



***Nailor***<sup>®</sup>  
***Industries Inc.***



# **ELECTRIC DUCT HEATERS**

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# **Nailor International Inc.**

Today, we are proud that the Nailor International Group of manufacturing companies are recognized worldwide in the HVAC industry for our comprehensive product offering. However, many may not know that the group had humble beginnings.

The company commenced operations in 1971 at a small facility in Toronto, Canada manufacturing a single air control device (the curtain fire damper). Michael T. Nailor (President and CEO) started with the founding principle that the company would be customer focused and service orientated, dedicated to fulfilling the need for high quality, competitively priced products, delivered to our customers on schedule. That attitude and the values instilled by Mike in all Nailor employees, still applies today and as a result the company has been rewarded with a continually increasing demand for our products.

Our track record is one of technical leadership and innovation, pioneering the development of new products that exceed industry standard design and performance specifications. Just one example is the commercial introduction in 1995 of the EC motor (ECM) in fan powered terminal units, providing substantial energy savings and which has now become the industry standard. This was followed in 2005 with the introduction of a new line of innovative commercial fan coil units, the first available with variable air volume EPIC Fan Technology® and ECM to provide increased occupant comfort as well as energy savings. We felt the significance of this new development at the time, should also herald a new brand name – Engineered Comfort.

In order to benefit the industry, continue to innovate and stay ahead, Nailor is committed to actively participating on technical committees and in the standards writing process at ASHRAE, AHRI and AMCA for our product lines.

Today, Nailor International Inc. is still a privately held company with Group Headquarters in Houston, Texas. The company now has manufacturing plants totaling one million square feet strategically located in three countries with an international distribution network of representatives working together to not only meet, but exceed the expectations of clients, engineers and customers around the world.

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**GENERAL OVERVIEW**

**A**

**MODELS**

**B**

**CONTROL PANEL FEATURES**

**C**

**COMPONENTS OPTIONS & ACCESSORIES**

**D**

**CONSTRUCTION & DIMENSIONAL DATA**

**E**

**WIRING DIAGRAMS**

**F**

**ENGINEERING SECTION**

**G**

**NEC & UL REQUIREMENTS**

**H**

**HEATER CONFIGURATIONS**

**I**

**SUGGESTED SPECIFICATIONS**

**J**

**TABLE OF CONTENTS****Page No.**

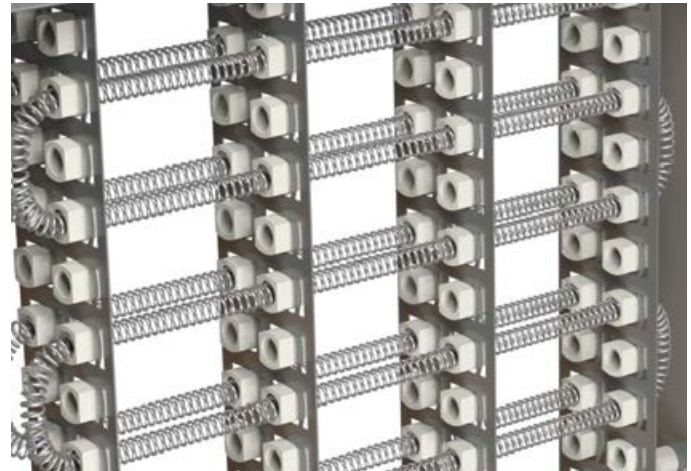
<b>General Overview</b>	<b>1</b>
<b>Nailor Models</b>	<b>2</b>
<b>Control Panel Features</b>	<b>3</b>
<b>Components Options &amp; Accessories</b>	<b>4</b>
<b>Construction &amp; Dimensional Data</b>	<b>10</b>
<b>Wiring Diagrams</b>	<b>12</b>
<b>Engineering Section</b>	<b>15</b>
<b>Duct Heater Location</b>	<b>18</b>
<b>Duct Heater Installation</b>	<b>19</b>
<b>NEC &amp; UL Requirements</b>	<b>28</b>
<b>Heater Configurations</b>	<b>29</b>
<b>Suggested Specifications</b>	<b>30</b>



## GENERAL OVERVIEW

Nailor Electric Duct Heaters (EDH) are self-contained heating units designed for installation in commercial and light industrial air moving systems. They provide precision heating for proper space control by handling dynamic heating load demands such as those seen in large duct applications or in systems with branch ducts. Multiple duct heater locations within a single building allows for maximum potential for individual control of each zone.

provide constant heat as long as the heater is energized and the air velocity over the elements is constant. The wire surface temperature may vary from 800 °F to 1200 °F (427 °C to 649 °C) under normal conditions so that the operating temperature is below that which would produce a red glow.



Typical element with ribbed type insulators

### Model DHRS (Shown with optional SCR Controls)

Duct heaters can be used as a primary source of heat for example in Air Handling Units or as supplemental heat (also known as auxiliary or stand-by) as an integral component of other HVAC equipment such as variable air volume terminal units, fan coil units and heat pumps.

## CONFIGURATION TYPES

Nailor Electric Duct Heaters are available in two basic configurations, slip-in (insert) type or flanged type:

- **Primary Heat:** The heat source for the entire building.
- **Preheat:** Tempers outside air prior to another air conditioning source.
- **Reheat:** Raises the temperature of air previously conditioned by another process before distribution to the zone.
- **Supplemental Heat:** Temporarily boosts the heating capacity of another piece of HVAC equipment.

### Slip-in (Insert) Type:

Slip-in type heaters are constructed to slide the entire frame, excluding the terminal box, into an opening in one side of a duct without removing or disturbing the duct section.

### Flanged Type:

Flanged heaters are constructed with flanges on both ends of the heater frame. They become a section of the duct when installed. The inside dimensions of the frame match the inside dimensions of the duct.

All Nailor duct heaters are ETL listed for zero clearance and dual directional airflow. They are designed with electrical resistance elements arranged in the most advantageous pattern for heat transfer to the air stream and can be configured in a variety of sizes for suit a broad range of applications. Nailor duct heaters are "open coil" design, constructed of helically wound resistance heating elements exposed directly to the air stream. The elements are supported by ribbed type high-temperature ceramic insulators that surround the element. Nailor duct heaters provide low pressure drop solutions that can be attributed to the high percentage of open space across the heater.

When compared to finned tubular type, open coil elements offer lower resistance to airflow, provide a small surface to attract dirt or lint, and typically run cooler. Nailor duct heaters



Nailor Industries Inc. Electric Duct Heaters have been tested and approved to the following standards by ETL Testing Laboratories Inc., Courtland, N.Y.

(Listing Report No. 554250. Category:

Duct Heaters 327 U.S.A. and 328 Canada)

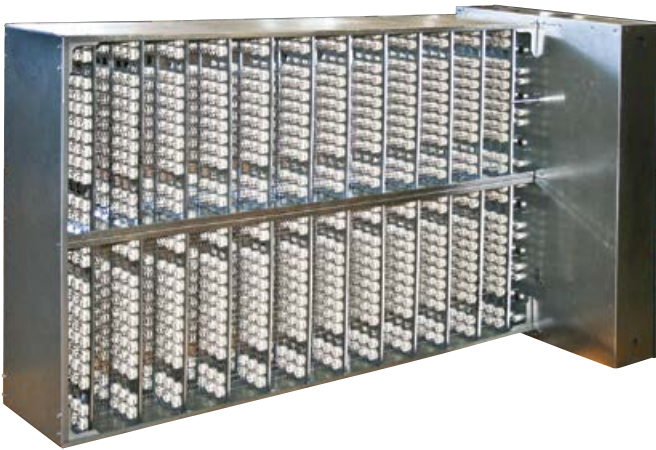
ANSI/UL Standard 1996, "Electric Duct Heaters"

CSA Standard C22.2 No. 155-M1986. "Electric Duct Heaters"

## NAILOR MODELS

### Model DHRS Slip-in/Insert Mount:

ETL listed slip-in model with all controls in an enclosed panel attached to the heater. The open coil element is encapsulated in ribbed ceramics. Model DHRS is available in custom sizes and all kW ranges (voltage/phase dependent). A variety of control options and accessories can be used with the model DHRS.



### Model DHRF Flanged Mount:

ETL listed flanged model with all controls in an enclosed panel attached to the heater. The open coil element is encapsulated in ribbed ceramics. Model DHRF is available in custom sizes and all kW ranges (voltage/phase dependent). A variety of control options and accessories can be used with the model DHRF.



### Model DHRS/DHRF with Optional Remote Control Panel:

ETL listed models with all controls in an enclosed panel remote to the heater. Install the control panel in a suitable location for the specified panel type. The wiring diagrams inside the heater door and the remote control panel door show point-to-point interconnecting wiring. Panels should be mounted in sight of unit, unless an additional disconnect is located at unit.



### Model DHRR Round Duct Connection:

ETL listed round duct connection model with all controls in an enclosed panel attached to the heater. The open coil element is encapsulated in ribbed ceramics. Model DHRR features an insulated (1" [25] dual density edge coated) 20 ga. (1.0) zinc coated steel casing and is available in custom sizes and all kW ranges (voltage/phase dependent). A variety of control options and accessories can be used with the model DHRR.



## UL STANDARD 1996 AND NEC REQUIREMENTS

Heaters with current loads over 48 amperes must be subdivided into multiple circuits, each of which must not exceed 48 amperes. Each sub-circuit must be internally fused or supplied with other overcurrent devices furnished by the heater manufacturer.

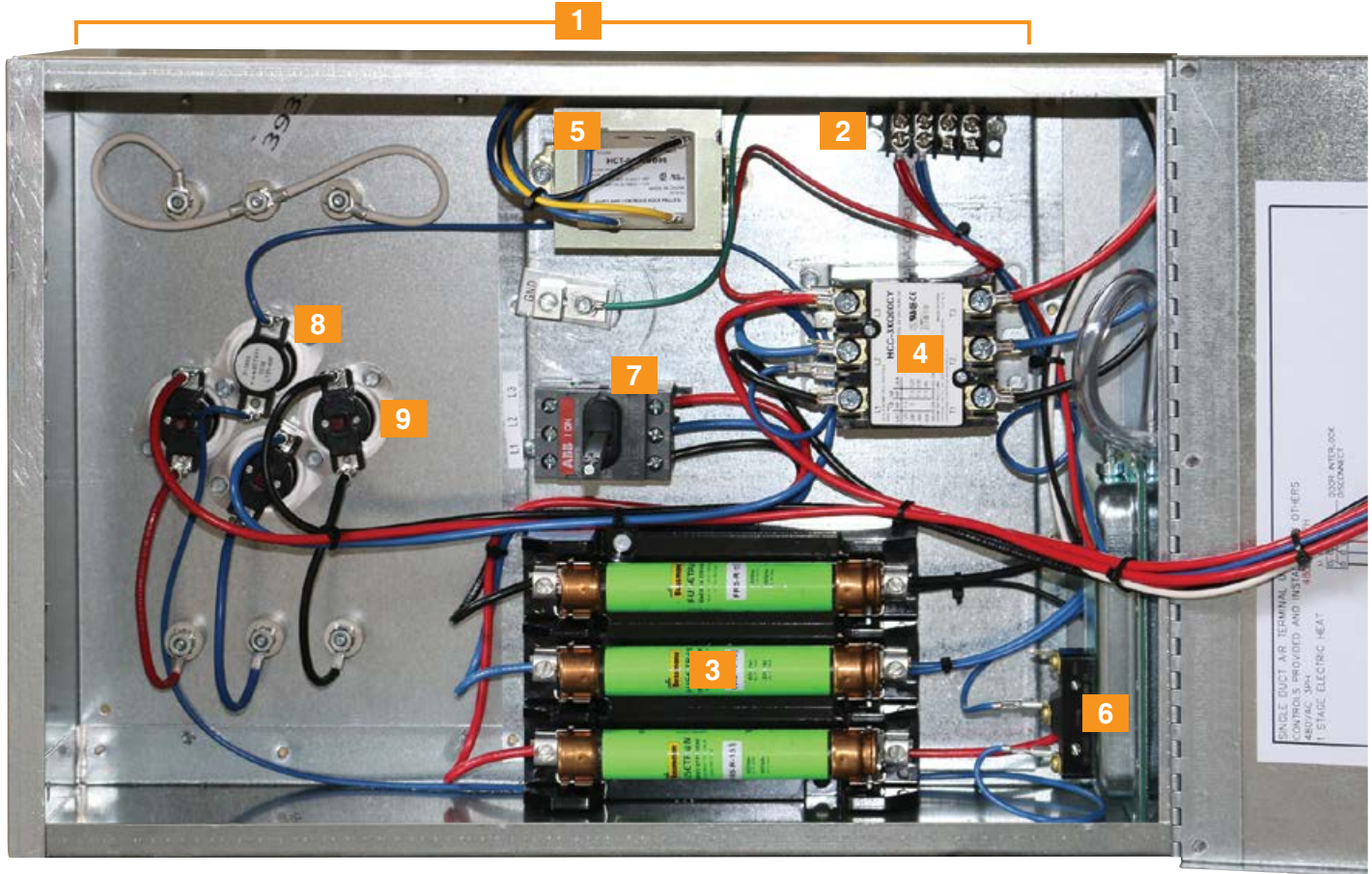
Heaters must be:

- Furnished by the manufacturer with installation instructions.
- Provided with a grounding terminal or lug.

- Furnished by the manufacturer with an airflow switch (pressure type) or with a fan interlock relay in the heater control panel.
- Furnished with an individual and specific wiring diagram permanently fixed to the control panel of the heater.
- Furnished with proper safety and warning labels to warn of electric shock hazard.



## CONTROL PANEL FEATURES



C

CONTROL PANEL FEATURES

- 1. Control Panel**  
 Constructed of heavy gauge, corrosion-resistant galvanized steel with side knock-outs properly sized for conduit connections and a solid non-perforated hinged door with screwdriver operated latch that protects equipment from dust and assures trouble-free operation.
- 2. Terminal Blocks**  
 Main power supply terminal blocks are provided as standard for field connection.
- 3. Fuses**  
 Fuses are provided as standard equipment on all heaters exceeding 48 amps to meet UL and NEC code requirements. Fuses are optional on all other heaters drawing less than 48 amps.
- 4. Contactors**  
 Disconnecting magnetic contactors for staged heat are standard on all duct heaters. Optional SCR or SSR control, mercury or quiet disconnecting contactors available.
- 5. Transformer**  
 Required when control voltage differs from line voltage. Non-Class II units must have protection by fusing, Class II units have internal protection and do not require additional fusing, unless otherwise specified.
- 6. Airflow Switch**  
 Differential pressure airflow switch provides positive protection against loss of airflow and protects the heater from being energized when the fan is not on.
- 7. Disconnect Switch**  
 Optional door interlocking or toggle type switches available when specified.
- 8. Primary Reset**  
 Auto reset lower limit switch for over temperature protection.
- 9. Secondary Reset**  
 Manual reset higher limit switch(es) for additional over temperature protection.
- 10. Pilot Lights (optional and not shown)**  
 Provide visual means of indication for the following conditions: Heater energized; Stage energized; Airflow switch open.
- 11. Heater Elements (not shown)**  
 Nailor manufactures every element wire for each application from highest grade "Class A" 80/20 nickel/chromium wire for longer life and elimination of coil sag and oxidation. Conservative rating assures low operating temperatures, and coils do not glow if there is adequate airflow across the entire face. Ribbed type insulators with ceramic bushings feature support brackets that are specially reinforced along the edges.

## MODELS: DHRS, DHRF AND DHRR

### Basic Custom Heater Models

.5 to 1000 kW

## COMPONENTS, OPTIONS & ACCESSORIES

### Model Type

- **DHRS** Slip-in Electric Duct Heater
- **DHRF** Flanged Electric Duct Heater
- **DHRR** Round Electric Duct Heater

### Duct Size

- W x H (Specify)

### Airflow/Overhang

- Horizontal/Left (standard) (default)
- Horizontal/Right
- Horizontal Bottom Mount (Centered)
- Vertical/Panel Down
- Vertical/Panel Up

### Line Voltage/Phase

- 120V/1 ph.
- 208V/1 ph.
- 240V/1 ph.
- 277V/1 ph.
- 347V/1 ph.
- 480V/1 ph.
- 208V/3 ph.
- 240V/3 ph.
- 480V/3 ph.
- 600V/3 ph.

### kW

- Specify

### Control Type

- Staged Electric
- Staged Pneumatic
- SCR 0–10 Vdc
- SCR 4–20 mA
- SSR 4–32 Vdc Pulsed
- SSR 24 Vac Pulsed

### No. Stages

- 1 Stage
- 2 Stages
- 3 Stages
- 4 Stages
- 5 Stages
- 6 Stages
- 7 Stages
- 8 Stages
- 9 Stages
- 10 Stages
- 11 Stages
- 12 Stages
- 13 Stages
- 14 Stages
- 15 Stages
- 16 Stages

### Air Proving Means

- Airflow Switch (default)
- Fan Interlock Relay 24V
- Fan Interlock Relay 120V
- Fan Interlock Relay 208V
- Fan Interlock Relay 240V
- Fan Interlock Relay 277V
- Fan Control Relay
- Fan Connection Terminal Block
- A/F Switch Fan + I.L. Relay 24V
- A/F Switch Fan + I.L. Relay 120V
- A/F Switch Fan + I.L. Relay 208V
- A/F Switch Fan + I.L. Relay 240V
- A/F Switch Fan + I.L. Relay 277V

### Control Voltage

- 24 Volts (default)
- 120 Volts

### PE Switch

- Load carrying Nom. Open (default)
- Load carrying Nom. Closed
- Pilot duty Nom. Open (default)
- Pilot duty Nom. Closed

### Control Contactors

- Magnetic Disconnecting (default)
- Quiet Disconnecting
- Mercury Disconnecting

### Safety Contactors

- Magnetic Disconnecting (default on SSR/SCR)

### Transformer

- Class II, 1–3 stages (default)
- Class II, 4 stages +
- Class II, Resettable
- Primary Fused, 1–3 stages
- Primary Fused, 4 stages +

### Fusing

- Min. per NEC/UL (48A+) (default)
- One fuse block per heater
- One fuse block per stage

### Disconnect Switch (optional)

- Door Interlocking
- Toggle Type

### Undersizing for duct liner

- 1" (25) Insulation (default)
- 1/2", 1-1/2" or 2" (13, 38 or 51) Insulation
- Unlined duct [- 1/4" (6.35)]

### OTHER OPTIONS & ACCESSORIES

#### Step Controller

- 1 – 8 Stage(s)
- 9 – 16 Stages

#### Vernier Controller

- 1 – 8 Stage(s)
- 9 – 16 Stages

#### Derated Coils

- 45 Watts/sq. in.
- 35 Watts/sq. in.
- 25 Watts/sq. in. Open (default)

#### Remote Control Panel

#### Class A 80/20 Ni/Cr Wire

#### Stainless Steel Element Connections

#### Insulated Panel

#### Recessed Terminal Box (specify)

#### Dust Tight Construction (Chicago code)

#### Protective Screen

- One side (inlet)
- Both Sides

#### Flanged Heater with Full Sleeve

#### Pilot Lights

- Heater (control circuit) on
- Each stage on
- Airflow switch open

#### Pilot Switches

- De-energize all contactors
- De-energize each stage

#### PE Transducer (KMC TPE-1001)

#### Thermostats

- 1 stg. Mech. °F T822K-1018, 24V
- 1 stg. Mech. °C T822K-1026, 24V
- 1 or 2 stg. Dig. display °F TH5220D1003, 24V
- 1 or 2 stg. Duct Stat. T678A
- SSR/SCR VT7225 Dig. display

#### Duct Temp. Sensor

Remote (Vic. S2000D1000)

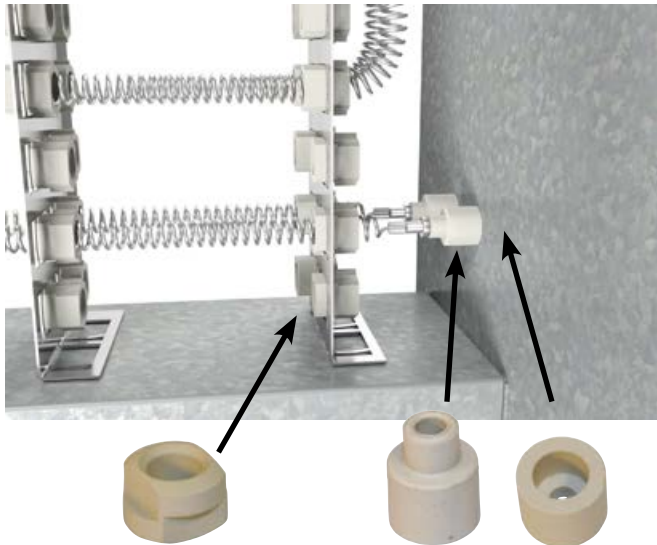


## COMPONENTS OPTIONS & ACCESSORIES

### Control Box

Electric Duct Heaters are supplied with a sturdy controls enclosure that has sealed seams; however, when required for dust tight applications, a gasket can be added between the enclosure and the door to improve the seal when the door is closed.

### Ribbed Type Element Insulators



Nailor uses the highest grade ceramic insulators to hold the element wires in the air stream. Rack assemblies incorporate ribbed insulators that are encapsulated within two layers of galvanized steel and allow the ceramic bushings to float within their own enclosures without allowing the rack to warp. They surround the element wire.

### Element Wires

**The highest Class 'A' 80/20 nickel/chrome wire is used in all Nailor duct heaters.** Element wires have limited densities to keep the surface temperature low for longer life and to eliminate coil sag. Conservative ratings assure low operating temperatures, and coils do not glow if adequate airflow is supplied to the entire face of the heater. This iron-free wire has a higher maximum operating temperature, greater life, lower sag, less resistance change and higher corrosion resistance than other commonly used resistance wires.

### Element Termination



Nailor provides electrical and mechanical bonding between the element wires and the corrosion-resistant hardware for long lasting connections on both ends of each element wire.

### Primary High Limit Switch (Auto-reset)



Nailor provides a disc type, automatic reset, high limit control device as standard in the control circuit on all heaters for primary high temperature protection. The standard cut-out temperature is 120°F (49°C). This control automatically cuts the heater off if overheating should occur. It will automatically bring the heater back on after a cool down period. The disc type cut-offs are required by UL 1996 and NEC Article 424.

### Secondary High Limit Switch (Manual Reset)



Nailor provides manually re-settable limit switches in the line side of each heater element. The standard cut-out temperature is 210°F (99°C) in the heater control panel. Replacement or servicing does not require removing the heater from the duct.

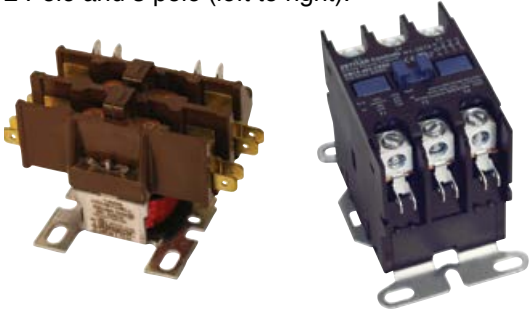
## COMPONENTS OPTIONS & ACCESSORIES (con't)

### Magnetic Contactors



Magnetic contactors are the industry standard and are used in the vast majority of applications. Used to energize individual steps of heat when a heater is electrically or electronically controlled. They are also used in pneumatically controlled heaters when the heater load exceeds the pneumatic-electric switch amp rating. One, two, three and four pole contactors are available with coil ratings of 24, 120, 240 and 277 VAC. They are reliable and very cost effective. However, their electro-magnetic action creates a clicking noise or chatter which may be audible in quiet surroundings.

2 Pole and 3 pole (left to right).



### Quiet Contactors (Magnetic)

Quiet (not silent) contactors are an option for smaller single phase duct heaters. Available only as 2 pole, 30 amps maximum with a 24VAC coil rating.

### Mercury Contactors



Nailor Electric Duct Heaters can be supplied with mercury contactors when control systems require frequent cycling or silent operation. Because of the sealed mercury contacts, chattering, arcing, and noise are completely eliminated. Mercury contactors are durable with long life expectancies,

however they are substantially more expensive than the magnetic type and are also position sensitive.

### Pneumatic Electric (PE) Switches



Like contactors, PE switches are used to energize stages of electric heat. They are used exclusively on heaters that are pneumatically controlled and convert pneumatic pressure signals to electric signals. One PE switch is required per step of heat. Small heaters may often use a load carrying PE switch as the only control component. Local codes however may prohibit this practice and require back-up contactors. At a specified and factory pre-set input pressure, the electrical contacts on the switch make and so energize the heater. The switch can be wired to energize the heater on either a rising or falling pressure signal. The industry standard is for the switch to fail normally open with a reverse acting thermostat and normally closed with a direct acting room thermostat. The fail position must therefore be specified. A single pneumatic field connection is required, regardless of the number of stages in the heater.

Back-up (Safety) Contactor. Provided in addition to the primary controlling contactor or other device and controlled only by the primary auto-reset high limit cut-out. All heaters with SSR/SCR control require a safety contactor.

### Air Proving Means

#### Airflow Switch - Standard

UL and NEC require that at least one of the following fan interlocking methods must be provided as an integral part of the heater. This protects the heater and prevents it from being energized unless the fan is energized.



D

COMPONENTS & OPTIONS

## COMPONENTS OPTIONS & ACCESSORIES (con't)

An airflow switch of the pressure type above is the best and most positive method of protection against loss of airflow. The switch has a built-in diaphragm that senses the pressure difference from the inside to the outside of the duct via a probe placed in the airstream facing against the direction of airflow and measuring total pressure. The airflow switch is wired in series with the primary auto-reset limit switch. If airflow stops or falls below 0.07" w.g. (17 Pa), contact is broken and the heater is de-energized. To maintain this, a downstream static pressure of .1" w.g. is required.

The air pressure switch is superior to a fan interlock relay as it protects against fan belt failure whereas the fan relay does not and it eliminates dependency on field wiring that the fan relay requires. For these reasons, Nailor Electric Duct Heaters are supplied with airflow switches as standard.

### Fan Relay - Optional

Nailor will provide a fan relay in lieu of an airflow switch when required or requested. There are two methods.

**Option A – Fan Interlock Relay.** Prevents the heater from operating unless the fan is energized. Utilizes a separate external power source, either from the load side of the fan starter or from the fan control voltage circuit. A separate relay with open contacts is wired to the common wire in the control circuit of the heater and the holding coil is wired to a terminal block. The fan interlock voltage must be specified when this option is ordered. This method is often used with continuous fan applications or where a common fan supplies several heaters.

**Option B – Fan Control Relay.** The heater control circuit energizes the fan simultaneously with first stage of heat. An extra set of open contacts are provided on the first stage heater contactor and wired to a two pole terminal block with both poles marked 'fan'. In some applications a separate relay is provided with contacts wired to a terminal block and the holding coil wired into the common wire of the heater control circuit. This option is normally used where there is an individual fan for each heater and intermittent fan operation is desired.

Both a fan interlock relay and an airflow switch can be furnished.

### Transformers



A control transformer is required on most electrically or electronically controlled heaters when the control voltage

differs from the line voltage and a separate control source is not available. The usual control voltage is 24 or 120 volts, reduced from the higher line voltage being used to power the heater.

Pneumatically controlled heaters also require a transformer where back-up contactors are required and a control voltage cannot be tapped directly from a three phase four wire or single phase three wire service.

Class 2 transformers reduce line voltage to 24 volts, have built-in internal overcurrent protection and are used as standard when control power supply requirements are less than 100VA. When 24 volt control power supplies require more than 100 VA or the control voltage requirement is 120 volts, a transformer with primary fusing will be supplied per NEC requirements.

### Power Fusing and Fuse Blocks



Nailor Electric Duct Heaters will be supplied standard with fuses and fuse blocks whenever the total load exceeds 48 amperes as required by NEC Article 424. Heaters with loads below 48 amperes can be supplied with fuses if requested. Heaters with loads in excess of 48 amperes must be subdivided into circuits of 48 amperes or less. Each circuit must be individually fused per NEC Article 424 for its individual load.

Over current protection must be sized according to minimum circuit ampacity (MCA) for 125% of the circuit load.

### Terminal Blocks (Power Distribution Blocks)



Terminal blocks or power distribution blocks are supplied for all field connections exceeding 24 VAC for convenient field connections. These blocks are sized to accept the correctly sized field wiring.



## COMPONENTS OPTIONS & ACCESSORIES (con't)

### Disconnect Switch – Door Interlocking



Door Interlocking Disconnect Switches completely disconnect all components within the control enclosure before the door or cover will open. When used with power fusing, it serves as a fused disconnect.

### Disconnect Switch – Toggle type (Non-Door Interlocking)



Electric Duct Heaters can be supplied with Toggle Disconnect Switches wired into the power circuit, as long as the total load on the switch is not in excess of 48 amperes which requires a 60 amp disconnect switch. This allows the power to be disconnected independent of the control panel door.

### Toggle Switches (Pilot Duty)



Toggle Switches can be mounted in the control enclosure, allowing all or any part of the controlling contactors to be manually switched or locked out. These switches are wired into the control voltage circuit only. They are not available in the line voltage circuit.

### Pilot Lights

Nailor Electric Duct Heaters are available with pilot lights wired in the control voltage circuit and mounted on the outside of the control panel. The lights give a visual indication of operation mode. The following pilot lights are available:

1. Heater (control circuit) on.
2. End stage that is on.
3. Airflow Switch is opened (low airflow).



### Step Controller



Electronic step controllers are available if required. They are used to stage multiple steps of heat with electric (beyond the capability of a traditional 2 or 3 stage thermostat) or pneumatic control 45 amps maximum per stage. Switching multiple stages with step controllers ensures that the room set point does not drift as load requirements change.

A built-in transformer is required and provides a 24 volt control circuit. Pneumatic control includes a transducer to convert the air pressure changes to the electrical signal needed for the controls. For electric control, the analog input signal is selectable with DIP switches, 0–10 vdc, 4–20 mA or 0–135 Ohm.

These controls are such that if the power is interrupted, all the stages will recycle to off and upon restoring power, re-energize the switches in a stepping sequence.

### SSR (pulsed input) and SCR (analog input) Proportional Controllers



Nailor Electric Duct Heaters can be equipped with SSR/SCR controls. One hundred percent solid state proportioning control is noiseless and contains no mechanical switching devices. SSR/SCR controlled duct heaters provide very fine space temperature control and are designed for the highest reliability.

Modulation from 0 to 100% is achieved by time base proportional firing which is varied in response to the thermostat demands. Proportioning is achieved by varying the number of on cycles with regard to the off cycles. SSR/SCR controls are available for single or three phase heaters and can be operated with any available variable input source.

D

COMPONENTS & OPTIONS

## COMPONENTS OPTIONS & ACCESSORIES (con't)

The standard SSR control input signal is 4.32 Vdc pulsed (time proportional). 24 Vac pulsed is optional with the addition of an ac/dc converter board. The SCR analog input is selectable with DIP switches, 0–10 Vdc, 4–20 mA or 0–135 ohm.

VOLTAGE/PHASE	MAX. AMPS	MAX. KW
120/1	180	21.6
208/1		37.4
240/1		43.1
277/1		49.8
480/1		86.4
208/3	90	32.4
240/3		37.4
480/3		74.8
600/3		93.5

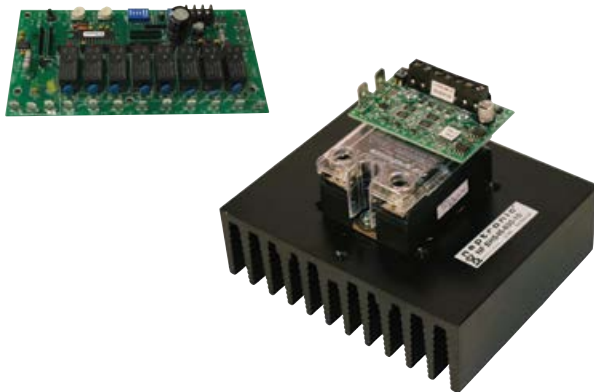
### Kilowatt Limitations For SSR/SCR Controllers

### Vernier Proportional Controllers

For large kW loads when the load is larger than in the table above, the same fine control can be obtained by using a solid state Vernier Control System which utilizes an integrated SSR controller on one stage and an electronic step controller to control magnetic contactors.

This is a more economical solution than using multiple master/slave SSR/SCR controllers on each 45 amp circuit.

The SSR operates first and will fine tune between the steps controlled by the step controller. It still offers 100% modulation, but only one stage is actually controlled by the SSR. The others are switched on and off by the step controller, as required by the analog input signal.



### Derated Coils

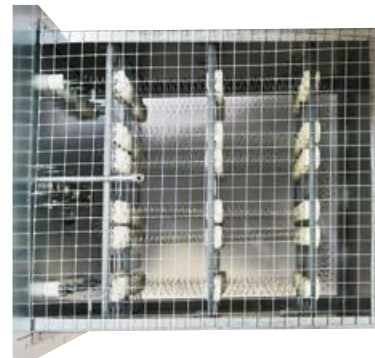
Typically, Nailor Duct Heaters are derated to operate in the 40 to 60 watts per square inch of element surface density range. This is conservative enough to ensure a long service life. Nailor heaters may optionally be ordered with 35 or 25 watts per square inch element wire if 'very low' watt density is required. While derating of coils reduces the wire surface temperature, it is no substitute for good even air distribution and maintenance of minimum recommended airflow.

### Bottom Mount Heaters



Bottom mounted slip-in or flanged construction is optionally available, where due to space considerations, the control enclosure must be located below the duct.

### Protective Screen



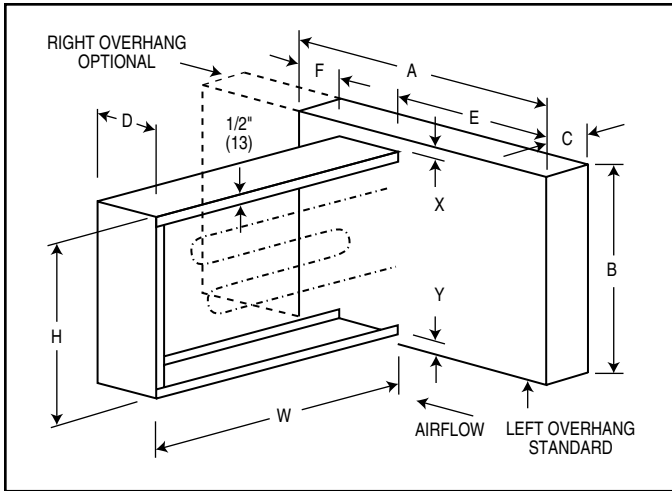
A protective screen is installed on either one side or both side of the heater element, it is to prevent for possible debris to be in the air stream of the duct and come in contact with the heater elements or for personal protection.

### Insulation On Panel (Vapor Barrier)

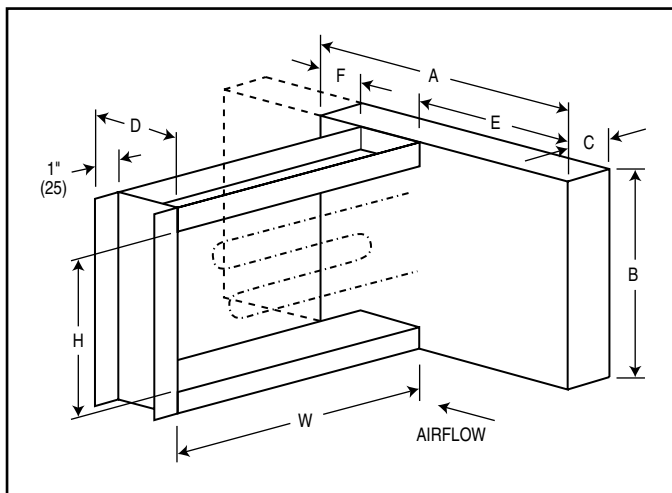
On the rare occasion when the heater is to be installed in uninsulated ductwork, condensation may form inside the control box. To eliminate this problem, the back of the control box can be factory insulated.

## CONSTRUCTION & DIMENSIONAL DATA

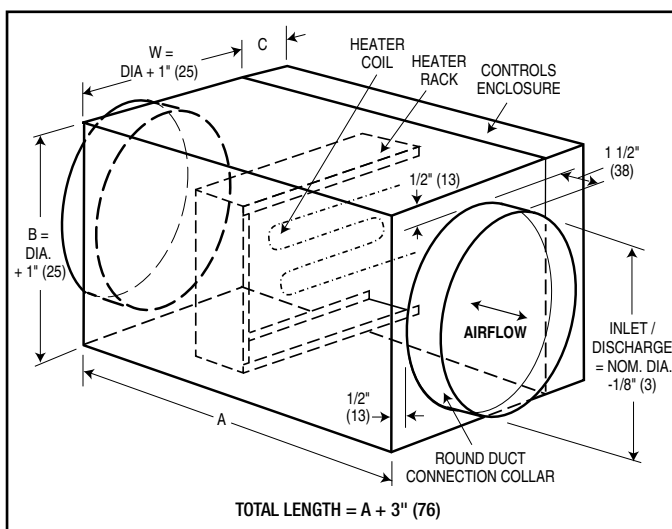
### Model DHRS Slip-in / Insert Mount



### Model DHRF Flanged Mount



### Model DHRR Round Duct Connections



### Notes:

1a. For Slip-in:

W = Duct width - 1" (25).

H = Duct height - 2" (51).

B = H + 2" (51) standard.

X and Y = 1" (25) standard.

1b. For Flanged:

W and H = Duct size.

B = Duct height + 2" (51) standard.

1c. For Round Duct Connections

W = Dia. + 1" (25).

B = Dia. + 1" (25).

Nom. Duct Diameter: Min. 6" (152); Max. 24 (610).

**Note:** Inlet and Discharge collars are equal in diameter.

2. F = 1" (25) standard.

3. For both models DHRS and DHRF A, B, C, D and E dimensions vary dependent upon duct size, kW and controls. For model DHRR A, B and C dimensions vary dependent upon duct size, kW and controls.

If there is a critical dimension that the control panel may not exceed due to clearance restrictions, please note this information on the order, otherwise the computer designed control panel enclosure will be supplied.

Nailor Electric Duct Heaters are available in custom sizes to suit any ductwork installation. Minimum size is 8" W x 6" H (203 W x 152 H). Maximum size is 118" W x 118" H (2997 W x 2997 H).

For larger custom sizes, contact your Nailor representatives.

Control enclosures and control layouts are custom computer designed for each heater. Sufficient space is provided for the mounting and wiring of the required components and to allow satisfactory heat dissipation.

They are furnished with left to right horizontal airflow and a left hand control panel overhang as standard (viewed when facing the panel). Standard position for the control panel is on the right side of the element rack when looking in the direction of airflow. Refer to the illustrations on the submittal form (page 29) for the various optional configurations available.



## CONSTRUCTION & DIMENSIONAL DATA (con't)

### Model DHRS Slip-in / Insert Mount

The slip-in (insertion) design is suitable for the majority of applications. The heater is installed into existing ductwork through a rectangular cut-out in the side of the duct. The duct cut-out should be approximately 1/2" (13) larger than the heater element rack depth and height for ease of installation.

The standard slip-in heater ordered by nominal duct size is built and undersized to accommodate the industry predominant 1" (25) internal duct installation. Slip-in heaters may also be ordered factory undersized for 1/2" (13) internal insulation or for unlined duct (1/4" undersized).

They are undersized approximately 1" (25) in width and 2" (51) in height. This allows 1" (25) clearance around the three sides of the element rack. For thicker than 1" (25) insulation, deduct one additional insulation thickness above 1" (25) from the actual duct width and two additional insulation thicknesses above 2" (51) from the actual duct height and order the standard undersized unit.

**Example:** Duct size is 18" W x 12" H (457 W x 305 H) with standard 1" (25) thick internal insulation. Standard slip-in heater is built as 17" W x 10" H (432 W x 254 H).

### IMPORTANT:

**STANDARD SLIP-IN HEATERS ARE FACTORY UNDERSIZED FOR 1" (25) INTERNAL DUCT LINER (FOR OTHER THICKNESSES SEE ABOVE).**

### Flanged Mount

Flanges are turned out 1" (25) around three sides of the element rack, providing a mounting surface for the heater and adding additional rigidity for larger ducts. Bolts are generally run through the matching duct (which should also be flanged on three sides) and heater flanges to support the weight of the heater. Additional screws through the control cabinet into the duct complete the installation.

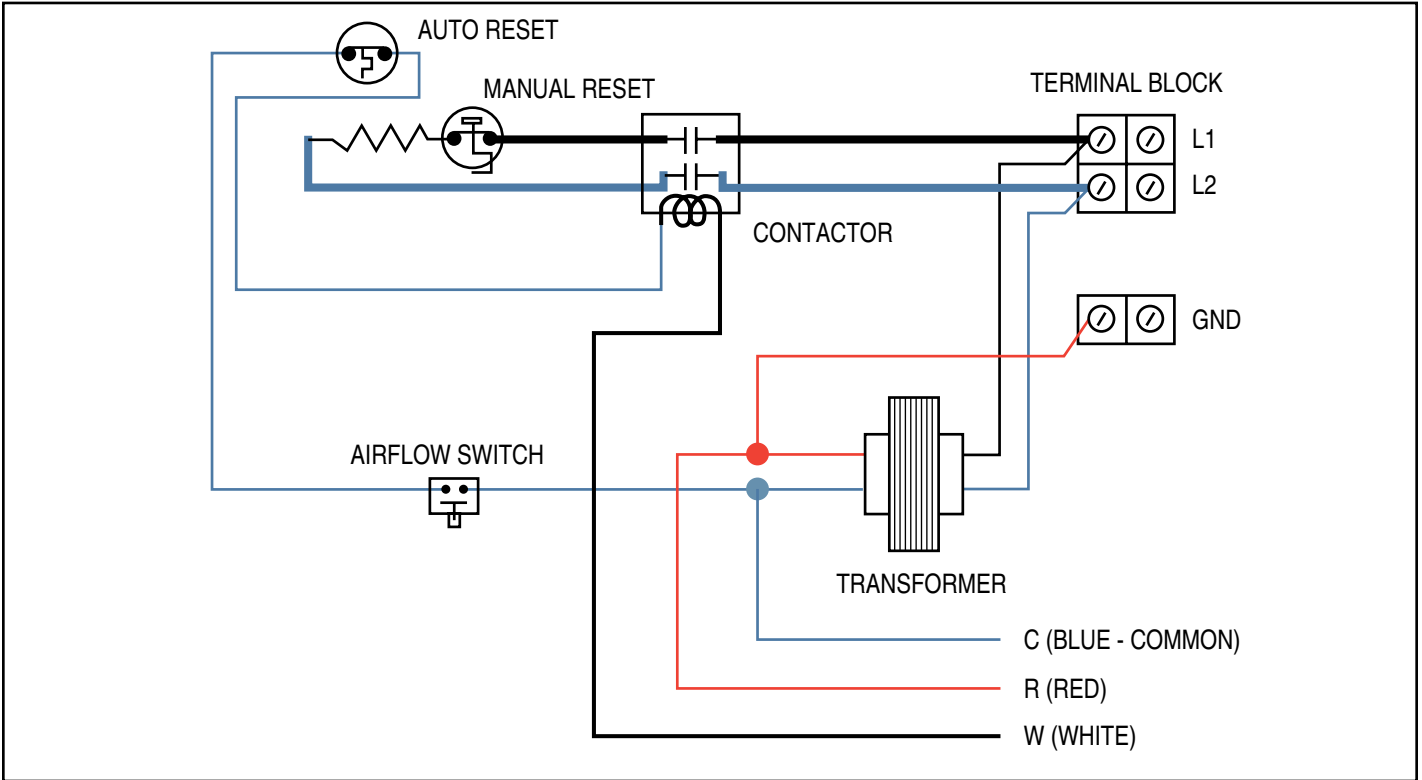
### IMPORTANT:

**ORDERS FOR ALL HEATERS MUST SPECIFY ACTUAL DUCT SIZE.**

### Model DHRR Round Duct Connections

The round duct connection model allows an easy method of installing an electric duct heater in a round sheet metal duct. The electric heat wrapper comes factory installed in a factory sleeve with square to round transition collars, undersized for nominal round duct connection. The unit is internally lined with 1" (25) insulation.

**WIRING DIAGRAMS**

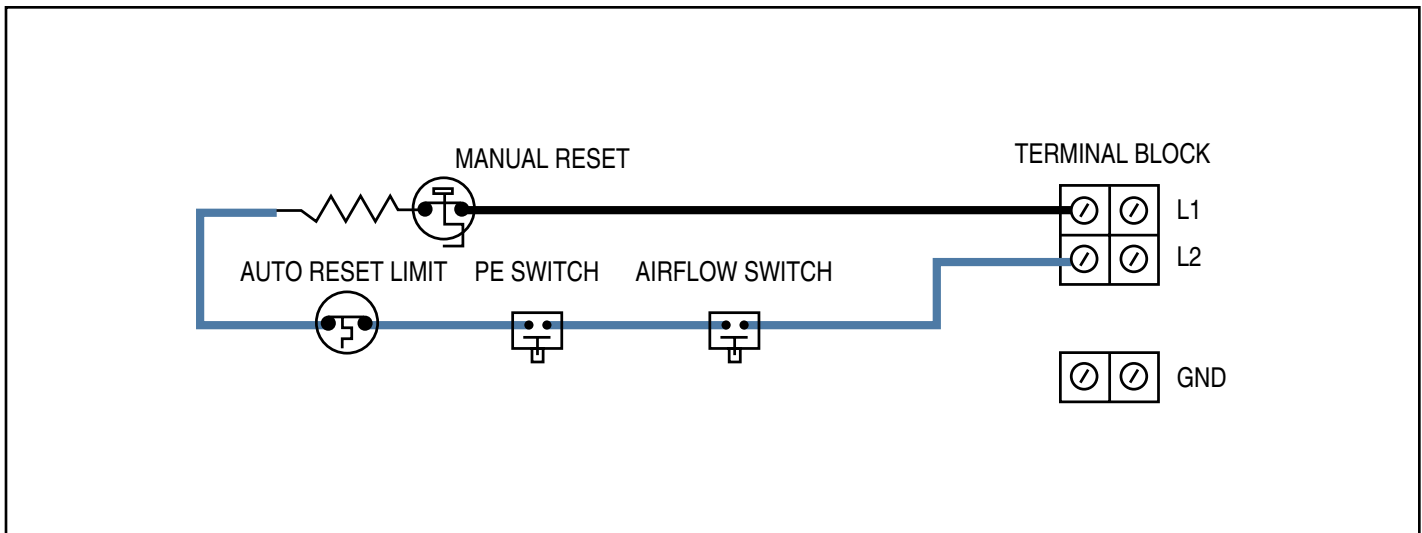


Typical Wiring Diagram No. 1

Single Stage – Airflow Switch – Disconnecting Contactor

F

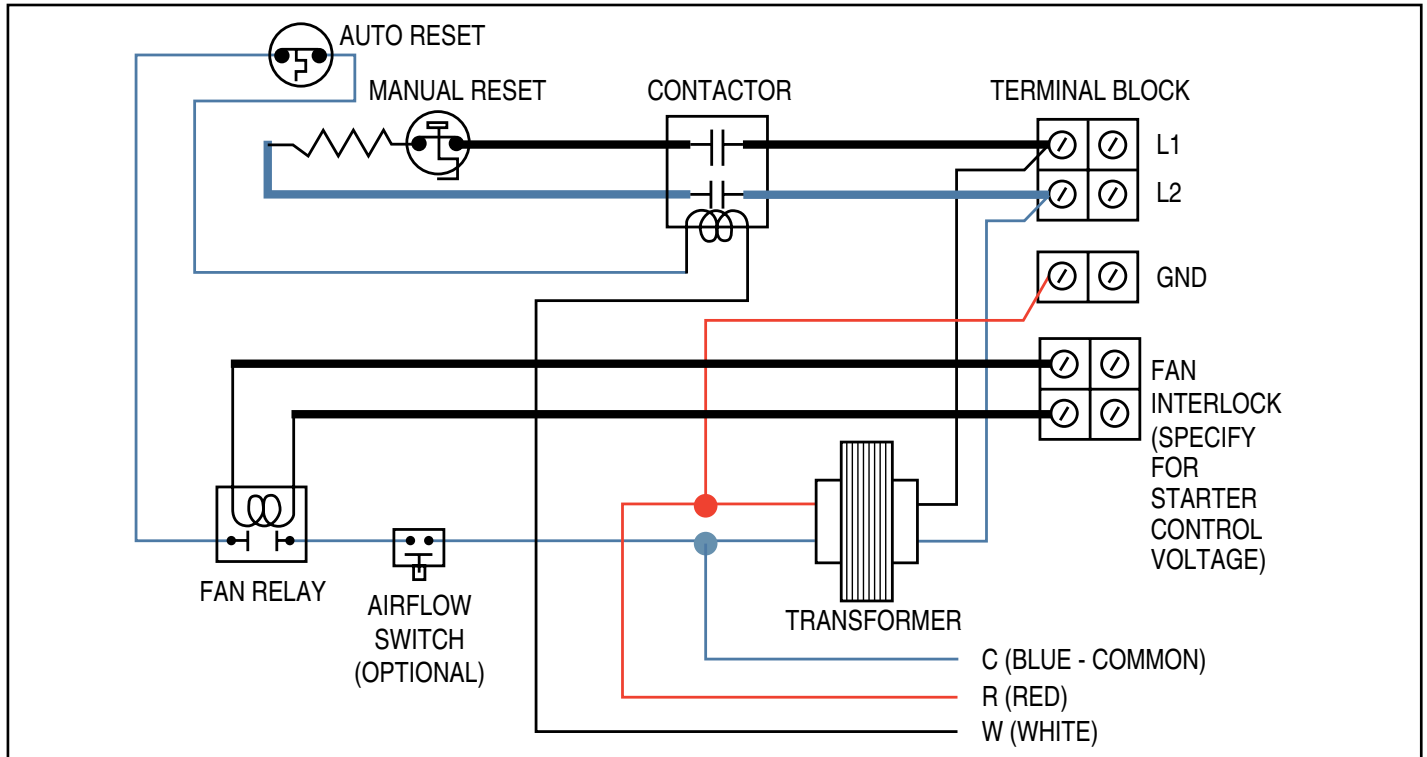
WIRING DIAGRAMS



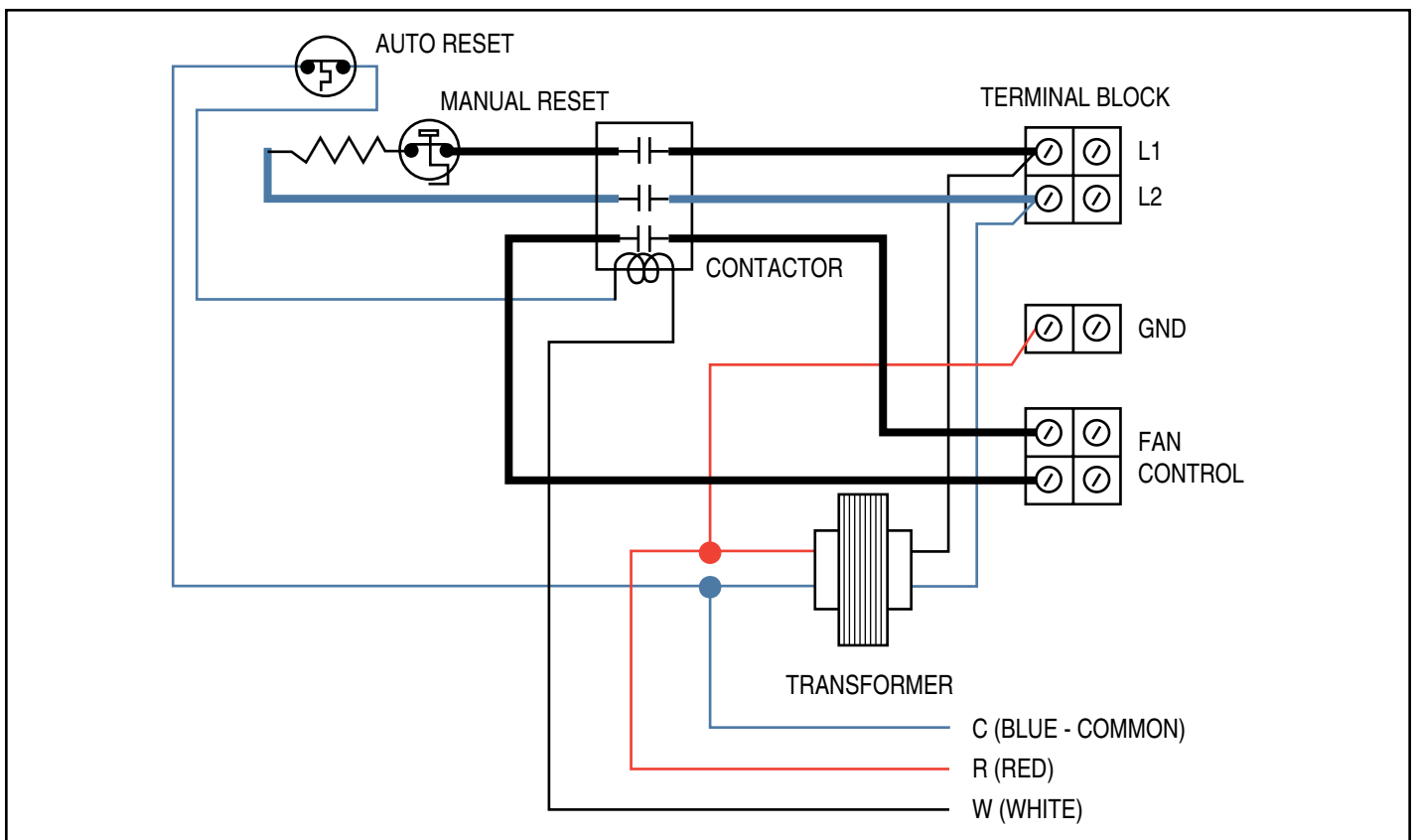
Typical Wiring Diagram No. 2

Single Stage – Airflow Switch – Pneumatic Controls - Load Bearing PE Switch

**WIRING DIAGRAMS**



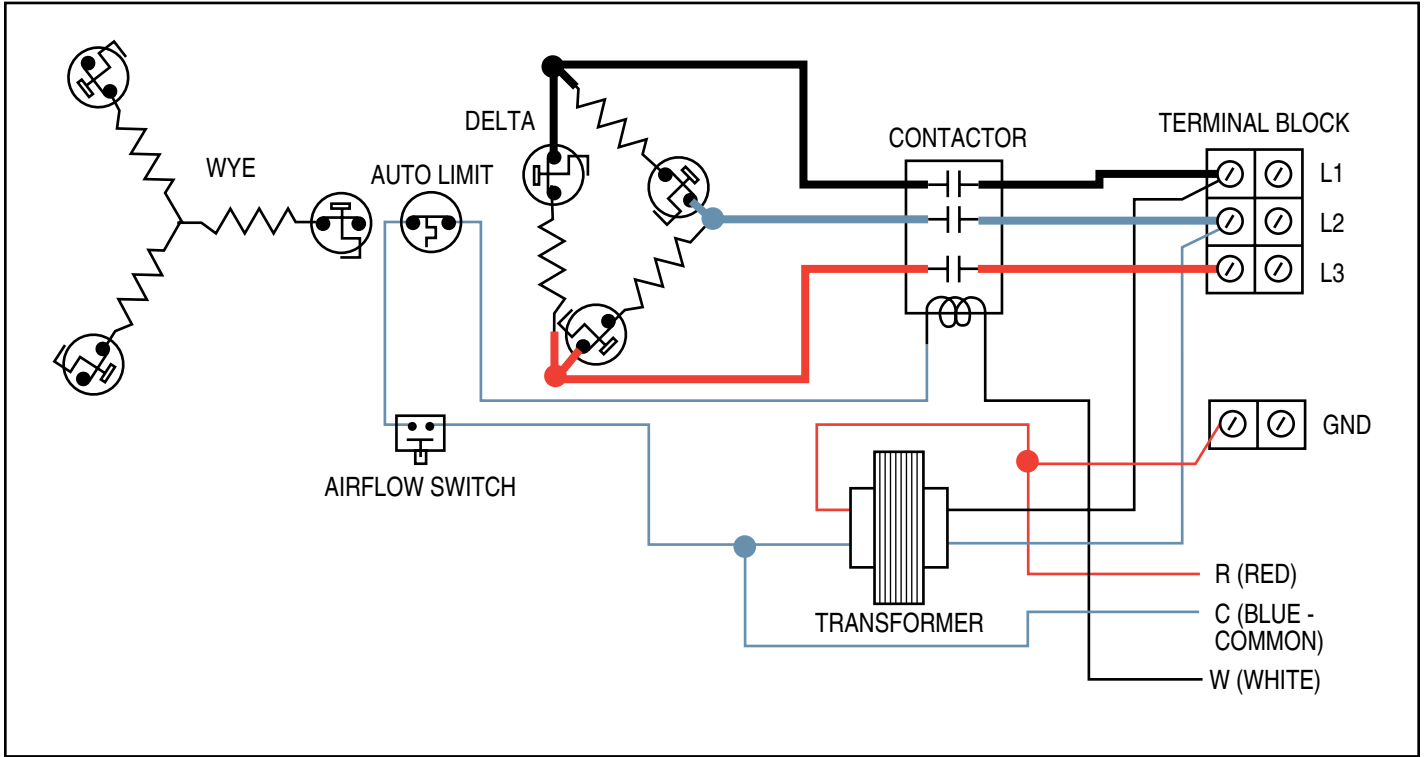
**Typical Wiring Diagram No. 3**  
**Single Stage – Fan Interlock Relay – Disconnecting Contactor**



**Typical Wiring Diagram No. 4**  
**Single Stage – Fan Control Relay – Disconnecting Contactor – One fan / one heater use**

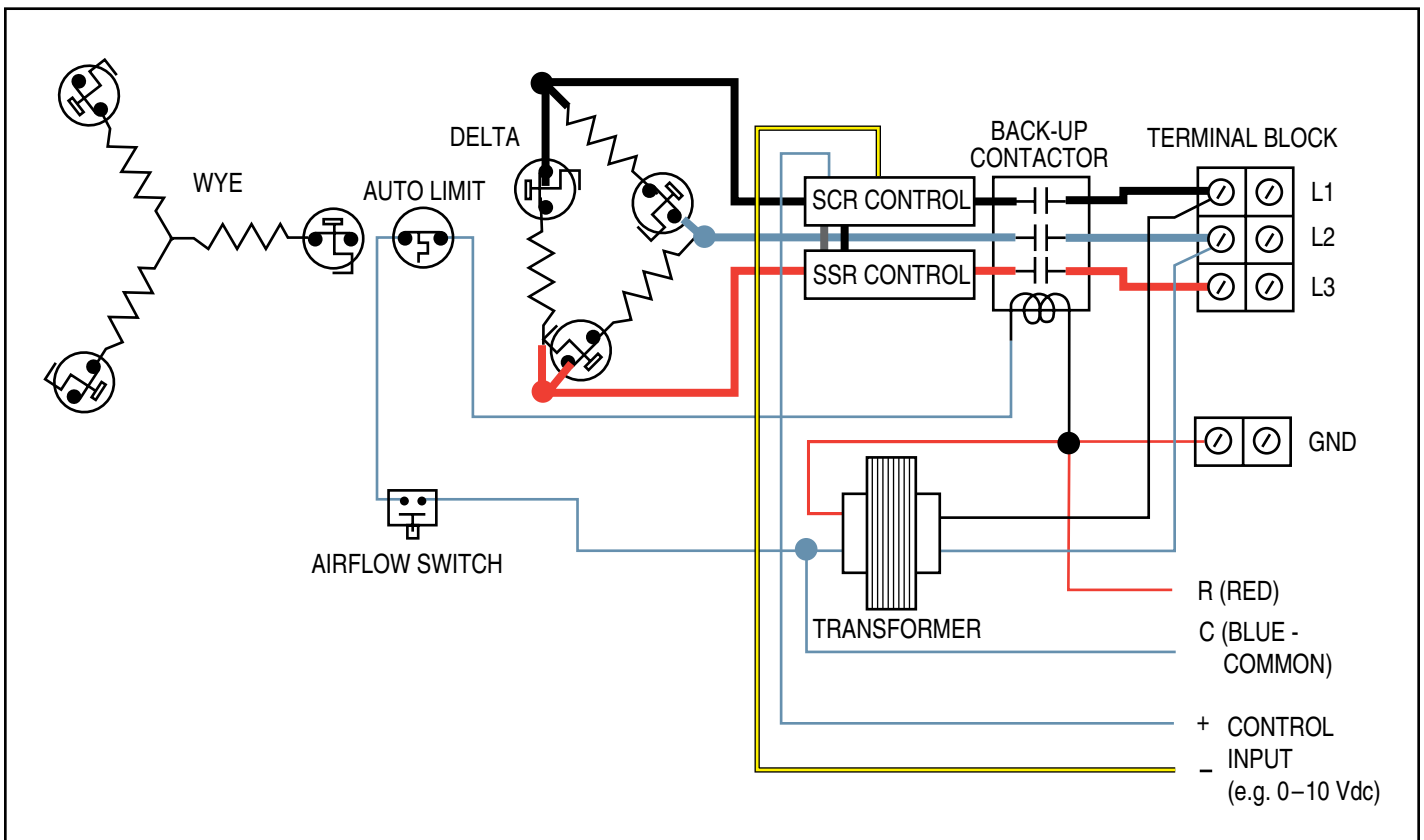


**WIRING DIAGRAMS**



**Typical Wiring Diagram No. 5 – Three Phase Delta or Wye  
Airflow Switch – Disconnecting Contactor – Transformer**

**WIRING DIAGRAMS**



**Typical Wiring Diagram No. 6 – Three Phase Delta or Wye – Airflow Switch  
Disconnecting Back-up (Safety) Contactor – Transformer – SCR Control**

## ENGINEERING SECTION

### Calculating kW, Amps and Resistance

Voltage is the energy available to push the current through the element wire and overcome the resistance. It is measured in volts and is constant within a building. Voltage within a building is whatever the power company provides unless the building occupant changes it with a transformer.

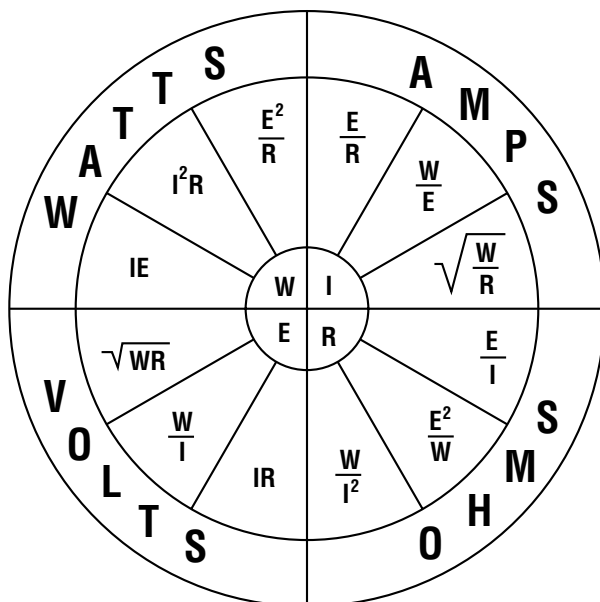
Amperage is the current (the number of electrons) flowing through the element wire. Current is measured in amps and depends on the voltage available and the resistance of the element wire.

Resistance is the resistance of the element wire. It is measured in Ohms. Resistance resists the flow of electrons and creates heat when voltage is applied to the element wire. Copper wire is usually sized by the amount of current that will flow through it when the heater is operating.

Wattage is the power produced when current flows through the element wire. Power is generally measured in kilowatts (watts x 1000). Work is power per unit of time, usually kW per hour for electric heaters. Power companies charge in units of kW-hours, or kW per hour x the number of hours the power was used.

### Single Phase:

The relationships between power, voltage, amperage and resistance are defined for single phase electric heaters as shown in the chart below.



**Ohms Law** (applicable to single phase current).

### Three Phase:

For three phase heaters, line current should be calculated using the following equation:

$$\text{Amperes (I)} = \frac{\text{Watts (W)}}{\text{Line Voltage (V)} \times 1.732}$$

### Heat Capacity Calculations

$$\Delta T = \frac{\text{kW} \times 3160}{\text{CFM}}$$

$$\text{kW} = \frac{\text{CFM} \times \Delta T}{3160}$$

$$\text{CFM} = \frac{\text{kW} \times 3160}{\Delta T}$$

Where  $\Delta T$  is the difference between discharge and inlet air temperature (temperature rise  $T_2 - T_1$ ) in  $^{\circ}\text{F}$ .

The above equations are based upon standard air at 13.33 ft<sup>3</sup>/lb. density and a specific heat of 0.237 BTU/lb.  $-^{\circ}\text{F}$ .

Ex.: 10 kW heater, 20" x 10" duct, 1000 cfm, inlet air = 75 $^{\circ}\text{F}$ .

- Determine temperature rise/outlet temperature.**

$$\Delta T = \frac{\text{kW} \times 3160}{\text{CFM}} = \frac{10 \times 3160}{1000} = 31.6^{\circ}\text{F}$$

Therefore, outlet air temperature = 75 + 31.6 = 106.6 $^{\circ}\text{F}$ .

- Determine heat requirement.**

$$\text{kW} = \frac{\text{CFM} \times (T_2 - T_1)}{3160} = \frac{1000 \times (106.6 - 75)}{3160} = 10.0 \text{ kW}$$

- Determine air volume.**

$$\text{CFM} = \frac{\text{kW} \times 3160}{(T_2 - T_1)} = \frac{10 \times 3160}{106.6 - 75} = 1000 \text{ CFM}$$

### Minimum Air Volume

Minimum airflow should be maintained at every point on the face of the heater. Since an electric duct heater maintains a constant BTU output while the heater is energized, minimum air velocity through the heater must be maintained in order to: a) achieve good heat transfer;

b) prevent over-heating and nuisance tripping of the protection devices; and c) maintain life expectancy. Minimum acceptable uniform airflow across an electric duct heater is directly related to the temperature of the inlet air. The table below shows the minimum volume of air per kW for different inlet air temperatures. For non-standard air conditions or if unusually low outdoor air temperatures are to be tempered by electric heat, consult Nailor.

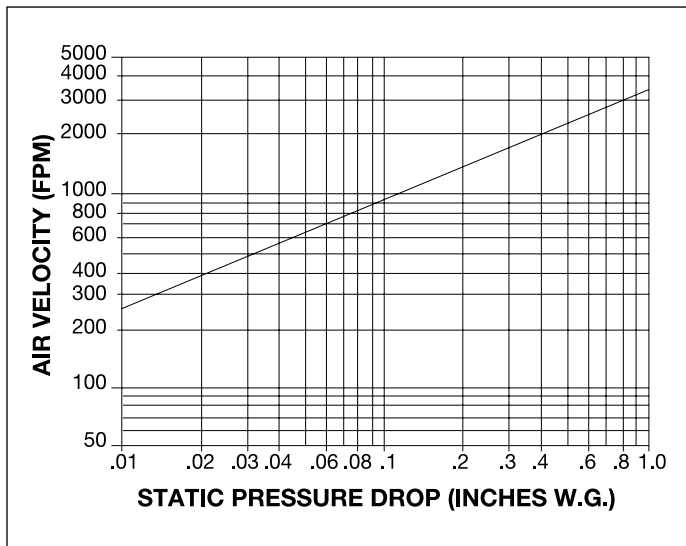
INLET AIR TEMPERATURE	MINIMUM AIRFLOW IN CFM PER kW (FOR DUCT AREA TEMPERATURE kW DENSITIES SHOWN)		
	$\leq 17 \text{ kW/ sq. ft.}$	$\leq 20 \text{ kW/ sq. ft.}$	$\leq 25 \text{ kW/ sq. ft.}$
$^{\circ}\text{F}$ ( $^{\circ}\text{C}$ )			
85 (29)	90	110	150
75 (24)	70	82	103
55 (13)	50	55	62
40 (4)	40	44	48
25 (-4)	33	36	39
0 (-18)	27	28	30

## Maximum Heater kW

The maximum heat density permissible for Nailor Electric Duct Heaters is 25 kW/square foot, as shown in table on the previous page.

## Pressure Drop

Static pressure drop through the duct heater may be conservatively estimated by using the 'Pressure Drop Through Heater' graph shown below. Pressure drop depends on the number of rows of heating elements and their density. This may vary widely dependent on coil size and capacity. The graph is based on an 8" (203) coil depth and will suffice for most applications.



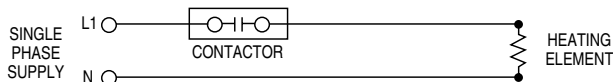
Pressure Drop Through Heater [8" (203) Coil Depth]

## Contactors Power Circuitry

Since 2009, UL requires that all open coil element duct heaters are supplied with disconnecting contactors that break all ungrounded conductors.

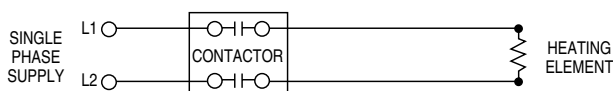
The following diagrams present the most commonly used arrangements (only power circuit shown. Safety devices etc. omitted):

### Disconnecting Type (single line break):



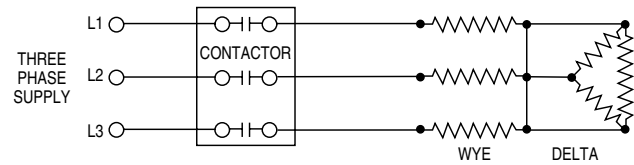
Heating is disconnected by breaking only one side of the line through the action of the single contact providing the contactor breaks the ungrounded line. This types would be disconnecting for 120V and 277V only.

### Disconnecting Type (two line break):



Heating power is completely disconnected by breaking both sides of the power source. All ungrounded power conductors are disconnected (208, 240 and 480V, single phase).

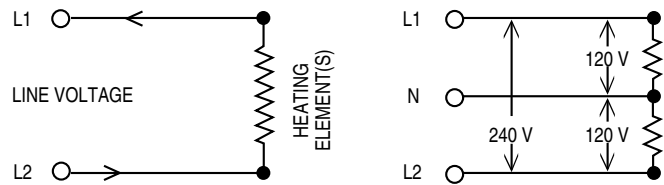
## Disconnecting Three Phase:



All ungrounded conductors disconnected. Both Wye and Delta configurations shown.

## Heating Element Wiring Configurations and Properties

### SINGLE PHASE:



#### "Edison" Connection

1. Element Voltage = Line Voltage.

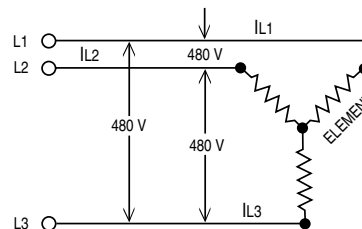
1. Element Voltage =  $\frac{\text{Line Voltage}}{2}$

### THREE PHASE:

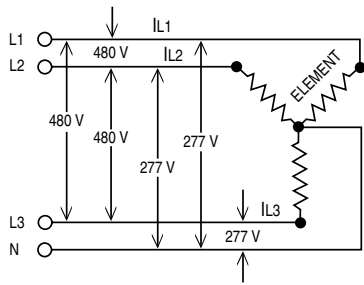
#### Three Wire "Delta" Connection (208 and 240V heaters)

1. Element Voltage = Line Voltage.
2. Element Current =  $\frac{IL1, 2 \text{ or } 3}{1.73}$
3. Phase Currents  $IL1 = IL2 = IL3$ .
4. Voltage measured between any two power legs (L1 to L2 etc.) should be equal to the three phase line voltage.

#### Three Wire "Wye" Connection (480 and 600V heaters)



1. Element Voltage =  $\frac{\text{Line Voltage}}{1.73}$
2. Element Current = Phase Current.
3. Phase Currents  $IL1 = IL2 = IL3$ .
4. Voltage measured between any two power legs (L1 to L2 etc.) should be equal to the three phase line voltage.



### Four Wire "Wye" Connection

1. Element Voltage =  $\frac{\text{Line Voltage}}{1.73}$
2. Phase Currents  $IL1 = IL2 = IL3$ .
3. The voltage between any two power legs and neutral (N) =  $\frac{\text{Line Voltage}}{1.73}$
4. Voltage measured between any two power legs (L1 to L2 etc.) should be equal to the three phase line voltage.

Heating elements, namely those used in three phase, balanced, configurations are factory wired, as manufacturers standard in two basic configurations Delta or Wye. A variation of Wye called 4 wire must be clearly specified as a special handling requirement.

### Formula For Calculating Line Currents

The following formula may be used to quickly determine total amps. It is common practice to select voltage/phase in order to keep total amps below 48 where possible and so eliminate the NEC requirement for circuit fusing and hence minimize heater cost.

#### Single Phase:

- 120 Volt: kW x 8.333 = Total amps
- 208 Volt: kW x 4.808 = Total amps
- 220 Volt: kW x 4.545 = Total amps
- 230 Volt: kW x 4.349 = Total amps
- 240 Volt: kW x 4.167 = Total amps
- 277 Volt: kW x 3.610 = Total amps
- 347 Volt: kW x 2.882 = Total amps
- 480 Volt: kW x 2.083 = Total amps
- 600 Volt: kW x 1.667 = Total amps

#### Three Phase:

- 208 Volt: kW x 2.776 = Total amps
- 230 Volt: kW x 2.509 = Total amps
- 240 Volt: kW x 2.406 = Total amps
- 460 Volt: kW x 1.255 = Total amps
- 480 Volt: kW x 1.203 = Total amps
- 600 Volt: kW x 0.962 = Total amps

$$\text{Kilowatts} = \frac{\text{BTU's}}{3,412} \quad \text{or} \quad \frac{\text{MBH}}{3.412}$$



## DUCT HEATER LOCATION

After determining the use of a heater, a location in the air system must be selected that will permit satisfactory performance. The heater must be installed in a location having suitable airflow characteristics. Where non-uniform airflow conditions exist at duct fittings, at equipment connections, at air terminals, or other sections, minimum lengths of straight runs of duct must be installed before and after the heater.

### Elbows

The preferred location for duct heaters adjacent to elbows is upstream of the elbow as illustrated in Figure 7-7. When the heater must be downstream, Figure 7-8 illustrates the minimum requirements.

### Equipment

Electric heaters installed in a duct outlet downstream from a heat pump, an air conditioning unit, or a fan unit must comply with the minimum distances illustrated in Figures 7-15 and 7-16 unless the heater is specifically approved for installation at a lesser distance and is so marked.

### Branch Ducts

Branch connections are also particularly susceptible to turbulent airflow conditions. In order to reduce the need for derated coils on the entering air side of the branch duct, the heater should be placed as far from the branch connection as practicable and not less than the minimum distances illustrated in Figures 7-10, 7-11, 7-12, 7-13 and 7-14. When the aspect ratio exceeds recommended practice, the minimum distances from the heater to turbulent flow duct fittings should be increased.

### Grilles

Whenever electric duct heaters must be located near grilles, registers or diffusers, the exposure and visibility should be evaluated. Increased spacing or the use of a screen should be considered where protection against probes or other foreign objects is advisable or where visibility of the heater is objectionable. Figures 7-10, 7-11, 7-12 and 7-14 illustrate the minimum recommended distance from a heater to a grille or register regardless of the length of the duct branch. Figure 7-9 illustrates the 12" (305) minimum recommended distance that a heater should have from the diffuser collar in a duct.

### Fibrous Glass Ducts

When Electric Duct Heaters are to be located in fibrous glass ducts, the requirements for location are similar to those for sheet metal ducts. For special installation details, see the "Installation" section of this catalog and Figures 7-4 and 7-5.

### Special Locations

When Electric Duct Heaters are used in preheat or reheat applications in plenums or casings, a special study of the location is recommended. Irregular airflow patterns are often found in the air movement through outside air louvers,

filters, mixed air plenums and associated dampers. At fresh air intakes, for example, the air entry should be rain-tight. As a precaution against water damage, it is recommended that the bottom elevation of the Electric Duct Heater be above the floor. Another important consideration is the safety of individuals entering a plenum or casing chamber. Reasonable provisions for protection should be made and these should include warning signs outside the electric coil chamber.

### Other Factors

Other factors to be considered in locating the heater are:

- a) Heat loss from the duct before the tempered air reaches its destination.
- b) The temperature and humidity of the space surrounding the heater. If a section of duct containing an electric heater is installed in an atmosphere conducive to the collection of moisture either inside the duct or on the outside of the duct, special provisions must be made to insure that moisture does not damage either the heater or the controls.
- c) The accessibility of the heater and its control panel. Terminal boxes are often integral with the heater and may exceed the height of the duct. The total installation must be designed to accommodate the space and access requirements of this component. Remote control panels may be used where conditions dictate.
- d) Hazards. To avoid damage and insure safety, special consideration must be given to the proximity of combustible material. Minimum clearance required by the manufacturer or applicable codes, whichever is greater, must be maintained.

### Heater Position

Standard open coil Electric Duct Heaters are designed for the elements to be in a horizontal position, whether the heater is installed in a horizontal duct or in a vertical duct. The coils would not be properly supported if the elements were oriented in the vertical position.

### Clearance

Duct heaters rated 50 kW or less are normally suitable for installation with zero distance between the heater and combustible materials. Heaters larger than 50 kW should be installed with regard to minimum spacing requirements. (All Nailor Duct Heaters are rated for zero clearance).'

### Airflow Direction

Airflow direction is determined by facing the terminal box side of the duct and should be specified for all types of heater. The manufacturer and the installer should know whether the airflow is horizontal (that is, to the right or left) or vertical (that is, up or down) since safety devices are located differently in each case. Furthermore, since terminal boxes vary in width and since space conditions may be limited, the terminal box overhang should be designed as left hand or right hand.

## DUCT HEATER INSTALLATION

This section concerns the suspension, positioning, fastening and connecting of electric duct heaters. Certain additional features not covered elsewhere are included. Furthermore, although Figures 7-6 through 7-16 illustrate flanged heaters, the installation requirements are equally applicable to slip-in heater installations.

### Slip-In Heaters

Figure 7-2 illustrates a slip-in heater installation for both lined duct and unlined duct.

For the lined duct, a sheet metal channel should be placed on the interior surface of the lining to protect the lining and support the heater. Care should be exercised to prevent tearing or penetration of the lining.

A recessed terminal box should be used in order to:

- use the entire face of the heating elements; and
- correctly position the thermal cutouts.

Furthermore, to prevent condensation on lined duct and insulated duct installations, terminal boxes should be provided with interior insulation. However, to prevent overheating of electrical components, the exterior of the terminal box must not be insulated.

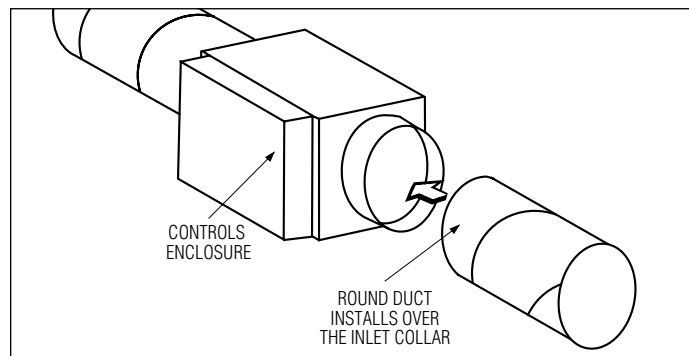
When a slip-in heater is necessarily smaller than the cross-sectional area of the duct as illustrated in Figure 7-3, an equalizing grid should be used to maintain bypass air velocity at approximately the same rate as the velocity through the heater. The grid (wire mesh or perforated plate) should have approximately the same friction loss as the heater and should be fastened to the sides of the duct.

### Flanged Heaters

Flanged heaters are connected to unlined and lined ducts in the manner illustrated in Figure 7-1. For flow and performance considerations, the inside dimensions of the duct must match the inside dimensions of the heater. Furthermore, on lined ducts, heaters must have wide flanges, insulated terminal boxes, and insulation on the exposed exterior of the frame.

On lined duct and insulated duct installations, terminal boxes should be provided with interior insulation. However, to prevent overheating of electrical components, the exterior of the terminal box should not be insulated.

### Round Duct Connections



Installation of the round duct heater consists of attaching round duct to the inlet and outlet collars and bolting in place. Seal connection and duct joint.

### General Requirements

Refer to SMACNA's Duct Construction Standards, Metal and Flexible for all sheet metal fabrication and construction details.

For installations in fibrous glass ducts, refer to SMACNA's Fibrous Glass Duct Construction Standards.

If alternate corrections or locations are not available when turbulent flow conditions exist and critically low velocities are experienced (or anticipated) in the duct cross-section on the entering side of the heater, a flow equalizing device (such as a perforated plate having 50% or more free area) may be installed in the duct in front of the heater. However, consideration should be given to the pressure drop that such a device will add to the system.

When transitions are necessary on the inlet or outlet of a heater, the flow must be controlled within the limits illustrated in Figure 7-6.

The design of the installation must include adequate provision for support of the duct heater.

Terminal boxes are integral with the heater and may often exceed the height of the duct. The total installation must be designed to accommodate the space and access requirements of this component. Remote control panels may be used where condition dictates.

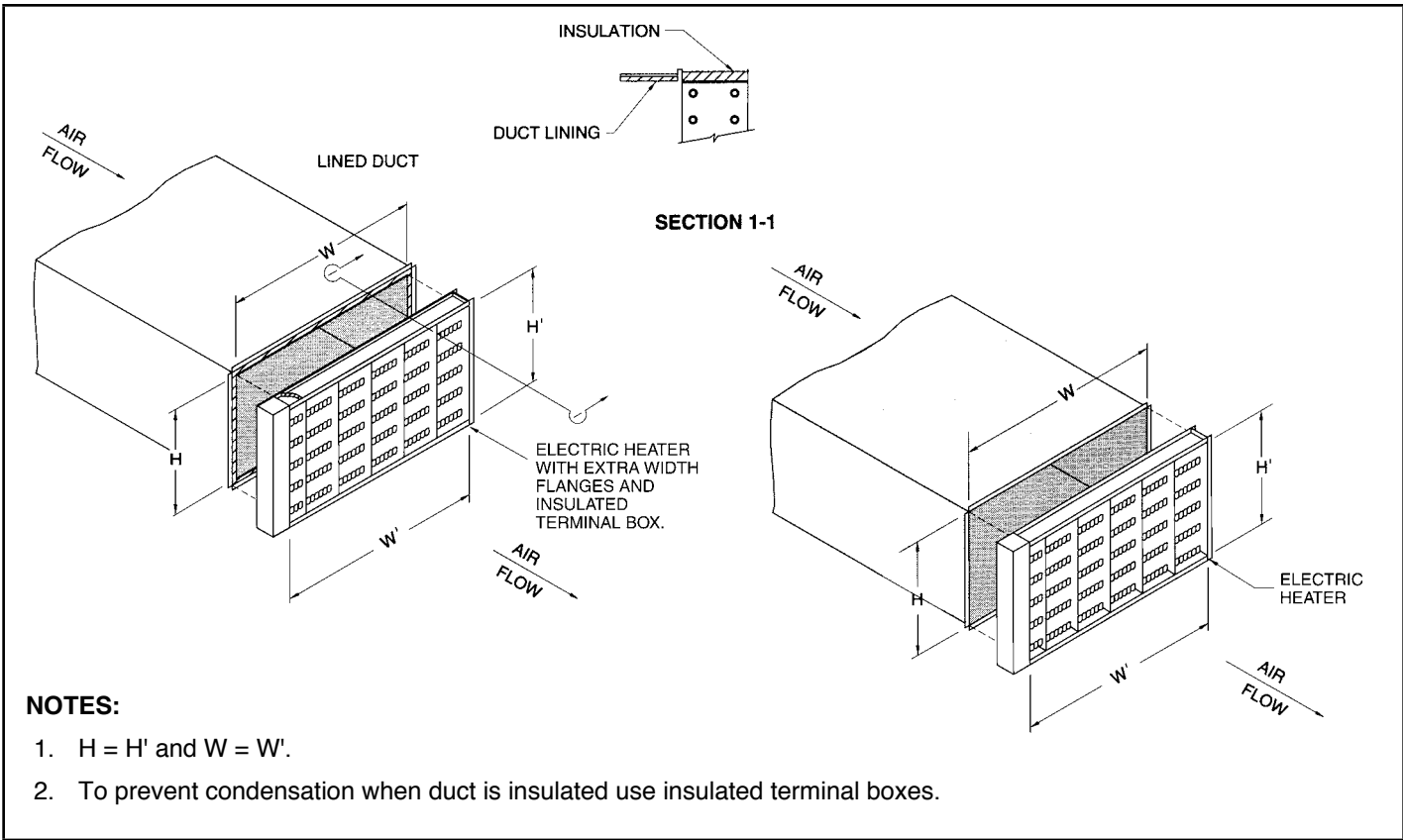
Airflow direction through the heater should be verified immediately preceding installation in a duct. Particular attention should be given to the designated location of built-in thermal cut-outs.

Electric duct heaters are not generally designed for installation in series; that is, consecutively in a duct. This arrangement may be used in special applications in which the air temperature leaving the first heater does not exceed the maximum recommended air temperature entering the second heater.

Access for servicing or for removal of electric duct heaters must be provided. When ducts are in concealed spaces, provision must be made for suitable access panels in walls or ceilings as necessary.

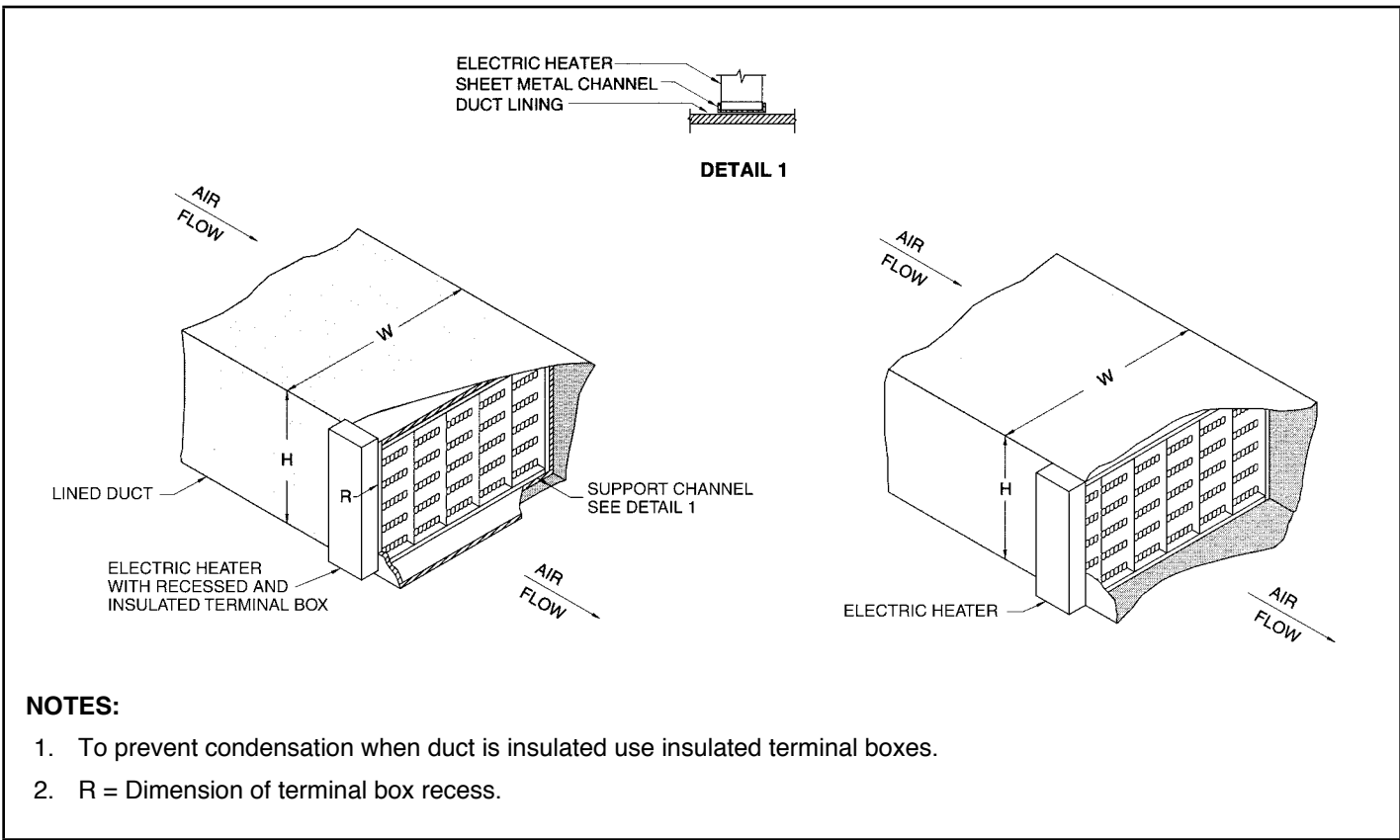
The installation should be reviewed for compliance with the recommendations of the heater manufacturer.

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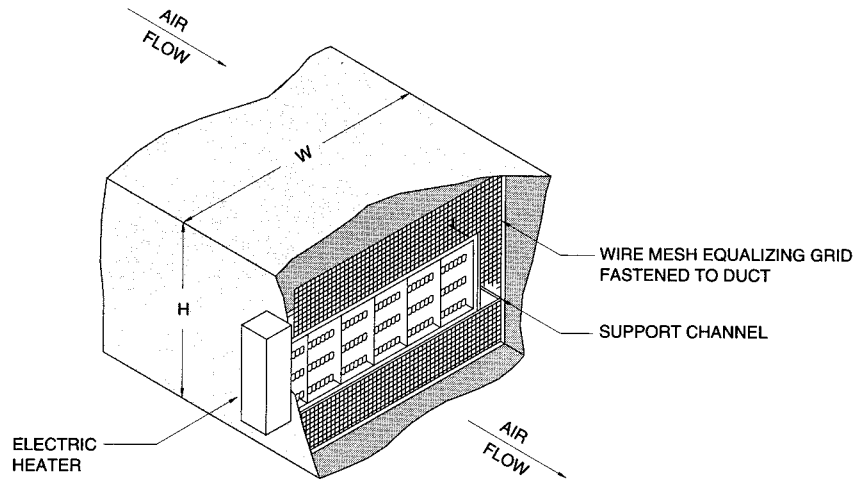
**FLANGED DUCT HEATER**

**SMACNA FIG. 7-1**



**SLIP-IN DUCT HEATER**

**SMACNA FIG. 7-2**

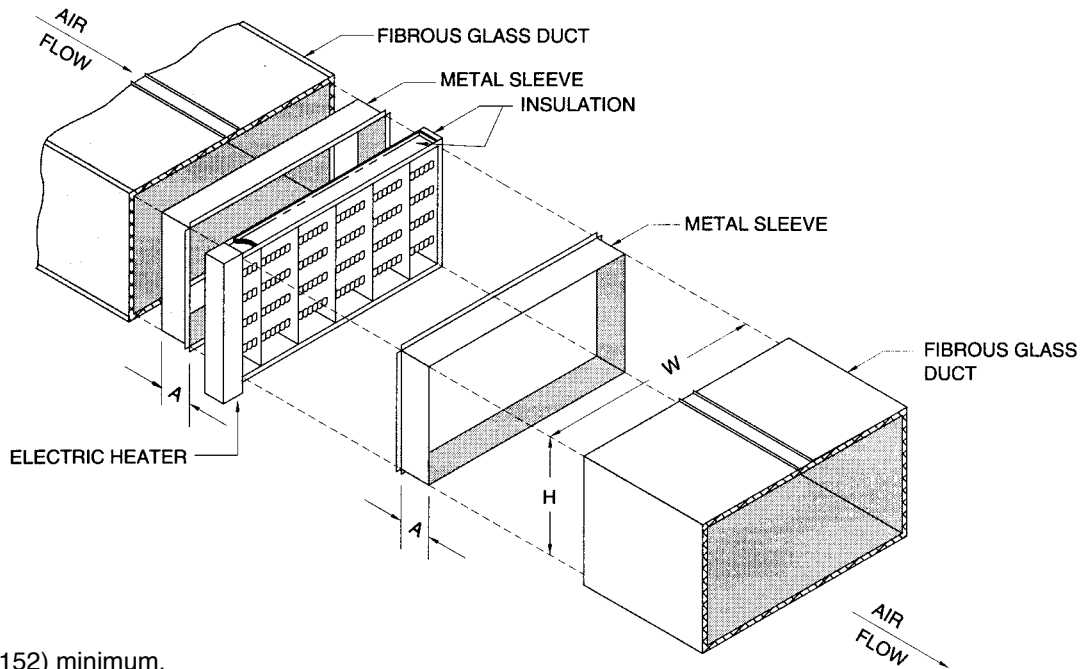


**NOTES:**

1. The equalized grid should have the same pressure drop as the duct heater.

**EQUALIZED GRID**

**SMACNA FIG. 7-3**



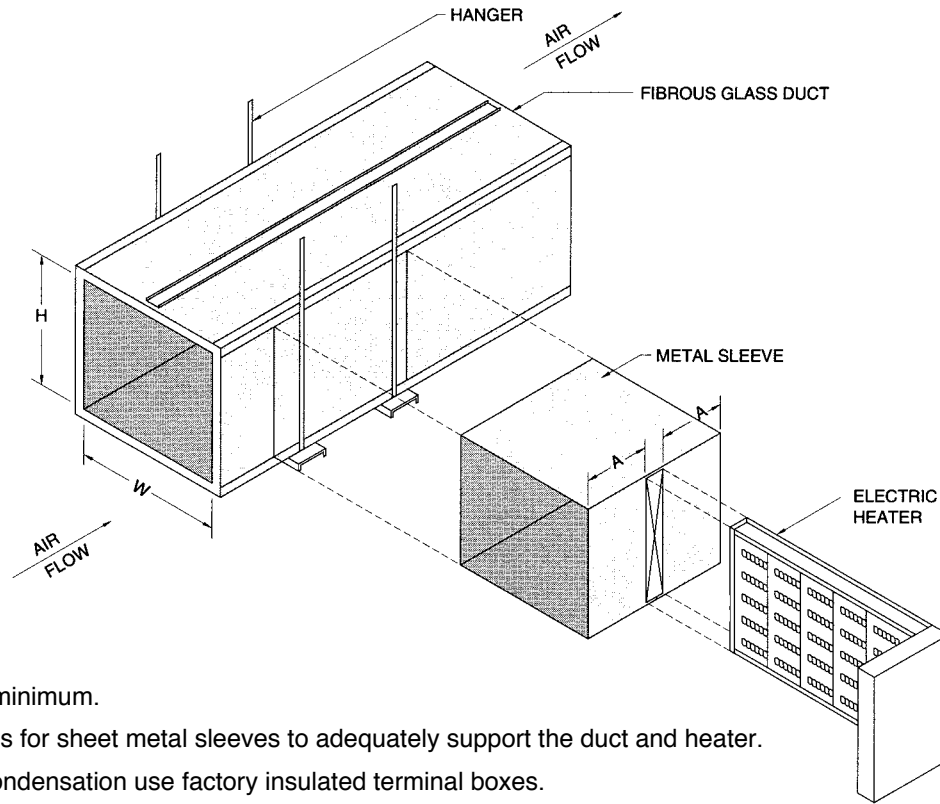
**NOTES:**

1. A = 6" (152) minimum.
2. Install hangers for sheet metal sleeves to adequately support the duct and heater.
3. To prevent condensation use factory insulated terminal boxes.

**FLANGED HEATER IN FIBROUS GLASS DUCT**

**SMACNA FIG. 7-4**



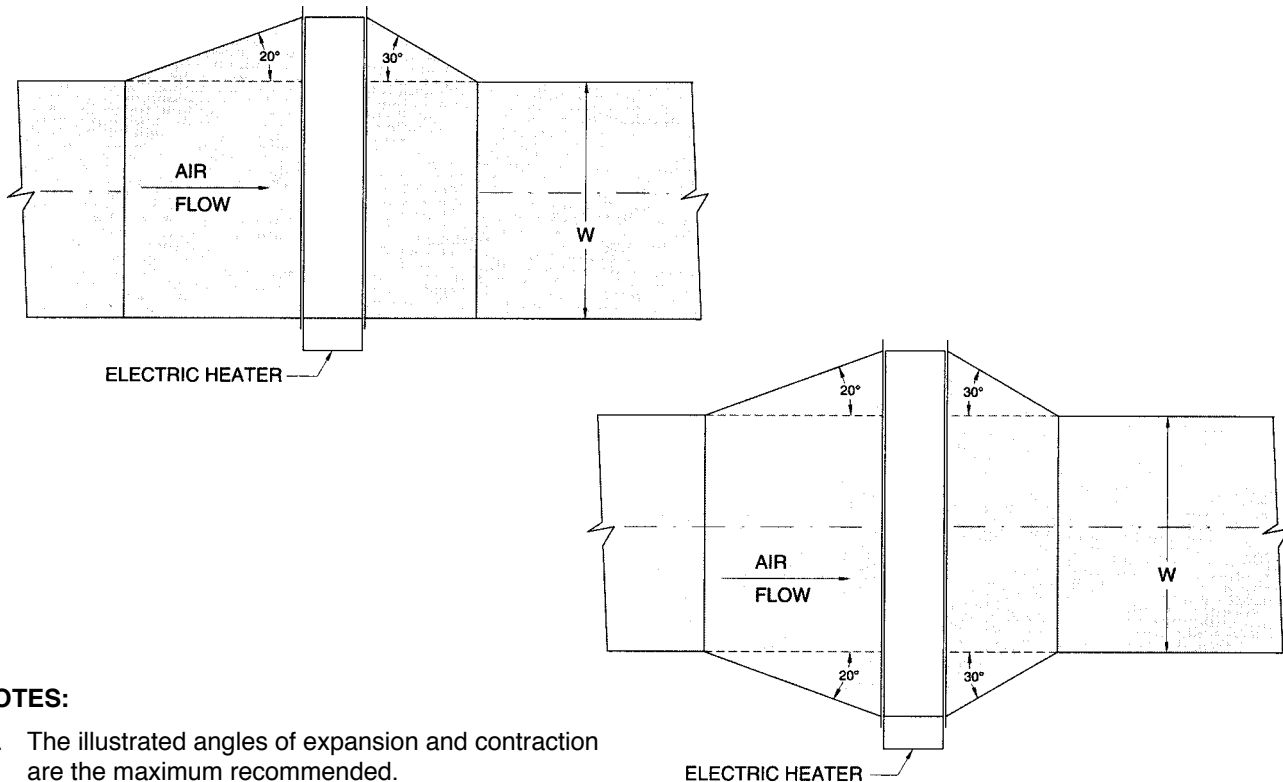


**NOTES:**

1. A = 6" (152) minimum.
2. Install hangers for sheet metal sleeves to adequately support the duct and heater.
3. To prevent condensation use factory insulated terminal boxes.

**SLIP-IN HEATER IN FIBROUS GLASS DUCT**

**SMACNA FIG. 7-5**

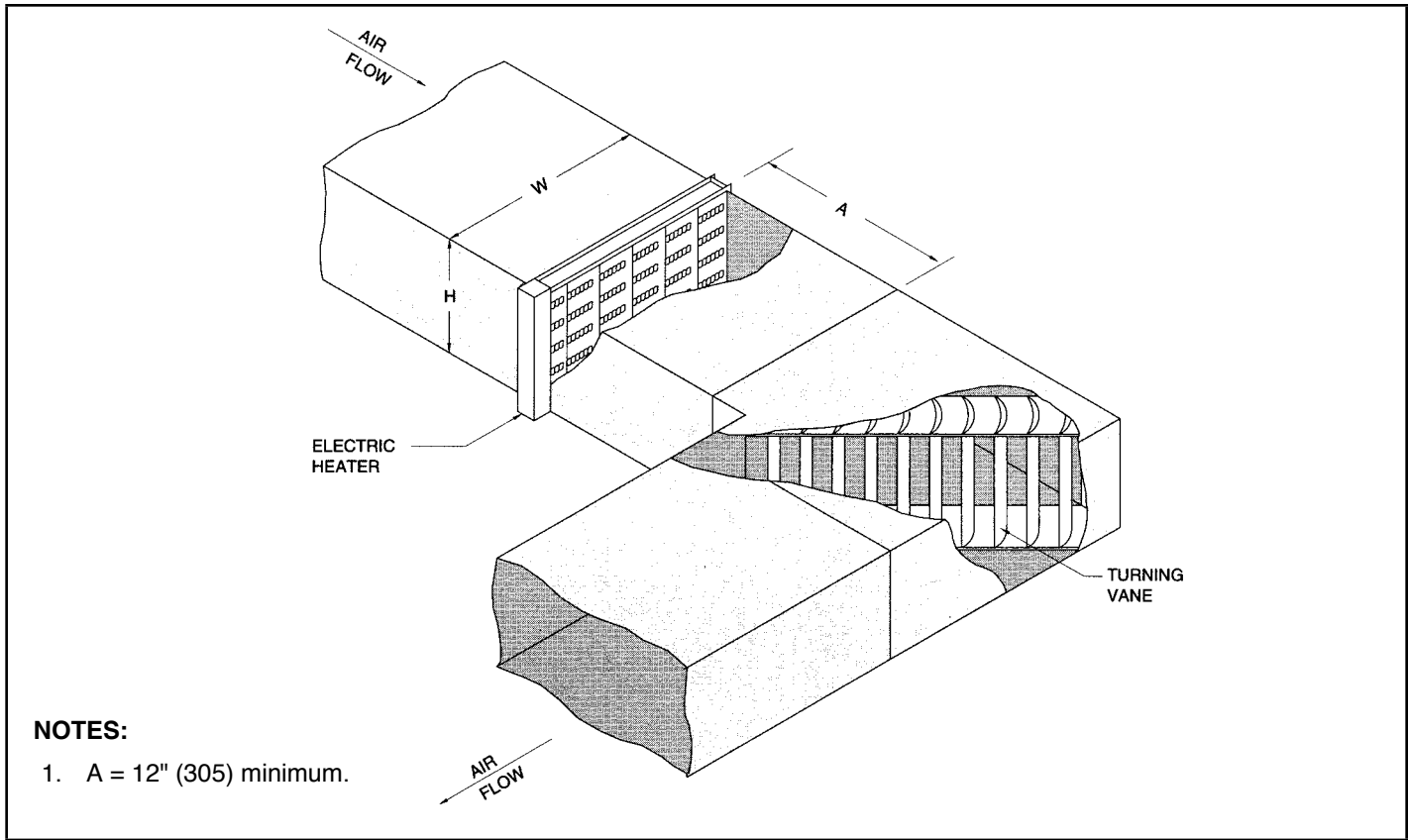


**NOTES:**

1. The illustrated angles of expansion and contraction are the maximum recommended.

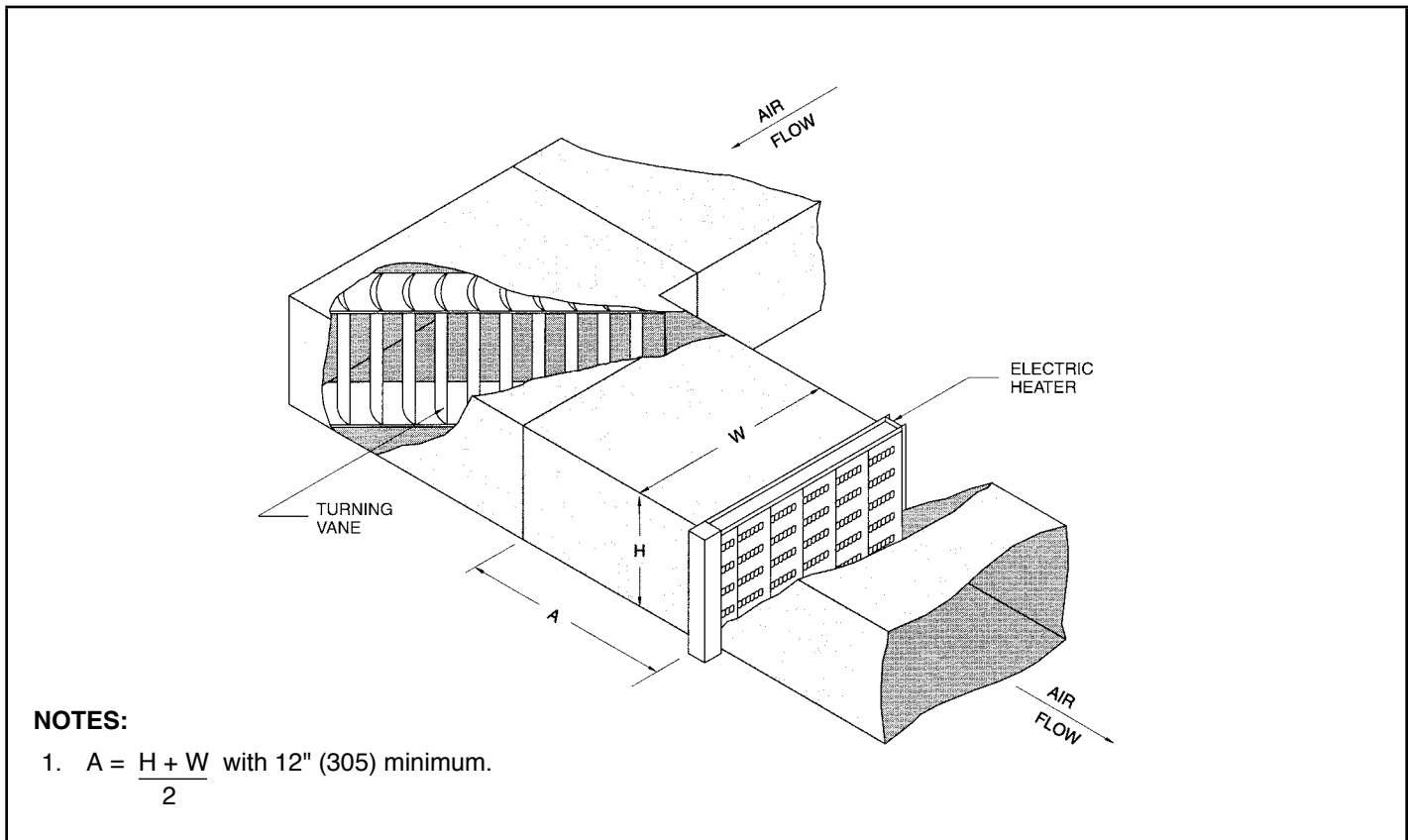
**DUCT TRANSITIONS – PLAN VIEW**

**SMACNA FIG. 7-6**



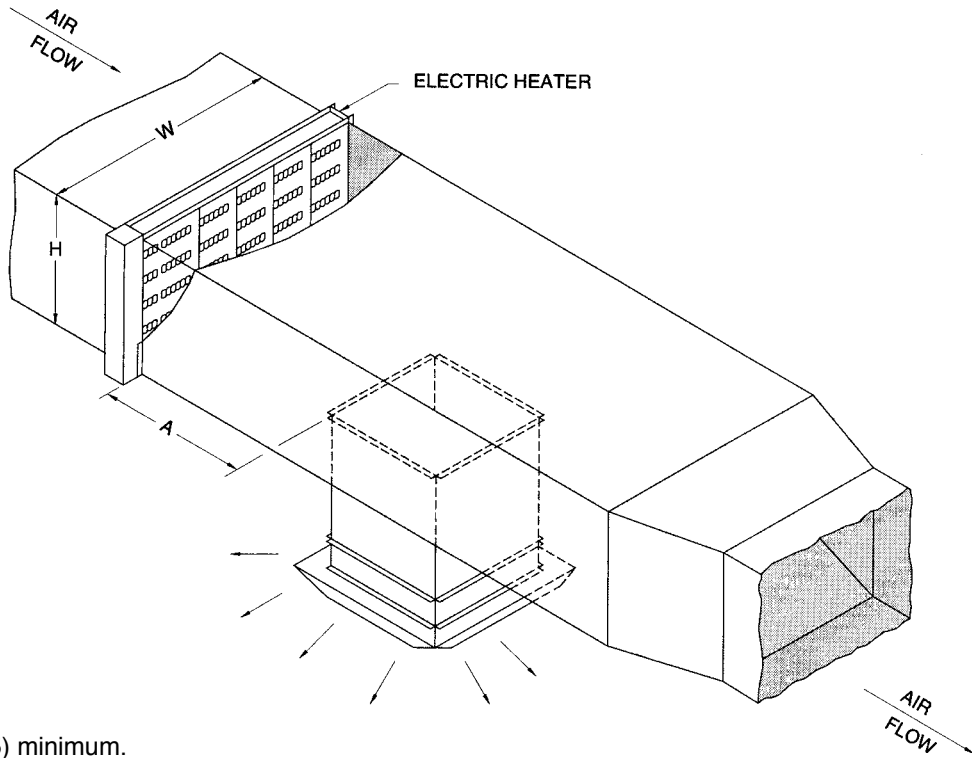
**HEATER UPSTREAM FROM ELBOW**

**SMACNA FIG. 7-7**



**HEATER DOWNSTREAM FROM ELBOW**

**SMACNA FIG. 7-8**



**NOTES:**

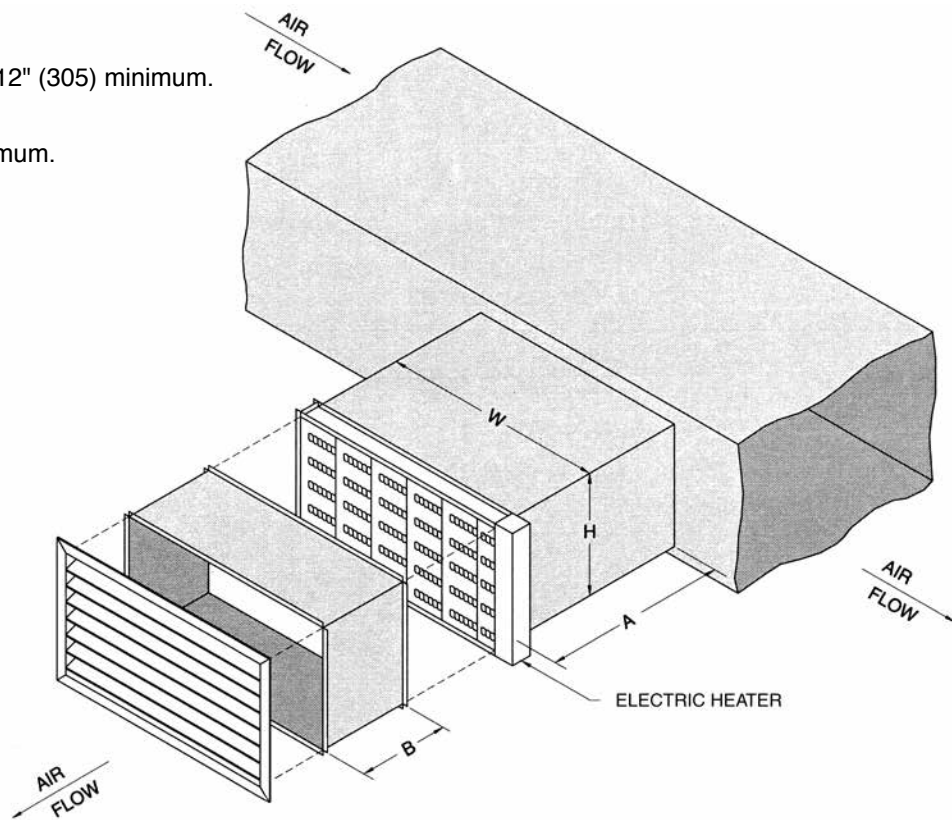
1. A = 12" (305) minimum.

**HEATER UPSTREAM FROM OUTLET CONNECTION**

**SMACNA FIG. 7-9**

**NOTES:**

1.  $A = \frac{H + W}{2}$  with 12" (305) minimum.
2. B = 6" (152) minimum.

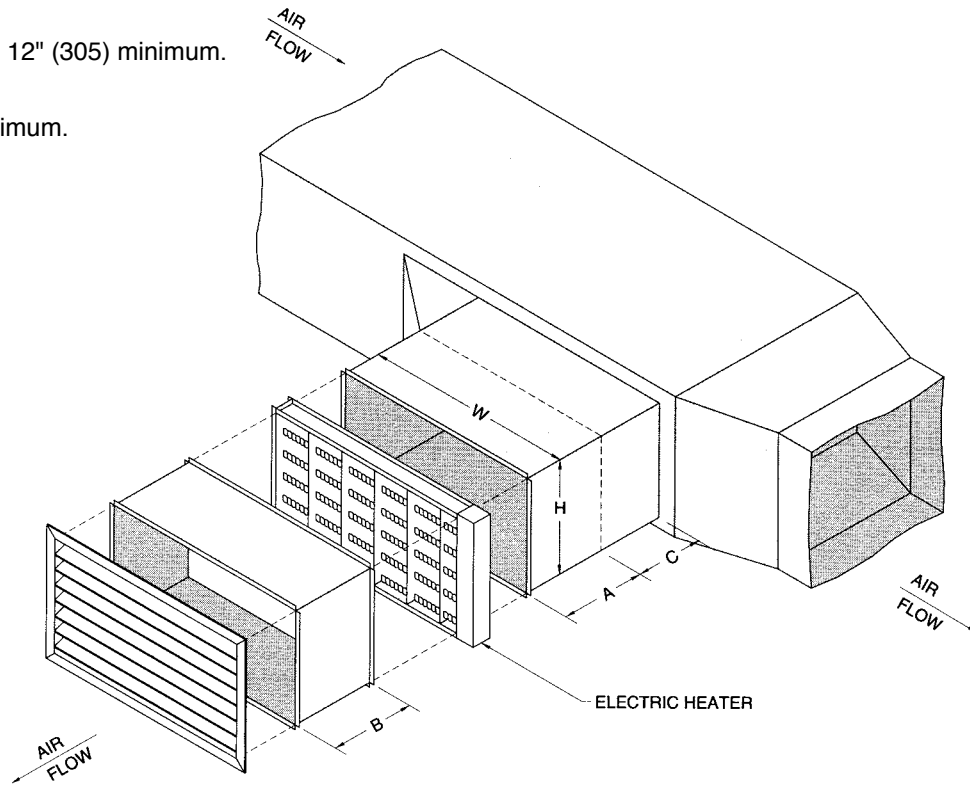


**HEATER IN BRANCH DUCT**

**SMACNA FIG. 7-10**

**NOTES:**

1.  $A = \frac{H + W}{2}$  with 12" (305) minimum.
2.  $B = 6"$  (152) minimum.
3.  $C = \frac{W}{2}$

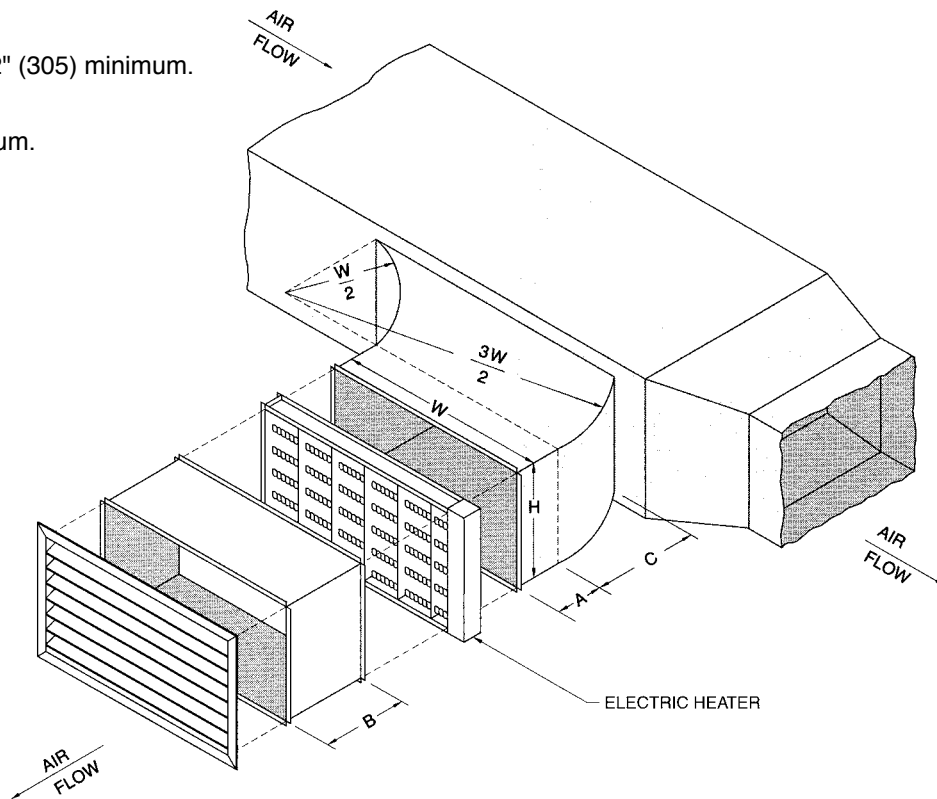


**HEATER IN BRANCH DUCT**

**SMACNA FIG. 7-11**

**NOTES:**

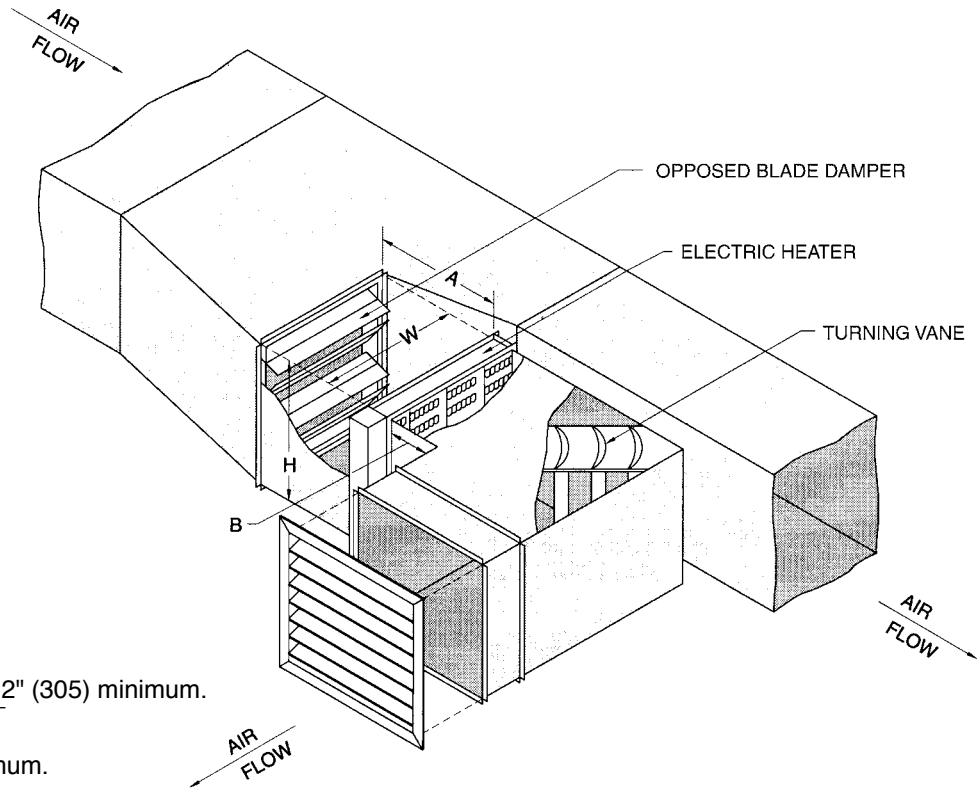
1.  $A = \frac{H + W}{2}$  with 12" (305) minimum.
2.  $B = 6"$  (152) minimum.
3.  $C = \frac{W}{2}$



**HEATER IN BRANCH DUCT**

**SMACNA FIG. 7-12**



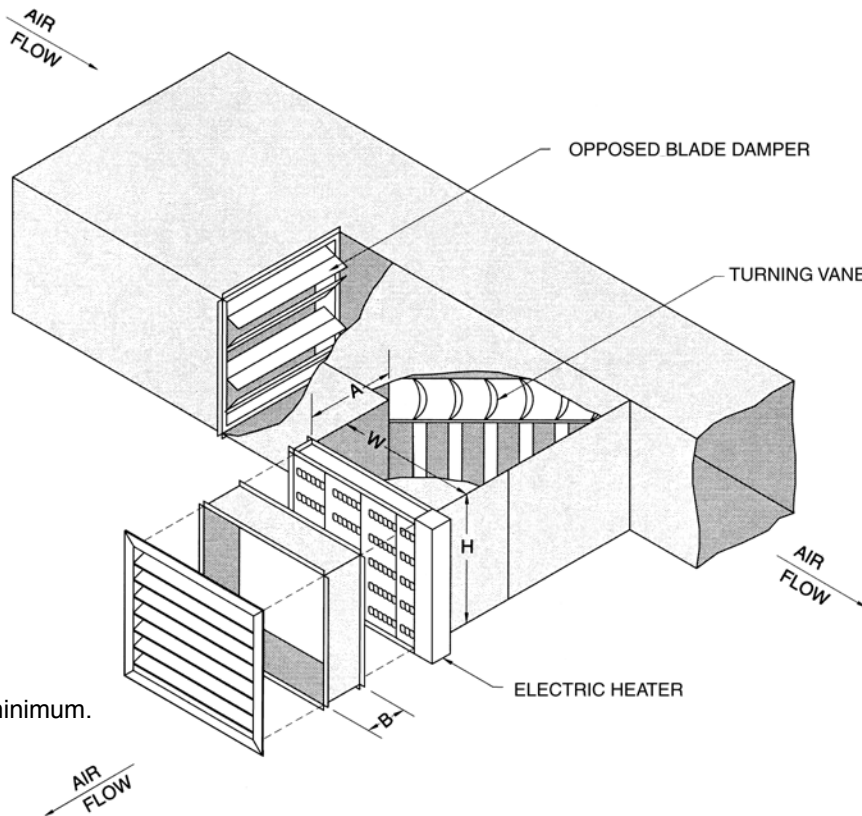


**NOTES:**

1.  $A = \frac{H + W}{2}$  with 12" (305) minimum.
2. B = 6" (152) minimum.

HEATER IN BRANCH DUCT

SMACNA FIG. 7-13

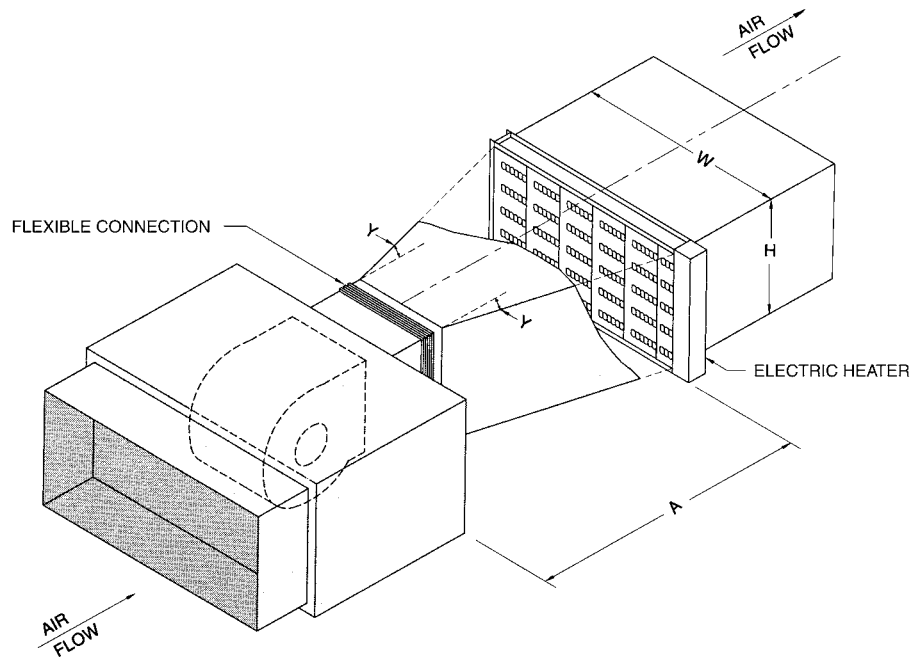


**NOTES:**

1.  $A = \frac{H + W}{2}$  with 12" (305) minimum.
2. B = 6" (152) minimum.

HEATER IN BRANCH DUCT

SMACNA FIG. 7-14

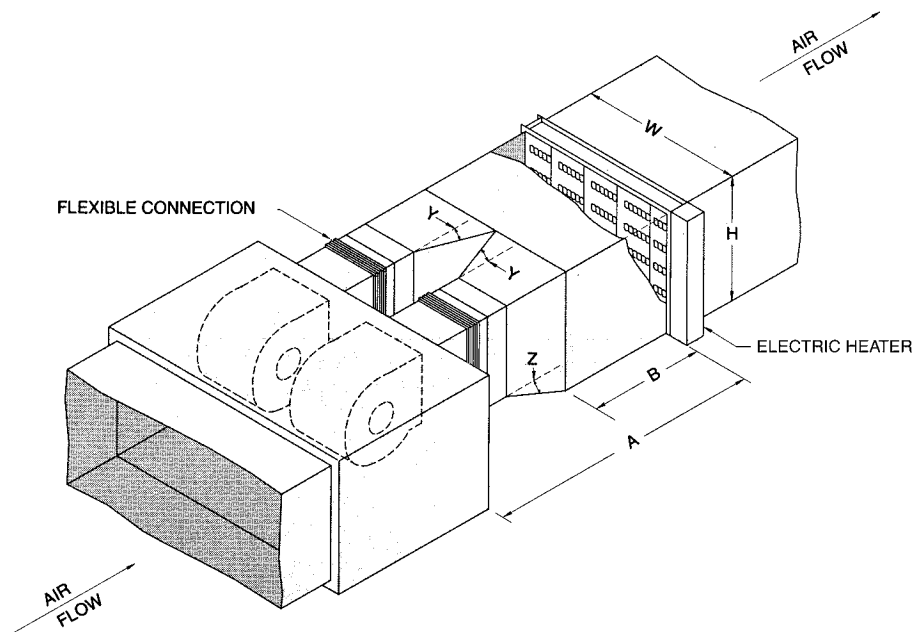


**NOTES:**

1.  $A = \frac{H + W}{2}$  with 48" (1219) minimum for heat pumps and air conditioners and with 24" (610) minimum for fan units.
2. Angles Y are 20° maximum.

**HEATER IN BRANCH DUCT**

**SMACNA FIG. 7-15**



**NOTES:**

1.  $A = \frac{H + W}{2}$  with 48" (1219) minimum for heat pumps and air conditioners and with 24" (610) minimum for fan units.
2. B = 12" (305) minimum.
3. Angles Y and Z are 20° maximum for all units.

**HEATER IN BRANCH DUCT**

**SMACNA FIG. 7-16**

## National Electric Code (NEC, 2014) and ANSI/UL 1996 (4th Edition, 2009) Requirements for Duct Heaters

### Location of Disconnecting Means:

(NEC 424-65) "Duct heater controller equipment shall be accessible with the disconnecting means installed at or within sight of the controller."

### Overcurrent Protection:

(UL 1996 23.2.1)

"A duct heater employing resistance type heating elements shall be protected at no more than 60 amperes, and the protected circuit shall not have a concurrent load exceeding 48 amperes. These heating elements shall be connected in protected subdivided circuits if any total concurrent load of the unit exceeds 48 amperes based on nameplate ratings. When the over-current protective devices are in a separate assembly for independent mounting,... the rating of the over-current protective devices also shall not exceed 1.5 times the current rating of the connected load, if such rating is more than 13.3 amperes."

(UL 1996 23.2.3) The overcurrent protection specified in 23.2.1 and 23.2.2 shall be circuit breakers, cartridge fuses, or type S plug fuses, of a type and rating appropriate for branch circuit protection, in accordance with the requirements of the National Electric Code, ANSI/NFPA 70. Plug fuses shall not be used in circuits exceeding 150 V to ground; screw shells of plug fuses shall be connected to the load side of the circuit."

### Transformer Overcurrent Protection:

(UL 1996 22.7) "... a transformer having a high voltage primary shall be protected by an overcurrent device (or devices) located in the primary circuit, and rated or set as indicated in Table 22.1."

Rated Primary Current. (Amps)	Maximum rating of overcurrent device. (percent of transformer primary current rating)
Less than 2	300%
2 or more, less than 9	167%
9 or more	125%

**Table 22.1 Rating of Overcurrent Device**

(UL 1996 22.9) "Except as indicated in 22.10, a transformer having a rated output of not more than 30 volts and 100 volt-amperes shall be protected by an overcurrent device located in the primary circuit. The overcurrent device shall be rated or set at not more than 167% of the primary current rating of the transformer."

(UL 1996 22.10) "If the transformer is Class 2, compliance with 22.9 is not required."

(UL 1996 22.12) "Overcurrent protection in the secondary circuit of a transformer... shall be provided as part of the equipment."

### Transformer Grounding:

(UL 1996 22.15) "The secondary of a transformer supplying power to low-voltage circuits shall be grounded when... :

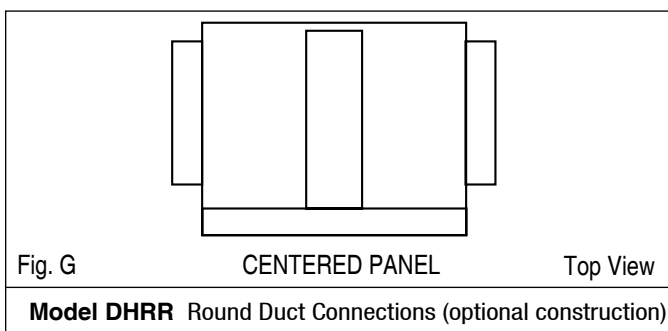
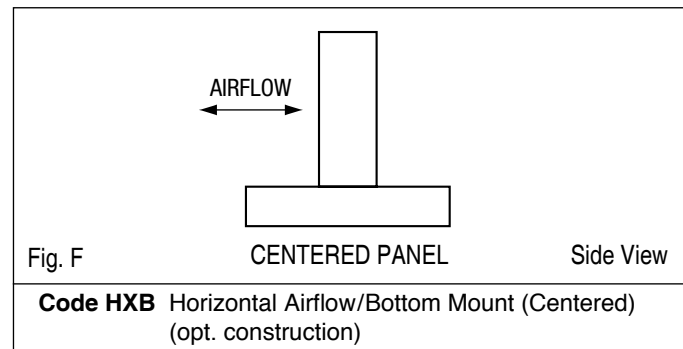
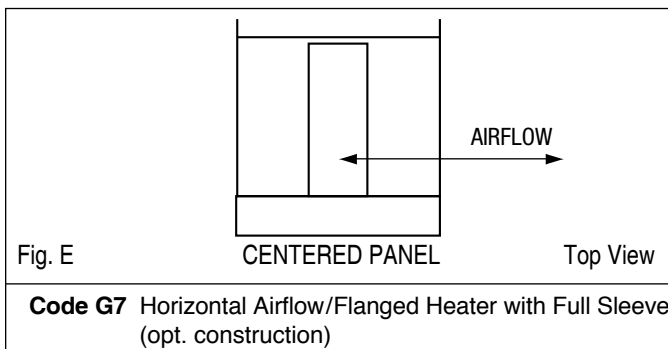
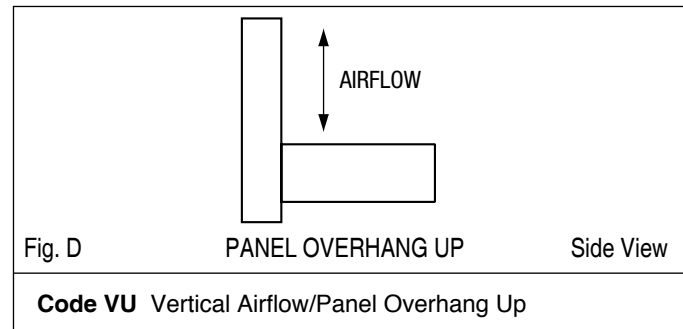
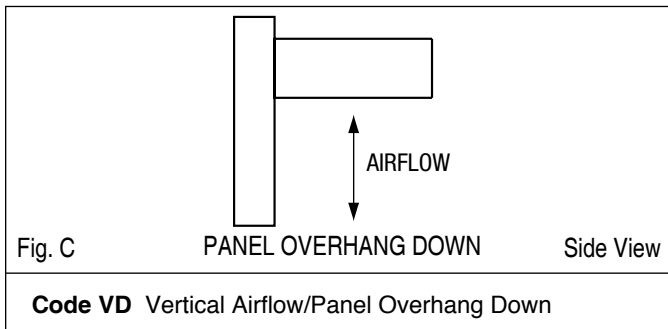
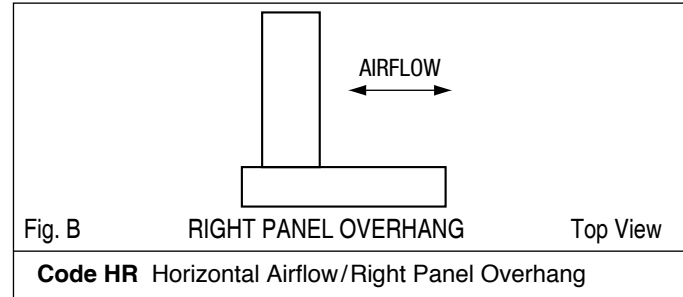
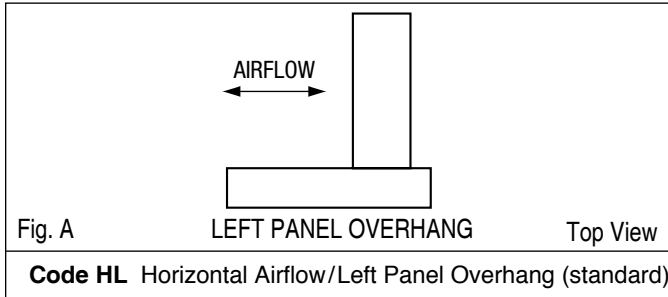
- a) The primary is energized from a source rated at more than 150 volts-to-ground; or b) It supplies power to a control circuit that is a safety circuit."

### Fan Control:

(UL 1996 21.5) "A duct heater shall have terminal or leads for field connection of an interlock circuit for a circulating fan motor unless an airflow interlock is provided as an integral part of the heater and arranged so that no heating element circuit can be energized unless the interlocking contacts are closed or the interlocking power supply energized. This does not preclude the use of a fan delay control that complies with the applicable requirements for a fan control."

## HEATER CONFIGURATIONS

### Airflow Direction/Control Panel Overhang



#### Important:

1. Nailor electric duct heaters are ETL listed, designed and built for either horizontal or vertical dual directional airflow. Standard horizontal configuration is Code HL Horizontal Airflow/Left Panel Overhang (Fig. A). Standard vertical configuration is Code VD Vertical Airflow/Panel Overhang Down (Fig. C). When heaters are supplied with an airflow switch (which can only sense flow in one direction), the airflow probe is installed in the factory facing towards the panel overhang. In other words, the air must pass the panel overhang first.
2. Before installing, inspect the airflow direction stamped on the airflow probe in the controls enclosure. The airflow direction on the stamp must be in the same direction as the air in the duct. If these two directions are opposite of each other, unscrew the two screws from probe, rotate 180 degrees, and reinstall the airflow probe.



## SUGGESTED SPECIFICATIONS

Electric Duct Heaters shall be of the size, type and capacity as shown on the drawings.

Heaters shall be ETL listed and tested in accordance with the latest version of ANSI/UL Standard 1996 for zero clearance from all combustibles and shall bear the ETL listing mark. Each heater shall meet the requirements of NEC and shall be of the open coil design and shall be as manufactured by Nailor Industries, Inc.

Each heater shall be furnished with two levels of over temperature safety devices serviceable and/or replaceable in the terminal box without removing the heater from the duct. The primary safety device shall be a disc type automatic reset that will cut the heater off on an over-temperature condition and automatically bring the heater back on when the condition is corrected. The secondary safety device shall be of the disc type, manually resettable or replaceable, and wired in the power lines in series with the heater elements such that failure of a sufficient number of these devices will de-energize or disconnect the heater until service is rendered if the primary device should fail.

The heater terminal box and frame shall be of heavy gauge (minimum 20 gauge) galvanized steel sufficiently formed and braced to assure structural rigidity of the entire heater assembly. Terminal box and lid must be totally enclosed and free from any perforations or louvers. The terminal box shall have a Nailor sub-panel design for greater cooling effect and rigidity.

Elements shall be "Class A" 80/20 nickel chromium wire. Elements shall be held in place with high grade ceramic insulators that are encapsulated within two layers of galvanized steel that allow the ceramic bushings to float within their own enclosures to prevent warping of the element rack.

Each heater shall be furnished with an exact 'as is' color wiring diagram. Typical wiring diagrams are not acceptable.

Heaters shall be constructed as slip-in, flanged, or round duct connection as shown on the drawings.

Built-in components shall include:  
(write in the desired options)

1. Built-in Air Pressure Switch or Fan Interlock Relay. (Specifier select one).
2. Magnetic Contactors, Quiet Contactors or Mercury Contactors for silent operation or excessive switching. (Specifier select one).
3. Manual reset secondary hi-limit protection.
4. Insulated Terminal Box
5. Control Transformer
6. Overcurrent Protection as required by NEC and UL (on heaters over 48 amperes), or Overcurrent Protection for each stage, or Overcurrent Protection for all heaters regardless of amp ratings. (Specifier select one).
7. Built-in Disconnect Switches that will disconnect all power lines prior to the heater control enclosure opening.
8. Pneumatic Electric Switches factory mounted and wired for each stage.
9. Electronic Step Controllers with modulating thermostats that will control each stage of heat.
10. SCR Controllers complete with back-up contactors and factory supplied thermostats that will modulate the heat output of the heaters from 0 to 100% as required by the room thermostat.
11. Pilot Lights showing:  
Heater on or  
stages on or  
Airflow Switch off, etc.
12. Pilot switches to de-energize all contactors or each stage.
13. Heaters so specified on the drawings or in the schedules shall be supplied with remote control panels manufactured by the heater manufacturer for use with the heaters.

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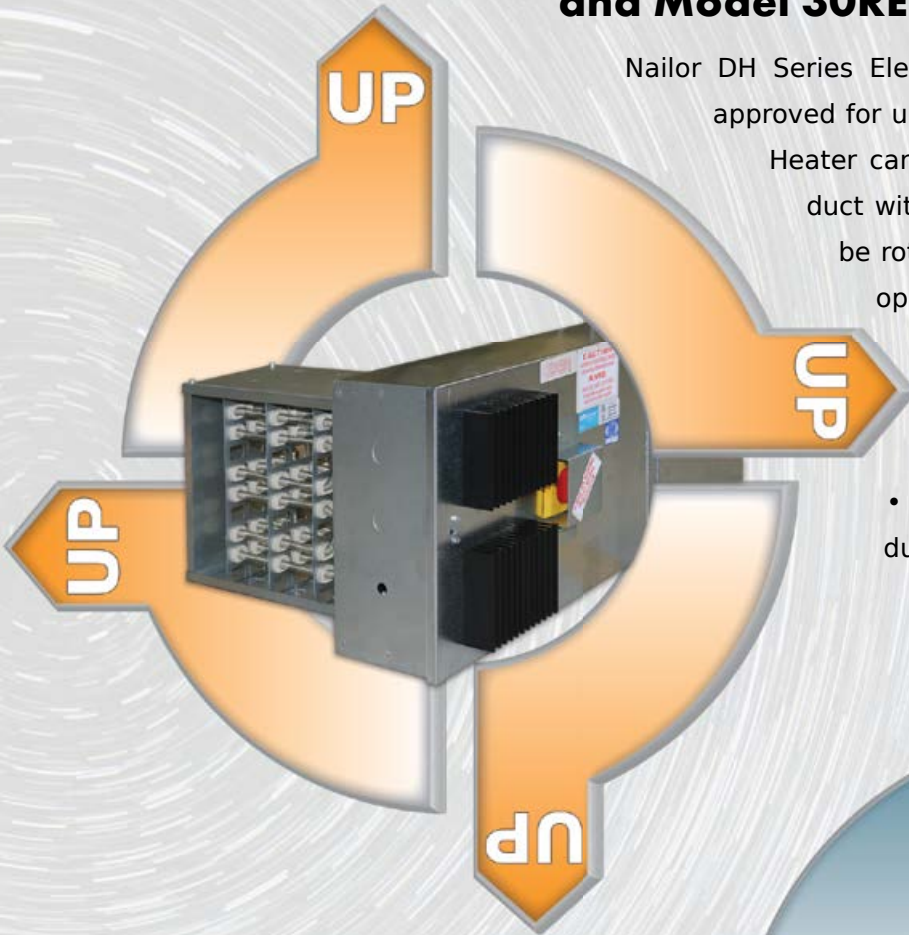
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# UP AND DOWN AND ALL AROUND

## An upgrade to Nailor DH Series Electric Duct Heaters and Model 30RE Single Duct Terminal Units.

Nailor DH Series Electric Duct Heaters are now designed and approved for universal installation. The same Electric Duct Heater can be applied in both horizontal and vertical duct with airflow in either direction. They may also be rotated to place the controls enclosure on the opposite side where field restrictions dictate.

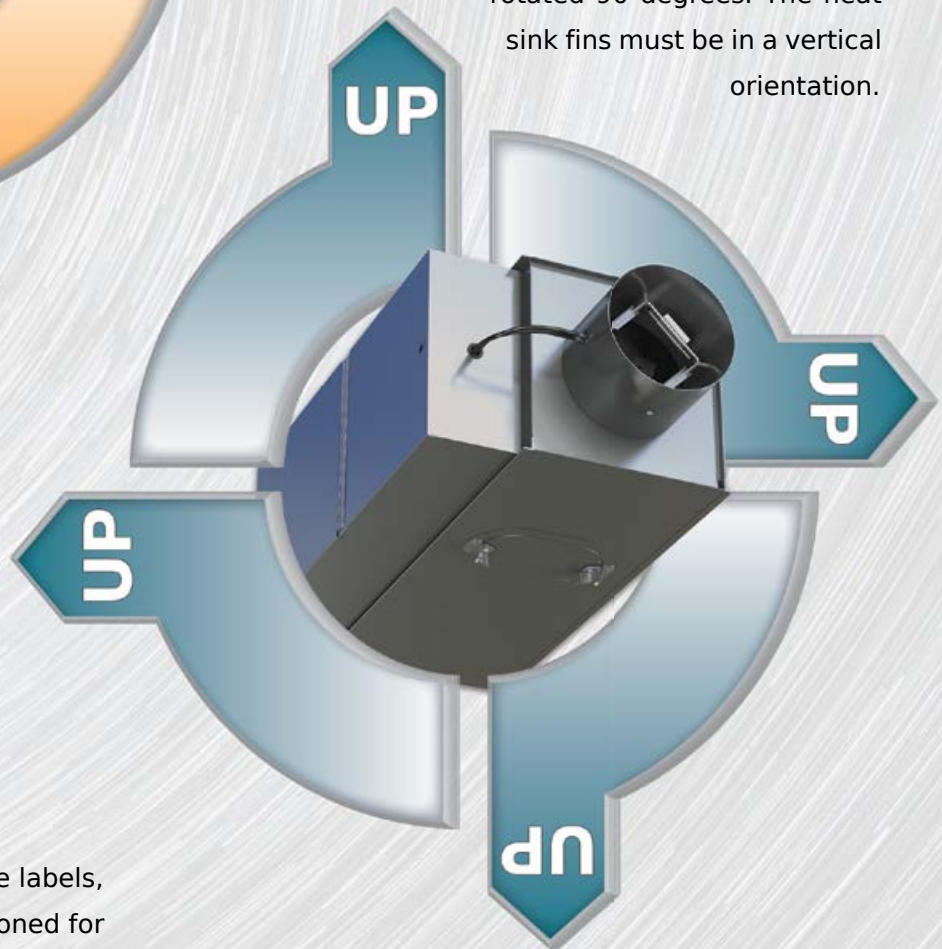
- Changing airflow direction in the field (from factory order) requires nothing more than rotating the airflow switch pick-up probe.
- Changing from a horizontal duct to a vertical duct requires the SCR (if there is one) to be rotated 90 degrees. The heat sink fins must be in a vertical orientation.



Nailor Model 30RE Single Duct Terminal Unit with Electric Reheat can still be flipped over for Right Hand or Left Hand control enclosure orientation, but now they can now also be applied for both horizontal and vertical installation.

- The same rule as above apply for SCR controls.

Ordering procedures still require a desired airflow direction and orientation so that the labels, probe tube and SCR can be properly positioned for the application. However, if the application changes, you no longer need to purchase a new heater or terminal unit. Field changes to the heater are simple.







#### **Air Distribution Products:**

- Flowline
- Grilles and Registers
- Ceiling Diffusers
- Linear Diffusers
- Plenum Slot Diffusers
- Fire Rated Assemblies
- Hospital/Cleanroom Diffusers



#### **Air Control Products:**

- Louvers
- Control & Backdraft Dampers
- Curtain Fire Dampers
- Multi-Blade Fire Dampers
- Smoke Dampers
- Combination Fire/Smoke Dampers
- Ceiling Dampers
- Access Doors



#### **Terminal Units:**

- Single Duct
- Dual Duct
- Fan Powered
- Bypass
- Retrofit



#### **Green Building Products**

- Underfloor Air Distribution Systems
- Displacement Ventilation



#### **Fan Coil Units**

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- Horizontal Fan Coil Units
- Vertical Sill Fan Coil Units

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