

Procedures for Induced-Draft Gas-Fired Furnaces

INTRODUCTION

The desire to conserve energy has created greater use of insulation, improved vapor barriers, weather stripping, etc. Homes are now tighter, resulting in less natural air infiltration and inefficient furnace operation. The condition is further affected by the growing use of kitchen and bathroom exhausts and even fireplaces. Field studies indicate that combustion air starvation, particularly in closet installations, points to a need for positive furnace air supply, plus new guidelines for today's furnace applications.

These instructions cover *minimum* combustion air requirements and venting practices. They also reflect current conditions found in the field, and conform to existing national standards and safety codes. In some instances, these instructions exceed certain local codes and ordinances, especially those that may not have kept pace with changing construction practices. *Carrier requires these standard procedures as a minimum for safe installation.*

CAUTION: Do not block openings in front of furnace or on furnace top along side vent pipe. These openings provide air for combustion and ventilation. Never store anything on or in contact with furnace, such as aerosol cans, rags, brooms and mops, cleaning tools and aids, perfumers, bleaches, stains, plastic items, gasoline, kerosene, lighter fluids, cleaning fluids, thinners, painting compounds or paper products.

Installation Procedures — These recommendations apply to the installation and operation of gas furnaces and piping systems for natural or LP (propane) gases. Use these procedures in conjunction with your specific furnace installation instructions.

Refer also to your gas supplier regulations and local building, heating, plumbing and other codes for your installation area.

Portions of the following have been adopted in part from the "National Fuel Gas Code" (NFPA No. 54-1980 or ANSI Z223.1-1980) copyrighted by the National Fire Protection Association and American Gas Association. For further details, consult this publication or current edition available

from NFPA, Batterymarch Park, Quincy, MA 02269, or American Gas Association, 1515 Wilson Boulevard, Arlington, VA 22209.

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INSPECTION

Check available power supply to be sure it meets specifications on wiring diagram and all motors in furnace.

Check available gas supply to see that it conforms to gas specifications on AGA rating plate.

FURNACE LOCATION — COMBUSTION/VENTILATION AIR

Locate furnace close to chimney and as near to the center of the air distribution system as possible. Provide ample space for servicing and cleaning. *Always comply with minimum fire protection clearances shown on unit rating plate.* Install furnace as level as possible. *Do not install directly on carpeting, tile or any combustible material* other than wood flooring. Accessory combustible floor base is available from your dealer when required.

The relief-air supply for the draft safeguard duct (drafthood) must be in the same atmospheric pressure zone as the combustion-air inlet supply to the furnace.

When a furnace is installed so that the supply ducts carry air to areas outside the space containing the furnace, the return air must also be handled by duct(s) sealed to the furnace casing and terminating outside the furnace location area.

All fuel-burning furnaces must be supplied with air that enters the combustion process and then is vented to the outdoors. Sufficient air must enter the

space containing the furnace to replace the amount drawn up the vent stack. Replacement air must be provided by means of ducts from the outside to the furnace area or heated space. Under *all* conditions, enough air *must* be provided to ensure there will be no negative pressure condition within the space containing the furnace. A positive seal *must* be made between the furnace base and platform or return-air duct connections. Even a slight leak can create a negative pressure condition in a confined closet or basement and affect combustion. If necessary, seal the furnace base-to-floor opening with fiberglass or other approved material. Furnaces with side-connected returns should use the factory-supplied bottom closure, properly sealed.

For complete combustion and ventilation, the furnace requires approximately 20 cu ft of air for every 1000 Btuh of gas consumed. Thus, for each 1000 Btuh of gas consumed, a total of 20 cu ft of air must be supplied. For a 100,000 Btuh gas furnace, this equals 2000 cu ft of air per hour (100×20) or 33 cu ft of air per minute ($2000 \div 60$). In the past, the infiltration of outside air assumed in heat loss calculations (one air change per hour) was sufficient. However, current construction methods using more insulation and vapor barriers, tighter fitting and gasketed doors and windows, or weatherstripping, and the presence of fuel-burning fireplaces and household exhaust fans require positive introduction of outside air.

Use of exhaust fans, kitchen ventilation systems, clothes dryers and fireplaces may create conditions that require special attention to avoid unsatisfactory furnace operation. Exhaust fans and range hoods can handle from 60 to 300 cfm (or more). Gas and electric clothes dryers remove even more air. Use of multiple appliances requires special mandatory provisions for positive introduction of outside air. This air requirement is several times that required by the furnace and must be replaced, in addition to the air required by the furnace.

CAPTION: Combustion air must come from a source not contaminated by halogens, which include fluorides, chlorides, bromides and iodides. These elements are found in aerosols, detergents, bleaches, cleaning solvents, salts, air fresheners and other household products. Vapors from these products are highly corrosive to gas-fired furnaces, even in extremely low concentrations — as low as 1/2 part per million. When such contaminants are present, outside air must be ducted separately to the furnace room.

Requirements for combustion and ventilation air depend upon whether furnace is located in a *confined or unconfined* space. An unconfined space is defined as a space where volume is not less than 50 cu ft per 1000 Btuh of the total input rating of all appliances installed in that space. Rooms directly

open (no doors) to the space in which the appliances are installed are considered a part of the unconfined space. A confined space is defined as a space with volume less than 50 cu ft per 1000 Btuh of the total input ratings of all appliances in that space.

Furnaces in Confined Spaces (Typical Furnace Closet)

ALL AIR FROM INSIDE BUILDINGS — The confined space shall be provided with 2 permanent openings, one beginning within 12 in. of the top and one beginning within 12 in. of the bottom of the enclosure. Each opening shall have a minimum free area of 1 sq in. per 1000 Btuh of the total input rating of all equipment in the enclosure, but not less than 100 sq inches. The openings must freely communicate with other interior areas served by the furnace, of sufficient volume so that the combined volume of all spaces meets the criteria for an unconfined space. This can be accomplished thru either permanent openings or louvered doors.

In addition, if the building is of unusually tight construction, there shall be one permanent opening communicating directly with outdoors. This opening shall have a minimum free area of 1 sq in. per 5000 Btuh of total input rating of all equipment in the enclosure. Ducts shall be used to convey make-up air, and shall be of the same cross-sectional area as the free areas of the openings to which they connect. This duct should be connected to the cold air return of the heating system. The minimum dimension of the rectangular air ducts should not be less than 3 inches. See Fig. 1.

If furnace is installed on a raised platform to provide a return air plenum, and return air is taken directly from the hallway or space adjacent to the furnace, all air for combustion must come from the outside, as prescribed in paragraph below.

ALL AIR FROM OUTDOORS — The confined space shall be provided with 2 permanent openings, one commencing within 12 in. of the top and one commencing within 12 in. of the bottom of the enclosure. These openings shall communicate directly, or by ducts, with outdoors. See Fig. 2.

- a. When communicating with the outdoors thru horizontal ducts, each opening shall have a minimum free area of 1 sq in. per 2000 Btuh of the total rated input of all equipment in the enclosure. If vertical ducts or openings with louvers and grilles are used, each opening or duct shall have a minimum free area of 1 sq in. per 4000 Btuh of the total rated input of all equipment in the enclosure.
- b. When ducts are used, they shall be of the same cross-sectional area as the free area of the openings to which they connect. The minimum dimension of rectangular air ducts shall not be less than 3 inches.

CAUTION: Return air must not be taken from the room, unless an equal or greater amount of air is supplied to the room. All duct connections to the furnace must be airtight to avoid causing a negative pressure condition within the room.

GAS PIPING

Avoid low spots in long runs of pipe. It is best to slope all pipe 1/4 in. in 15 ft to prevent traps. All horizontal runs should slope away from the meter, to risers. Risers should be used to connect to the furnace and to the meter.



Table 1 — Maximum Capacity of Gas Pipe*

NOMINAL IRON PIPE SIZE (in.)	INTERNAL DIAMETER (in.)	LENGTH OF PIPE (ft)				
		10	20	30	40	50
1/2	0.622	175	120	97	82	73
3/4	0.824	360	250	200	170	151
1	1.049	680	465	375	320	285
1 1/4	1.380	1400	950	770	660	580
1 1/2	1.610	2100	1460	1180	990	900

*Cu ft of gas per hour for gas pressure of 0.5 psig or less, and a pressure drop of 0.5 in. wg (based on a 0.60 specific gravity)
Ref: Table C-4 NFPA 54-1980

Joint compounds (pipe dope) should be applied sparingly and only to the male threads of the joints. Consult local supplier for type of compound to be used. This pipe dope must be resistant to the action of LP (propane) gas.

Install a sediment trap in the riser leading to the furnace. This trap collects dirt or condensate. It can be installed by connecting a Tee to the riser leading to the furnace, so that the straight-thru section of the Tee is vertical. Then connect a capped nipple into the lower end of the Tee. The capped nipple should extend below the level of the gas controls. See Fig. 3. Where a gum filter is required by local codes, install it in accordance with those requirements.

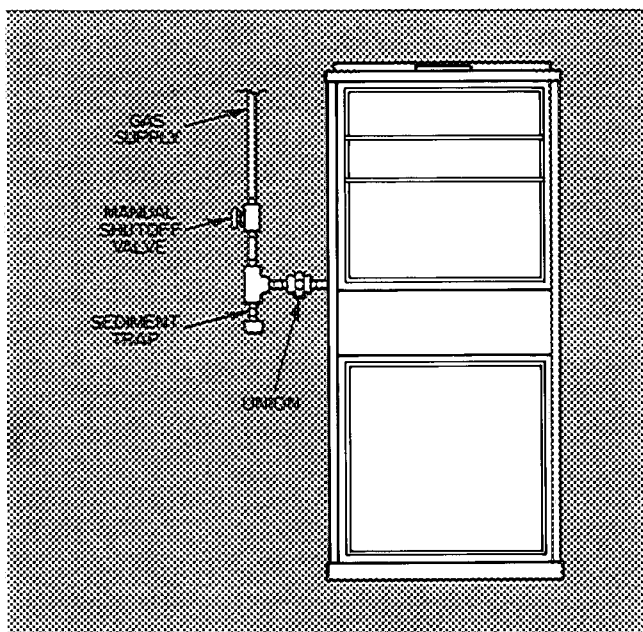


Fig. 3 — Sediment Trap

An accessible manual shutoff valve shall be installed upstream of the furnace gas controls and within 6 ft of the furnace. A 1/8-in. NPT plugged tapping, accessible for test gage connection, must be installed immediately upstream of the gas supply connection to the furnace, and downstream of the manual shutoff valve.

Place a ground joint union between the gas control manifold and the manual gas shutoff valve. See Fig. 4.

Protect all segments of the piping system against physical and thermal damage. Support all piping with the appropriate straps, hangers, etc. (one hanger every 6 ft minimum). For pipe sizes larger than 1/2-in., follow recommendations of national codes.

WARNING: When a flexible connector is used, it must be physically and permanently protected from contact with edges of the gas line entrance opening in the casing.

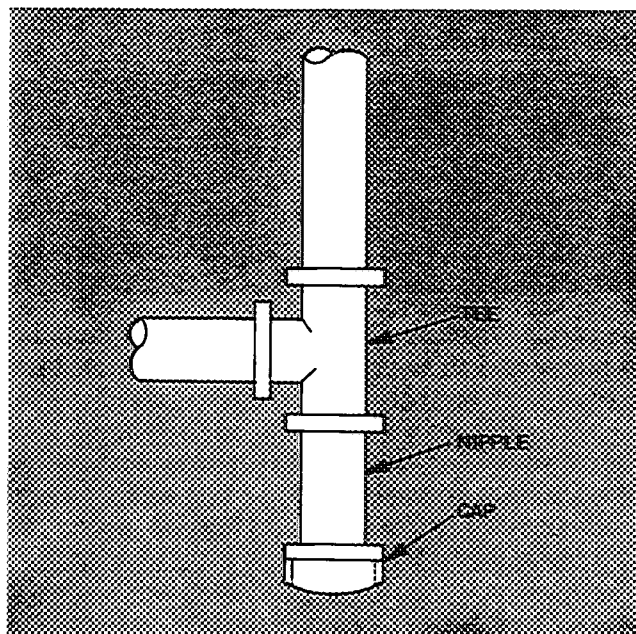


Fig. 4 — Union Location

Piping should be pressure tested in accordance with local and national plumbing and gas codes before furnace has been attached. If pressure exceeds 0.5 psig (14 in. wg), gas supply pipe must be disconnected from furnace before pressure test. If test pressure is equal to or less than 0.5 psig (14 in. wg), close manual shutoff valve located on gas valve before test. Ground joint union should be cracked before pressure testing.

After all connections have been made, purge the lines and check for leakage.

WARNING: Never purge a line into a combustion chamber. Never use matches, candles, flame, or other sources of ignition for the purpose of checking leakage. Use a soap-and-water solution to check for leakage.

VENTING

Consult local codes. For additional information refer to the "National Fuel Gas Code" (NFPA No. 54-1980 or ANSI Z223.1-1980). Unless the local

codes direct otherwise, unit may be vented to a permanent chimney, or to a listed type-B1 gas vent. Connect the vent collar to the chimney or gas vent to be used. Follow these recommendations:

1. Select flue connection material that is satisfactory for installation and that meets requirements of local codes.
2. Flue connection pipe must be at least as large as outlet collar on furnace. *No reduction in this size is permissible in pipe run.*
3. Run pipe as directly as possible with minimum number of turns and minimum of 12 in. straight pipe before the first bend.
4. Maintain minimum of 1/4 in. per linear ft upward slope on all horizontal runs.
5. Rigidly support flue pipe with hangers and straps to insure that there will be no movement after installation.
6. Insert smallest flue connection pipe at highest level consistent with available headroom or clearance to combustible materials, when 2 or more vent connectors enter a common gas vent or chimney flue.
7. Extend flue connection pipe thru chimney wall flush with inner face of chimney liner and above extreme bottom to avoid restriction.

WARNING: Never connect into a chimney serving a fireplace unless the fireplace opening is sealed off.

8. No portion of venting system shall extend into, or pass thru, any circulating air duct or plenum.
9. Chimney or gas vent shall extend at least 5 ft above highest connected draft hood and should extend high enough above roof or neighboring obstruction, so that wind from any direction will not create positive pressure in vicinity of chimney or gas vent outlet. Chimney or gas vent should extend 3 ft higher than point of emergence thru roof, and at least 2 ft higher than any object within a radius of 10 ft. See Fig. 5.
10. A type-B1 gas vent shall terminate above roof surface with a listed cap or roof assembly.

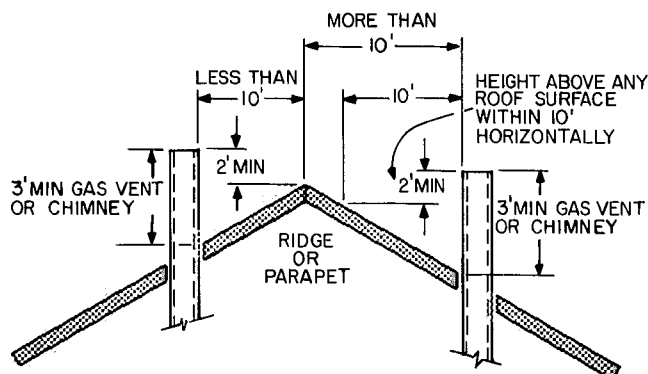


Fig. 5 — Chimney, Gas Vent Height

Common Venting with Other Appliances —

This furnace may be connected to a common chimney or listed type-B1 gas vent with other listed gas-fired appliances. The vent system of this induced-draft furnace operates at negative pressure during normal operation. If for any reason the pressure in the vent system becomes positive (may happen if chimney is inadvertently blocked), the furnace shuts down and locks off. This is accomplished by means of draft safeguard switch located on tube attached to relief box just above draft inducer blower. The design of this furnace, equipped with draft safeguard switch, has been tested by the American Gas Association Laboratories.

Type-B1 Gas Vent — Note that this furnace may be connected to type-B1 gas vents. Type-B1 vents are suitable, providing the vent system always operates at zero or negative pressure. The vent system of this furnace meets this standard.

ELECTRICAL

IMPORTANT: Before proceeding with electrical connections, make certain that voltage, frequency and phase correspond to that specified on the furnace rating plate. Also, check to be sure the service provided by the utility is sufficient to handle the additional load imposed by this equipment. Refer to unit rating plate for equipment electrical requirements.

The specific furnace installation instructions contain wiring diagrams which show the proper field high- and low-voltage wiring. Make all connections in accordance with National Electrical Code and any local codes or ordinances that apply.

WARNING: The cabinet must have an uninterrupted or unbroken ground according to National Electrical Code, ANSI/NFPA 70-1991, ANSI C1-1978 and local codes to minimize personal injury if an electrical fault should occur. Ground may be electrical wire or conduit, approved for electrical ground when installed in accordance with electrical codes. Do not use gas piping as electrical ground.

CAUTION: If manual disconnect switch is to be mounted on furnace, select a mounting location where drill or fastener will not contact electrical or gas components.

NOTE: Use only copper wire between disconnect switch and furnace. If aluminum wire is used between service panel and disconnect switch, adhere to the following recommendations.

When making aluminum conductor connections to copper conductors or terminals, use only connectors that are UL approved (Marked Al/Cu with the UL symbol) for the application and wire size. Do not reduce wire size to fit connector by cutting off strands. Use properly sized connectors.

After insulation has been stripped from the aluminum conductor, coat the conductor end with corrosion inhibitor (Burndy Pentrox A or equivalent), and wire-brush the aluminum surface thru the inhibitor.

CAUTION: Do not wire-brush connectors and lugs. The plating will be broken.

After cleaning, recoat the aluminum conductor with inhibitor, and make connection, then coat entire connection. When it is suspected that the connection will be exposed to moisture, it is very important to cover the entire connection completely to prevent an electrochemical action that will cause the connection to fail very quickly.

If aluminum conductors are used, the wire size selected must have a current capacity not less than that of the copper wire specified, and must not create a voltage drop between the service panel and the furnace in excess of 2% of the unit rated voltage.

Check all electrical connections (both factory and field) for tightness. This should also be done after the unit has reached operating temperature, especially if aluminum conductors are used.

START-UP, ADJUSTMENT, AND SAFETY CHECK

Intermittent Ignition Systems — Check to be sure all connections have been properly made, then proceed as follows:

Light furnace, using the procedure outlined on the Lighting Instruction Plate attached to the furnace. However, when lighting the pilot for the first time, perform the following additional steps:

1. If supply line was not purged before connecting furnace, it will be full of air. It is recommended that the ground joint union be cracked, and supply line be allowed to purge until odor of gas is detected. Never purge gas lines into a combustion chamber. Immediately upon detection of gas odor, retighten the union. Allow 5 minutes to elapse, then light pilot in accordance with instructions on furnace.
2. After pilot lights, main burners should light in 25-75 seconds. If main burners do not light within that time period, adjust pilot flame, allow pilot to cool for 5 minutes, repeat time check.
3. Locate pilot adjusting screw on top of gas valve.
 - a. Remove cap screw; turn pilot adjusting screw counterclockwise to decrease burner-on time delay, clockwise to increase burner-on time delay.
 - b. Replace cap screw.

Gas Input — Determine gas input as follows:

NATURAL GAS

- a. Turn off all other gas appliances and pilots.
- b. Measure time (in seconds) for gas meter test dial to complete one revolution.
- c. Refer to Table 2 for cu ft of gas per hour.

- d. Multiple cu ft per hour times heating value of gas (Btu/cu ft). Obtain heating value of gas from local utility.

Example:

Btuh heating input = Btu/cu ft/hr

Heat value of gas = 1070 Btu/cu ft

Time for one revolution of 2 cu ft dial = 72 seconds

Gas rate = 100 cu ft/hr (from Table 2)

Btuh heating input = 1070 x 100 = 107,000 Btuh

- e. Measured gas input should not exceed gas input shown on unit rating plate.
- f. To adjust input rate, remove cap that conceals regulator adjustment. Turn adjusting screw counterclockwise (out) to decrease input. When adjusting, DO NOT change manifold pressure more than 0.3 in. wg. Make any major adjustment by changing main burner orifices.

HIGH ALTITUDE — Ratings are approved for altitudes to 2000 ft for all gases. Ratings for altitudes over 2000 ft are 4% less for each 1000 ft above sea level. (Furnace must be derated by changing main burner orifices.)

Table 2 — Gas Rate (Cu Ft Per Hr)

SECONDS FOR ONE REVOLU- TION	SIZE OF TEST DIAL			SECONDS FOR ONE REVOLU- TION	SIZE OF TEST DIAL		
	1 cu ft	2 cu ft	5 cu ft		1 cu ft	2 cu ft	5 cu ft
10	360	720	1800	50	72	144	360
11	327	655	1636	51	71	141	355
12	300	600	1500	52	69	138	346
13	277	555	1385	53	68	136	340
14	257	514	1286	54	67	133	333
15	240	480	1200	55	65	131	327
16	225	450	1125	56	64	129	321
17	212	424	1059	57	63	126	316
18	200	400	1000	58	62	124	310
19	189	379	947	59	61	122	305
20	180	360	900	60	60	120	300
21	171	343	857	62	58	116	290
22	164	327	818	64	56	112	281
23	157	313	783	66	54	109	273
24	150	300	750	68	53	106	265
25	144	288	720	70	51	103	257
26	138	277	692	72	50	100	250
27	133	267	667	74	48	97	243
28	129	257	643	76	47	95	237
29	124	248	621	78	46	92	231
30	120	240	600	80	45	90	225
31	116	232	581	82	44	88	220
32	113	225	563	84	43	85	214
33	109	218	545	86	42	84	209
34	106	212	529	88	41	82	205
35	103	206	514	90	40	80	200
36	100	200	500	92	39	78	196
37	97	195	486	94	38	76	192
38	95	189	474	96	38	75	188
39	92	185	462	98	37	74	184
40	90	180	450	100	36	72	180
41	88	176	439	102	35	71	178
42	86	172	429	104	35	69	173
43	84	167	419	106	34	68	170
44	82	164	409	108	33	67	167
45	80	160	400	110	33	65	164
46	78	157	391	112	32	64	161
47	76	153	383	116	31	62	155
48	75	150	375	120	30	60	150
49	73	147	367				

Temperature Rise — Do not exceed the range of temperature rise specified on the unit rating plate. Determine the air temperature rise as follows:

1. Place duct thermometers in return and supply ducts as near furnace as possible. Be sure thermometers do not “see” heat element so that radiant heat will not affect thermometer readings. This is particularly important with straight-run ducts.
2. When thermometer readings stabilize, subtract return-air temperature from supply-air temperature to determine air temperature rise.
3. Adjust air temperature rise by adjusting blower speed. Increase blower speed to reduce temperature rise. Decrease blower speed to increase temperature rise.

Thermostat Heat Anticipator Check — Thermostat heat anticipator must be set to match amp draw of gas valve and electrical components in R-W circuit. Accurate amp draw readings can be obtained at thermostat subbase terminals R & W. Figure 6 illustrates an easy method of obtaining actual amp draw. Amp reading should be taken after blower motor has started.

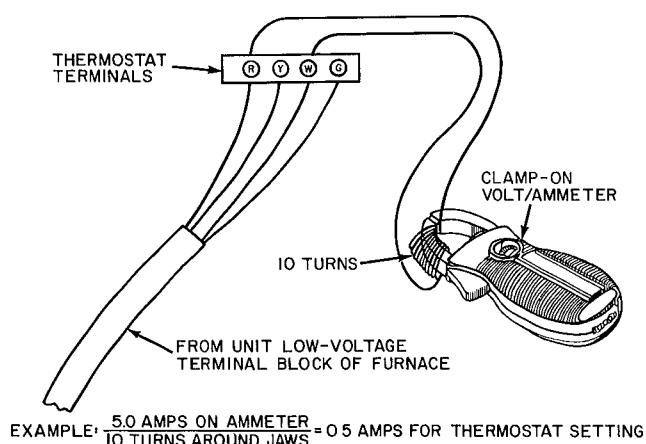


Fig. 6 — Amp Draw Check with Ammeter

Limit Control Safety Check — This control shuts off the combustion control system and energizes the circulating-air blower motor if the furnace overheats.

The recommended method of checking the limit control is to gradually block off the return air after the furnace has been operating for at least 5 minutes. As soon as the limit has proven safe, the return air opening should be unblocked to permit normal air circulation. By using this method to check the limit control, it can be established that the limit is functioning properly and will “fail-safe” if there is a motor failure. The downflow/horizontal furnaces have a manual reset limit switch located on blower housing.

Pressure Switch Safety Check — This control proves operation of the draft inducer blower. Check as follows:

1. Turn off 115-volt power to furnace.
2. Remove control door and disconnect inducer motor lead wires from inducer printed-circuit board.
3. Turn on 115-volt power to furnace.
4. Close thermostat switch as if making a normal furnace start. The pilot should light and then cycle off and on. If main burners do not light, pressure switch is functioning properly.
5. Turn off 115-volt power to furnace.
6. Reconnect inducer motor wires, replace control door, turn on 115-volt power.

Draft Safeguard Switch Safety Check — This control permits safe shutdown of furnace during certain blocked flue conditions. Check as follows:

1. Disconnect power to furnace and remove heat pipe from furnace outlet collar. Allow time for vent pipe to cool before removing.
2. Set room thermostat above room temperature and restore power to furnace.
3. After normal start-up, allow furnace to operate 2 minutes. Block (100%) flue outlet. Furnace should cycle off within 2 minutes.
4. Reconnect vent pipe to furnace outlet collar.
5. Wait 5 minutes. Reset draft safeguard switch.

FURNACE LOCATION WITH RESPECT TO COOLING EQUIPMENT

The cooling coil must be installed parallel with, or on the downstream side of the furnace to avoid condensation in the heating element. When installed parallel with a furnace, dampers or other means used to control the flow of air must prevent chilled air from entering the unit. If the dampers are manually operated, they must be equipped with means to prevent operation of either unit unless the damper is in the full-heat or full-cool position.

SPECIAL LOCATIONS

When the furnace is installed in a residential garage, burners and ignition source should be no less than 18 in. above floor. Furnace should be protected against physical damage by vehicles.

When the furnace is installed in public garages, airplane hangars, or other buildings having hazardous atmospheres, it should be installed in accordance with recommended good practice requirements of the National Fire Protection Association.

Manufacturer reserves the right to discontinue, or change at any time, specifications or designs without notice and without incurring obligations.

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Catalog No 515-804