⚠ WARNING**

**The disconnect must be in the OFF position and properly locked and tagged before proceeding and performing the following procedures.**

2. Pick up the windbar assembly with a forklift. Make sure the windbar is centered and securely mounted on the forklift. Guide the windbar up into the bottom of the Windbar Tracks mounted on the door's side column assemblies.

3. Remove the bottom  $\frac{3}{4}$ " fastener hardware from the Lower Windbar Track Mounts. (See Figure 48)
4. Guide and raise the Windbar Assembly into the Windbar Tracks. Push the Windbar and Tracks toward the door until the Tracks are in full contact with the side column covers. (See Figure 48)
5. Reinstall the  $\frac{3}{4}$ " fastener hardware as shown. (See Figures 48 and 56)

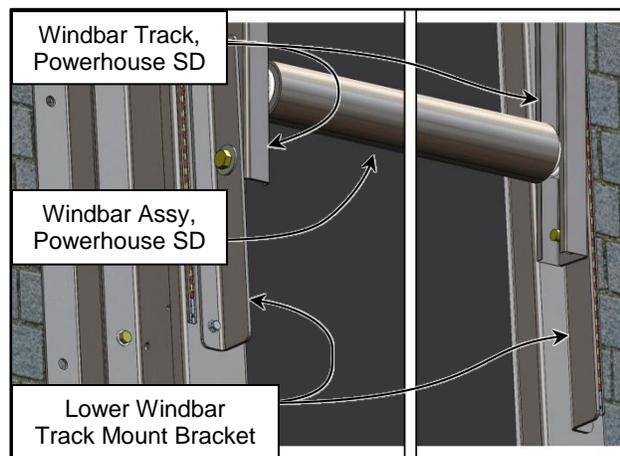


Figure 56

6. Confirm the Windbar can freely travel in the tracks. Lower the Windbar until it is completely resting on the  $\frac{3}{4}$ " fastener hardware.
7. Route the Windbar Straps down from the panel drum between the Windbar and Panel, under the Windbar, and back up in front of the Windbar to the Front Strap Clamp assemblies on either side of the Head Assembly Front Truss as shown. Make sure not to twist the straps, route them symmetrically, and along the shortest distance between the drum mount and the front truss mounted strap clamp assemblies. (See Figure 57)

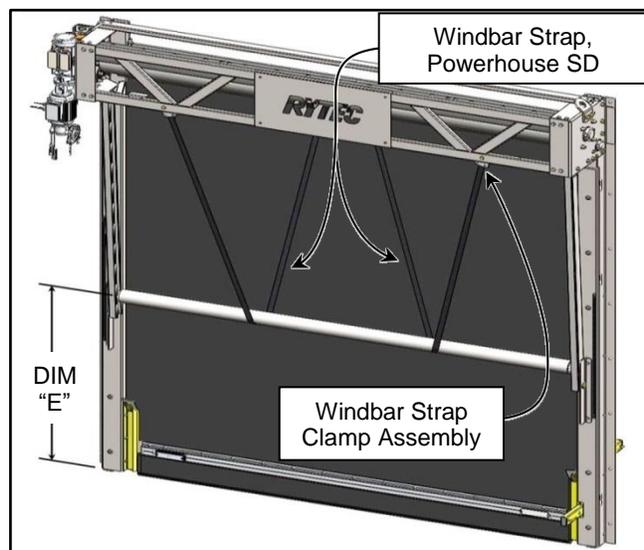
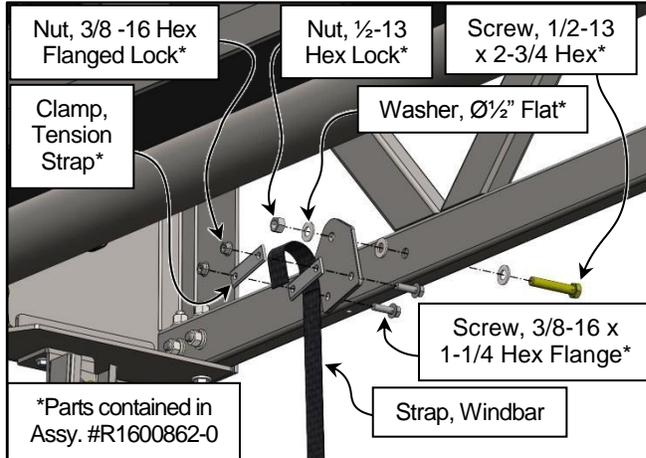


Figure 57

8. Pull both the Windbar Straps taught. Secure the straps in the front mounted Strap Clamp Assemblies as shown. (See Figure 58)



**Figure 58**

9. Check that the Windbar is level and approximately Dim "E" from the floor to the Windbar centerline ("E" = Door Height / 2). Adjust the straps as required. (See Figure 57)
10. After the Windbar is positioned correctly, tighten all the fasteners.

***IMPORTANT: Windbar Straps length must be equal when fully installed. If this is not done, Door and Windbar performance will be affected and may result in door operation failure or damage.***

11. Take the extra length of Windbar Strap and roll it up in a tight roll. Zip tie the strap roll to the taught strap by the clamp assembly. Do not cut off the strap ends. Further adjustment may be necessary in the future.
12. Remove the forklift from under the windbar.
13. Re-energize the door's power supply.
14. Jog the door up to the full open position and check that the windbar is above the door lintel and in front of the bottom bar when the door is in the fully open position. Also check that the windbar moves smoothly and doesn't hang up at all while traveling in the tracks.
15. Jog the door down to the full closed position and check that the windbar goes back to the doors center or DIM "E". Again check that the windbar moves smoothly and doesn't hang up at all while traveling in the tracks.
16. Repeat steps 14 and 15 several times or until performance is consistent.

17. If adjustments are necessary place the forklift under the windbar for support and adjust the windbar and straps as required.

### REAR MOUNT WINDBAR ASSEMBLY (OPTIONAL)

All installation and operating instructions from the Powerhouse Model SD Installation Manual and Owner's Manual apply and must be followed when installing and operating your door with Rear Mounted Windbar Assembly.

Powerhouse SD Rear Mounted Windbar assemblies are most easily mounted on new installations of Powerhouse SD model doors. This is because the Rear Mounted Windbar Assembly requires mounting the door assembly onto a special pullout. When retrofitting on an installed door, the installation procedure has some additional steps, most notably, removing the door from its current installation, installing the pullout assembly, and remounting the door.

#### Anchoring Methods

Refer to and follow the procedures in the "Anchoring Methods" section of this manual for how to anchor the Rear Mount Windbar Pullouts. Substitute the side column pullouts and pullout spreader in place of the side columns and header.

#### Retrofit Rear Mount Windbar Assembly

Perform the following steps if the Rear Windbar Assembly is to be installed or retrofitted onto a door which is currently mounted. Then proceed to the next section. This section can be skipped if this is a new installation.

1. Open the door to the completely open position. Jog the door till the door panel is just out of the side columns. Turn off the door's power.

### ⚠ WARNING

**The disconnect must be in the OFF position and properly locked and tagged before proceeding and performing the following procedures.**

2. Completely remove the door assembly from the structure it is mounted to. Refer to the Powerhouse Model SD Installation Manual for how to do this by reversing the order of the installation procedures.
3. After the door is removed proceed to installing the Rear Mount Windbar Assembly.
4. Mount the Door Assembly onto the Pullout Assembly by once again following the installation procedures but instead of mounting the door to the wall, mount it to the Pullout Assembly.

# INSTALLATION—REAR WINDBAR PULLOUT SPREADER ASSEMBLY

## Locating Side Column Pullouts

In addition, refer to, follow, and apply the procedures in the “Locating Side Columns” section of the Powerhouse Model SD Installation Manual to the side column pullouts instead of the side columns.

### **CAUTION**

This door is equipped with a breakaway bottom bar assembly. To ensure that it works properly, the width of the door opening must not be smaller (narrower) than the production width of the door. If the width of the opening is narrower than the designed width of the door, do not proceed with the installation. Contact your Rytec representative or the Rytec Technical Support Department at 800-628-1909.

1. Orient the Side Column Pullouts so the top inner windbar track hole is closer to the wall than the bottom inner windbar track hole. This results in the windbar track slanting towards the wall as shown. Position the pullouts as shown. Also, the edge of the windbar tracks should end up being flush with the door jamb like the front windbar tracks. (See Figures 59 and 60)

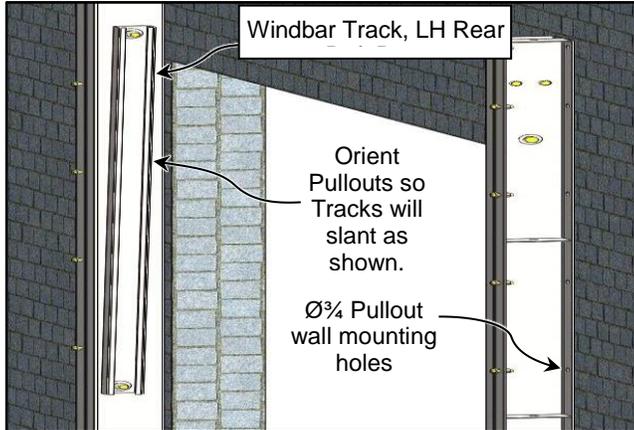


Figure 59

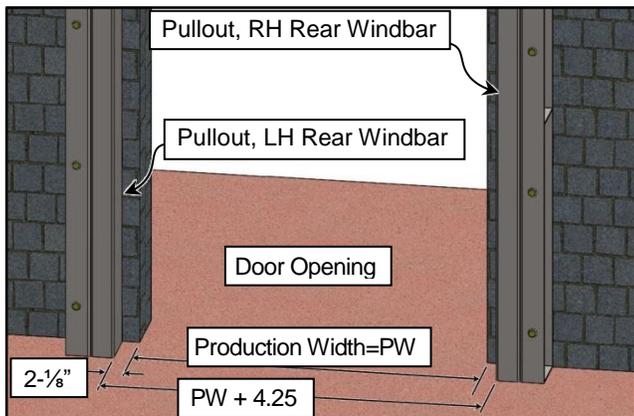


Figure 60

## Rear Windbar Pullout Spreader Assembly

1. Assemble the Windbar Strap Clamp Assemblies to the Rear Windbar Pullout Spreader as shown on both ends. Orient the bracket assemblies so they are closest to the edge. (See Figures 61 and 62)

## Side Column Pullouts and Pullout Header Assembly

In addition, refer to, follow, and apply the procedures in the “Side Columns and Head Assembly” section of the Powerhouse Model SD Installation Manual to the side column pullouts and side column pullout header instead of the door side columns and header.

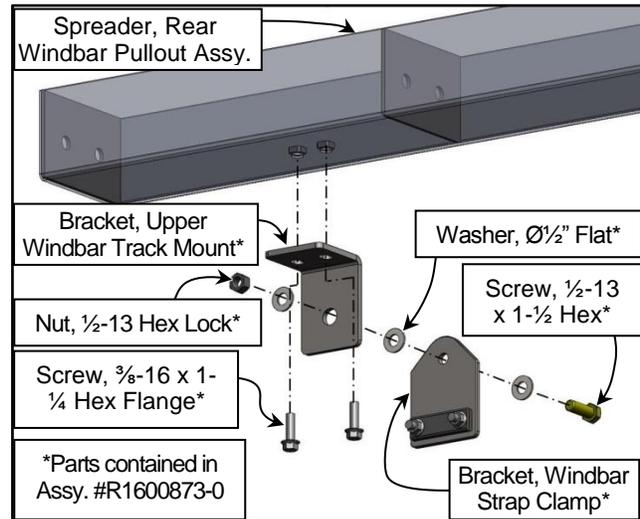


Figure 61

1. Confirm the side column pullouts are set level, plumb, square, and positioned per the dimension specifications. (See Figure 60)
2. Anchor the side column pullout weldments to the wall in the same fashion as the side columns per the Powerhouse Model SD Installation Manual (See “ANCHORING METHODS”). DO NOT tighten the anchors completely at this time – they will be tightened later on after the pullout spreader assembly is installed. (See Figure 59)

**NOTE:** It is critical that the pullouts are properly mounted. The door assembly gets mounted to them instead of the wall for the rear mounted windbar application.

## INSTALLATION—REAR WINDBAR TRACK ASSEMBLY MOUNTING

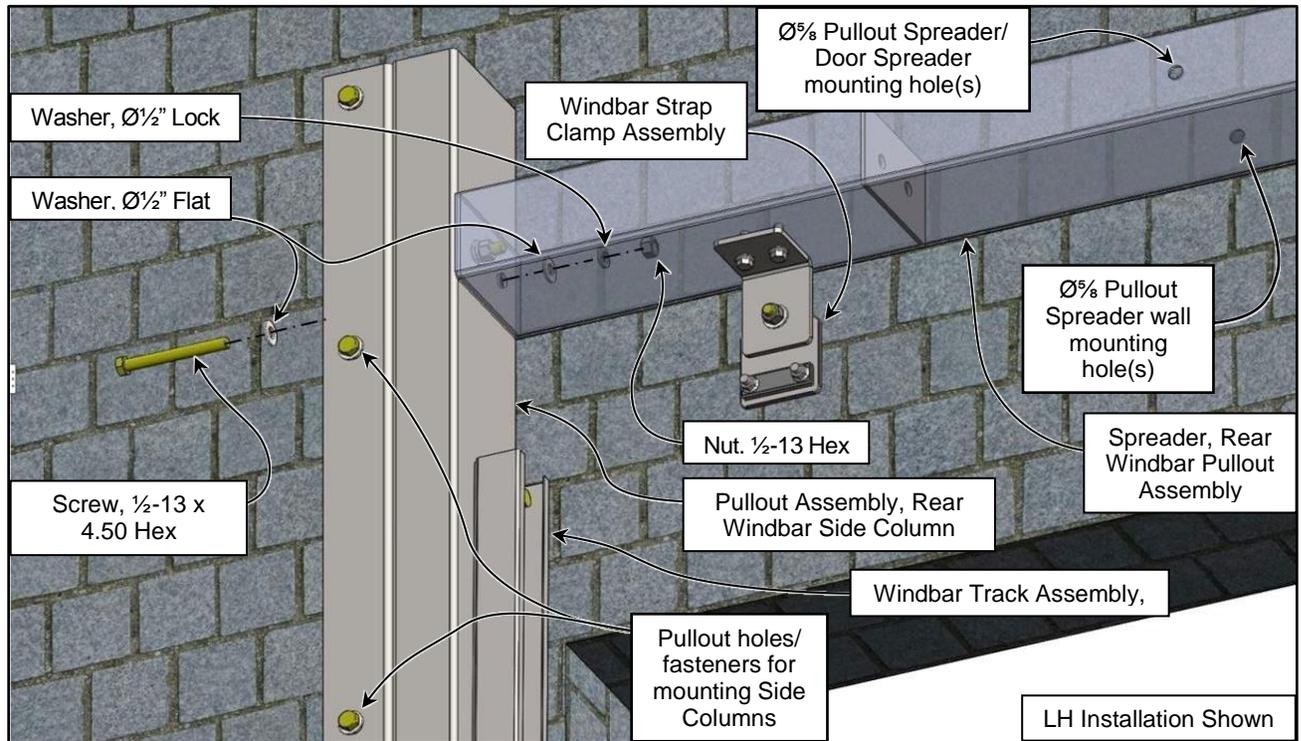


Figure 62

3. Orient the spreader so the bracket mounting holes are closer to the wall. Securely attach the pullout spreader assembly to a lifting device and lift it up to the door top as shown. (See Figure 62)

### **WARNING**

**When lifting the side column spreader it must be properly secured in place.**

4. Install the rear spreader assembly between the two side column pullouts using four (4) ½-13 x 4.50 in. hex head cap screws, eight (8) Ø½ in. flat washers, and four (4) Ø½ in. lock washers. DO NOT completely tighten the anchors at this time. Adjustment may be required. (See Figure 62)
5. With both side column pullouts set, clamped down, and snugly anchored in place, check the overall level, plumb, and squareness of each column. (See Figure 63)

Compare the diagonal measurements and the upper and lower horizontal measurements across the side column pullouts. The side column pullouts are square and parallel when both the diagonal and horizontal measurements are equal.

*NOTE: If either side column pullout requires slight repositioning (when the difference of either comparison is greater than ¼ in.), use a block of wood and a mallet to nudge the column into position.*

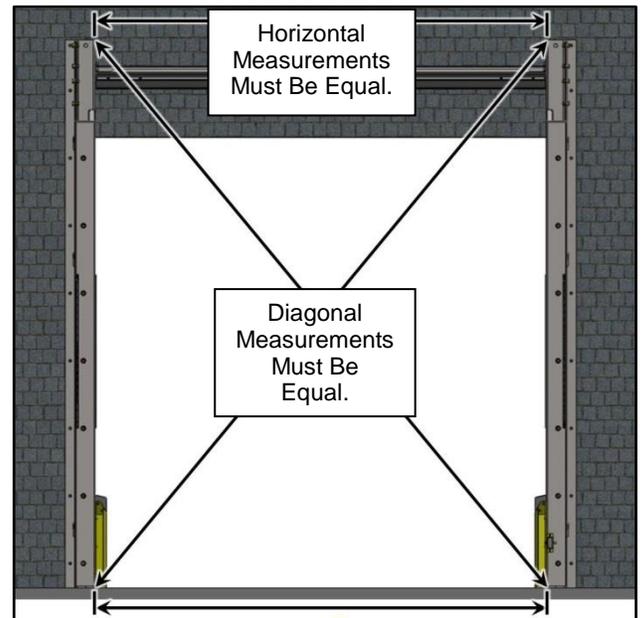


Figure 63

6. Install anchors into the rear pullout spreader assembly to secure it to the wall. (See Figure 62)
7. Tighten all bolts securing the pullouts to the wall.

*NOTE: The bolts may be loosened for adjustment.*

## INSTALLATION—REAR WINDBAR-DOOR ASSEMBLY MOUNTING

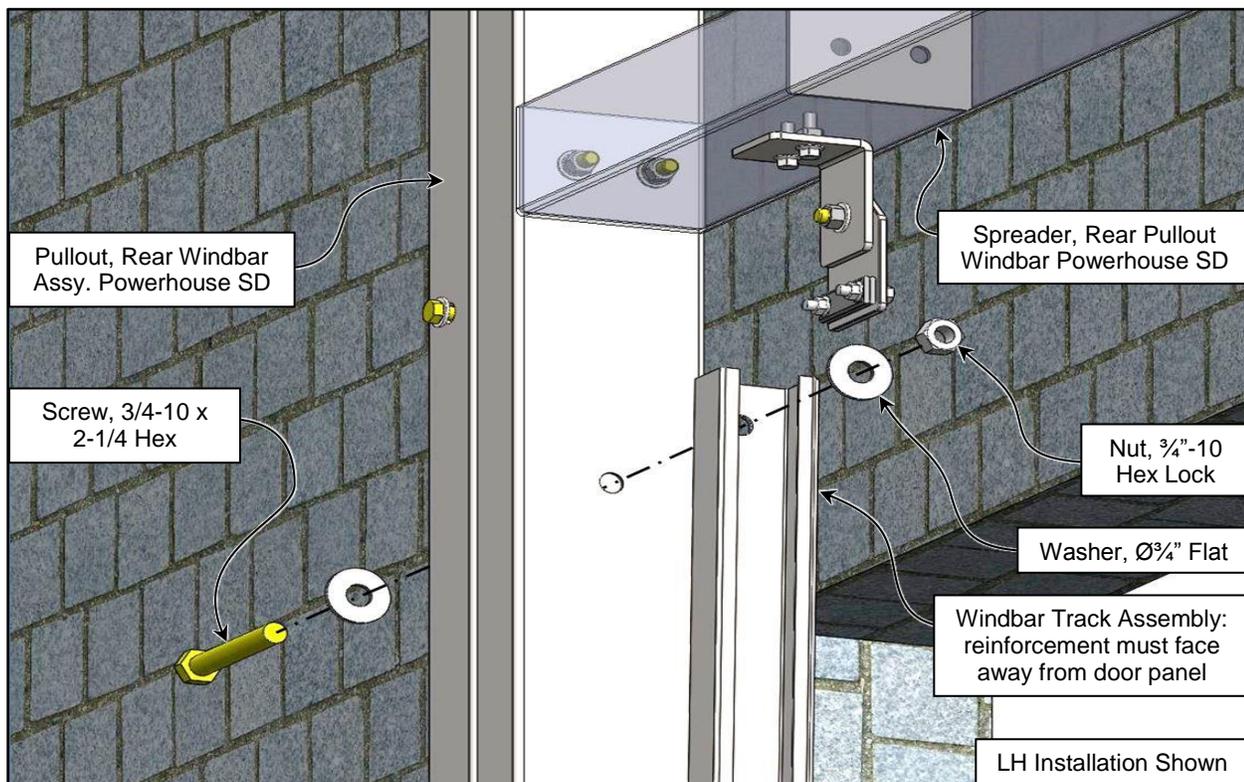


Figure 64

### Rear Windbar Track Assembly Mounting

1. Locate the Windbar Track Assembly and match it up with the holes in the Side Column Pullout Assembly.
2. Hang and fasten the Windbar Tracks from the Upper Windbar Track Mounting holes with the hardware shown. The track must be oriented with the thick face of the track facing away from the door panel as shown. Also, the track's inside face/edge must be mounted flush with the inside edge of the Door Jamb/Side Column. Screw the bolts into the nuts so full thread engagement is achieved and they are snug. Do not tighten the brackets in place yet. They will need adjustment later. (See Figures 45 and 65)
3. Align the bottom holes of the Windbar Tracks with the bottom track mounting holes in the pullouts. Mount the hardware as shown and identical to the previous step. (See Figure 65)

### Door Assembly Mounting to Rear Windbar Pullout Assembly

Once the Rear Windbar Pullout Assembly is installed, the door assembly may now be mounted. Follow all procedures as if mounting the door to any wall except that the side columns and header will be fastened to the pullout assembly. In addition to the procedures listed in the "LOCATING SIDE COLUMNS" and "SIDE COLUMNS AND HEAD ASSEMBLY" sections perform the following steps:

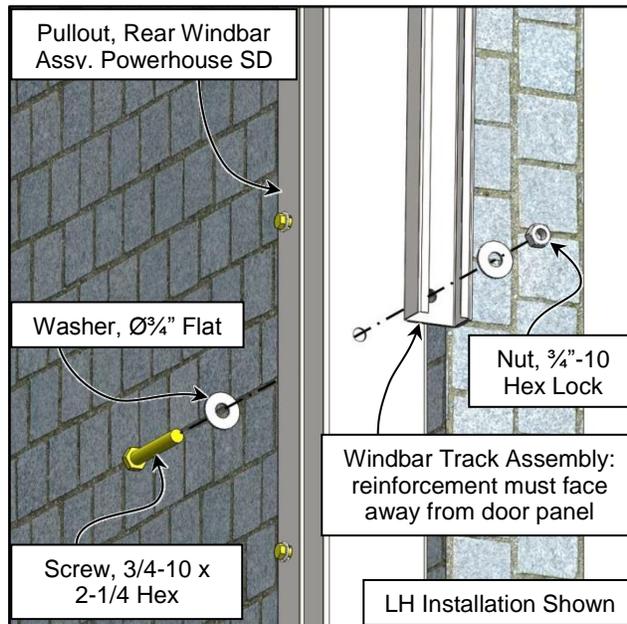


Figure 65

1. Shim the door's side column's so that the mounting holes of the side column pullouts and the side columns as well as the headers are in alignment.
2. Check and confirm that the door assembly is level, plumb, and square after mounting the side column and head assemblies to the pullouts. Adjust as necessary. *Tighten all fasteners.*

## INSTALLATION—REAR WINDBAR and STRAP FINAL ASSEMBLY MOUNTING

### Rear Windbar and Strap Final Assembly Mounting

1. Close the door panel/bottom bar so the panel bottom bar is in full contact w/ the floor. (See Figure 57)
2. Turn off the door's power.



**The disconnect must be in the OFF position and properly locked and tagged before proceeding and performing the following procedures.**

3. Pick up the windbar assembly with a forklift. Make sure the windbar is centered and securely mounted on the forklift. Guide the windbar up into the bottom of the Windbar Tracks mounted on the door's side column pullout assemblies.
4. Remove the bottom  $\frac{3}{4}$ " fastener hardware from the Lower Windbar Track Mounts. (See Figure 65)
5. Guide and raise the Windbar Assembly into the Windbar Tracks and raise it enough to clear the  $\frac{3}{4}$ " fastener holes. Re-align the holes of the Windbar Tracks and the rear side column pullouts. (See Figure 65)
6. Reinstall the  $\frac{3}{4}$ " fastener hardware as shown. (See Figures 65 and 66)

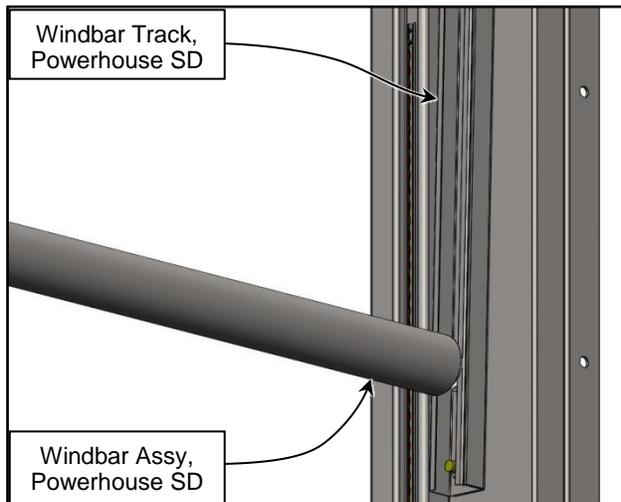


Figure 66

7. Confirm the Windbar can freely travel in the tracks. Lower the Windbar until it is completely resting on the  $\frac{3}{4}$ " fastener hardware.

8. Route the Windbar Straps down from the panel drum between the Windbar and Panel, under the Windbar, and back up in front of the Windbar to the Rear Strap Clamp assemblies on either side of the Head Assembly Rear Pullout Spreader as shown. Make sure not to twist the straps, route them symmetrically, and along the shortest distance between the drum mount and the front truss mounted strap clamp assemblies. (See Figure 67)

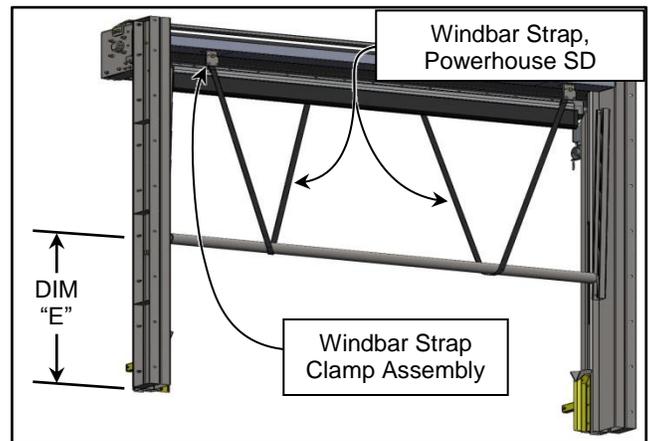


Figure 67

9. Pull both the Windbar Straps taught. Secure the straps in the front mounted Strap Clamp Assemblies as shown. (See Figure 68)

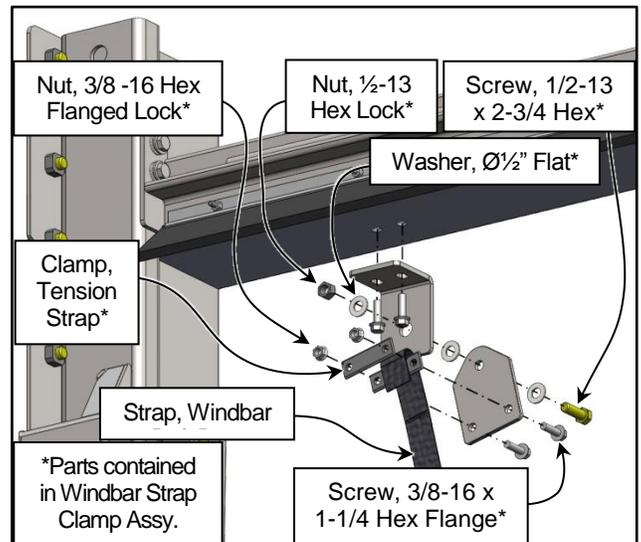


Figure 68

10. Check that the Windbar is level and approximately Dim "E" from the floor to the Windbar centerline ("E" = Door Height / 2). Adjust the straps as required. (See Figure 67)

## INSTALLATION—REAR WINDBAR HOOD ASSEMBLY (OPTIONAL)

11. After the Windbar is positioned correctly, tighten all the fasteners.

**IMPORTANT: Windbar Straps length must be equal when fully installed. If this is not done, Door and Windbar performance will be affected and may result in door operation failure and/or damage.**

12. Take the extra length of Windbar Strap and roll it up in a tight roll. Zip tie the strap roll to the taught strap by the clamp assembly. **Do not cut off the strap ends.** Further adjustment may be necessary in the future.
13. Re-energize the door's power supply.
14. Jog the door to the full open position and check that the windbar is above the door lintel and in front of the bottom bar when the door is in the fully open position. Also check that the windbar moves smoothly and doesn't hang up at all while traveling in the tracks.
15. Jog the door down to the full closed position and check that the windbar goes back to the doors approximate center or DIM "E". Again check that the windbar moves smoothly and doesn't hang up at all while traveling in the tracks.
16. Repeat steps 14 and 15 several times or until performance is consistent.
17. Remove the forklift from under the windbar.
18. Run the door through four or five complete cycles to verify that the door and Windbar(s) are operating smoothly and efficiently, and that binding or unusual noises do not exist. Readjust as necessary.
19. If adjustments are necessary place the forklift under the windbar for support and adjust the windbar and straps as required.

## REAR WINDBAR HOOD ASSEMBLY (OPTIONAL)

The hood is an option for the Powerhouse SD door. It is built at the factory and delivered separately to the door site. The installer will have to assemble and install the hood assembly. For installation of the Rear Windbar Hood Assembly on a door refer to the "Hood (Optional)" section along with the following additions.

### **WARNING**

**The disconnect must be in the OFF position and properly locked and tagged before proceeding and performing the following procedures.**

1. Fasten the Rear Windbar Hood Spreader to the Windbar Pullout as shown (See Figure 69)
2. Prior to attaching both the right and left head assembly end covers onto the front truss assembly, install both End Cover Spacers. Align the top of the spacers so they are flush w/ the Rear Windbar Hood Spreader. Anchor the End Cover Spacers to the wall. (See Figure 69)

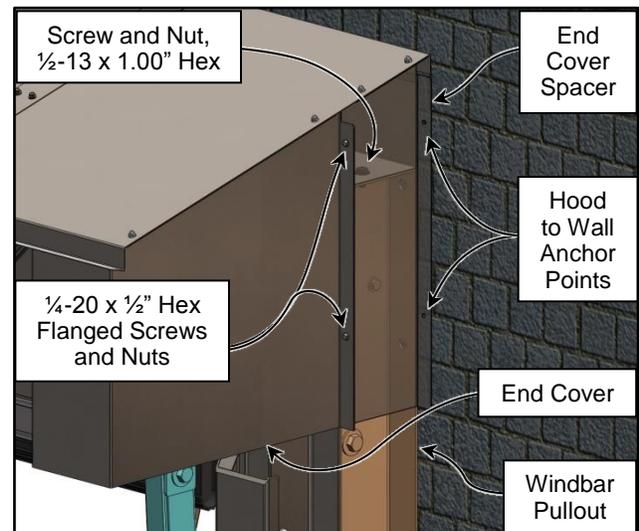


Figure 69

3. Use  $1/4$ -20 fasteners to secure the End Cover Spacers to the End Covers. (See Figure 69)

## ADJUSTMENTS—STRAPPED WINDBAR ADJUSTMENT (OPTIONAL FEATURE)

### ADJUSTMENTS

#### SETTING DOOR LIMITS

See the System 4 Drive & Control RY-WI System Installation and Owner's Manual for setting door limits.

Set open door limits with the lower edge of the bottom bar even with the lintel of the door opening. (See Figure 70)

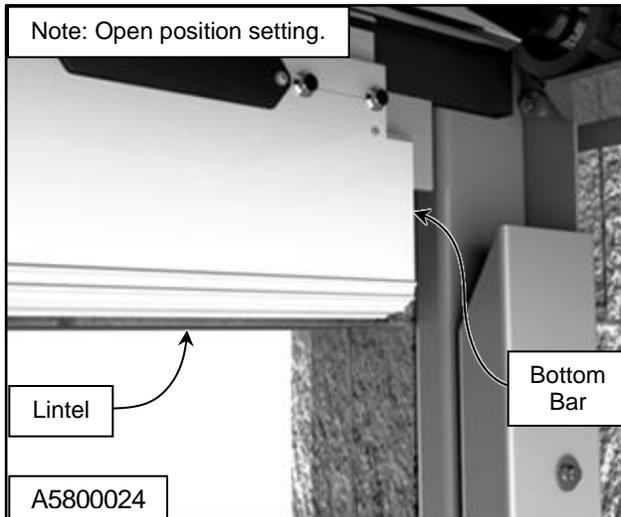


Figure 70

Set closed door limits so that door travel allows the lower edge of the bottom bar to gently seal against the floor resting lightly on the floor of the door opening. (See Figure 71)

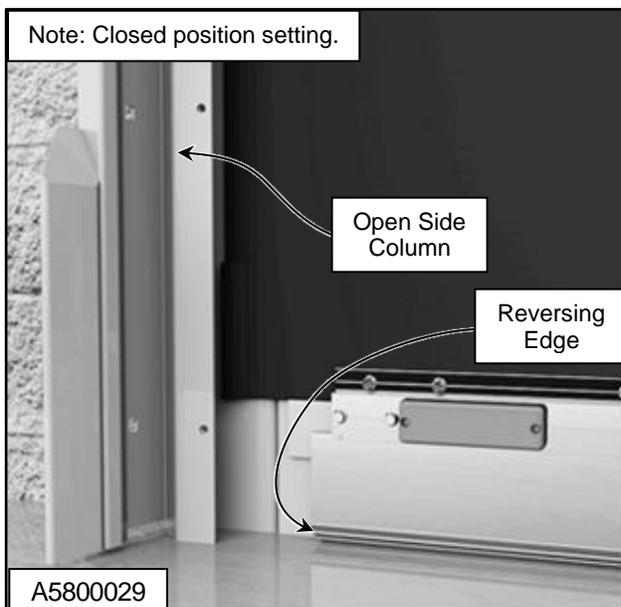


Figure 71

### CAUTION

Damage to the rubber reversing edge or other bottom bar parts can occur if the door seal is allowed to seal too tightly against the floor. (See Figure 71)

#### MANUAL DOOR PANEL MOVEMENT

The drive motor has red and green handles hanging from the bottom of the motor. When the green handle is pulled or in the lowest position, the drive motor is engaged to run on electrical power. When the red handle is pulled or in the lowest position, electrical power has been disengaged and manual door operation is required using the chain. Also, when the red handle is pulled, a sensor is engaged and will not allow electrical power to the door.

Electrical power can be shut off anytime to operate the electric motor in manual mode. Control panel limit settings will not be affected when switching the power off and back on. The door will return to a normal operating mode. (See Figure 72)

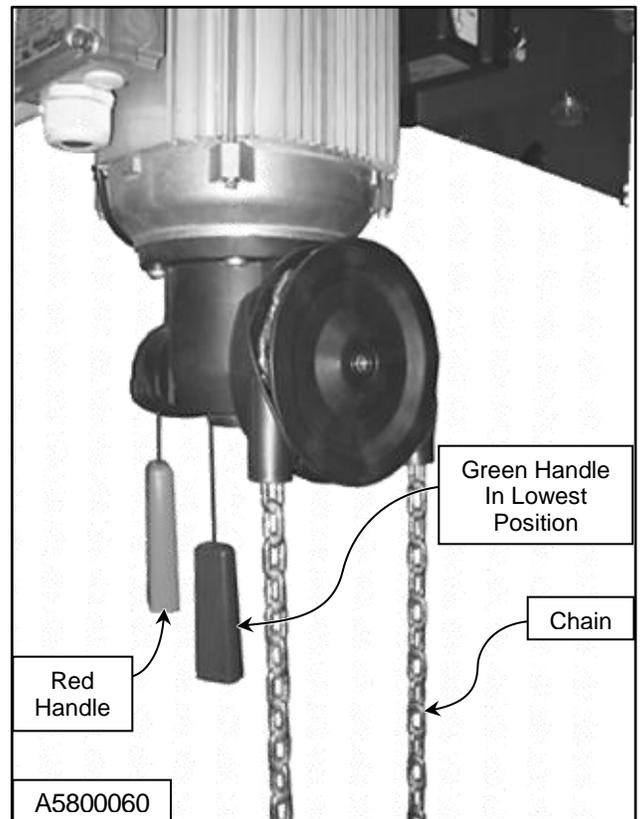


Figure 72

## ADJUSTMENTS—STRAPPED WINDBAR ADJUSTMENT (OPTIONAL)

### STRAPPED WINDBAR ADJUSTMENT (OPTIONAL)

1. Move the door panel to the open position.
2. Turn off the power to the door.

### **⚠ WARNING**

The disconnect must be in the OFF position and properly locked and tagged before proceeding and performing the following procedures.

3. The windbar(s) should be in the position shown in Figure 73.

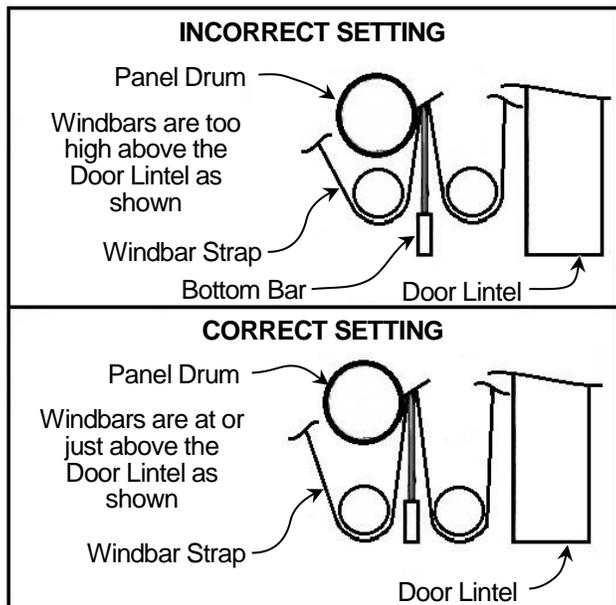


Figure 73

4. Inspect all strapped windbars (if installed). When the door is opened, a strapped windbar should be approximately at or just above the top of the door opening. When both front and rear windbars are installed, once the front windbar is properly positioned, the rear windbar should be at the same height. If the Windbars are too low they will be in the open doorway and infringe traffic. (See Figure 73)

### **⚠ CAUTION**

Keep tension on the windbar straps when adjusting. The windbar is free to fall when windbar straps are not retained by the clamp plates and must be secured at all times.

5. To adjust the rear windbar, pick up the windbar assembly with a forklift. Make sure the windbar is centered and securely supported on the forklift.
6. Loosen the rear strap clamp bolts and loosen the straps up or down through the clamps as necessary. Move the Windbar up or down, as required, by raising or lowering the windbar on the forklift. Also make sure the Windbar is level. (See Figure 74)
7. Retighten the straps in the strap clamps after properly leveling and adjusting the Windbar height.
8. Retighten the clamp bolts when the Windbar is in the correct position and the straps retightened. (See Figure 74)

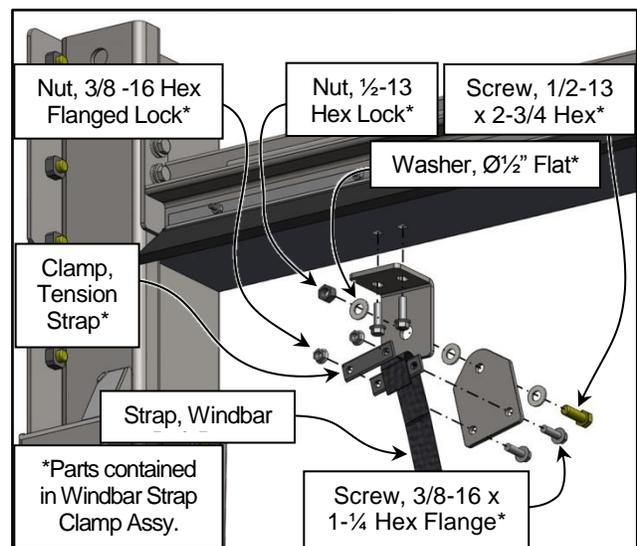
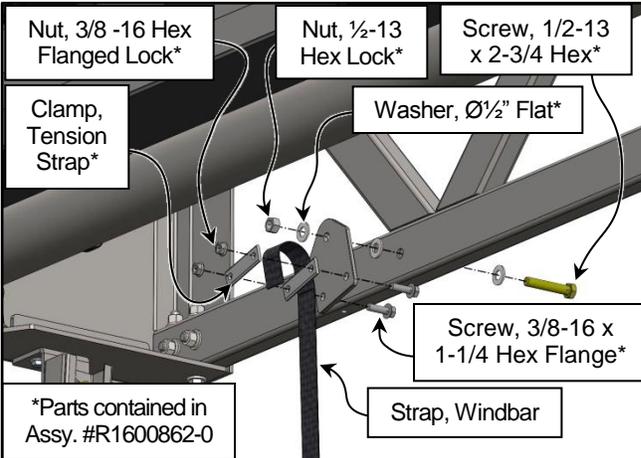


Figure 74

9. To adjust the front windbar, pick up the windbar assembly with a forklift. Make sure the windbar is centered and securely supported on the forklift.
10. Loosen the front strap clamp bolts and loosen the straps up or down through the clamps as necessary. Move the Windbar up or down, as required, by raising or lowering the windbar on the forklift. Also make sure the Windbar is level. (See Figure 75)

## **ADJUSTMENTS—STRAPPED WINDBAR ADJUSTMENT (OPTIONAL FEATURE)**

11. Retighten the straps in the strap clamps after properly leveling and adjusting the Windbar height.
12. Retighten the clamp bolts when the Windbar is in the correct position and the straps retightened.  
(See Figure 75)



**Figure 75**

13. Turn on the power to the door.
14. Run the door through four or five complete cycles to verify that the door and Windbar(s) are operating smoothly and efficiently, and that binding or unusual noises do not exist. Readjust as necessary.

## MISCELLANEOUS—FINAL CHECKS

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### MISCELLANEOUS

#### FINAL CHECKS

*NOTE: Check the following door systems and components after the door panel has been cycled at least 20 times.*

**Head Assembly:** Check that all mounting hardware is in place and properly tightened.

**Side Columns:** Check that the side columns are plumb and square and that all anchor bolts are tightly secured.

**Light Curtain:** Check that the light curtains operate as described in the Powerhouse SD Owner's manual.

**Activators:** Check to see that the activators operate as specified by the manufacturer.

**Open and Close Limits:** Check open and close limits. See "SETTING DOOR LIMITS" on page 16.

**Caulk:** Ensure that all edges of the jamb and header frames and pullouts are sealed where they meet the wall of the building. Use a high-quality caulk rated for the environment in which the door is installed, as required.

**Strapped Windbar:** Positioned as described in both the FRONT and REAR "WINDBAR and STRAP FINAL ASSEMBLY MOUNTING" and "STRAPPED WINDBAR ADJUSTMENT" sections (IF INSTALLED) on pages 22, 27, and 30.



