Refrigeration, Heating & Air Conditioning

Electric Heat Fundamentals and Maintenance Procedures

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Bryan, Ohio 43506

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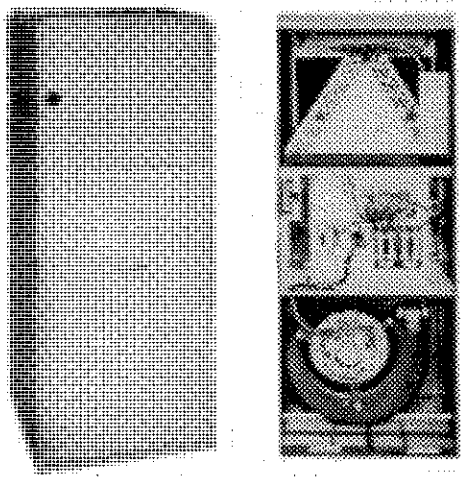
Electric heat is the 100% conversion of electrical energy to heat energy. Because no fuel is burned in an electric furnace, there is no need for a chimney or vent to channel combustion by-products outdoors. This allows for greater safety of operation and greater flexibility in installation and location of the unit.



Cutaway of typical electric furnace

Supply Power

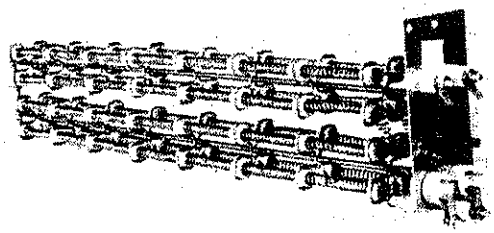
Line voltage entering an electric furnace at the main disconnect switch is 240V ac. 240V electrical service consists of two 120V "hot wires" and one neutral wire, all encased in conduit. Where supply voltage enters the furnace, there is a sub-fusing box or circuit breakers wired into each hot wire. These serve as safety devices, protecting the unit from wiring overloads or short circuits. If an overload occurs, the fuses will blow or the circuit breakers will trip, de-energizing the operation of the furnace.

A stepdown transformer converts the high voltage to 24V ac which is necessary for the thermostat connection and associated control devices in the furnace.

Heat Elements

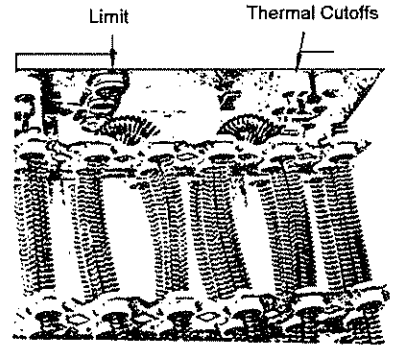
The function of the line voltage heating element is to generate heat. An alloy of nickel and chromium metals, a typical nichrome wire heating element is rated at 5 kilowatts (KW), although elements are available in other KW ratings. Wattage is a measurement of electrical power; the equivalent measurement for heat is British thermal units. One KW = 1,000 watts. Given there are 3.412 BTU's of heat per watt, a typical element will produce 17,060 BTU's of heat per hour. The formula for computing heat output generated by wattage is watts x 3.412 BTU's/watt = total BTU output. Most electric furnaces will have several elements, typically ranging between 2 and 6. The number of elements determines the heat capacity of the unit. The amperage draw per element is usually in the range of 15 - 22 amps.

In a properly operating unit, energized heat elements should never glow red, because the air routed over them by the blower absorbs heat. This means the furnace blower should always be energized just prior to or at the same time a heat element is energized. If the blower is not moving an adequate volume of air across the elements, overheating will occur. Overheating can cause the nichrome wire of the element to crystallize due to the frequent expansion and contraction of the metal. This can cause a break in the nichrome wire. The blower will be energized by a blower relay or heat contactor switch which energizes both blower and element at the same time.



Safety Limits and Thermal Cutoffs

In addition to the circuit-sensitive fuses or circuit breakers, an element furnace also has heat sensitive safety devices. These are temperature limits and thermal cutoffs, one for each heat element. The limit electrically de-energizes the heating element branch circuit when air temperature surrounding the element exceeds the setting, usually 120 to 170°. Possible causes of this could be restricted airflow due to a dirty filter, blower too small or running at too slow a speed, or an electrical malfunction with the blower circuit. The safety limit switch will automatically reset when the air temperature drops 15 to 30° below its break point allowing the heat element to be energized again. As long as there is a call for heat from the thermostat, the elements will continue to come on and cycle off on their respective limits. It is undesirable to allow this to persist, however, because of possible crystallization damage to the elements. An additional safety device called a thermal cutoff acts as backup safety switch in the event that the limit switch fails. A onetime safety device, the blown thermal cutoff must be replaced before the element will work again.



Staging of Heat Elements

Staging of electric heat elements is a popular energy saving feature. This is accomplished by means of a two-stage heating thermostat or a single or two-stage heating thermostat used in conjunction with a 24V outdoor thermostat (discussed in the thermostat section).

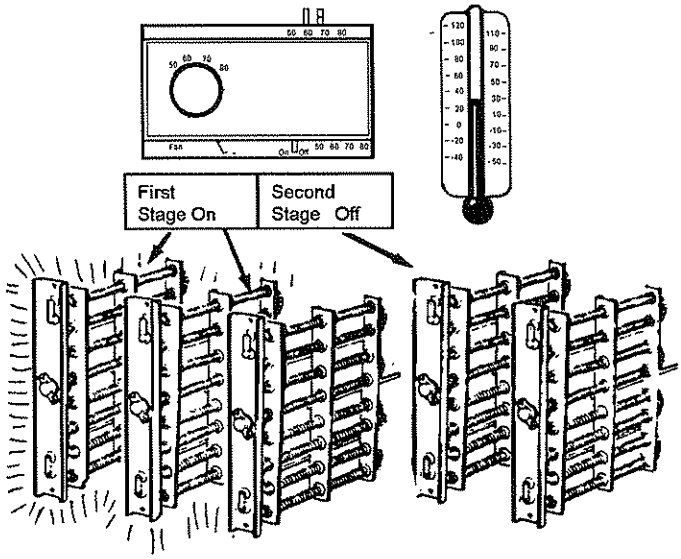
To illustrate the staging of elements, let's use a 5 element electric furnace. The first stage of heat controls elements 1 and 2 and the second stage controls elements 3, 4, and 5.

The first stage of heat, or 2 elements, operates when the thermostat calls for heat during periods of moderate outdoor temperature. The

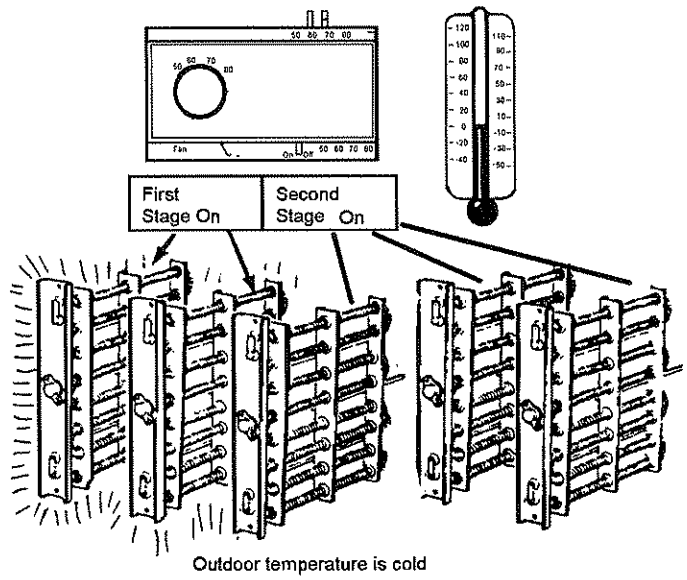
second stage, or elements 3, 4, and 5, is engaged only during periods of extreme cold when the first stage cannot satisfy the heating demand. Energy savings result because not all of the elements are energized every time there is a call for heat.

NOTE: The first stage will always be energized before the second stage of heat, while the second stage will always be satisfied and de-energized before the first stage.

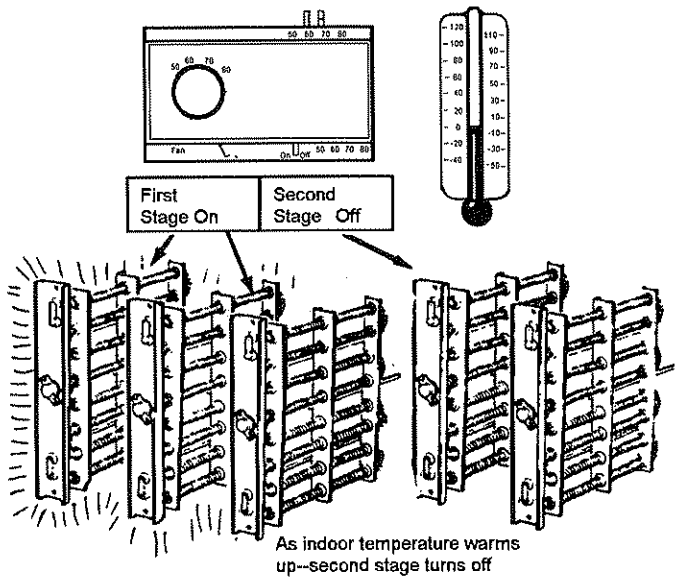
Due to the operation of the different control devices, elements will be on within each stage of heat. Also, a two-stage thermostat used in conjunction with an outdoor thermostat can provide 3 stages of heat. More than one outdoor thermostat may be used to deliver additional stages of heat. For example, a 6 element furnace, by use of multiple thermostats, could deliver 6 stages of heat if desired.



Outdoor temperature cool



Outdoor temperature is cold



As indoor temperature warms up--second stage turns off

Basic Maintenance Procedures

Below you will find the steps necessary to perform basic maintenance checks on an electric furnace. For common checks performed at the thermostat and in the furnace blower cabinet, refer to the previous section on Basic Systems, Components, and Maintenance Procedures.

Heat Section Checks

NOTE: Most electric heat elements are rated at 240V ac. Depending on the power company, supply voltage will normally register 208-240V. As supply voltage registers less than 240V, BTU output of the unit will decrease proportionately.

☐ Check all electrical wiring for loose connections and damaged insulation. **Be sure power is off at the unit disconnect switch when making these checks.**

1. Remove screws and take out vestibule panel. This exposes all wiring and fuse panel for the above check.

☐ Check amp draw as each heating element comes on.

NOTE: Blower must engage prior to or simultaneously with the first element.

1. Snap the amprobe around one hot wire in the furnace vestibule. Set amprobe so the face can be seen.
2. Turn on furnace disconnect and watch the indicator on the amprobe. There is no need to handle the amprobe while making this check. Since this is a high voltage area, avoid doing so, for safety reasons.
3. The amprobe indicator should make a definite 15 - 22 amp jump as each element comes on. The jumps should equal the number of elements in the furnace.

NOTE: If all elements do no come on, there could be two possible causes:

1. An electrical malfunction with a control device of the element or

2. The system has an outdoor thermostat which is holding out one or more elements (outdoor thermostat must be returned to initial set point).

☐ Check total unit amp draw and record.

1. When using amprobe, be sure total amp draw reading is taken on all wires running from power source to elements.
2. Turn off the furnace disconnect and remove amprobe.
3. Replace vestibule panel.
4. Replace front door.

NOTE: There is no limit check for basic maintenance electric, because of potential damage to the elements.

☐ With power on, check temperature rise through the furnace.

NOTE: The proper temperature rise will be listed on unit nameplate.

1. Make sure all doors are on furnace.
2. Place thermometer in supply plenum, positioned out of direct line of the heat element.
3. Place thermometer in return air plenum close to furnace.
4. There should be about 40°F - 70°F difference between the thermometer in the return air duct and the thermometer in the supply duct.
5. If the temperature difference is less than 40°F - 70°F, the blower is running too fast. Slow blower down.
6. If the temperature is more than 40°F - 70°F, the blower is running too slow. Speed blower up.

☐ Return outdoor thermostats to original settings, if present.

Built-In Cooling Coil Compartment — Slide-in type for easier conversion to summer cooling. Accommodates 1-1/2, 2, 2-1/2, and 3 ton cooling coils.

Controls — On demand from the wall thermostat, the heating elements are energized by electrical contactors. The 15 thru 30KW versions have the blower motor interlocked with each stage for safety. Easily two staged.

Limit Switch — Thermal snap disc in each heating element shuts off power automatically if system air temperature becomes excessive.

Built-In Transformer — Provides power supply for heating and optional cooling controls.

Blower Relay — Provides automatic blower speed changeover to meet heating and cooling air delivery requirements.

Branch Circuit Fusing — Factory installed in models rated over 48 amps.

Heating Elements — Nickel-chrome wire with individual fusible links for long life. Entire assembly slides out for easy maintenance.

Motor — Multi-speed for both heating and cooling.

Blower — Heated air is quietly circulated by large volume centrifugal blower that is matched to the electrical heating system for efficiency. Slides out for easy maintenance.

Filters — Twin permanent type slide out from front for easy cleaning on all models except Models EFC5 and EFC10.

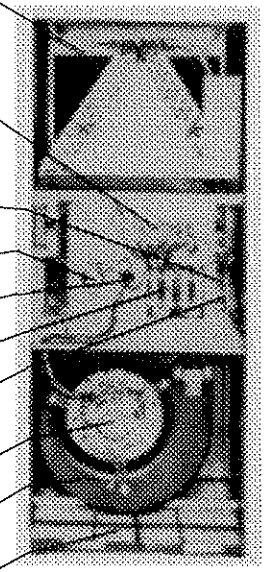
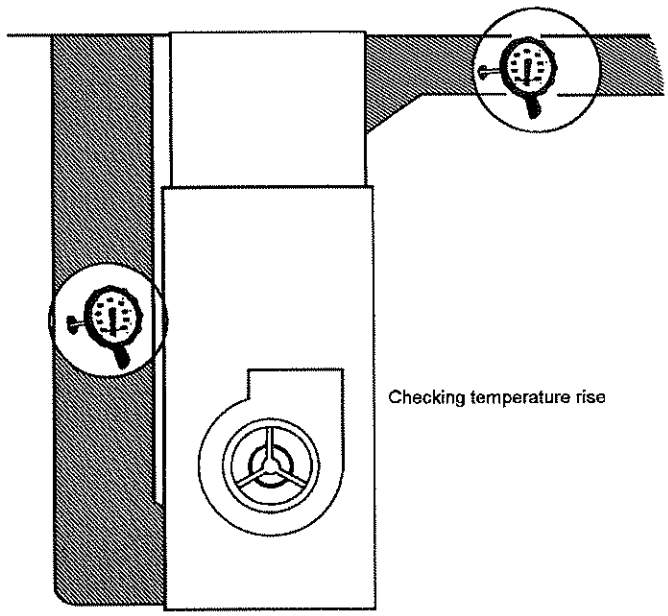


Table 1 — Wire Sizing Table

Wire Size AWG	Copper — 60°C Minimum Circuit Ampacity		Aluminum — 60°C Minimum Circuit Ampacity	
	3-Wires Per Conduit	6-Wires Per Conduit	3-Wires Per Conduit	6-Wires Per Conduit
#12	0 - 20A	0 - 16A	0 - 15A	0 - 12A
#10	21 - 30A	17 - 24A	16 - 25A	13 - 20A
#8	31 - 40A	25 - 32A	26 - 30A	21 - 25A
#6	41 - 55A	33 - 44A	31 - 40A	26 - 32A
#4	56 - 70A	45 - 56A	41 - 55A	33 - 45A
#3	71 - 80A	57 - 64A	56 - 65A	46 - 52A
#2	81 - 95A	65 - 76A	66 - 75A	53 - 60A
#1	96 - 110A	77 - 88A	76 - 85A	61 - 68A
#1/0	111 - 125A	89 - 100A	86 - 100A	69 - 80A
#2/0	126 - 145A	101 - 116A	101 - 115A	81 - 92A
#3/0	146 - 165A	117 - 132A	116 - 130A	93 - 104A

NOTE: All local codes must be observed.



Checking temperature rise

Table 2 — Electric Heater Table (KW vs. Voltage)

HEATER ① MODEL	240V KW	240V BTUH	240V AMP	230V KW	230V BTUH	230V AMP	220V KW	220V BTUH	220V AMP	208V KW	208V BTUH	208V AMP
4KW	4.0	13,652	16.7	3.68	12,560	16.0	3.36	11,468	15.3	3.0	10,239	14.4
5KW	5.0	17,065	20.8	4.6	15,700	20.0	4.2	14,335	19.1	3.75	12,799	18.0
8KW	8.0	27,304	33.3	7.36	25,120	32.0	6.72	22,935	30.5	6.0	20,478	28.8
10KW	10.0	34,130	41.6	9.2	31,400	40.0	8.4	28,669	38.2	7.5	25,598	36.1
12KW	12.0	40,956	50.0	11.04	37,680	48.0	10.08	34,403	45.8	9.0	30,717	43.3
15KW	15.0	51,195	62.5	13.8	47,099	60.0	12.6	43,004	57.3	11.25	38,396	54.1
20KW	20.0	68,260	83.3	18.4	62,799	80.0	16.8	57,338	76.4	15.0	51,195	72.1
25KW	25.0	85,325	104.2	23.0	78,499	100.0	21.0	71,673	95.5	18.75	63,944	90.1
30KW	30.0	102,390	125.0	27.6	94,199	120.0	25.2	86,008	114.5	22.5	76,793	108.2
9KW-3PH	9.0	30,717	21.7	8.28	28,260	20.8	7.56	25,802	19.8	6.75	23,038	18.7
12KW-3PH	12.0	40,956	28.9	11.04	37,680	27.7	10.08	34,403	26.5	9.0	30,717	25.0
15KW-3PH	15.0	51,195	36.1	13.8	47,099	34.6	12.6	43,004	33.1	11.25	38,396	31.2
18KW-3PH	18.0	61,434	43.4	16.56	56,519	41.6	15.12	51,605	39.7	13.5	46,076	37.5
24KW-3PH	24.0	81,912	57.8	22.08	75,359	55.4	20.16	68,806	52.9	18.0	61,434	50.0
30KW-3PH	30.0	102,390	72.2	27.6	94,199	69.3	25.2	86,008	66.1	22.5	76,793	62.4

① All heaters are rated at 240V nominal.

Note: The KW, BTUH and Amp change with the applied voltage.

Maintenance Checksheet

Dealer _____ Address _____

Customer _____ Address _____

Date _____ Person _____ Time In _____ Time Out _____

Equipment Make & Model _____

Notes _____

Pre-Service Check

☐ Customer satisfied with system performance _____

_____

☐ Customer dissatisfied with system performance _____

_____

Thermostat Checks

☐ Record thermostat settings: Temp.: _____ F

Mode: HEAT OFF COOL FAN ON AUTO

☐ Check terminal connections for tightness

☐ Clean bimetal. Inspect mercury switch

☐ Check thermostat for level

☐ Check control circuit amperage: _____ A

☐ If customer dissatisfied with temperature control in heating season, adjust anticipator to match control circuit amp draw

☐ Initiate appropriate seasonal demand from thermostat

Blower Compartment Checks

☐ Check supply voltage at junction box: _____ vac _____ time

☐ Check blower motor amperage: _____ A _____ nameplate rating

☐ Turn power at unit main disconnect to OFF

☐ Check all wiring for loose connections and bad insulation

☐ Clean or change filter

Direct Drive Blower

☐ Check blower bearings

☐ Lubricate blower bearings

☐ Clean blower and compartment

☐ Check blower wheel for free and balanced rotation

☐ Check all blower housing mounts and setscrews for tightness

☐ Unused motor leads taped and out of way

Belt Drive Blower

☐ Remove blower belt and check for wear

☐ Check motor bearings for wear

☐ Lubricate motor bearings

☐ Check blower wheel bearings for wear

☐ Lubricate blower wheel bearings

☐ Clean blower and compartment

☐ Check blower wheel for free and balanced rotation

☐ Check pulley alignment

☐ Check motor and blower pulley setscrews for tightness

☐ Put belt back on blower and motor pulley and check belt tension

☐ Check all blower housing and motor mounts for tightness

Heating Section Checks

Electric

☐ Check electrical wiring — connections and insulation

☐ Check amperage draw of each element

☐ Check total amperage draw of elements _____ amps

☐ Check temperature rise _____ F

☐ Return outdoor thermostats to original settings if present

Gas

☐ Check all electrical wiring for loose connections and damaged insulation

☐ Check burners for lint, dust and scale

☐ Check for cracks in heat exchanger

☐ Check furnace vent for size and deterioration

☐ Check for quiet, even burner ignition

☐ Check supply line gas pressure NAT _____ in. w.c. LP _____ in. w.c.

☐ Check manifold gas pressure NAT _____ in. w.c. LP _____ in. w.c.

Electronic Ignition Control

☐ Check electronic ignition control sequence of operation

☐ Check safety lockout _____ min.

☐ Check pressure switch _____

Standing Pilot

☐ Check pilot flame

☐ Check thermocouple open circuit _____ dcmv closed circuit _____ dcmv

☐ Check pilot valve safety drop-out time _____ min.

☐ Check automatic vent damper system

☐ Check limit safety

☐ Check temperature rise _____ °F

☐ Gas manifold hand valve is open before leaving

Oil

☐ Check electrical wiring — connections and insulation

☐ Inspect combustion chamber

☐ Inspect for soot in heat exchanger

☐ Change fuel oil tank for sludge/water

☐ Change oil line filter

☐ Check oil lines

☐ Service oil burner

☐ Conduct combustion efficiency test:

_____ in. w.c. smoke _____ % CO2 _____ °F net

☐ Check limit safety

☐ Check temperature rise

☐ Check primary control

☐ Check furnace vent for rust

Cooling

☐ Check electrical wiring — connections and insulation (indoor)

☐ Check/clean evaporator coil

☐ Check/clean condensation drain

☐ Check static pressure drop _____ in. w.c. _____ cfm (dry coil)

☐ Check wiring — connections and insulation (outdoor)

☐ Check/clean condenser coil

☐ Lubricate condenser fan motor

☐ Check line set and connections for evidence of leaks

☐ Check and record supply voltage

☐ Check refrigerant charge

☐ Check amperage draw on condenser fan motor

☐ Check amperage draw on compressor

Humidifier

☐ Check electrical wiring — connections and insulation

☐ Check transformer voltage _____ vac

☐ Check damper position

Spray Type

☐ Check solenoid valve

☐ Check nozzle spray pattern

Drum Type

☐ Check for free rotation and scale

☐ Check water level adjustment

☐ Check overflow/drain line

Electronic Air Cleaner

☐ Check electrical wiring — connections and insulation

☐ Check sail switch or electrical blower interlock

☐ Check test button operation

☐ Check supply voltage _____ vac (120 vac)

☐ Check voltage to collecting plates _____ vdc (3500 vdc)

☐ Check voltage to ionization wires _____ vdc (8000 vdc)

☐ TURN POWER OFF

☐ Wash cells

☐ Wash prefilter screens

Post-Service Checks

☐ Return thermostat to original settings recorded at beginning of service call

☐ Leave copy of completed checksheet with customer

☐ Power ON before leaving