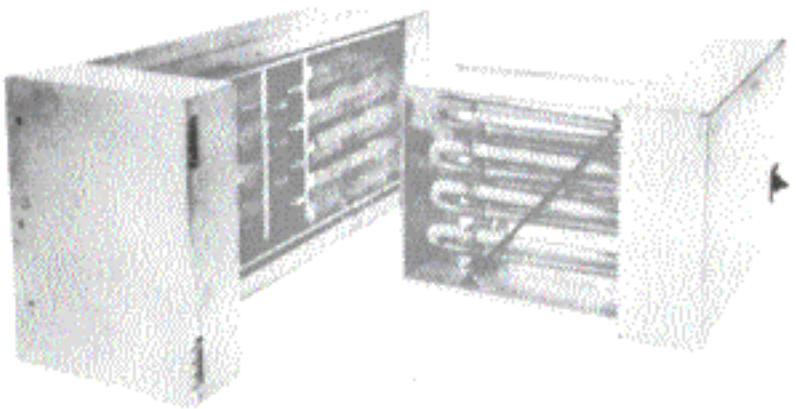
Duct Heaters

Specification and Selection Manual

Featuring Metal Sheath Heating Elements

Heavy Duty
Commercial
Industrial



Type "CHMS" Insert or Flange Types

GOLDEN STAR®

Markel

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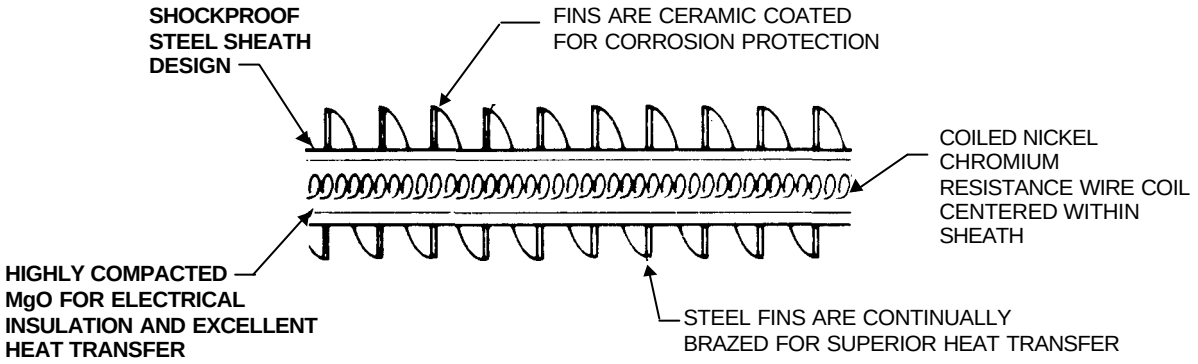
METAL SHEATH DESIGN

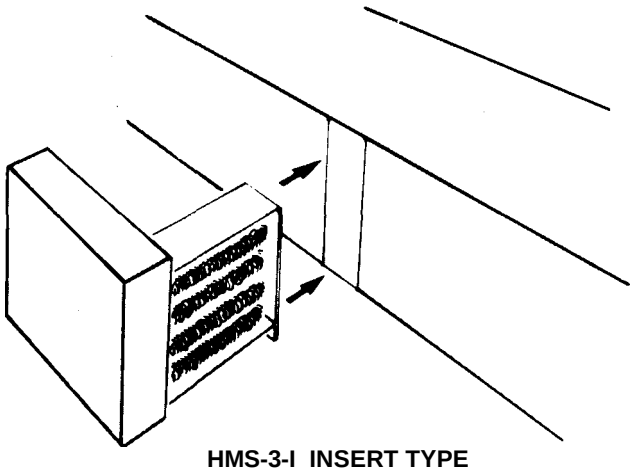


Element Construction	Coiled alloy resistor wire is centered and permanently encased within highly compacted, rockhard refractory material surrounded by a steel sheath. Helical fins are furnace brazed to the sheath for rapid heat transfer. Sheath and fins are permanently coated with a high temperature fired ceramic for corrosion resistance.
Flash-Fire Hazard	Low surface operating temperatures minimize any hazard from dust accumulation or combustibles in the air stream.
Electrical Shock Hazard	All current carrying parts within the duct are safely enclosed from accidental shock hazard.
Static Pressure Drop	Static pressure drop is greater than open coil, but considerably less than equivalent capacity hydronic coils.
Mechanical Damage	Fintubes are fully protected against mechanical shock, vibration or breakage. They are virtually immune to physical damage. Fintube failure, if it should occur, cannot effect adjacent elements or ductwork.

All heaters and remote control enclosures unless otherwise noted are listed with Underwriter's Laboratories (U.L.) Heaters are listed for "0" clearance complete with automatic reset (primary) and manual reset (secondary) high limit controls and meet standard requirements of the National Electric Code.

MOUNTING CONFIGURATIONS

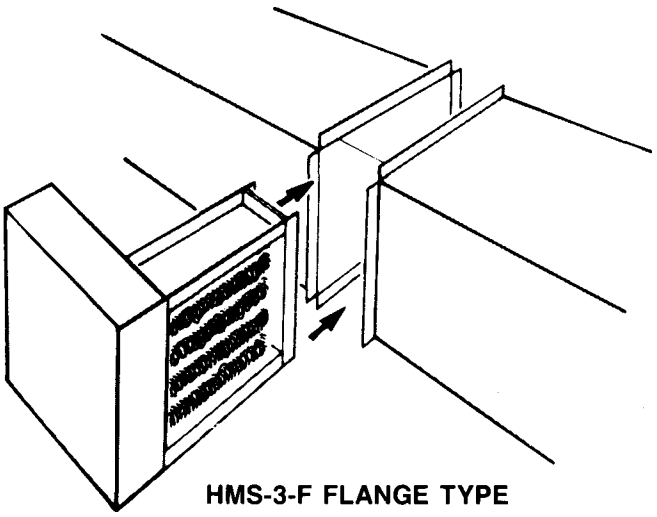
The duct heater is made in two mounting configurations insert type and flange type. The insert type is used for a slide fit into smaller size ducts, with minimum ¼' internal clearance on all sides. (See Fig. 1)



HMS-3-I INSERT TYPE

Figure 1

The flange type duct heater is attached directly to the duct work, as shown below. It is normally used with large ducts (48" or larger - either dimension) or where site conditions would make it impossible or impractical to use the insert type. (See Figure 2.)



HMS-3-F FLANGE TYPE

Figure 2

LARGE CHMS HEATERS feature straight heating elements. (Figure 3)

Heaters designed for ducts over 56" wide will have straight elements with an end terminal box for wiring and element terminations.

Multiple Heaters in a single duct (figure 4). When duct heights exceed 96" two or more CHMS heaters may be combined to match almost any duct size.

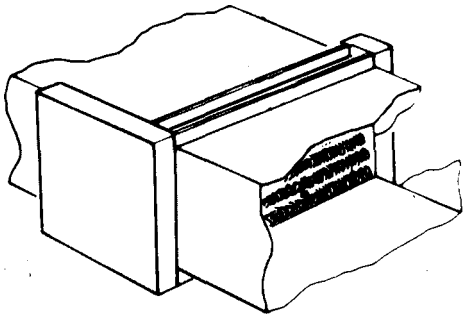


Figure 3

CHMS STRAIGHT ELEMENT TYPE

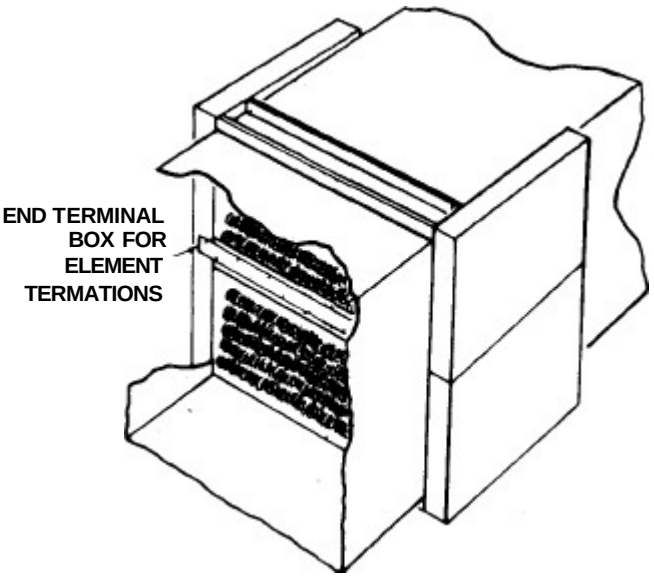


Figure 4

MULTIPLE HEATERS IN A SINGLE DUCT

HEATER DIMENSIONS

The face dimension of both the flange and insert type heater match nominal duct dimensions. Standard heater widths ("W" Dimension) will vary from 8" to 240"; heights ("H" Dimension) vary from 8" to 96". See Figures 5, 6 and 7 for dimensions.

To provide the necessary support in handling shipping and mounting, all heaters greater than 56" in width (W) must be ordered as flanged construction.

Model CHMS-3-1 Insert
Type with "D" Bend Elements

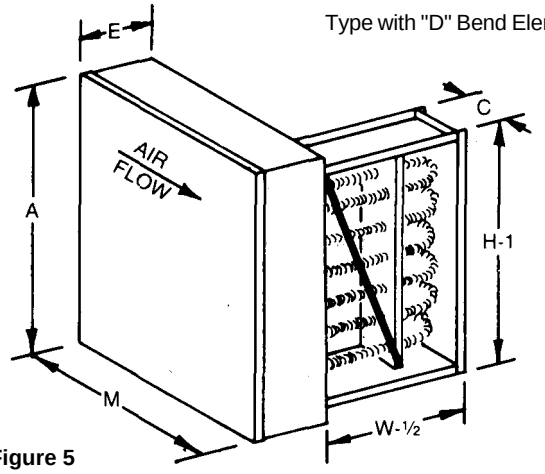


Figure 5

Model CHMS-3-F Flange
Type with "U" Bend Elements

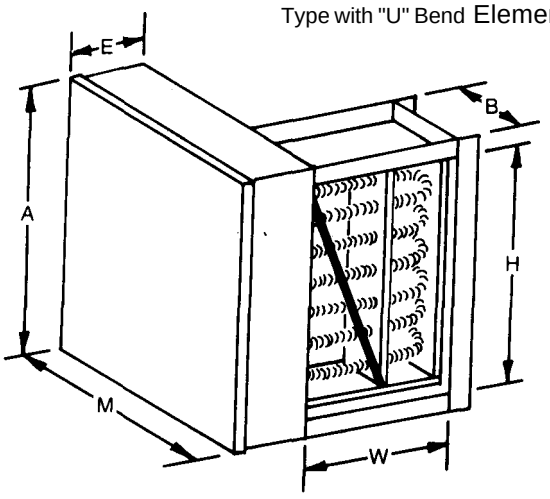
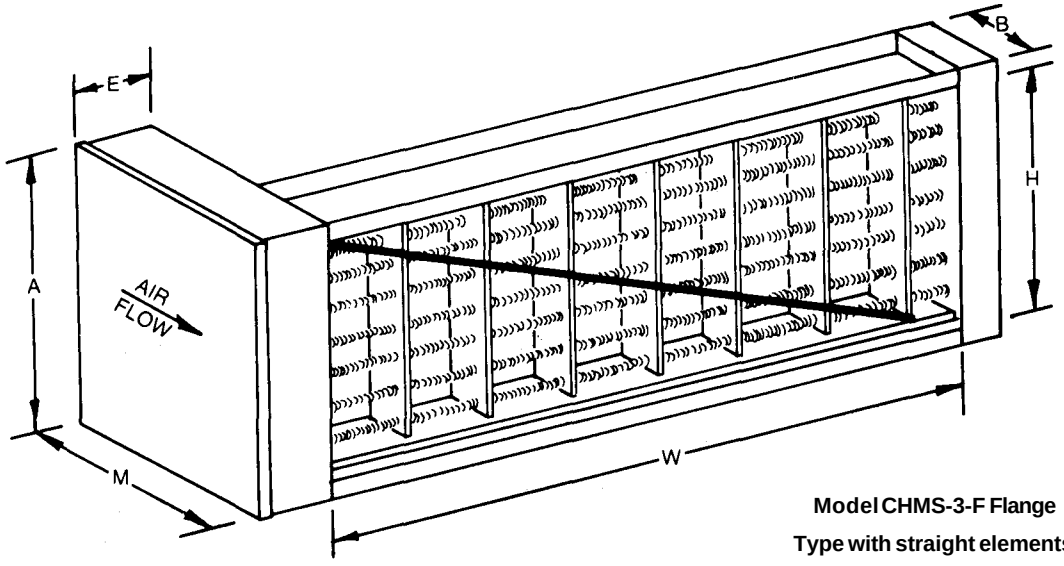


FIgure 6



Model CHMS-3-F Flange
Type with straight elements

Figure 7

MOUNTING POSITION

Both flange and insert type duct heaters are designed for installation in either horizontal ducts with terminal or control box at side (Fig. 8) 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 mustbe observed.

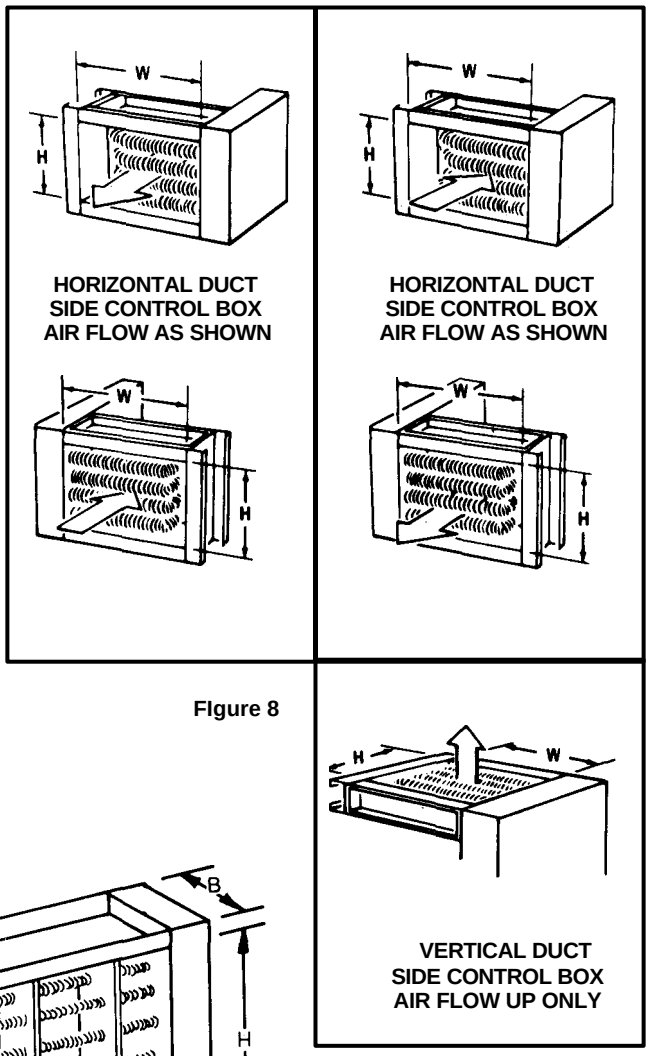


FIgure 8

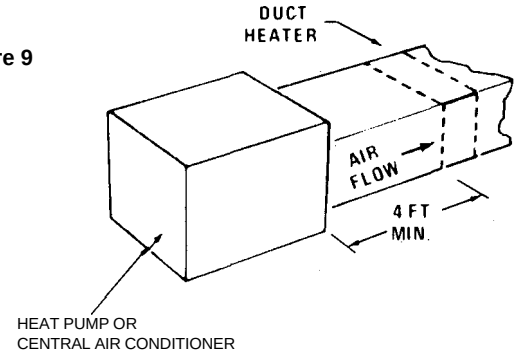
MOUNTING LIMITATIONS

Unlike hot water coils, electric duct heaters produce 100% of their heating capacity (regardless of airflow) 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.

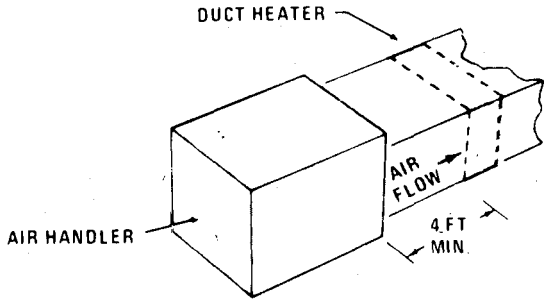
To aid in providing this minimum air velocity, follow the mounting limitations listed below.

Installing With Heat Pump or Central Air Conditioner. Refer to Figure 9.

Figure 9



Installing Near Air Handler Discharge. Refer to Figure 10.



Installing in Branch Duct Take-Off. Refer to Figure 11.

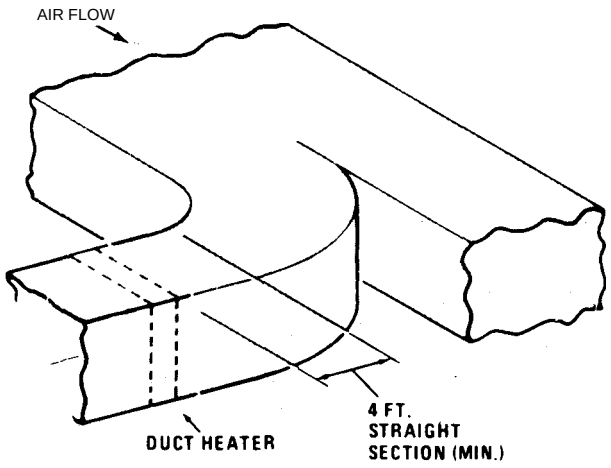


Figure 11

Installation Near Turns. (Refer to Figure 12). 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.

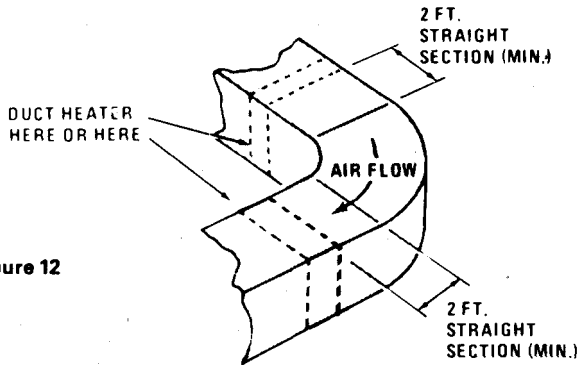


Figure 12

Installation in Internally Lined Ducts. See Figures 13, 14.

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.

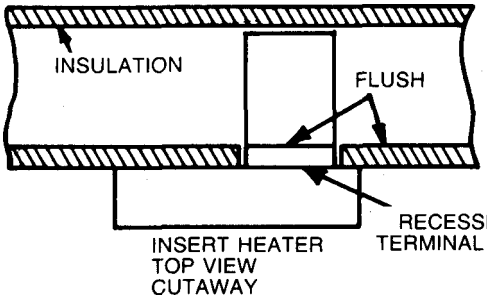


Figure 13

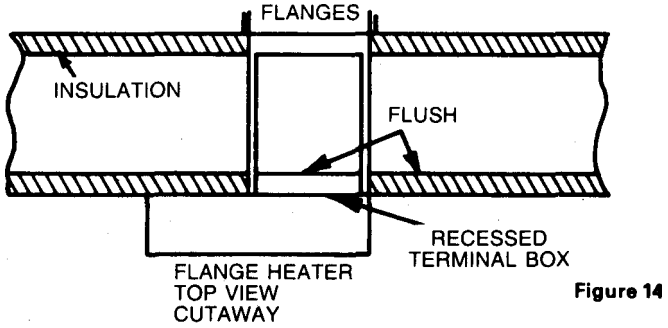


Figure 14

Installation with Dampers or Filters. Maintain at least 2 feet between duct heater and dampers, filter frames or other similar obstructions. (Refer to Figure 15.)

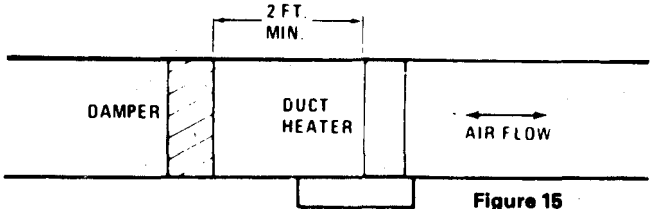
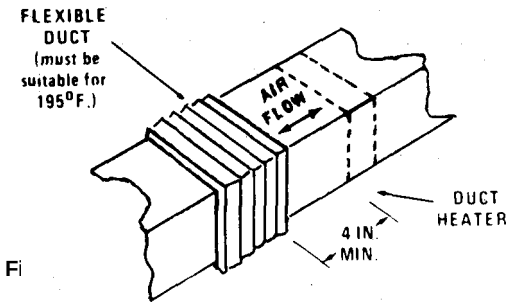


Figure 15

Installation With Flexible Duct. Where a duct heater must be installed near a flexible duct connection, be certain that a 4" minimum distance between duct heater and flexible connector exists and that the connector is suitable for 195ºF temperatures. (Refer to Figure 17.)



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Do Not Install Duct Heaters Outdoors. Duct heaters cannot be installed with roof top equipment where they are exposed to the weather.

ZERO CLEARANCE

Zero clearance between the flange type heater frame or between duct and surrounding combustible building material is permissible. However, adequate clearance for service or inspection must be provided around the terminal or control box and, if the ductwork is to be installed, the insulation must not cover any part of the terminal box.

NOTE: Good engineering practice would normally allow some clearance between combustible surfaces and the duct heater.

CONTROL PANEL SIZES

In manufacturing CHMS control panels, the size is determined by the duct height and the number of finned tube elements. Also of great importance is the number of control options built into the panel. We must allow a certain square inch area for each control component per U.L. Contact the factory for dimensions if space for control panel is limited or if your application has a small duct height with multiple stages and lots of control options.

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.

DUCT HEATER PRESSURE DROP CURVE

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

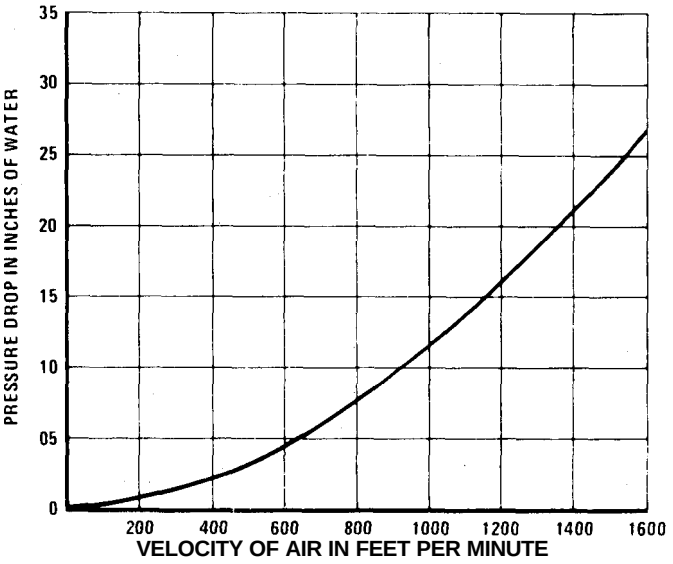


Figure 18 BASED ON ONE ROW OF U-BEND ELEMENTS

HEATER WEIGHTS

Heater weights vary according to the heater type, dimensions and the number of control accessories selected. With larger heaters, diagonal braces may be required to support the ductwork and heater.

CHMS-3-1 DUCT HEATER (LESS OPTIONAL CONTROLS)

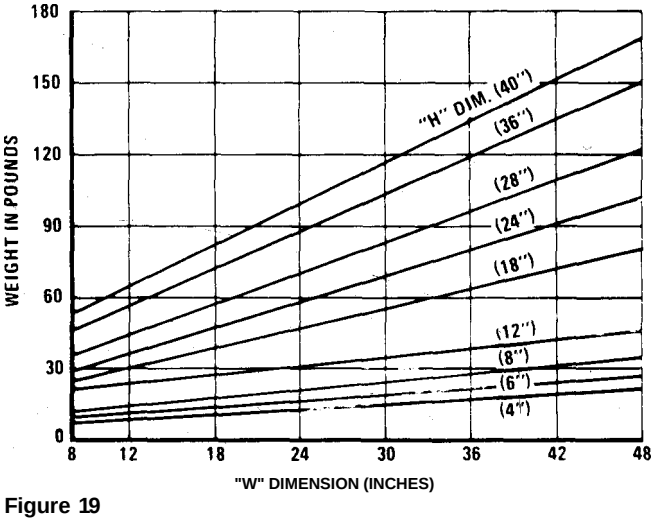


Figure 19

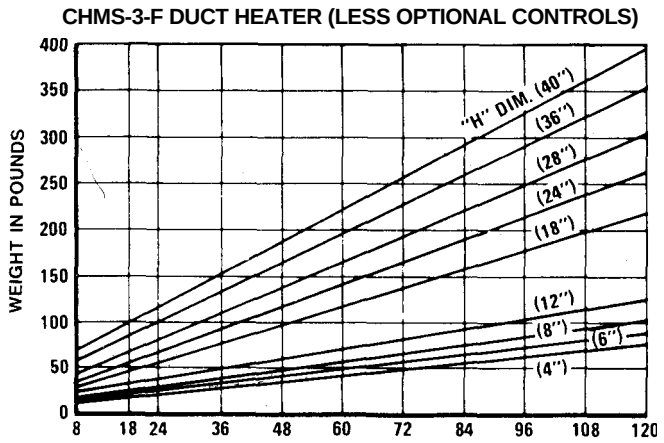


Figure 20 "W" DIMENSIONS (INCHES)

NOTE: The weights shown in figures 19 and 20 are for estimating purposes only. The actual heater weights may vary considerably.

Safety Protection

OVERTEMPERATURE PROTECTION

Markel Metal Sheath Duct Heaters have been designed to fulfill the safety protection required by the National Electric Code and the space heating requirements of Under writer's Laboratories and Applied Research Laboratories.

Primary Overtemperature Protection (Automatic Reset)

This requirement is satisfied by an automatic reset thermal cutout wired in control circuit which limits delivered air temperature to 210ºF.

For single-phase heaters and all three-phase heaters, the cutout must be wired in series with the staging contactor holding coil. (See Figure 21)

Secondary Overtemperature Protection (Manual Reset)

This requirement is satisfied by a manual reset thermal cutout, single (1) pole pilot duty device and must be used in conjunction with back-up contactors on all heaters. This capillary manual resettable device limits temperature to 240ºF.

On any single (1) phase application back-up contactors must be used (See Figure 23).

For larger loads, one or more back-up contactors controlled by only the manual reset cutout, are required. (See Figure 21).

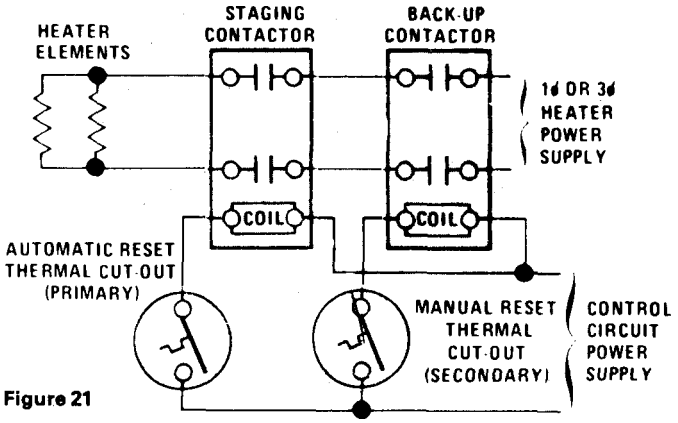


Figure 21

ZERO CLEARANCE.

U.L. 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 U.L. listed for zero clearance. However, good engineering practice would normally allow some clearance between combustible surfaces and the duct heater.

CALCULATION OF LINE CURRENTS (AMPS)

$$\text{(AMPS) SINGLE PHASE CURRENT} = \frac{\text{Watts}}{\text{Volts}}$$

Example: Single phase 5 KW, 208 Volts

$$\frac{5000 \text{ Watts}}{208 \text{ Volts}} = 24 \text{ Amps}$$

$$\text{THREE PHASE CURRENT} = \frac{\text{Watts}}{\text{Volts} \times 1.73}$$

Example: Three phase 14.4 KW, 208 Volts

$$\frac{14400 \text{ Watts}}{208 \text{ Volts} \times 1.73} = \frac{14400}{360} = 40 \text{ Amps}$$

When a given temperature rise is required and the C.F.M. is known the approximate required K.W. may be determined by usinq the following formula.

$$\text{K.W.} = \frac{\text{C.F.M.} \times \text{T.R.}}{3150}$$

Approximate temperature rise of a duct heater may be calculated if the K.W. and C.F.M. are known by using the following formula.

$$\text{T.R.} = \frac{\text{K.W.} \times 3150}{\text{C.F.M.}}$$

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

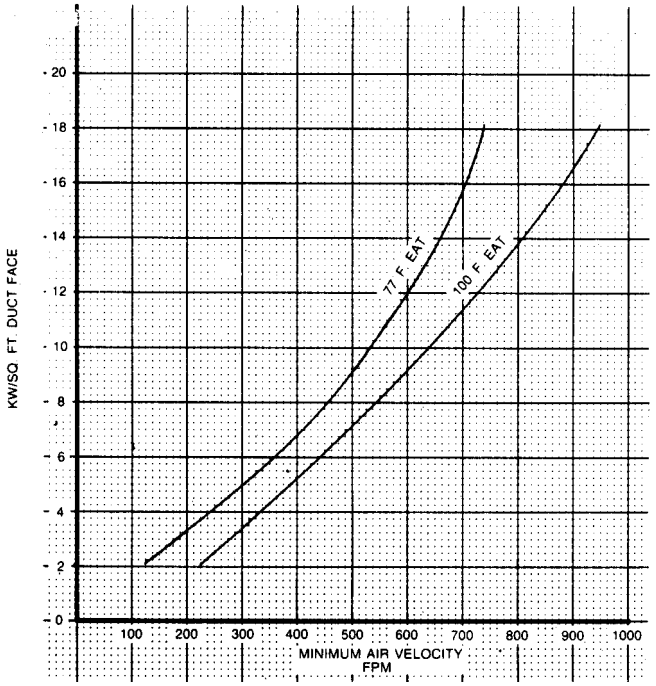
$$\text{Watt Density} = \frac{\text{Duct heater total K.W.}}{\text{Duct heater face area in sq. ft.}}$$

To convert C.F.M. to F.P.M. use the following formula

$$\text{F.P.M.} = \frac{\text{C.F.M.}}{\text{Duct area sq. ft.}}$$

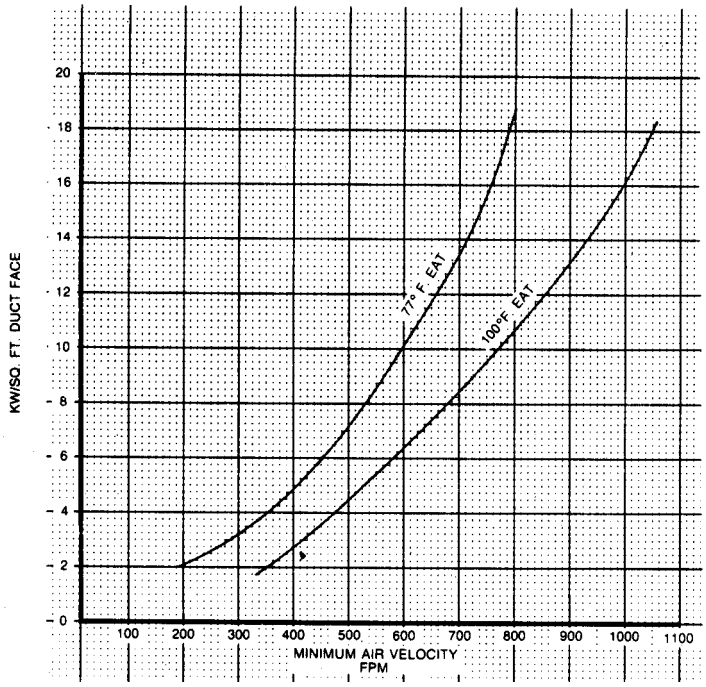
CHMS MINIMUM AIR VELOCITY
VS. KW/SO. FT. FOR
HORIZONTAL AIRFLOW

Figure 22. Horizontal air flow



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

Figure 23. Vertical up air flow



The following information is a guide in controlling electric duct heaters for comfort applications. When the application employs the use of a temperature control contractor, be sure to follow this recommendations explicitly.

DETERMINING NUMBER OF STAGES REQUIRED

In order to achieve modulating control of the heater, it is possible to specify multiple heating steps or stages. Normally, the number of stages available depends upon the number of Fintubes per heater.

TABLE A
Possible number of elements per stage

Number of stages	1	2	3	4	5	6	7	8	9
Single Phase	1-2-3	2-4.6	3.6-9	4-8-12	5-10-15	6-12-18.	7-14	8-16	9-18
Three Phase	3-6-9	6-12-18	9-18-27	12-24-36	15-30-45	18-36	14.28	24-48	27-54

NOTE: This table illustrates possible number of element combinations for phase and number of stages,

Method 1. Based on 48 Amperes per Stage.

The National Electrical Code requires a maximum of 48 amperes per heater circuit. Choosing the number of stages equal to the number of 48 ampere circuits will normally produce the lowest cost heater. This method, however, has little or no bearing on the degree of temperature control that will result in the space.

Method 2. Based on Temperature Control Desired.

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 (At) across the duct heater. The air temperature leaving the heater minus the air temperature entering the heater is the At variable, and a most important consideration in controlling space temperature swing. (See Table 1).

Table 1 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.*

Table 1

Space Temperature Control

T (Temperature Rise)	Temperature Control	Approx. Space Temperature Swing
Variable (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

ELECTRICAL DESIGN

Power Wire Sizing:

If a long run of wire is required or more than three wires are run in a conduit the allowable capacity on a given wire size must be reduced as per NEC requirements (see note 13 to NEC Table 310-16 and 310-18).

MAXIMUM AMP LOAD ALLOWED ON VARIOUS WIRE SIZES FOR FIELD WIRING TO DUCT HEATERS
De-Rated 20%

AWG - MCM Wire Size	Temperature Rat			
	75 ºC		90 ºC	
	Copper	Aluminum	Copper	Aluminum
14	12	--	20	--
12	16	12	24	20
10	24	20	32	24
8	36	32	40	32
6	52	40	56	44
4	68	52	72	56
3	80	60	84	64
2	92	72	96	76
1	104	80	112	88
0	120	96	124	100
00	140	118	148	116
000	160	124	168	132
0000	184	144	188	148
250	204	164	216	172
300	228	184	240	192
350	248	200	260	208
400	268	216	288	232
500	304	248	324	264

HEATER POWER CIRCUITRY

See wiring diagrams for details of the various wiring systems mentioned below.

All stages of a heater are of equal KW unless specified otherwise.

1 - Single phase power circuits: Each circuit consists of a heating coil (or coils connected parallel) which cannot exceed 48 amp for over-current protection.

A single stage heater may be controlled directly by a line voltage thermostat without using a controlling contactor if the heater rating is within the rating of the thermostat, the over-temperature protection controls of the fan interlock.

Larger loads are controlled by contactors, S.C.R. controllers or load carrying step controllers.

2 - Balanced Three Phase Power Circuits: Each circuit cannot exceed 48 amp for over-current protection and consists of three (or a multiple of three) heating coils factory connected in delta or wye system at the factory's option. The load will be balanced (equal) among the three phases and the entire circuit is controlled as a unit and operates identically whether the power source is three or four wire. Therefore a neutral terminal is not furnished on balanced circuits.

Each circuit is normally controlled by a contactor which in turn is controlled by a thermostat or step controller in the control circuit.

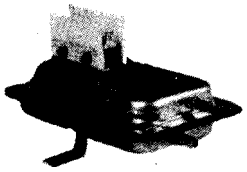
TABLE2

Table 3
Maximum Number of Conductors in Trade Size of Conduit or Tubing
(Based of Table 1, Chapter 9)

Conduit Trade Size (Inches)		½	%	1	1¼	1½	2	2½	3	3½	4	4½	5	6
Type Letters	Conductor Size AWG, MCM													
RHW and RHH	14	6	10	16	29	40	65	93	143	192				
(without outer	12	4	8	13	24	32	53	76	117	157				
Covering,	10	4	6	11	19	26	43	61	95	127	163			
THW	8	1	3	5	10	13	22	32	49	66	85	106	133	
TW,	6	1	2	4	7	10	16	23	36	48	62	78	97	141
T,	4	1	1	3	5	7	12	17	27	36	47	58	73	106
THW,	3	1	1	2	4	6	10	15	23	31	40	50	63	91
RUH (6 thru 2),	2	1	1	2	4	5	9	13	20	27	34	43	54	78
RUW (6 thru 2),	1		1	1	3	4	6	9	14	19	25	31	39	57
FEPB (6 thru 2),	0		1	1	2	3	5	8	12	16	21	27	33	49
RHW and	00		1	1	1	3	5	7	10	14	18	23	29	41
RHH (with-	000		1	1	1	2	4	6	9	12	15	19	24	35
Out outer	0000			1	1	1	3	5	7	10	13	16	20	29
covering)	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

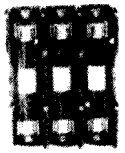
TYPICAL SAFETY CONTROLS

BUILT-IN FAN INTER-LOCK
Differential Pressure Switch
All models are .05 w.c. approx. Compact in size. models offer extremely low pressure sen sitivity. reliable operation, long life. This switch is wired in series with the Automatic Thermal cutouts to deenergize the entire heater in case of fan failure.



AUTOMATIC RESETTING TEMPERATURE LIMIT CONTROL (Primary) opens at 210ºF
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.

BUILT-IN FUSES DUAL ELEMENT TYPE
Power and Transformer Circuits
Meets all UL and NEC requirements. Blocks are available in one, two. and three poles for class R, Type fuses rated from 10 thru 60 AMP for 120 thru 600 volts. Blocks are phenolic. made to resist chips, cracks and temperatures above normal with maximum protection between fuses,

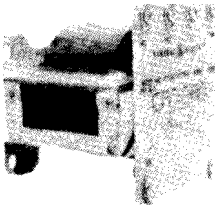


SECONDARY TEMPERATURE LIMIT CONTROL
Capillary Type Manual Resettable Cutout
Temperature to open 240 degree F. Primarily used for back-up system. Controlling back-up magnetic contactors.

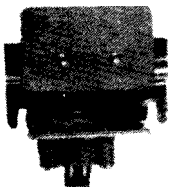
TYPICAL OPTIONAL CONTROL COMPONENTS

Electric Step Controllers: This built-in modulating electric step controller was developed especially for use in duct heaters and has a 150 degree F ambient temperature rating. Standard time cycle for 10 switches to come on is 13 minutes. Built-in recycle relay prevents entire load from coming on at once after power failures. Switches are rated for pilot duty only (up to 240V) and must be used to control contactors. Specify holding coil voltage of 120V, 208V or 240V. For 480V line voltage applications, specify a 480V/120V transformer.

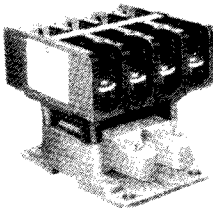
TRANSFORMERS
For units where a separate control voltage is not available or a savings in bringing in supplies is desired. This machine tool type transformer is a heavy duty unit with primaries of 208, 240 to 480V AC and secondaries of 120 and 24V AC. Units are available form50 to 250V A,



PNEUMATIC-ELECTRIC SWITCHES (P.E.)
When a pneumatic control system is being used and P.E. switches are required to control the heater or to operate the controlling contactors within the duct heater, the P.E. switches. in many cases, may also be built-in and factory wired. This leaves only the tubing connections and adjustment to be done in the field by the controls people,



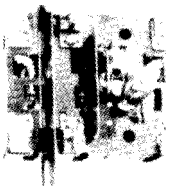
DEFINITE PURPOSE CONTACTOR
For single and three phase applications. Heavy duty contact and encapsulated coil — resists oil, dirt, moisture and mechanical damage. Available in two, three and four pole, 25 amp. 30 amp, 40 amp and 50 amp. Coils available from 24 to 277 volts. Coil data; 8.8 VA holding. 77 VA in rush.



TIME DELAY

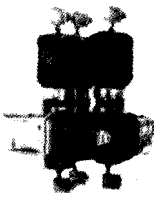
Time Dela, Relay type 24A11. 25 Second Delay. Switc 1 rating 25 amp, 250 voltage maximum. Timer draws .15 amp for anticipator setting.

DISCONNECT SWITCH
Fused or 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.



MERCURY CONTACTOR

When noise is a definite factor this type of contactor should be used, Available in one, two, and three pole. Also used for frequent cycle duty with proportioning controllers and similar devices requiring fact cycling. Available with coil voltages of 120, 208,240,277 and 24. Contact Ratings are: 30 & 60 AMP at 120 Volt; 30 & 50 AMP at 240 Volt: 20 & 40 AMP at 480 Volt



CIRCUIT BREAKER
When breakers are required, they are available in current ratings of 20, 30, 40, 50 and 60 amperes and voltage ratings of 250, 480 and 600. Optional feature is available, factory wired in the control compartment or remote.

ECONOMICS OF HEATER SELECTION

Where economy is an important objective in the selection of a duct heater, there are two general rules that canbe followed.

1. Selecting higher wattage Fintube elements will reduce the cost of the heater, since the higher the wattage per Fintube the fewer the number of Fintubes required.
2. Although normal application seldom requires more than three stages of heat, many stages are possible. The number of stages chosen depends upon the degree and frequency of heating load fluctuations and their associated control components. Here the importance of precise temperature control should be weighted against the higher cost of multiple stage heaters.See page 8 for temperature control guidelines.

HOW TO SELECT DUCT HEATERS

The Markel Metal Sheath Duct Heater is available in U.L. Listed capacities to and "W" x "H" dimensions to 240" x 96"

This duct heater line features an integral control panel with standard control options which includes contactors, fuses, transformers, step controllers, air flow switches, and disconnect switches.

SELECTION PROCEDURE

A particular duct heater is first selected to fit the duct dimensions and provide necessary kw heat output at a given voltage. Further selection defines the heater type (insert or flange) and the mounting position. Finally, the selection defines the number of heating stages, the control circuit voltage and built-in or remote optional controls.

Step 1 — SELECTING BASIC HEATER

Knowing...
Duct Size .....
Entry of Heater into duct } Available W & H dimensions

Required kw capacity ..... .Available kw capacity*
Required voltage ..... .Available voltage

Step 2 — VERIFY MINIMUM AIR FLOW VELOCITY

Knowing...	**Check...**
Entering Air Temperature	Minimum Air Flow
Design Duct Air Flow Velocity	Velocity From Tables

If actual or design duct air velocity is less than minimum air velocity, go back to Step 1 and select a heater with a lower kw rating.

NOTE: The minimum air velocity is not an average velocity but the minimum required at any point across the duct heater.

Step 3 — DETERMINE HEATER MOUNTING

Knowing...	**Select…**
Duct Size	Insert Mounting, Standard Flange Mounting, Optional
Duct Orientation	Mounting position (Figure 8)

If no special construction is required, this completes the selection of the basic heater including heating elements, thermal cutouts, and terminal box.

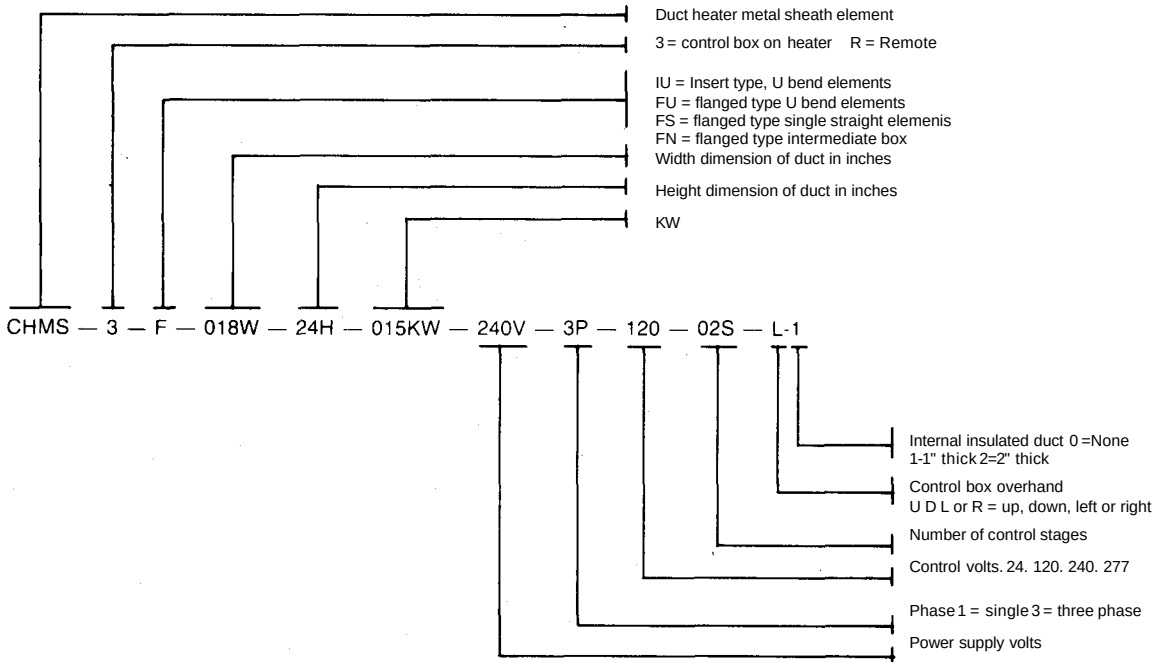
Step 4 — OPTIONAL BUILT-IN CONTROLS (Installed only when specified)

De-energizing Contactor
Disconnecting Contactor
Mercury Contactor
Electric Step Controller
Pneumatic Step Controller
SCR Controller
P.E. Switch
Transformer w/pri. fusing
Transformer w/pri. & sec. fusing
Differential Pressure Switch
Fan Interlock Relay
Fusing Dual Element
Circuit Breaker
Fused Disconnect Switch
Unfused Disconnect Switch
Dust Proof Enclosure
80/20 'A' Elements
Derated Elements
Protective Screen
Time Delay
Cover Interlock Switch
Pilot Lights
Pilot Switch
Back-up Contactors (required)

EXAMPLE

CHMS heaters are specified by model numbers. Below is an example model number.

MODEL NUMBER DESIGNATIONS



*You need only to specify insert or flanged type.

Designer please note: Much time and effort has gone into making our "CHMS" line a true custom product. Be aware that U.L. limits us to 18.1 KW** per sq. ft. of clear duct area. Watt density equals duct heater total KW divided by duct clear area in square feet.

$$\frac{KW}{sq.\ ft.} = KW/sq\ ft.)$$

* * This is one of highest ratings In the industry.

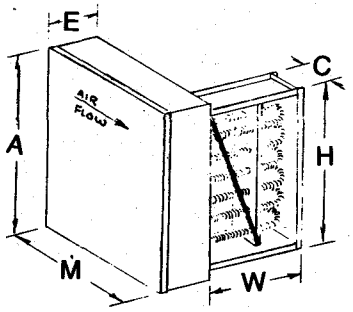
CHMS SERIES

Metal Sheath Element Electric Duct Heater SUBMITTAL

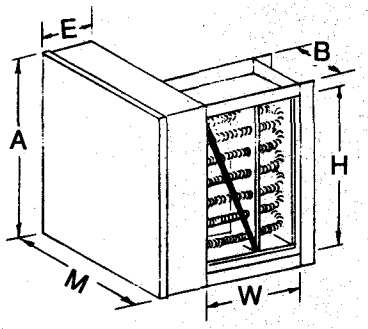
submittal # 050591 A

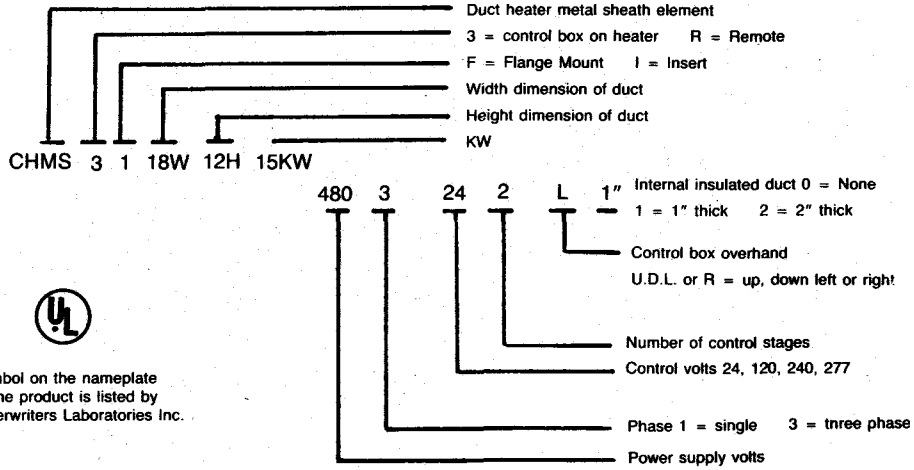
AGENT	PROJECT	DATE
CUSTOMER	CONTRACTOR	
ARCHITECT	ENGINEER	
APPROVED	APPROVED AS NOTED	
REMARKS		P.O. NUMBER

CHMS INSERT TYPE



CHMS FLANGED TYPE





This symbol on the nameplate means the product is listed by the Underwriters Laboratories Inc.

TAG	QTY.	KW	LINE VOLTS	PHASE	NO. OF STEPS	Control VOLTS	W	H	M	A	E	C B	CATALOG NUMBER

CHMS series heaters include capillary automatic reset Primary over temperature protection: capillary manual reset and backup contactors for secondary over temperature protection.

OPTIONAL CONTROLS:_____

_____

_____

_____

REMOTE CONTROL PANEL (When specified)

TAG	QTY	A	M	E	NEMA Type

CHMS SERIES

SUGGESTED SPECIFICATIONS

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 as per schedule.
3. Heaters to be either slip-in or flanged type as called for on schedule.
4. All heaters to be U.L. listed for zero clearance to combustible surfaces and bear U.L. 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 as well as 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, rockhard refractory material, surrounded by a 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 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 automative reset thermal cutout. Capillary cut-out shall be U.L. listed and of the fail safe type.
2. Secondary overtemperature 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 heater face.
4. Overcurrent protection incorporating fuses or circuit breakers must be provided for all heaters rated more than 48 amperes, a 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 subcircuits (as allowed by states) of less than 48 amperes and be protected at not more than 60 amperes. The main conductors supplying these overcurrent protection devices are considered branch circuit conductors and are subject to the 125% ampere rating rule of NEC.

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.

TOTAL AMPERAGE RATING CHART

K.W. Rating	B.T.U.H.	208 AMP	Volts Rating	220 AMP	Volts Rating	230 AMP	Volts Rating	240 AMP	Volts Rating	277 Volts AMP Rating	440 Volts AMP Rating	480 Volts AMP Rating	550 Volts AMP Rating
		1 PH	3PH	1 PH	3 PH	1 PH	3 PH	1 PH	3 PH	1 PH	3 PH	3 PH	3 PH
0.5	1,706	02.4	01.4	02.3	01.3	02.2	01.3	02.1	01.2	01.8	0.7	0.6	0.5
1.0	3,413	04.8	02.8	04.5	02.6	04.3	02.5	04.2	02.4	03.6	1.3	1.2	1.0
2.0	6.826	09.6	05.6	09.1	05.2	08.7	05.0	08.3	04.8	07.2	2.6	2.4	2.1
3.0	10,239	14,4	08.3	13.6	07.9	13.0	07.5	12.5	07.2	10.8	3.9	3.6	3.1
4.0	13,652	19.2	11.1	18.2	10.5	17.4	10.0	16.7	09.6	14.4	5.2	4.8	4.2
5.0	17,065	24.0	13.9	22.7	13.1	21.7	12.6	20.8	12.0	18.1	6.6	6.0	5.2
6.0	20,478	28.8	16.7	27.3	15.7	26.1	15.1	25.0	14.4	21.7	7.9	7.2	6.3
7.0	23,891	33.7	19.4	31.8	18.4	30.4	17.6	29.2	16.8	25.3	9.2	8.4	7.3
8.0	27,304	38.5	22.2	36.4	21.0	34.8	20.1	33.3	19.2	28.9	10.5	9.6	8.4
9.0	30,717	43.3	25.0	40.9	23.6	39.1	22.6	37.5	21.7	32.5	11.8	10.8	9.4
10.0	34,130	48.1	27.8	45.5	26.2	43.5	25.1	41.7	24.1	36.1	13.1	12.0	10.5
11.0	37,543	52.9	30.5	50.0	28.9	47.8	27.6	45.8	26.5	39.7	14.4	13.2	11.5
12.0	40,956	57.7	33.3	54.5	31.5	52.2	30.1	50.0	28.9	43.3	15.7	14.4	12.6
13.0	44,369	62.5	36.1	59.1	34.1	56.5	32.6	54.2	31.3	46.9-	17.1	15.6	13.6
14.0	47.782	67.3	38.9	63.6	36.7	60.9	35.1	58.3	33.7	50.5	18.4	16.8	14.7
15.0	51,195	72.1	41.6	68.2	39.4	65.2	37.7	62.5	36.1	54.2	19.7	18.0	15.7
16.0	54,608	76.9	44.4	72.7	42.0	69.6	40.2	66.7	38.5	57.8	21.0	19.2	16.8
17.0	58,021	81.7	47.2	77.3	44.6	73.9	42.7	70.8	40.9	61.4	• 22.3	20.4	17.8
18.0	61.434	86.5	50.0	81.8	47.2	78.3	45.2	75.0	43.3	65.0	23.6	21.7	18.9
19.0	64,847	91.3	52.7	86.4	49.9	82.6	47.7	79.2	45.7	68.6	24.9	22.9	19.9
20.0	68,260	96.2	55.5	90.9	52.5	87.0	50.2	83.3	48.1	72.2	26.2	24.1	21.0
21.0	71,673	101.0	58.3	95.5	55.1	91.3	52.7	87.5	50.5	75.8	27.6	25.3	22.0
22.0	75,086	105.8	61.1	100.0	57.7	95.7	55.2	91.7	52.9	79.4	28.9	26.5	23.1
23.0	78,499	110.6	63.8	104.5	60.4	100.0	57.7	95.8	55.3	83.0	30.2	27.7	24.1
24.0	81.912	115.4	66.6	109.1	63.0	104.3	60.2	100.0	57.7	86.6	31.5	28.9	25.2
25.0	85,325	120.2	69.4	113.6	65.6	108.7	62.8	104.2	60.1	90.3	32.8	30.1	26.2
26.0	88,738	125.0	72.2	118.2	68.2	113.0	65.3	108.3	62.5	93.9	34.1	31.3	27.3
27.0	92.151	129.8	74.9	122.7	70.9	117.4	67.8	112.5	65.0	97.5	35.4	32.5	28.3
28.0	95,564	134.6	77.7	127.3	73.5	121.7	70.3	116.7	67.4	101.1	36.7	33.7	29.4
29.0	98,977	139.4	80.5	131.8	76.1	126.1	72.8	120.8	69.8	104.7	38.1	34.9	30.4
30.0	102,390	144.2	83.3	136.4	78.7	130.4	75.3	125.0	72.2	108.3	39.4	36.1	31.5
31.0	105,803	149.0	86.0	140.9	81.4	134.8	77.8	129.2	74.6	111.9	40.7	37.3	32.5
32.0	109,216	153.8	88.8	145.5	84.0	139.1	80.3	133.3	77.0	115.5	42.0	38.5	33.6
33.0	112.629	158.7	91.6	150.0	86.6	143.5	82.8	137.5	79.4	119.1	43.3	39.7	34.6
34.0	116,042	163.5	94.4	154.5	89.2	147.8	85.3	141.7	81.8	122.7	44.6	40.9	35.7
35.0	119,455	168.3	97.2	159.1	91.9	152.2	87.9	145.8	84.2	126.4	45.9	42.1	36.7
36.0	122,868	173.1	99.9	163.6	94.5	156.5	90.4	150.0	86.6	130.0	47.2	43.3	37.8
37.0	126,281	177.9	102.7	168.2	97.1	160.9	92.9	154.2	89.0	133.6	48.6	44.5	38.8
38.0	129.694	182.7	105.5	172.7	99.7	165.2	95.4	158.3	91.4	137.2	49.9	45.7	39.9
39.0	133.107	187.5	108.3	177.3	102.4	169.6	97.9	162.5	93.8	140.8	51.2	46.9	40.9
40.0	136,520	192.3	111.0	181.8	105.0	173.9	100.4	166.7	96.2	144.4	52.5	48.1	42.0
41.0	139,933	197.1	113.8	186.4	107.6	178.3	102.9	170.8	98.6	148.0	53.8	49.3	43.0
42.0	143,346	201.9	116.6	190.9	110.2	182.6	105,4	175.0	101.0	151.6	55.1	50.5	44.1
43.0	146,759	206.7	119.4	195.5	112.8	187.0	107.9	179.2	103.4	155.2	56.4	51.7	45.1
44.0	150,172	211.5	122.1	200.0	115.5	191.3	110.5	183.3	105.9	158.8	57.7	52.9	46.2
45.0	153,585	216.3	124.9	204.5	118.1	195,7	113.0	187.5	108.3	162.5	59.0	54.1	47.2
46.0	156,998	221.2	127.7	209.1	120.7	200.0	115.5	191.7	110.7	166.1	60.4	55.3	48.3
47.0	160,411	226.0	130.5	213.6	123.3	204.3	118.0	195.8	113.1	169.7	61.7	56.5	49.3
48.0	163,824	230.8	133.2	218.2	126.0	208.7	120.5	200.0	115.5	173.3	63.0	57.7	50.4
49.0	167.237	235.6	136.0	222.7	128.6	213.0	123.0	204.2	117.9	176.9	64.3	58.9	51.4
50.0	170,650	240.4	138.8	227.3	131.2	217.4	125.5	208.3	120.3	180.5	65.6	60.1	52.5
51.0	174.063	245.2	141.6	231.8	133.8	221.7	128.0	212.5	122.7	184.1	66.9	61.3	53.5
52.0	177.476	250.0	144.3	236.4	136.5	226.1	130.5	216.7	125.1	187.7	68.2	62.5	54.6
53.0	180,889	254.8	147.1	240.9	139.1	230.4	133.0	220.8	127.5	191.3	69.5	63.8	55.6
54.0	184,302	259.6	149.9	245.5	141.7	234.8	135.6	225.0	129.9	194.9	70.9	65.0	56.7
55.0	187,715	264.4	152.7	250.0	144.3	239.1	138.1	229.2	132.3	198.6	72.2	66.2	57.7
56.0	191,128	269.2	155.4	254.5	147.0	243.5	140.6	233.3	134.7	202.2	73.5	67.4	58.8
57.0	194,541	274.0	158.2	259.1	149.6	247.8	143.1	237.5	137.1	205.8	74.8	68.6	59.8
58.0	197,954	278.8	161.0	263.6	152.2	252.2	145.6	241.7	139.5	209.4	76,1	69.8	60.9
59.0	201.367	283.7	163.8	268.2	154.8	256.5	148.1	245.8	141.9	213.0	77.4	71.0	61.9
60.0	204,780	288.5	166.5	272.7	157.5	260.9	150.6	250.0	144.3	216.6	78.7	72.2	63.0