



Markel[®]

Products Company

CUSTOM BUILT ELECTRIC DUCT HEATERS

OPEN COIL
HF SERIES



FINNED TUBULAR
CHMS SERIES



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MARKEL PRODUCTS COMPANY

Limited Warranty

TPI Corporation provides a limited warranty of materials and workmanship for a period of (i) ten (10) years for elements in 2900 Series baseboard heaters, (ii) two (2) years for Thermostats and Controls, (iii) five (5) years on HD and HDH series fans, (iv) three (3) years on UHP and IHP series fans, (v) and twelve (12) months for all other products, with the warranty period commencing on the original date of purchase. The TPI warranty is limited to materials manufactured and work performed by TPI Corporation, and does not include damage or failure caused by acts of God, abuse, misuse, connected to or placed on other than rated voltage, abnormal usage, faulty installation, failure to follow suggested maintenance procedures enclosed with the product, improper maintenance or any repairs other than those provided by an authorized TPI Corporation service center. For the name of your nearest authorized TPI Corporation service center, please write to TPI Corporation, P.O. Box 4973, Johnson City, Tennessee, 37602 or call 1-800-682-3398.

During the warranty period, TPI Corporation will, at its sole option, repair or replace any defective parts or products returned, freight prepaid, to the TPI Corporation factory or such other location as TPI Corporation may designate. No parts or products will be accepted for repair or replacement without prior authorization from TPI Corporation and a return merchandise authority (RMA) number issued by TPI Corporation. Returned products must be packaged carefully and TPI Corporation shall not be responsible for damage in transit. When returning parts, the owner must provide the model number of the product and nature of difficulty being experienced.

This warranty does not obligate TPI Corporation to bear the cost of labor in replacing any assembly, unit or component part thereof, nor does TPI Corporation assume any liability for secondary charges, expenses for installing or removal, freight or damages. There will be charges rendered for product repairs made after the warranty period has expired. Proof of purchase, including date, must accompany request for in-warranty service. This warranty gives you specific legal rights and you may have other rights, which may vary, from state to state.

Except for the limited warranty provided in the foregoing paragraph, all parts and products sold by TPI Corporation are sold 'as is', 'where is', and without any other warranty of any kind or nature, whether express, implied, or statutory and including, without limitation, any implied warranty of specific performance or merchantability.

Under no circumstances, even with respect to claims covered by the foregoing warranty, will TPI Corporation be responsible for any incidental, consequential, special, or punitive damages of any kind or nature arising from or related to the parts or products sold by TPI Corporation.



In any event, TPI Corporation's maximum liability shall not in any case exceed the purchase price for the part or product claimed to be defective.

You hereby expressly agree to waive any and all rights to a trial by jury with respect to any product manufactured or supplied by TPI Corporation.

INTRODUCTION

Markel Products Company offers both open coil (HF Series) and finned tubular (CHMS Series) type duct heater construction. We have consolidated our literature to include both types in one up-to-date informative package. There are design and application similarities in both types of construction. We try to be concise in our general duct heater design and installation section to cover all areas where typical heaters can be applied (both HF & CHMS Series).

In the application, construction, and manufacturing of both types, there are differences that must be noted in design and specifications. We have a specific section for each series to aid in specification and design criteria that may not be common or applicable to both.

OPEN COIL	FINNED TUBULAR
 <ul style="list-style-type: none"> •Releases heat directly into air stream resulting in lower element temperature •Low pressure drop due to high percentage of open area •Light weight, easily installed with little or no mounting supports •Higher wattage per square foot of duct area •Economical with quick ship delivery available 	 <ul style="list-style-type: none"> •Slower heating and cooling, and relatively high thermal inertia for closer temperature regulation •Safety - shock hazard due to accidental contact in duct is reduced •Not as susceptible to shorting of elements due to foreign material in duct •Easily serviced for element replacement •Rugged, durable - withstands physical abuse

The information in this publication can be utilized for various purposes. For specifying engineers (designing), sales agents (submittals) and contractors (installation & operation instructions). Please refer to reference pages for information for above purposes.

PURPOSE	OPEN COIL	FINNED TUBULAR
DESIGN	PAGES 3-8, 12	PAGES 3-8, 15-17
SUBMITTALS	PAGE 11	PAGE 14
I & O INSTRUCTIONS	PAGES 5-6	PAGES 5-6, 15-17

GENERAL DESCRIPTION

An electric duct heater is a self-contained or two part assembly designed to be installed in the air stream of a duct system. It may be located in a main supply duct serving an entire building, in a branch duct serving one or several zones, or in a branch duct serving a single room.

The duct heater assembly consists of a steel frame, heating elements, and an integral or remote terminal box. These matched components are custom fabricated in a wide range of sizes, heating capacities, and control configurations.

Heaters are tested and listed to UL Standard 1996 by ETL (Intertek Testing Laboratories).

GENERAL APPLICATION REQUIREMENTS

1—The duct heater installation must provide uniform air flow over the entire face area of the heating elements.

2—The air duct should be installed in accordance with the standards of the National Fire Protection Association for the installation of air conditioning and ventilating systems of other than residence-type (Pamphlet No. 90A) and residence-type warm air heating and air conditioning systems (Pamphlet No. 90B).

3—The heater should be installed at least 48" from the duct flanges of a heat pump or central air conditioner.

4—Maximum inlet air temperature is 100°F.

CODES AND REGULATIONS

The design and installation of electric duct heaters must conform to all codes and regulations applying at the job site. These include standards and requirements published by Underwriters' Laboratories, Inc. (UL), Intertek Testing Laboratory (ETL), National Electrical Code (NEC), Canadian Standards Association (CSA), Canadian Electrical Code (CEC), and other state and local agencies.

Ductwork must be installed in accordance with one of the following: Standards of the National Fire Protection Association for the Installation of Air Conditioning and Ventilating Systems of other than Residential Type, (Pamphlet No. 90A), or Residential Type Warm Air Heating and Air Conditioning Systems, (Pamphlet No. 90B).

Adequate service capacity is an absolute necessity. Heating loads are sized to operate at full capacity, during design temperature conditions, for extended periods of time. If undersized electrical service is installed, full capacity operation will reduce the power available to other equipment. If overloading reaches a critical magnitude, it can cause conductor heating and contribute to premature insulation breakdown.

ZERO CLEARANCE

UL standards require a duct heater rated 50 kilowatts or less shall be suitable for installation with zero spacing between the duct and combustible surfaces. A duct heater rated more than 50 kilowatts may require that spacing be larger than zero.

All Markel duct heaters are designed and are UL and ETL listed for zero clearance. However, good engineering practice would normally allow some clearance between combustible surfaces and the duct heater.

DIELECTRIC TESTING

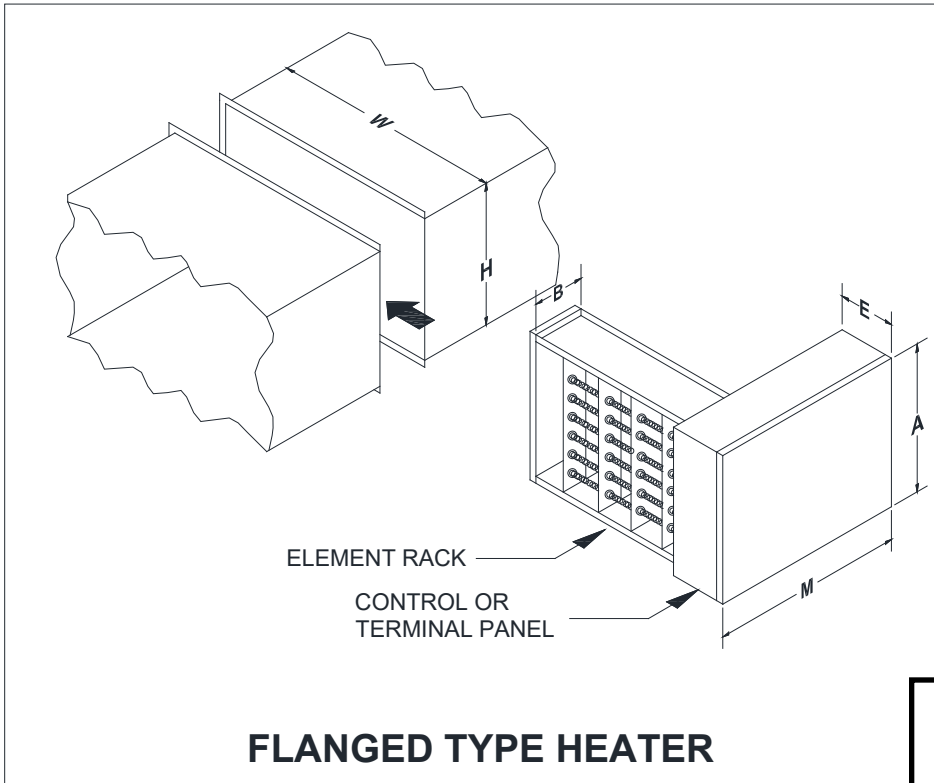
In manufacturing the Markel Duct Heater, safety is of prime importance. Each unit has a ground lug for each circuit and is tested for dielectric breakdown as specified by UL 1996. The minimum specified electrical spacings are exceeded.

SERVICE

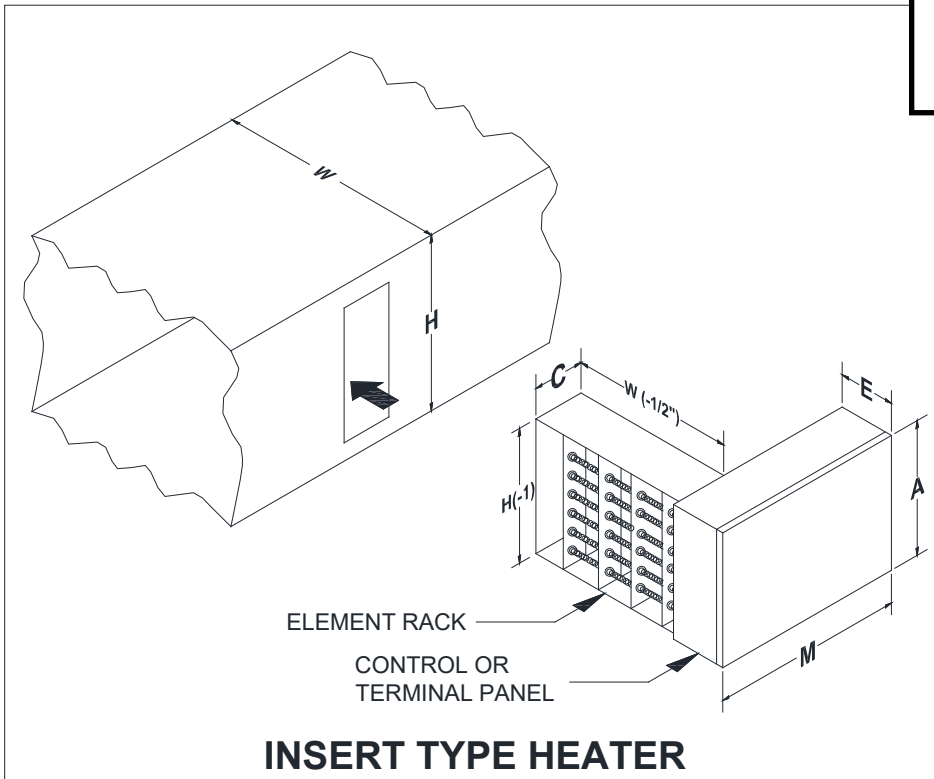
Since equipment service may be required at some future time, space to accomplish this service should be provided. It is also recommended that clearance be maintained so that equipment can be removed or replaced as an assembly without dismantling.

APPLICATION DATA

FLANGED HEATERS are custom designed to be installed as an integral part of the duct system. The inside of the flanged frame is the same dimensions as the air duct allowing for mating with, and securing to the duct flanges. A one inch flange is supplied as standard, unless otherwise specified.



W- DUCT WIDTH
H- DUCT HEIGHT
M- CONTROL BOX LENGTH
A- CONTROL BOX HEIGHT
E- CONTROL BOX DEPTH
C- INSERT RACK WIDTH
B- FLANGE WIDTH



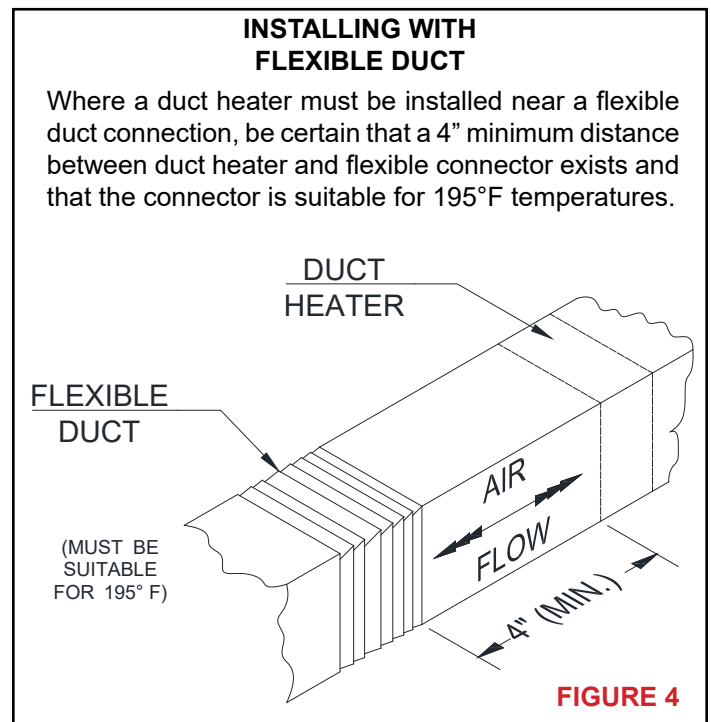
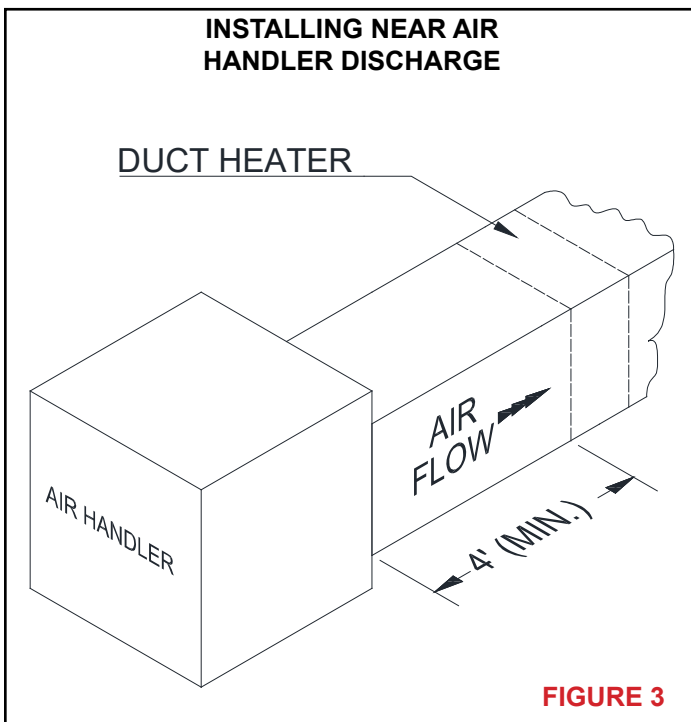
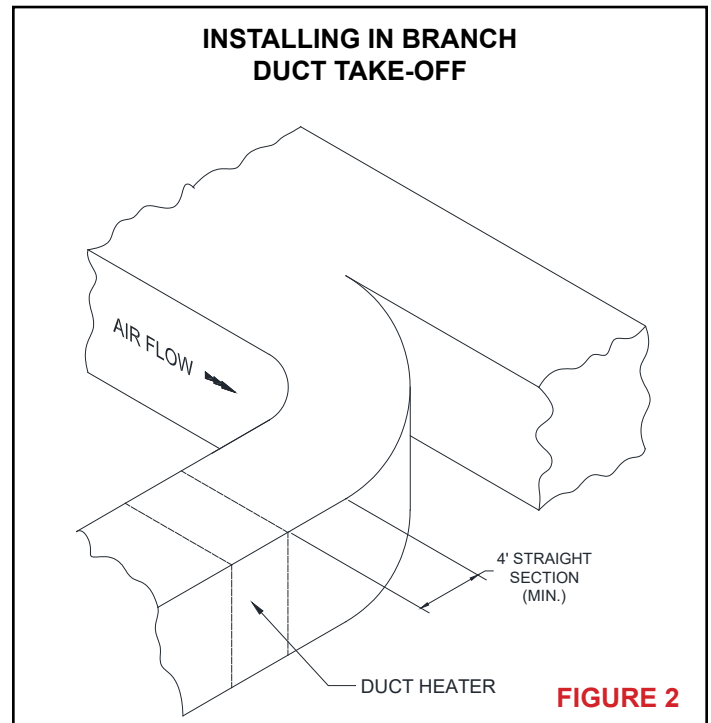
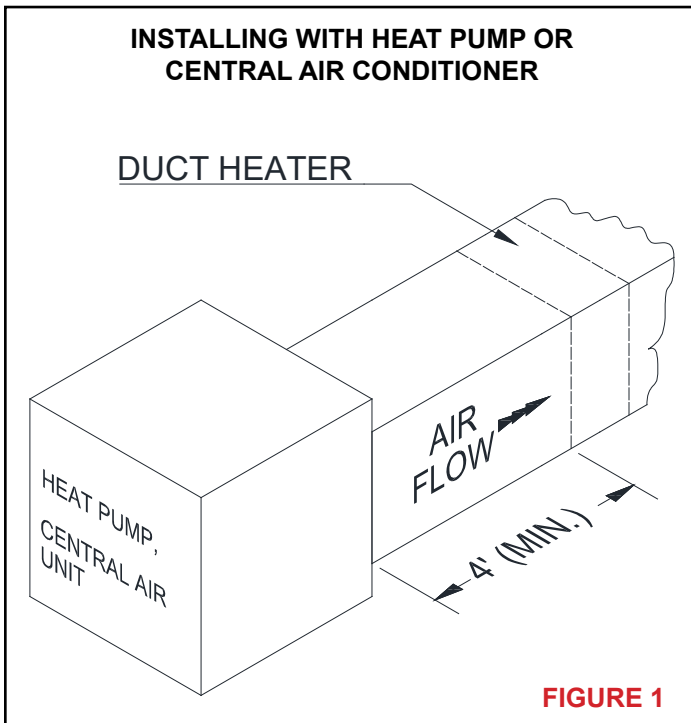
INSERT HEATERS are the most generally used type because of the ease of installation in the duct system. The heating element enclosure is inserted in the air stream through a hole cut in the side of the duct, and is secured to the duct with screws through the bottom of the terminal box.



MOUNTING LIMITATIONS

Unlike hot water coils, electric duct heaters produce 100% of their heating capacity (regardless of air flow) as long as the elements are energized. To avoid premature element burnout or nuisance tripping of the thermal cutouts, a certain minimum air velocity is required at all points across the duct heater face.

To aid in providing this minimum air velocity, follow the mounting limitations as follows.



INSTALLATION NEAR TURNS

If heaters must be installed closer than 2 feet from the downstream side of a turn, turning vanes must be installed in the turn. The turning vanes will straighten out the air flow so it will be uniform over the face of the heater.

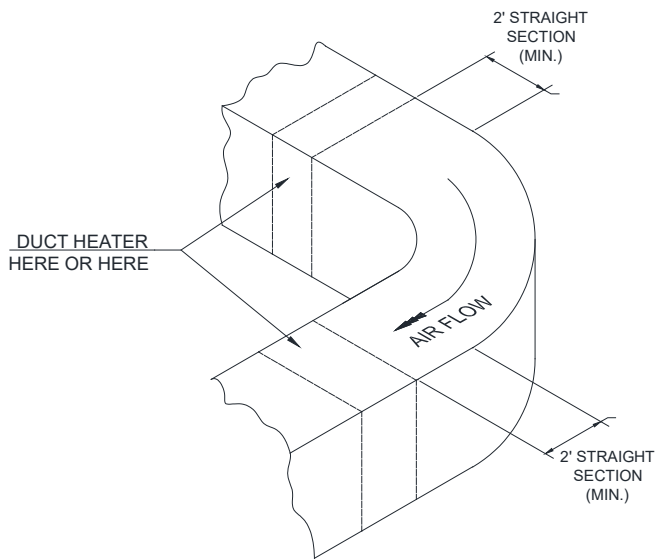


FIGURE 5

INSTALLATION IN INTERNALLY LINED DUCTS

When heaters are installed in internally lined ducts, the heating elements must be located in the free area. When specifying, specify metal to metal duct dimensions and duct liner thickness.

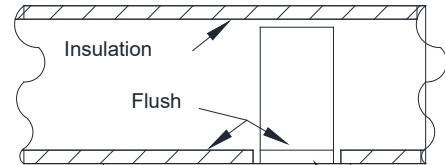


FIGURE 6

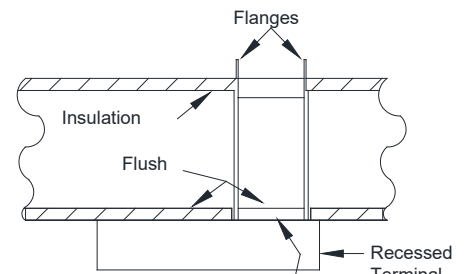
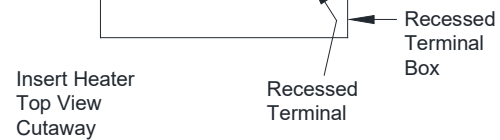
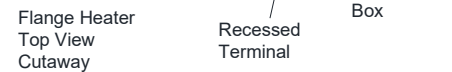


FIGURE 7



INSTALLATION WITH DAMPERS OR FILTERS

Maintain at least 2 feet between duct heater and dampers, filter frames, or other similar obstructions.

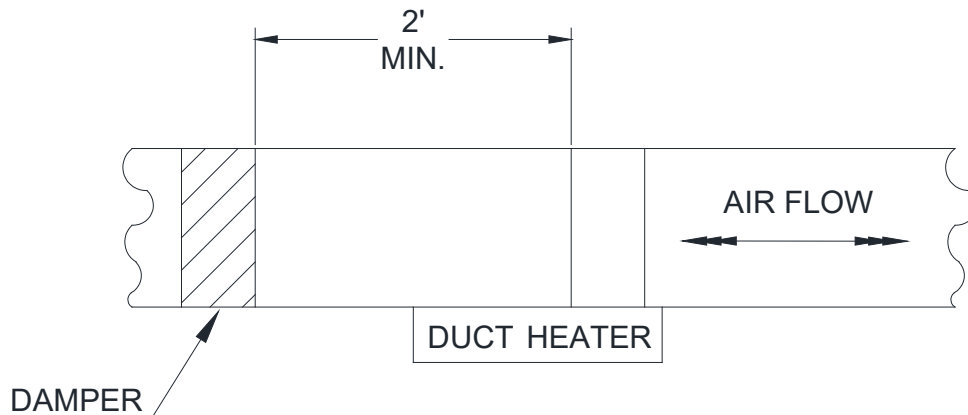


FIGURE 8

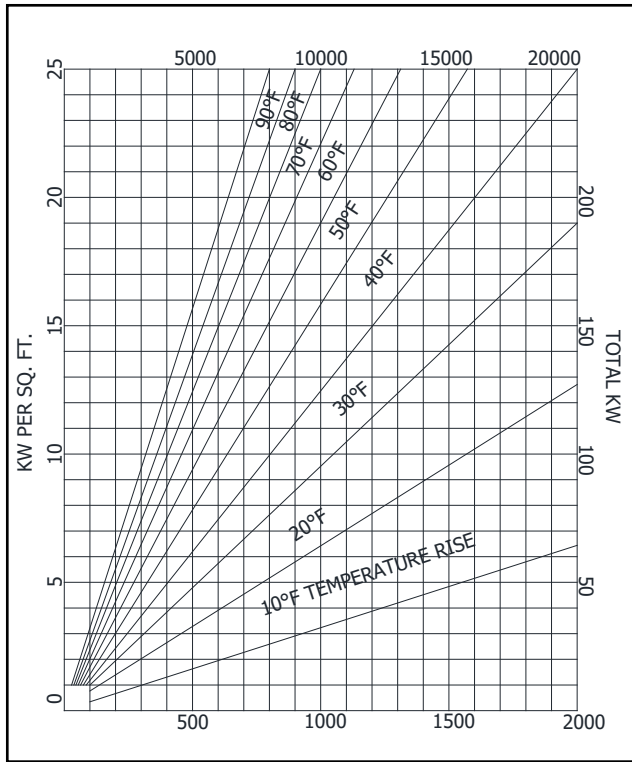
DO NOT INSTALL DUCT HEATERS OUTDOORS. Duct heaters cannot be installed with rooftop equipment where they are exposed to the weather.

For minimum FPM (Air Velocity) Required: See Figure 20 located on page 12.

The **Temperature Rise Chart** aids in calculating requirements or results from the known factors of FPM, CFM, Temperature Rise, Total KW, or KW per sq.ft. If two related factors are known, the others can be determined.

NOTE: (A) For values above or below those on the scale, multiply or divide the known factors by a convenient number. Make the necessary calculations on the chart, then multiply or divide the answer by the original number for the actual value.

FIGURE 9



OVER-CURRENT PROTECTION

UL requires compliance with paragraph 424-22 (c) of the National Electrical Code as follows: "Electric space heating equipment employing resistance type heating elements rated more than 48 amperes shall have the heating elements sub-divided. Each subdivided load shall not exceed 48 amperes and shall be protected at not more than 60 amperes."

This means that sub-circuit over-current protection must be provided if the total heater load exceeds 48 amperes. If over-current protection is not built-in, all heaters exceeding 48 amperes total line current are divided into a sufficient number of sub-circuits, each provided with line terminals for connection to remote over-current protection that must be supplied with the heater.

MAXIMUM KW PER CIRCUIT FOR OVER-CURRENT PROTECTION (48AMP)

VOLTAGE	SINGLE PHASE	THREE PHASE
120	5.7	--
208	9.9	17.2
240	11.5	19.9
277	13.2	--
480	23.0	39.9
600	28.8	49.8

Two or more circuits may be paralleled to make one heating stage.

FIGURE 10

Generally speaking, the greater the number of stages, the closer we can modulate the heat output and control the temperature swing (variation) in the space. As the stages are energized by the temperature controller, an incremental amount of heat is added to the air stream. This incremental heat is measured by the temperature rise (ΔT) across the duct heater. The air temperature leaving the heater minus the air temperature entering the heater is the ΔT variable, and a most important consideration in controlling space temperature swing. (See table)

The table below outlines general guidelines in providing space temperature control. Conditions of air change within the space, heat gain from other sources, distances between the duct heater and the space, thermostat and other conditions may change the absolute values of Temperature Swing shown. The relative values should remain the same. *The lower the ΔT , the better the control of space temperature.*

Space Temperature Control





ΔT Temp Rise Per Stage Variable	Temperature Control	Approx. Space Temperature Swing
SCR Control	VERY FINE	1°F or less 
5°F	FINE	1°-2°F 
10°F	MEDIUM	2°-4°F 
15°F	COARSE	3°-5°F 

FIGURE 11

When a given temperature rise is required and the CFM is known, the approximate required KW may be determined by using the following formula:

$$KW = CFM \times \text{Temp Rise} \div 3150$$

Approximate temperature rise of a duct heater may be calculated if the KW and CFM are known by using the following formula:

$$\text{Temp Rise} = KW \times 3150 \div CFM$$

To determine duct heater watt density (KW/sq.ft.) use the following formula:

$$\text{Watt Density} = \frac{\text{Duct heater total KW}}{\text{Duct Heater Face Area in sq.ft.}}$$

To convert CFM to FPM use the following formula:

$$FPM = CFM \div \text{Duct Area sq.ft.}$$

AMPERAGE FORMULAS:

Single Phase: Watts \div Volts = Amps
 Three Phase: Watts \div (Volts \times 1.73) = Amps
 $208 \times 1.73 = 359.8$
 $240 \times 1.73 = 415.2$
 $480 \times 1.73 = 830.4$

WATTAGE FORMULAS:

1 KW = 1000 Watts

BTU FORMULAS:

1KW = 3413 BTUs
 (#)BTUs \times 0.29307 = Watts

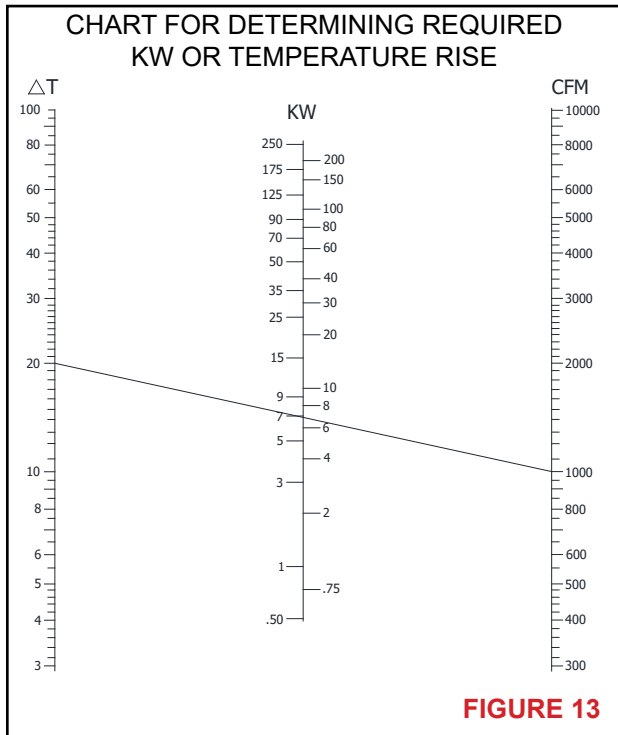
LENGTH CONVERSION FORMULAS:

English to Metric:
 1 inch = 2.54 centimeters

TEMPERATURE CONVERSION FORMULAS:

Celsius to Fahrenheit: $^{\circ}F = 1.8(^{\circ}C + 32)$
 Fahrenheit to Celsius: $^{\circ}C = .55(^{\circ}F - 32)$

FIGURE 12



EXAMPLE:

Find the KW required to raise 1000 CFM through a temperature rise (ΔT) at 20°F:

Lay a straightedge across the nomogram at 20 on the ΔT scale and 1000 on the CFM scale.

Find the required KW where the straightedge intersects the KW scale. For this example, required value is 6.2 KW.

To this value, add whatever safety factor is desired.

MAXIMUM KW/SQ.FT. OF DUCT (OPEN AREA)

HF SERIES (OPEN COIL) - 20 KW/SQ.FT.
 CHMS SERIES (FINNED TUBE) - 18 KW/SQ.FT.

DUCT HEATER ETL FILE NUMBERS

HF - 3179127CRT-004
 CHMS - 3179127CRT-005
 REMOTE PANEL - 103168679CRT-002

ELECTRICAL WIRING INSTRUCTIONS

WARNING: DISCONNECT ALL POWER SOURCES BEFORE DOING ANY WORK ON THE HEATER INSTALLATION

1. Use the wiring diagram supplied with the heater as a guide in correlating field wiring with the heater internal wiring. If there is more than one heating step, wire the unit so the steps are energized in the same sequence as numbered in the heater.
2. All field wiring to the heater must meet the requirements of the N.E.C. and applicable local codes.
3. Wiring to the heater must be rated for 75°C minimum.
4. Supply conductors must be sized to carry at least 125% of the ampere load of the circuit it supplies.
5. For ALL control circuits, use N.E.C. Class 1 wiring as described in Article 725 of the National Electrical Code.
6. The fan must be interlocked with the heater so that the heater is not energized unless the fan is on.
7. If heater does not have a built-in disconnect switch or main circuit breaker, install a remote disconnect (furnished by others) in accordance with the National Electrical Code, Article 424-65.
8. Do not bundle, tie, or wrap power wiring in groups as this may cause over-heating and eventual breakdown of insulation.
9. For low voltage control circuits using two supply transformers with a heating cooling thermostat, one for heating and one for cooling, a thermostat with isolating contacts must be used to prevent interconnection of the two different circuits.

Caution: For successful service using aluminum wiring, special treatment of all connections is an absolute necessity in order to prevent high resistance and oxidation problems. For recommended practice check with your local electrical utility.

SIZING OF SUPPLY CONDUCTORS

The required minimum size of supply conductors is marked at the field wiring terminals within the heater control box. However, for reference the following table is included. The wire gauges are calculated for 125% of the heater line current as required by the National Electrical Code, Article 424-3 (b) based on conductor insulation rated for 75°C (167°F).

AWG OR MCM	SUPPLY WIRE SIZE (NOT MORE THAN 6 CONDUCTORS IN A CONDUIT) ¹	
	MAX HEATER LINE CURRENT ²	
	COPPER ³	ALUMINUM ⁴
14	12	--
12	16	12
10	24	20
8	36	32
6	52	40
4	68	52
3	80	60
2	92	72
1	104	80
0	120	96
00	140	108
000	160	124
0000	184	144
250	204	164
300	228	184
350	284	200
400	268	216
500	304	248
600	336	272
700	368	300
750	380	308
800	392	316
900	416	340
1000	436	356

(1) For 7-24 conductors in a raceway or cable reduce allowable heater line currents to 87 ½% of those shown above.

(2) Based on 30°C (86°F) ambient temperature. For higher ambient temperature, N.E.C. table 310-12 note 13.

(3) Based on 80% of ratings in table 310-12 N.E.C. for 75°C insulation.

(4) Based on 80% of ratings in table 310-14 N.E.C. for 75°C insulation.

FIGURE 14

MAXIMUM NUMBER OF CONDUCTORS IN TRADE SIZE OF CONDUIT OR TUBING														
CONDUIT TRADE SIZE (IN)		½	¾	1	1 ¼	1 ½	2	2 ½	3	3 ½	4	4 ½	5	6
TYPE LETTERS	CONDUCTOR SIZE AWG, MCM													
RHW and RHH (without outer covering) THW	14	6	10	16	29	40	65	93	143	192				
	12	4	8	13	24	32	53	76	117	157				
	10	4	6	11	19	26	43	61	95	127	163			
	8	1	3	5	10	13	22	32	49	66	85	106	133	
TW, T, THW, RUH (6 thru 2), RUW (6 thru 2),	6	1	2	4	7	10	16	23	36	48	62	78	97	141
	4	1	1	3	5	7	12	17	27	36	47	58	73	106
	3	1	1	2	4	6	10	15	23	31	4	50	63	91
	2	1	1	2	4	5	9	13	20	27	34	43	54	78
	1	1	1	1	3	4	6	9	14	19	25	31	39	57
FEPB (6 thru 2), RHW and RHH (without outer covering).	0		1	1	2	3	5	8	12	16	21	27	33	49
	00		1	1	1	3	5	7	10	14	18	23	29	41
	000		1	1	1	2	4	6	9	12	15	19	24	35
	0000		1	1	1	1	3	5	7	10	13	16	20	29
	250			1	1	1	2	4	6	8	10	13	16	23
300			1	1	1	2	3	5	7	9	11	14	20	
350				1	1	1	3	4	6	8	10	12	18	
400				1	1	1	2	4	5	7	9	11	16	
500				1	1	1	1	3	4	6	7	9	14	

FIGURE 15

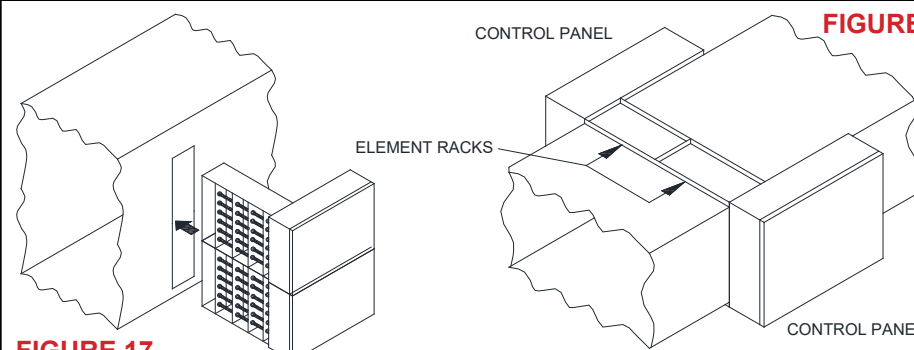


FIGURE 16 MULTIPLE HEATERS IN A SINGLE DUCT

Markel duct heaters can be installed as multiple units in single duct work to accommodate size or KW requirements. Heaters must be mounted parallel when used as multiple units. Duct heaters must not be mounted in series. Heaters can be installed as insert or flanged for either type of multiple unit shown. (Fig 16 & 17). Heaters exceeding 80" duct height must be made as multiple units. HF or CHMS series have specific size variations. Consult the dimensional data for design of each series in multiple applications.

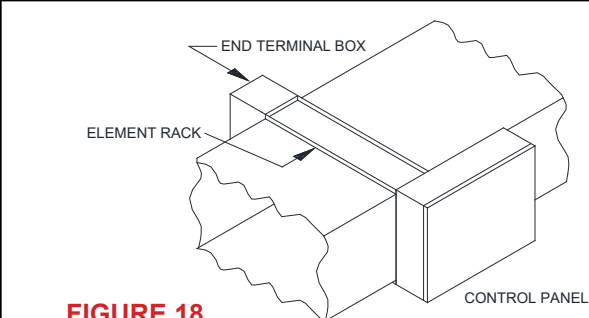


FIGURE 18

END TERMINAL BOX

When duct width is very large, it may be necessary to make flange construction with end terminations. In this application, care should be taken in installation to ensure access to end terminal box for field service or repair.

REQUIRED ON HF SERIES IF DUCT WIDTH EXCEEDS 120" AND ON CHMS SERIES IF DUCT WIDTH EXCEEDS 55"

AIR HANDLING UNITS

Markel duct heaters can be used with most manufacturers air handling equipment. Caution should be used when installing (see Fig. 3 installing near air handler discharge) to comply with UL and N.E.C. codes and restrictions. Specifying positive or negative air flow pressure is required when using air flow switch type fan interlock.

SPECIAL CONSTRUCTION OPTIONS

Stainless Steel - Units can be manufactured with stainless steel elements (CHMS only), control panel, or rack construction. Consult factory for stainless types and availability.

Remote Panels - Nema 1 standard - Also available in other Nema types (3, 4X, 12). Consult factory for remote or integral panels for your application.

GENERAL

1. Provide Series "HF", open coil, electric duct heaters, as manufactured by Markel Products Co. and as listed in the schedule.
2. Power voltage and phase, control voltage, wattage, duct size, number of steps to be as per schedule.
3. Heaters to be either Slip-in or Flanged type as called for.
4. Three phase heaters shall have balanced three phase steps unless specified otherwise.
5. All heaters to be ETL Listed for zero clearance to combustible surfaces and bear the ETL label.
6. All heaters shall meet the requirements of the latest National Electric Code.
7. Standard terminal box, recessed terminal box, standard control cabinet, remote control cabinet as well as element housing and racks all to be made of heavy gauge galvanized steel. (Aluminized steel optional).
8. All heating coils to be made of high grade nickel/chromium resistance wire and terminated by means of a loop of wire being sandwiched between stainless steel or nickel plated washers and terminal hardware. All terminal hardware to be insulated from the heater by a two piece ceramic bushing.

ELECTRIC ASSEMBLY

1. To be of "Modular" design with each module independently and easily removable from the terminal box or control cabinet.
2. Each module to contain no more than 2 layers of element coils so that any one coil may be replaced without disturbing others.
3. Element coils of each module to be on staggered spacing so that all coils per module will be in the air stream, and shadowing (overheating) and/or blank areas eliminated.

ELEMENT HOUSING

1. To be of No. 18 Ga. galvanized (aluminized) steel and to be of roll-formed construction with multiple brakes and ribs for stiffness and rigidity.

ELEMENT RACK

1. To be constructed of No. 20 Ga. galvanized (aluminized) steel and formed with multiple brakes and ribs for stiffness and rigidity.
2. Ceramic coil supports to be floating, but contained and easily replaceable.
3. Ceramic coil insulators to be on staggered spacing per rack to eliminate blank areas in the air pattern through the heater, and provide uniform heating over the entire cross section of the element.
4. Racks to support element coils on no more than 3 1/2" centers.

TERMINAL BOX

1. Shall be constructed of heavy gauge galvanized steel (aluminized optional) and in sizes up to 18" x 18" shall be No. 20 gauge and over to be No. 18 gauge. All boxes to have a solid cover, of the same gauge, complete with a piano type hinge on the longest side, approved tool operated latch and pull ring. Covers over 48" long to be provided with two latches and pull rings.
2. Insulation consisting of 1/2" high density fiberglass will be provided, attached to the cabinet, between the cabinet and the heating section.
3. Recessed terminal boxes used when ducts are internally insulated, or in air handling units, to be of the same general construction as item 1 above.

AIRFLOW DIRECTION

Heaters will be interchangeable for mounting in a horizontal or vertical duct except when position sensitive, SCRs or capillary type limit controls are built-in. In these cases, airflow direction is as specified.

SAFETY CONTROLS

1. Primary over temperature protection shall be provided by built in disc type automatic reset thermal cutouts for duct heaters up to 10' in width. Heaters over 40" high require two cutouts. Capillary type automatic reset thermal cutouts are required for any heater 10' wide or over. Capillary type controls to be UL listed and of the "fail safe" type.
2. Secondary over temperature protection shall consist of a sufficient number of load carrying replaceable disc controls to de-energize the elements if the primary system fails.
3. Fuse link type heat limiters shall not be acceptable.

All manual safety devices shall be resettable through the terminal box without removing the heater from the duct.

WIRING DIAGRAMS

1. A separate, complete and specific wiring diagram shall be permanently attached to each heater. Typical wiring diagrams are not acceptable.
2. Control and line terminals in each heater shall be marked identical to the wiring diagram.

HEATER CONTROLS

1. All heater controls shall be factory mounted and wired.
2. Contractors shall be definite purpose type. No appliance type relays will be acceptable.
3. All controls shall be furnished as specified.



HF SERIES
HF Series Open Coil Duct Heater
Insert Type

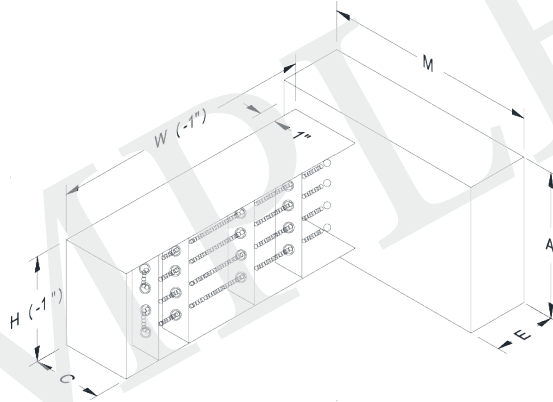


Quote# / Item# / QTY.	
Company	
Contractor	

Job Name	
Date	
PO Number	

STANDARD CONTROLS

- 24 VOLT CONTROL TRANSFORMER
- DOOR INTERLOCK DISCONNECT
- DISCONNECTING MAGNETIC CONTACTORS
- DIFFERENTIAL PREESURE AIR FLOW SWITCH
- PRIMARY AND SECONDARY OVER TEMPERATURE PROTECTION
- FUSING IF HEATER EXCEEDS 48 AMPS (PER NEC)
- LINE AND CONTROL TERMINAL BLOCKS
- GALVINIZED STEEL CONTROL BOX WITH 1/2 INSULATION AND HINGED COVER
- ETL LISTED



Division	Markel Mechanic
Kilowatts	
Tagging	
Volts	
Phase	
Heater Amps	
Control Volts	
Duct Width (inches)	
Duct Height (inches)	
Duct Liner	
Rack Width (W-1)	
Rack Height (H-1)	
Heater Type	
Airflow	
Door Interlock Disconnect Switch	
Controls	

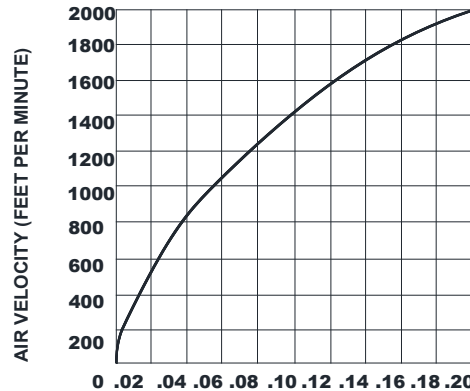
Number of Stages	
Amps per Stage	
Step Controller	
Thermostat	
80/20 Alloy Wire	
Fusing	
Remotel Panel	
NEMA Class	
Wiring Diagram	
Wiring	
****CONTROL BOX****	
Control Box E Dim	
Control Box A Dim	
Control Box M Dim	
Control Box C Dim	

VERSATILE DESIGN

Markel duct heaters or blast coils are packaged units, completely wired for simple connection to the power supply system. With the hinged enclosure cover open, line terminals are completely exposed in a large terminal box. Conduit knockouts and detailed wiring diagrams are included in each unit.

All duct heaters are listed by ETL in capacities ranging from five hundred watts to one million watts to fit ducts from a minimum of six inches high x eight inches wide to a maximum of six feet, eight inches high x twenty feet in width. This combination of heating capacities and duct sizes makes the duct heater a versatile type of heating system.

Markel duct heaters are approved for zero clearance to combustible surfaces, and meet all UL and National Electric Code requirements. Heaters are available for 120, 208, 240, 277, 480, and 600 volt electrical rating, single or three phase, with control voltages of 24, 120, 208, 240, or 277 volts.



PRESSURE DROP IN INCHES OF WATER
(TYPICAL STATIC PRESSURE DROP)

PRESSURE DROP

STATIC PRESSURE DROP THROUGH AN OPEN COIL HEATER IS QUITE LOW AND IN MOST CASES CAN BE IGNORED WHEN CALCULATING SYSTEM PRESSURE DROP.

FIGURE 19

HEATER ELEMENT

The Markel duct heater elements are constructed of high grade nickel-chromium resistance wire. Each element is coiled to the customer's wattage specification in our plant, assuring a closely controlled resistance. The coil is quality checked when produced, and again upon installation in a heater.

The heating element coils are designed for low watt density loading of the surface area of the wire (25, 35, or 55 watts per square inch). A heavier than standard gauge wire is used, with the longer coil stretch maintaining required resistance for a given wattage. This results in lower coil operating temperature which eliminates glow under standard operating conditions because of the greatly increased surface area and also gives a sturdier element for longer life.

The coil is mechanically connected to the high temperature #10 nickel plate terminal screw by means of loop of element wire being sandwiched between two stainless steel washers. Since a large area of element wire is used in making the connection, burn-outs due to nicked wire at the connection are minimized. The terminal is insulated by a two piece mating male and female ceramic brushing.

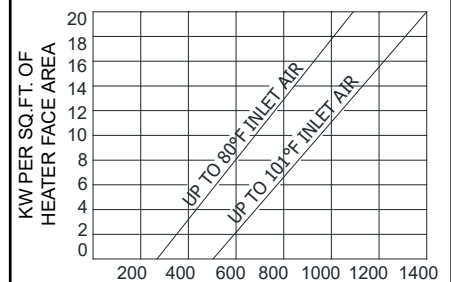
The high temperature special ceramic brushings, which insulate the coils from supporting metal, float freely in specially designed element channels. The ceramics will not crack or bind during the normal heating-cooling cycles of the element.

The heating coil is strung on a specially designed, 20 gauge galvanized or aluminized (optional) steel channel mounted in the heater frame. The channels are spaced 3½" on center to prevent coil sag and provide additional strength. Up to six rows of channels may be used per heater without excessive pressure drop. The channels are sectionalized and may be removed in the field should service be required.



MINIMUM VELOCITY REQUIREMENTS:

Electric duct heaters are different from steam or hot water coils, in that the BTU output remains constant as long as the heater is energized. To eliminate overheating and burn out due to low air velocity, an automatic reset temperature limiting control is built into each heater. The minimum velocity required to prevent nuisance tripping of the temperature limiting control is determined from the air velocity chart on the basis of entering air temperature, and watts per square foot of cross sectional duct area.



MIN AIR VELOCITY (FPM) AT EVERY POINT OF FACE AREA (20 KW/sq.ft. is maximum wattage permissible)

FIGURE 20

Formula: $H \times W \div \text{by } 144 = \text{sq.ft./area}$
 $\text{KW} \div \text{by area} = \text{KW/sq.ft. duct area (density)}$
 H = Element Frame Height
 W = Element Frame Width

BOTTOM TERMINAL BOX HEATERS

Markel heaters are specially designed to accommodate installations where side mounting is not possible. Since the resistance element wire must be strung horizontally, the safety controls are located in the side terminal compartment. Other controls except mercury contactors are located in bottom control box. Heaters limited to 60 KW max.



Typical Insert, Bottom Terminal Box Duct Heater
 Open Coil Heaters Only
 Minimum Duct Width 14"

**CHMS SERIES
SUGGESTED SPECIFICATIONS
(FINNED TUBULAR TYPE)****GENERAL**

1. Provide Series "CHMS" enclosed element electric duct heaters as manufactured by Markel Products Company and as listed on schedule.
2. Power, voltage, phase, control voltage, wattage, duct size, number of steps to be per schedule.
3. Heaters to be either slip-in or flanged type as called for on schedule.
4. All heaters to be ETL Listed for zero clearance to combustible surfaces and bear ETL label.
5. All heaters shall meet the requirements of the National Electric Code.
6. Standard terminal box, recessed terminal box, standard control cabinet, remote control cabinet and element housing to be made of 18 gauge aluminized steel.

ELEMENT CONSTRUCTION

1. All elements to be made of high quality alloy resistor wire, centered and permanently encased within highly compacted, rock hard refractory material, surrounded by steel sheath. Helical fins are furnace brazed to the sheath for rapid heat transfer. Sheath and fins are permanently coated with a high temperature fired ceramic for corrosion resistance. All element terminations shall be threaded stainless steel type to insure a positive connection to leads.

TERMINAL BOX OR CONTROL CABINET

1. Shall be constructed of 18 ga. aluminized steel. All boxes to have a solid cover of the same gauge, complete with a piano type hinge on the longest dimension, tool operated latch and pull ring.

SAFETY CONTROLS

1. Primary over-temperature protection shall be provided by built-in capillary type automatic reset thermal cutout. Capillary cutout shall be UL listed and of the "fail-safe" type.
2. Secondary over-temperature protection shall consist of a sufficient number of capillary type Manual resets controlling back-up contactors. Capillary shall be of the "fail-safe" and "trip-free" type. Capillary Manual reset shall be resettable without opening cover.
3. All capillaries shall be installed in a protective aluminum sheath. Sheath shall be etched and painted flat black to sense any over temperature condition the full length of the heater face.
4. Over-current protection incorporating fuses or circuit breakers must be provided for all heaters rated more than 48 amperes, and factory installed, within the heater enclosure or provided as a separate assembly by the heater manufacturer. Heaters exceeding 48 amperes total line current must be divided into sub-circuits of less than 48 amperes and be protected at not more than 60 amperes.

WIRING DIAGRAMS

1. A separate, complete and specific wiring diagram shall be permanently attached to each heater. Typical wiring diagrams are not acceptable.
2. Control and line terminals in each heater shall be marked to correspond to the wiring diagram.



CHMS SERIES CHMS Series Finned Tubular Duct Heater Flanged Type

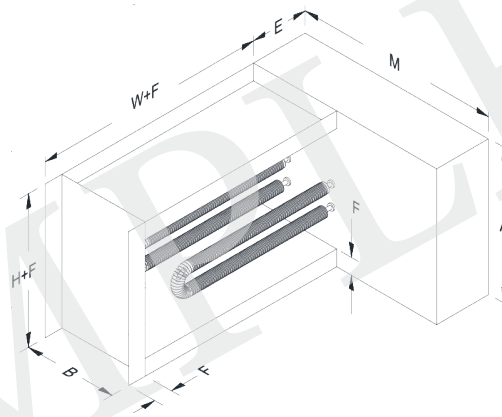


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PO Number	

STANDARD CONTROLS

- 24 VOLT CONTROL TRANSFORMER
- DOOR INTERLOCK DISCONNECT
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- DIFFERENTIAL PREESURE AIR FLOW SWITCH
- PRIMARY AND SECONDARY OVER TEMPERATURE PROTECTION
- FUSING IF HEATER EXCEEDS 48 AMPS (PER NEC)
- LINE AND CONTROL TERMINAL BLOCKS
- GALVINIZED STEEL CONTROL BOX WITH HINGED COVER
- ETL LISTED



Division	Markel Mechanic
Kilowatts	
Tagging	
Volts	
Phase	
Heater Amps	
Control Volts	
Duct Width (inches)	
Duct Height (inches)	
Rack Width (W-1)	
Rack Height (H-1)	
Heater Type	
Flange Size	
Airflow	
Door Interlock Disconnect Swit	
Controls	

Number of Stages	
Amps per Stage	
Step Controller	
Thermostat	
Fusing	
Remote Panel	
NEMA Class	
Wiring	
Wiring Diagram	
****CONTROL BOX****	
Depth of Control Box (E)	
Height of Control Box (A)	
Length of Control Box (M)	
Depth of Element Rack (C/B)	
Element Part No.	



CHMS INSERT TYPE

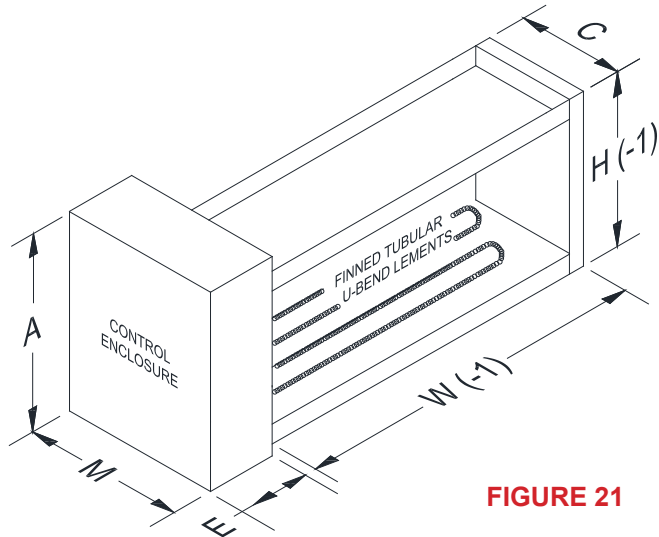


FIGURE 21

CHMS FLANGED TYPE

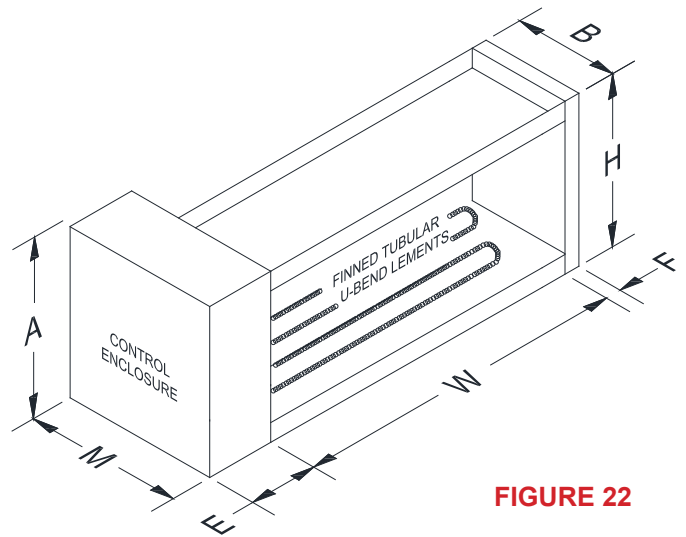


FIGURE 22

HEATER DIMENSIONS

The face dimension of both the flange and insert type heater match nominal duct dimensions.

**Model: CHMS 3-F Flange Type
with straight elements**

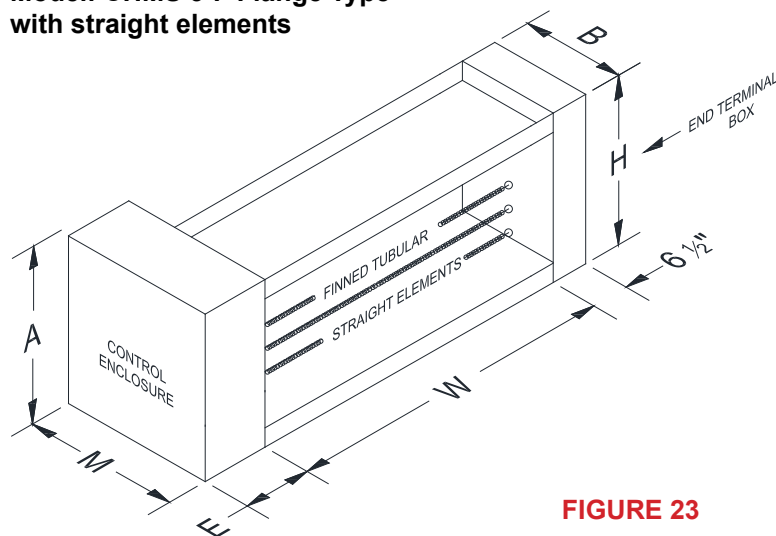


FIGURE 23

To provide the necessary support in handling shipping and mounting, all heaters greater than 55" in width (W) must be ordered as flanged construction and will be built with straight elements. (See Figure 23)

CHMS SERIES DESIGN INFORMATION
 CHMS MINIMUM AIR VELOCITY VS. KW/SQ. FT. FOR
 HORIZONTAL AIRFLOW

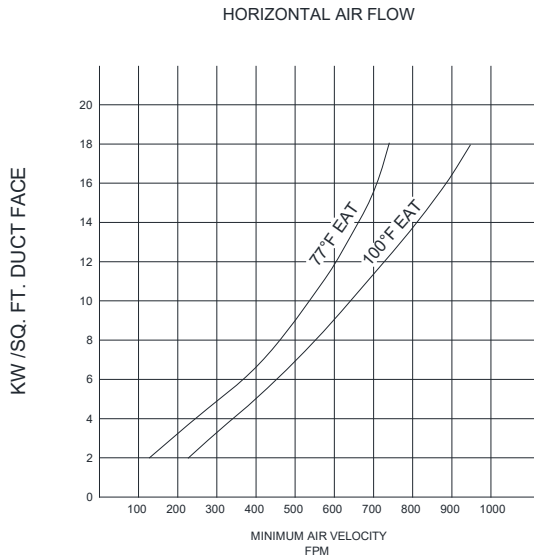


FIGURE 26

CHMS MINIMUM AIR VELOCITY
 VS. KW/SQ. FT. FOR
 VERTICAL UP AIRFLOW

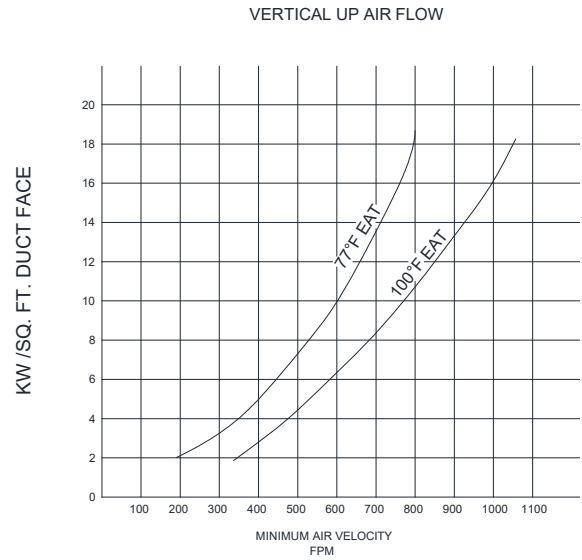


FIGURE 27

CHMS DUCT HEATER PRESSURE DROP CURVE

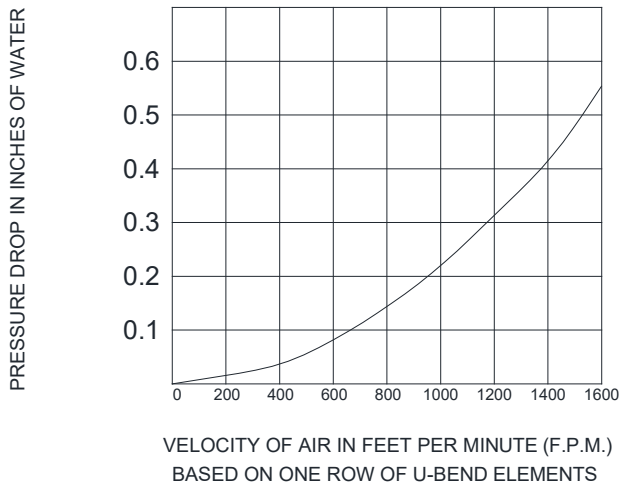
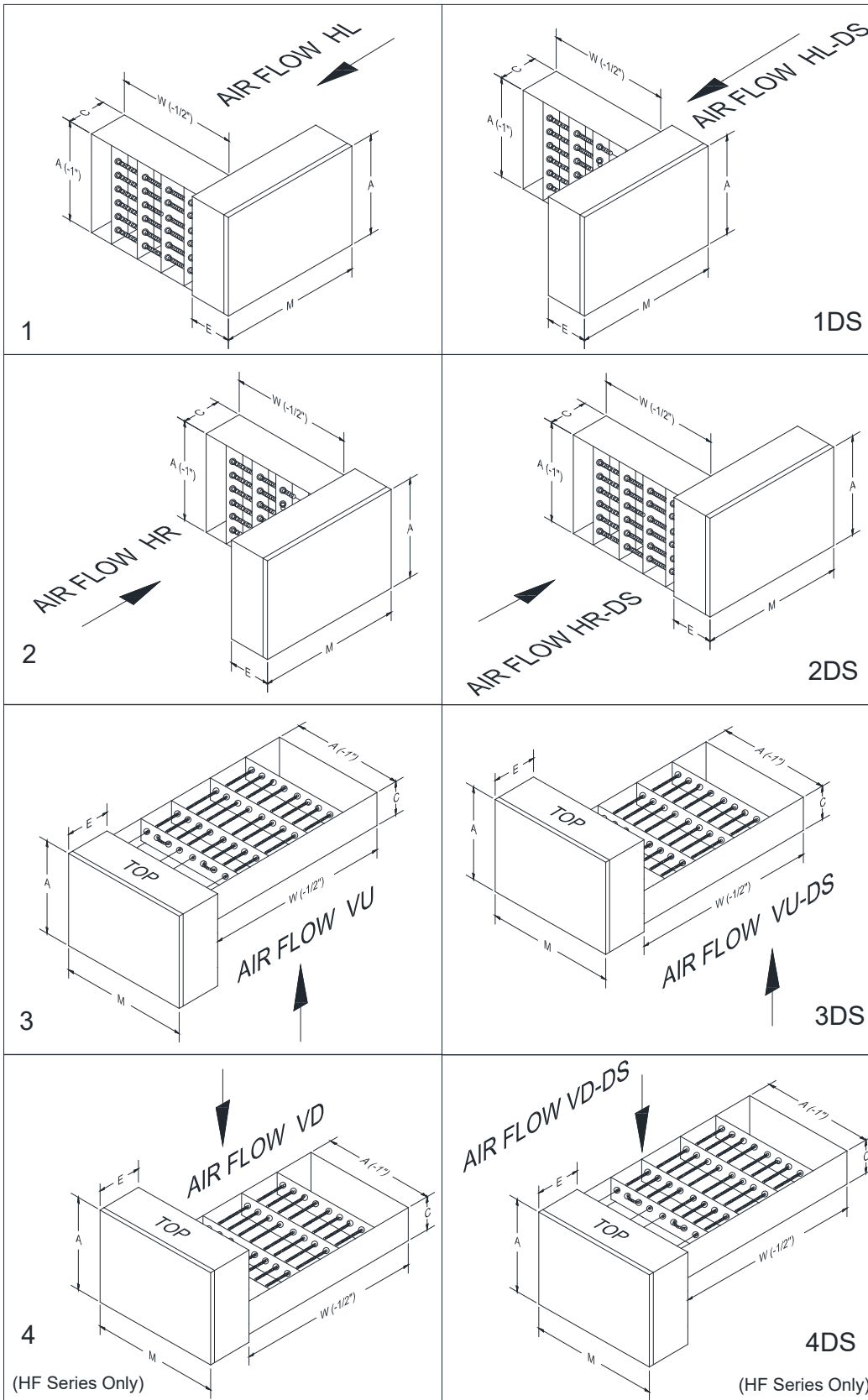


FIGURE 28

For electric duct heaters, with metal sheath elements air stream static pressure drops are small when compared to steam and water coil pressure drops.



Both flange and insert type duct heaters are designed for installation in either horizontal ducts with terminal or control box at side and in vertical ducts with terminal box at any of the four sides. This flexibility is particularly important where original installation or subsequent service could be restricted by the surrounding structure. Mounting positions as well as air flow direction must be observed.

BUILT-IN FAN INTER-LOCK Differential Pressure Switch

All models are .07" w.c. approx. Compact in size, all models offer extremely low pressure sensitivity, reliable operation, long life. This switch is wired in series with the Automatic Thermal cutouts to de-energize the entire heater in case of fan failure.



FIGURE 24

CHMS SERIES Standard Overtemperature Control

AUTOMATIC RESETTING TEMPERATURE CONTROL (Primary) opens at 210°F Capillary Type

An automatic resetting limit with a fixed temperature setting using a capillary to sense over temperature condition. Wired into control circuits to de-energize heating element preventing over heat. Capillary extends across width of duct to give protection from stratified air.

SECONDARY TEMPERATURE LIMIT CONTROL Capillary Type Manual Resettable Cutout

Temperature to open 240°F. Primarily used for back-up system. Controlling back-up magnetic contactors.

OVERCURRENT PROTECTION

BUILT-IN FUSES Power and Transformer Circuits

Meets all UL and N.E.C. requirements. Blocks are available in one, two, and three poles for Class H or K Type fuses rated from 10 through 60 AMP for 120 through 600V. Blocks are phenolic, made to resist chips, cracks, and temperatures above normal, with maximum protection between fuses.

CONTROL CONTACTORS

DEFINITE PURPOSE CONTACTOR

For single and three phase applications. Heavy duty contact and encapsulated coil – resists oil, dirt, moisture, and mechanical damage. Available in two, three, or four pole, 35 AMP, 40 AMP, AND 50 AMP. Coils available from 24 to 277V. Coil data: 8.8 VA holding, 77 VA in rush.

HF SERIES Standard Overtemperature Control

AUTOMATIC RESETTING TEMPERATURE CONTROL (Primary) Disc Type

An automatic resetting limit with a fixed temperature setting. Wired into control circuit to de-energize the heating elements when an over-heating condition occurs. May be wired into power line on single phase loads not to exceed its rated capacity. Resistive rating is 25 A at 120-240V; 21.6 A at 277V; and 12.5 A at 480V.

SECONDARY TEMPERATURE LIMIT CONTROL Disc Type (Replaceable) HF Series

Wired in a power circuit on single or three phase heaters to de-energize the heater stage on overheating. Rated at 48 AMP up to 600V. Temperature to open 210°F.

Manual Reset (CHMS Series)

Back up contactors with pilot duty manual reset. Manual reset is wired in series with backup contactor to de-energize heater.

ELECTRONIC STEP CONTROL

DISCONNECT SWITCH

Non-fused disconnect switches may be built-in duct heater terminal compartment when specified. The switches are snap-action type with the operating handle mounted on the hinged cover and inter-locked to open only when in the off position.

TRANSFORMERS

For units where a separate control voltage is not available. This machine tool type transformer is a heavy duty unit with primaries of 208, 240 to 480V AC and secondaries of 120 and 24V AC. Units are available from 50 to 250V A.



SCR FUNCTION

100% Proportional

SCR type controllers are designed to modulate electric duct heaters using a proportional time base of the AC circuit. This modulation is achieved by use of a line voltage "zero firing" triac. Firing at zero voltage crossing eliminates radio frequency interference (RFI). This modulation gives infinite control to duct heaters for very fine temperature control (see Figure 11 - page 7).

Vernier Control

When heater KW and AMP load make 100% proportional control price prohibitive. The Vernier System incorporates a sequencer, staging contactors, and SCR. The SCR proportions heater on and fills in between subsequent sequencer stages to achieve infinite control. This maintains a very fine temperature control at economical prices.

A 901-BP (pneumatic) board must be ordered for pneumatic controls and does not have electric/electronic connections.

AVAILABLE BUILT-IN COMPONENTS

1. Disc type automatic high temperature cutouts
2. De-energizing break magnetic contactors
3. Replaceable Thermal Cutoff (disc type)
4. Load carrying manual reset high temperature cutouts, disc type, and backup contactor
5. Non-fused disconnect switches
6. Class H, one time fuses 125% rated per the N.E.C. except: circuits in a remote box cannot be group fused, each circuit must be fused separately
7. SCR Controls
8. Class 1 Transformer with fusing per UL requirements
9. Electric step controllers
10. Differential pressure switch fan interlock
11. Time delay between stages
12. Pilot switches.
13. Cover interlock switch, pilot duty
14. Pilot relays
17. Capillary type automatic high temperature cutouts
18. Disconnecting break magnetic contactors
19. Capillary type manual reset high temperature cutouts
21. Manual reset high temperature cutouts pilot duty and back-up contactors
22. Dual element fuses
23. Transformer: Class II integrally protected secondary fused
24. Electrical fan interlock
25. Indicator pilot lights, each stage on, panel energized, etc.

OTHER OPTIONAL FEATURES

1. Aluminized terminal box, control cabinet, heater element assembly. For stainless steel construction, consult factory.
2. Protective screens, inlet side, outlet side, both sides.
3. Flanged heater frame for plain ducts or internally insulated ducts.
4. Dustproof terminal box, control cabinet.
5. Remote control cabinet, standard, dustproof.
6. Bottom insert construction (HF only).
7. Dual terminal box construction, flanged, insert.
8. Terminal box overhang on, downstream side, top, bottom.

COMMON TERMS USED IN DUCT HEATER DESIGN

A.W.G – American Wire Gauge

Backup Contactor – A contactor, usually controlled by a manual reset-cutout, that is wired to open the power circuit in case of failure of the primary controlling system.

Backup System – A system designed to prevent overheating in case of failure of the regular (primary) system.

B.T.U. – British Thermal Unit (1KW=3413 BTU) A measure of the amount of heat.

Built-In – Components installed within equipment

CFM – Cubic feet per minute of air passing a given point in a duct system (air flow).

Circuit (power) – That part of the heater power circuitry that is connected to an individual over-current protective device.

Contactor – A magnetic relay switch used to control an electric power circuit within a heater.

Control Circuit – The electrical circuitry, including control components, used for pilot duty to operate contactors, etc.

Cutout (high temperature) – An over-temperature limiting device.

De-energize – To open only enough power legs of a circuit to interrupt the flow of current.

Dielectric Test – A safety and quality test using high voltage.

Disconnect – To open all underground legs of the power circuit.

ETL – Intertek Testing Laboratories

Fan Interlock – A switch used to prevent the heater from operating unless the air handling equipment is energized.

FPM – Feet per minute of air velocity.

HZ – Hertz-International term for cycles per second

Inlet Temperature – The temperature of the air entering a heater.

KW – Kilowatt = 1000 Watts

Manual Reset (cutout) – An over-temperature limiting device that remains open until the plunger is reset

N.E.C.– National Electric Code.

Open Coil Elements – Heating elements which have the resistance wire exposed to the flow of air through the duct.

Primary System – The electrical circuitry regularly used to operate the heater.

Stage or Step – That increment of a heater that is operated (cycled off and on) by one switch of the thermostat or temperature controlling device.

Terminal Compartment – The box or electrical panel where the heater elements are terminated. It is an integral part of the heater and contains the over-temperature cutouts and, frequently, other built-in power and control components.

UL or U/L – Underwriters' Laboratories, Inc.–An independent, not-for-profit organization testing for public safety.

V.A. Holding – (Wattage) The power required to maintain a magnetic contactor, or similar device, in the closed position.

V.A. Inrush – The temporary surge of power in the control circuit required to close a magnetic contactor or similar device.

Watt Density – The number of watts of electric heat installed in a given area. Usually expressed as watts per square foot.

Zero Clearance – Equipment so listed has no requirements for installing with clearance from combustible material.

K.W Rating	B.T.U.H.	208 Volt AMP Rating		220 Volt AMP Rating		230 Volt AMP Rating		240 Volt AMP Rating		277 Volt AMP Rating	440 Volt AMP Rating	480 Volt AMP Rating	550 Volt AMP Rating
		1 PH	3 PH	1 PH	3 PH	1 PH	3 PH	1 PH	3 PH	1 PH	3 PH	3 PH	3 PH
00.5	1,706	2.4	1.4	2.3	1.3	2.2	1.3	2.1	1.2	1.8	0.6	0.6	0.5
01.0	3,413	4.8	2.8	4.5	2.6	4.3	2.5	4.2	2.4	3.6	1.3	1.2	1.0
02.0	6,826	9.6	5.5	9.1	5.2	8.7	5.0	8.3	4.8	7.2	2.6	2.4	2.1
03.0	10,239	14.4	8.3	13.6	7.9	13.0	7.5	12.5	7.2	10.8	3.9	3.6	3.1
04.0	13,652	19.2	11.1	18.2	10.4	17.5	10.1	16.6	9.6	14.4	5.2	4.8	4.2
05.0	17,065	24.0	13.8	22.7	13.1	21.7	12.6	20.8	12.0	18.1	6.6	6.0	5.2
06.0	20,478	28.8	16.6	27.3	15.7	26.1	15.1	25.0	14.4	21.7	7.9	7.2	6.3
07.0	23,891	33.6	19.4	31.8	18.4	30.4	17.6	29.1	16.8	25.3	9.2	8.4	7.3
08.0	27,304	38.5	22.2	36.4	20.9	34.9	20.1	33.3	19.2	28.9	10.5	9.6	8.4
09.0	30,717	42.8	24.9	40.9	23.3	39.1	22.6	37.7	21.4	32.5	11.8	10.8	9.5
10.0	34,130	48.1	27.4	45.4	26.2	43.5	25.1	41.7	24.0	36.1	13.2	12.0	10.5
11.0	37,543	52.9	30.5	50.0	28.6	47.8	27.6	45.8	26.4	39.7	14.5	13.2	11.6
12.0	40,956	57.7	33.2	54.5	31.5	52.1	30.2	50.0	28.6	43.3	15.8	14.4	12.6
13.0	44,369	62.5	36.0	59.1	34.1	56.9	32.7	54.2	31.3	46.9	17.1	15.6	13.7
14.0	47,782	67.3	38.8	63.6	36.7	60.9	35.2	58.3	33.7	50.5	18.4	16.8	14.7
15.0	51,195	72.1	41.5	68.2	39.1	65.2	37.7	62.5	35.1	54.2	19.8	18.0	15.8
16.0	54,608	76.9	44.3	72.7	41.9	69.6	40.2	66.7	38.5	57.8	21.1	19.2	16.9
17.0	58,021	81.7	47.1	77.3	44.3	73.9	42.7	70.8	40.9	61.4	22.4	20.4	17.9
18.0	61,434	86.5	49.8	81.8	47.2	78.3	45.2	75.0	43.3	65.0	23.7	21.6	19.0
19.0	64,847	91.3	52.6	86.4	49.6	82.6	47.7	79.2	45.7	68.6	25.1	22.8	20.0
20.0	68,260	96.1	55.1	90.9	52.5	86.9	50.3	83.3	48.1	72.2	26.4	24.0	21.1
21.0	71,673	100.0	58.2	95.6	55.1	91.3	52.9	87.5	50.5	75.8	27.7	25.2	22.1
22.0	75,086	105.8	60.9	100.0	57.7	95.7	55.3	91.7	52.9	79.4	29.0	26.4	23.1
23.0	78,499	110.6	63.7	104.5	60.4	100.0	57.9	95.8	55.3	83.0	30.3	27.6	24.3
24.0	81,912	115.4	66.5	109.1	62.9	104.3	60.3	100.0	57.7	86.6	31.7	28.8	25.3
25.0	85,325	120.2	69.2	113.6	65.3	108.6	62.8	104.1	60.1	90.3	33.0	30.1	26.4
26.0	88,738	125.0	72.0	118.2	68.3	113.0	65.3	108.3	62.5	93.9	34.3	31.3	27.4
27.0	92,151	129.8	74.8	122.7	70.9	117.4	67.8	112.5	64.7	97.5	35.6	32.5	28.5
28.0	95,564	134.6	77.2	128.2	73.5	121.7	70.3	116.6	67.3	101.1	36.9	33.7	29.5
29.0	98,977	139.4	80.3	131.8	76.0	126.0	72.9	120.8	69.7	104.7	38.3	34.9	30.6
30.0	102,390	144.2	83.1	136.4	78.7	130.4	75.4	125.0	72.1	108.3	39.6	36.1	31.7
31.0	105,803	149.0	85.9	140.9	81.3	134.7	77.9	129.2	74.5	111.9	40.9	37.3	32.7
32.0	109,216	153.8	88.7	145.4	83.9	139.0	80.4	133.4	76.9	115.5	42.2	38.5	33.8
33.0	112,629	158.6	91.5	149.9	86.5	143.3	82.9	137.6	79.3	119.1	43.5	39.7	34.8
34.0	116,042	163.4	94.3	154.4	89.1	147.6	85.4	141.8	81.7	122.7	44.8	40.9	35.9
35.0	119,455	168.2	97.1	158.9	91.7	151.9	87.9	146.0	84.1	126.4	46.1	42.1	36.9
36.0	122,868	173.0	99.9	163.4	94.3	156.2	90.4	150.2	86.5	130.0	47.4	43.3	38.0
37.0	126,281	177.8	102.7	167.9	96.9	160.5	92.9	154.4	88.9	133.6	48.7	44.5	39.0
38.0	129,694	182.6	105.5	172.4	99.5	164.8	95.4	158.6	91.3	137.2	50.0	45.7	40.1
39.0	133,107	187.4	108.3	176.9	102.1	169.1	97.9	162.8	93.7	140.7	51.3	46.9	41.1
40.0	136,520	192.2	111.1	181.4	104.7	173.4	100.4	167.0	96.1	144.4	52.6	48.1	42.2
41.0	139,933	197.0	113.9	185.9	107.3	177.7	102.9	171.2	98.5	148.0	53.9	49.3	43.2
42.0	143,346	201.8	116.7	190.4	109.9	182.0	105.4	175.4	100.9	151.6	55.2	50.6	44.3
43.0	146,759	206.6	119.5	194.9	112.5	186.3	107.9	179.6	103.3	155.2	56.5	51.8	45.3
44.0	150,172	211.4	122.3	199.4	115.1	190.6	110.4	183.8	105.7	158.8	57.8	53.0	46.4
45.0	153,585	216.2	125.1	203.9	117.7	194.9	112.9	188.0	108.1	162.5	59.1	54.2	47.4
46.0	156,998	221.0	127.9	208.4	120.3	199.2	115.4	192.2	110.5	166.1	60.4	55.4	48.5
47.0	160,411	225.8	130.7	212.9	122.9	203.5	117.9	196.4	112.9	169.7	61.7	56.6	49.5
48.0	163,824	230.6	133.5	217.4	125.5	207.8	120.4	200.6	115.3	173.3	63.0	57.8	50.6
49.0	167,237	235.4	136.3	221.9	128.1	212.1	122.9	204.8	117.7	176.9	64.3	59.0	51.6
50.0	170,650	240.2	139.1	226.4	130.7	216.4	125.4	209.0	120.1	180.5	65.6	60.2	52.7
51.0	174,063	245.0	141.9	230.9	133.3	220.7	127.9	213.2	122.5	184.1	66.9	61.4	53.7
52.0	177,476	249.8	144.7	235.4	135.9	225.0	130.4	217.4	124.9	187.7	68.2	62.6	54.8
53.0	180,889	254.6	147.5	239.9	138.5	229.3	132.9	221.6	127.3	191.3	69.5	63.8	55.8
54.0	184,302	259.4	150.3	244.4	141.1	233.6	135.4	225.8	129.7	194.9	70.8	65.0	56.9
55.0	187,715	264.2	153.1	248.9	143.7	237.9	137.9	230.0	132.1	198.6	72.2	66.2	57.9
56.0	191,128	269.0	155.9	253.4	146.3	242.2	140.4	234.2	134.5	202.2	73.5	67.4	58.8
57.0	194,541	273.8	158.7	257.9	148.9	246.5	142.9	238.4	136.9	205.8	74.9	68.6	59.9
58.0	197,954	278.6	161.5	262.4	151.5	250.8	145.4	242.6	139.3	209.4	76.2	69.8	60.9
59.0	201,367	283.4	164.3	266.9	154.1	255.1	147.9	246.8	141.7	213.0	77.5	71.0	62.3
60.0	204,780	288.2	167.1	271.4	156.7	259.4	150.4	251.0	144.1	216.6	78.8	72.2	63.0

(AMPS) SINGLE PHASE CURRENT = WATTS ÷ VOLTS
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