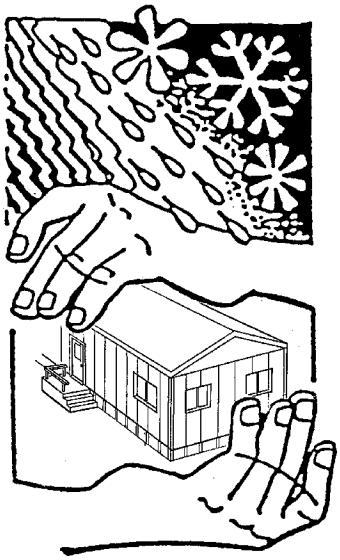


CALIFORNIA MOBILE HOME WEATHERIZATION INSTALLATION STANDARDS

for use in

California's Low Income Energy Efficiency Programs

administered by

San Diego Gas and Electric Company
Southern California Edison
Southern California Gas Company
Pacific Gas and Electric Company

PART 1

SEPTEMBER 15, 2005 –*REVISIONS*– *(WITH EDITS)*

ABBREVIATIONS AND ACRONYMS

AAMA	American Architectural Manufacturers Association
ACCA	Air Conditioning Contractors of America
ACDD	Annual Cooling Degree Days
AFUE	Annual Fuel Utilization Efficiency
AGA	American Gas Association
AHDD	Annual Heating Degree Days
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWG, awg	American Wire Gage
BEAR	Bureau of Electronic and Appliance Repair
BEF	*Ballast Efficacy Factor*
BOCA	Building Officials and Code Administrators
Btu	British Thermal Unit
Btu/hr	British Thermal Units per Hour
°C	Degrees Centigrade
CABO	Council of American Building Officials
Cal OSHA	California Occupational Safety and Health Administration
CAS	Combustion Appliance Safety
CASIF	Combustion Appliance Safety Inspection Form

ABBREVIATIONS AND ACRONYMS

CAZ	Combustion Appliance Zone
CBM	*Certified Ballast Manufacturers*
CBC	California Building Code
CBO	Community Based Organization
CCR	California Code of Regulations
CDD	*Cooling Degree Days (also see ACDD)*
CEC	California Energy Commission and California Electrical Code
CFL	Compact Fluorescent Lamp
CFM, cfm	Cubic Feet per Minute
CFM_{25}	Cubic Feet per Minute of Air Flow at 25 Pascals of Pressure
CFM_{50}	Cubic Feet per Minute of Air Flow at 50 Pascals of Pressure
CFR	Code of Federal Regulations
CMC	California Mechanical Code
CO	Carbon Monoxide
COP	Coefficient of Performance
CPSC	Consumer Products Safety Commission
CSD	(California Department of) Community Services and Development
DOE	(United States) Department of Energy
DV	Direct Vent (Furnace/Heater)
EER	*Energy Efficiency Ratio*
EPA	Environmental Protection Agency
ESP	Economic Stop Parameters/Economic Stop Policy
°F	Degrees Fahrenheit

ABBREVIATIONS AND ACRONYMS

F.S.	Federal Specifications
FAU	Forced Air Unit
fpm	Feet per Minute
GFCI	Ground Fault Circuit Interrupter
HCD	(California Department of) Housing and Community Development
HDD	*Heating Degree Days (also see AHDD)*
HDL	House Depressurization Limit
HPD	Heat Producing Device
HUD	(U.S. Department of) Housing and Urban Development
HVAC	Heating Ventilation and Air Conditioning
Hz	*Hertz*
ICBO	International Conference of Building Officials
ID	Inside Diameter
IWC, iwc	Inches of Water Column (Same as IWG, Inches of Water Gauge)
IWG, iwg	Inches of Water Gauge (Same as IWC, Inches of Water Column)
KHz	*Kilohertz*
MHCSS	HUD Manufactured Home Construction and Safety Standards
MVR	Minimum Ventilation Requirement
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council

ABBREVIATIONS AND ACRONYMS

NFVA, NFV Area	Net Free Venting Area: Total vent opening area minus the blocking effect of louvers, grilles, and screens
OC	On Center
OD	Outside Diameter
OSHA	Occupational Safety and Health Administration
P&P	Policy and Procedures
Pa	Pascal (1 Pa = 0.004 iwc, and 1 iwc = 250 Pa)
PPM, ppm	Parts Per Million
psf	Pounds per Square Foot
psi	Pounds per Square Inch
RTV	Room Temperature Vulcanization (e.g., RTV Silicone)
SEER	Seasonal Energy Efficiency Ratio
T&P Valve	Temperature and Pressure Relief Valve
TPE	Thermoplastic Elastomer
UBC	Uniform Building Code
UL	Underwriters Laboratories
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
UV	Ultraviolet
WC, wc	Water Column (Same as Water Gauge)
WG, wg	Water Gauge (Same as Water Column)
WIS	Weatherization Installation Standards
Wx	Weatherization

DEFINITIONS

Abandoned Appliance	*An appliance which is no longer used and has been removed from service and ~~by the following actions~~: (1) the flexible gas connector has been ~~disconnected and/or~~ removed, and (2) the gas line shut-off valve has been capped, or the valve has been removed and the pipe capped.*
Backdrafting	The reverse flow of combustion gases down the vent pipe and out the draft hood of a natural vent open combustion appliance. Intermittent backdrafting can be caused by wind gusts. Ongoing backdrafting can be the result of a negative pressure in the combustion appliance zone (CAZ) caused by (a) duct system return leaks in the vicinity of the appliance, and/or (b) the excessive influence of mechanical systems exhausting air from the structure (e.g., bathroom and utility room exhaust fans, range hood fan, clothes dryer, built-in vacuum system, etc.).
Closure System	The sum total of components utilized to secure and seal a duct system joint or seam against air leakage (e.g., pressure sensitive tape, or heat activated tape, or mastic with fiberglass mesh reinforcement). Closure systems for non-metallic flexible ducts include a drawband.
Combustion Air	The total amount of air provided to the space, which contains fuel-burning equipment; it includes air for fuel combustion, for draft hood dilution and for ventilation of the equipment enclosure. (Reference ~~1997~~ *2001* UMC, section 205~~, C, page 8~~.)
Combustion Appliance Zone (CAZ)	The room or area of a home in which an open combustion natural draft appliance (typically a furnace, water heater, wood burning stove or fireplace) is located. It could be a living room containing a wood burning stove, a kitchen or utility porch containing a water heater, or an appliance enclosure. Excessive depressurization of the CAZ causes backdrafting and spillage of combustion gases.
Conditioned Space	An area, room or space normally occupied and being

heated or cooled by any equipment for human habitation. (Reference ~~1997~~ *2001* UMC, section 205~~, C, page 8~~.)

Confined Space — A room or space having a volume less than 50 cubic feet per 1,000 Btu/h of aggregated input rating of all fuel burning appliances installed in the space. (Reference ~~1997~~ *2001* UMC, section 205~~, C, page 8~~.)

Drawband — A device which encircles a duct and mechanically secures the core-to-fitting attachment (i.e., a synthetic duct tie or a worm drive stainless steel clamp). Duct ties are also used to secure fiberglass duct wrap and to seal jacket overlaps at flexible duct splices.

Duct Systems — All ducts, duct fittings, plenums and fans assembled to form a continuous passageway for the distribution of air. (Reference ~~1997~~ *2001* UMC, section 206~~, D, page 9~~.)

Enclosed Cavity — *A building cavity that is totally enclosed and inaccessible for installation of measures. An example is a low-profile section of attic that is closed off by drywall, plywood or other sheathing. Because of inadequate crawl clearance, proper installation of insulation would not be feasible even if an access hole were cut.*

FAU — *Forced air unit, which is that portion of a central heating and/or air conditioning (A/C) system which contains the air handler (blower section). In a "Split System," it is the furnace. In a "Package System," the entire heating and A/C "Package Unit" may be referred to as the FAU.*

Heat Activated Tape — Metallic tape with an adhesive coating which is activated and cured by the application of heat and pressure.

Inaccessible Appliance — *A combustion appliance that cannot be accessed for NGAT testing, due to a locked passage or a physical impediment. Examples include a water heater in a locked room/enclosure for which a key is not available, an attic-mount furnace that requires entry through an inaccessible MUD unit, and a floor furnace in a crawl*

	space with inadequate crawl clearance. . A floor furnace may also be inaccessible because it has been covered over by plywood or attached floor covering (e.g., wall-to-wall carpet or vinyl). A floor or wall furnace may be inaccessible because it has been turned off and blocked by heavy furniture (e.g., a hutch or cabinet).
Labeled	*Equipment or materials to which has been attached a label of a nationally recognized testing agency that maintains periodic inspection of the production of labeled equipment or materials. Labeling indicates compliance with nationally recognized standards. (Also see "Listed" and "UL Classified, Labeled, Listed".)*
Lapped Seam	The seam (joint) formed where two pieces of material (usually sheet metal) are overlapped.
Longitudinal Joint	Lengthwise joint along a piece of duct (e.g., the joint running the full length of a snap-together sheet metal duct). [Note: *longitudinal* means "lengthwise"...in contrast with *transverse,* which means "across".]
Mobile Home	Mobile homes are manufactured homes regulated by the Department of Housing and Urban Development (HUD) through a national code, called the Manufactured Housing Construction and Safety Standards—the "HUD Code" for short. A manufactured home is built on a trailer (chassis) and designed to be delivered over the road to a permanent location, either as a single- or multiple-section unit. A mobile home is a permanent, full-time residential dwelling with a floor area of at least ~~320~~ *330* square feet.
NFPA 90B	Standards governing installation of "Warm Air Heating and Air Conditioning Systems" in one- or two-family dwellings and structures not exceeding 25,000 cu. ft. Provides specifications for the manufacture and installation of rigid metal ductwork and references UL 181 regarding factory made air ducts (e.g., flexible ducts). Installations in larger structures are addressed by NFPA 90A.

DEFINITIONS

NFV, NFVA	NFV stands for "net free venting." NFVA is "net free venting area," the net amount of venting area provided by a vent after the blocking effect of mesh and/or louvers has been subtracted from the gross area of the vent opening(s).
Package Unit	*A combination heating and air conditioning system contained within one housing unit, which is installed outdoors (on the roof or on a slab next to the house). (Also see "Split System.")*
Pascal (Pa)	*A small unit of pressure equivalent to 0.004 inches of water column (IWC). 1 Pa = 0.004 IWC, and 1 IWC = 250 Pa. 25 Pa, the pressure typically used to test duct systems for leakage, is equivalent to 0.1 IWC. Conversion formulas are: [Pa = IWC ¸ 0.004] and [IWC = Pa x 0.004].*
Perm	A unit of permeance, which refers to how permeable a material is (e.g., how well moisture will pass though a vapor barrier).
Plenum	An air compartment or chamber to which one or more ducts are connected and which form part of either the supply-air, return-air or exhaust-air system, other than the occupied space being conditioned. (Reference 1997 UMC, section 215-P, page 13.)
Pressure Sensitive Tape	Duct tape with a tacky adhesive coating (e.g., butyl, acrylic, etc.) which will adhere to a surface with the application of pressure (heat not required). Duct tapes used in the CSD-sponsored programs must be listed and marked per UL 181A and 181B standards.
Repair	*Corrective work performed by a qualified technician, intended to make a natural gas appliance operate properly, when correction is beyond the scope of "Service/Adjustment".*
Replacement	*Complete replacement of a defective natural gas appliance, when repair is <u>not</u> feasible: i.e., the cost to repair the appliance exceeds program guidelines, or parts required to make the appliance safely operable*

cannot be obtained.

Service/Adjustment — *Minor corrective work, within the normal scope of service, performed by utility gas service personnel, or designated representative, intended to make a natural gas appliance operate properly without repair or replacement.*

Spillage — In a natural vent open combustion appliance, the outflow of combustion gases from the draft hood and into the atmosphere of the room or area where the appliance is located (the combustion appliance zone, or CAZ). Spillage occurs when drafting through the vent system is inadequate to carry combustion gasses up through the vent pipe and out into the atmosphere. Spillage occurs briefly when combustion first begins in a cold appliance, because cold air in the vent pipe impedes exhaust flow until the systems warms up. Continuous spillage may result when the vent pipe is blocked by an obstruction or is improperly constructed (too many elbows, improper slope, inadequate diameter, etc.).

Split System — *A heating and cooling system in which the air conditioning evaporator coil is attached to the furnace, which is located indoors (typically in the garage, attic, or interior closet), and the condenser unit (with coil, compressor, and fan) is installed outdoors, usually on a slab next to the house. (Also see "Package Unit.")*

Transverse Joint — The joint formed when two pieces of duct are spliced together (e.g., the joint around the circumference where two round ducts are joined together, and the joint around the perimeter where two rectangular ducts are joined together). [Note: *transverse* means "across"...in contrast with *longitudinal*, which means "lengthwise".]

UL 181 — UL "Standard for Factory-Made Air Ducts and Connectors".

UL 181A — UL standard for pressure sensitive aluminum tapes, heat activated aluminum tapes, and mastic closure

systems for use with rigid fiberglass air ducts.

UL 181B

UL standard for pressure sensitive tapes and mastic closure systems for use with flexible air ducts.

UL Class 0 Duct

Air duct materials having a fire hazard classification of zero (flame spread and smoke developed).

UL Class 1 Duct

Air duct materials having a flame-spread rating of not over 25 without evidence of continued progressive combustion and a smoke-developed rating of not over 50.

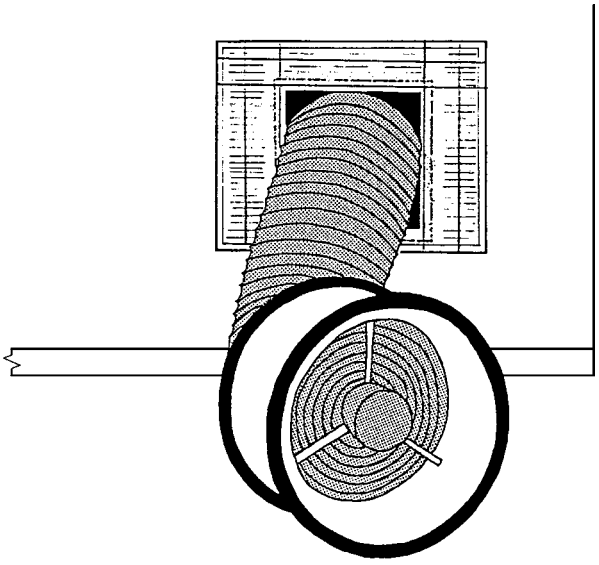
UL Classified, Labeled, Listed, Recognized

- **UL Classified** means that UL testing was limited to examination of one potential hazard.
- **UL Labeled** means that a product is either UL Listed or UL Classified. Note that a product can be certified and "listed" without involving UL. Other accredited laboratories (e.g., CSA International, ITS Intertek Services, ETL SEMKO, etc.) can test products and certify conformance with established standards. Such products can thus be "listed and labeled" without reference to UL. (See “Listed” and “Labeled” above.)
- **UL Listed** means that UL testing included examination of *all* foreseeable hazards.
- **UL Recognized** means that a component (such as a motor) is approved for use in a UL Listed product (such as an evaporative cooler). The complete cooler is UL Listed, but the tested and approved components used in it are “UL Recognized components.” Each UL Recognized component is tested to a UL standard applicable to that component, and it is “recognized” for use in a UL Listed product.

DUCT TESTING STANDARDS

1. EQUIPMENT

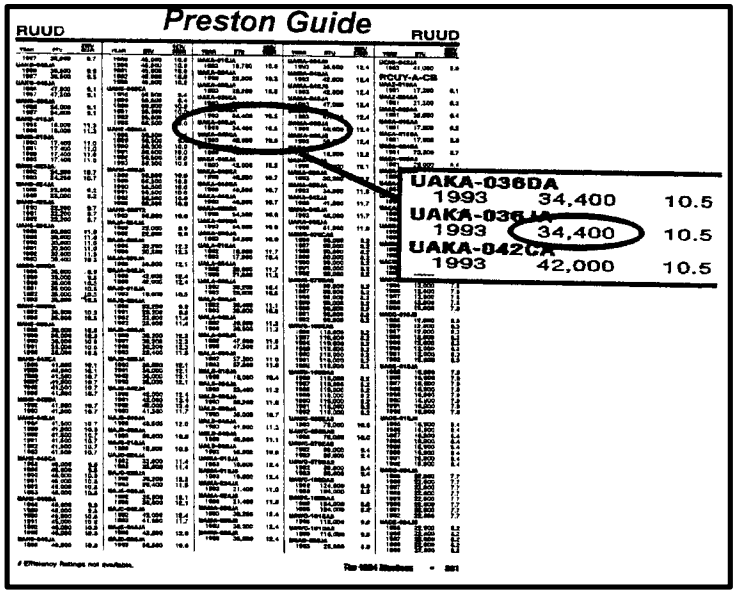
- **Instrumentation Minimum Specifications**
  - Pressure Measurements
    - Measurement systems shall have an accuracy of ± 0.2 Pa or 1% of reading, whichever is greater, and
    - Shall utilize static pressure probes specified by the measurement equipment manufacturer.
  - Duct Leakage Measurements
    - Duct leakage testing shall have an accuracy of ± 3% of measured flow, and
    - Shall utilize digital gauges specified by the measurement equipment manufacturer.
  - Airflow Measurements
    - Airflow testing shall have an accuracy of ± 7% of measured flow, and
    - Shall utilize digital gauges specified by the measurement equipment manufacturer.
- **Approved Leakage Measurement Equipment**
  - Equipment shall meet the Title 24 requirements specified in the 2005 Residential ACM Manual, Appendices RC and RE.
  - May include, but is not limited to a Duct pressurization system, e.g., Duct Blaster™.



DUCTS PRESSURIZED WITH DUCT TESTER FAN

2. HVAC SYSTEM AIRFLOW (FAN FLOW)

- **HVAC system airflow (fan flow) shall be determined in accordance with Title 24 2005 Residential ACM Manual, Appendices RC and RE, utilizing one of the following methods[1]:**
  - Nominal System Airflow (Fan Flow) Estimate
  - Flow Grid Measurement
  - Plenum Pressure Matching Measurement
  - Flow Capture Hood
- **Nominal System Airflow (Fan Flow) Estimate**
  - Air conditioner cooling capacity shall be determined in tons, and furnace heating capacity (output) shall be determined in KBtuh, in accordance with ACM Residential Manual Appendix RC-2005, §RC.4.2, "System Fan Flow."
    - Cooling-only Systems: Allow 400 cfm per ton of cooling capacity.
    - Heating-only Systems:
      - Allow 21.7 cfm per KBtuh heating output.
      - For electric heat: [(Watts x 3.413 x 0.95) / 1,000] or [Kilowatts x 3.242] = KBtuh output.
    - Heating and AC Systems: Fan flow cfm shall be the greater of cooling capacity cfm or heating capacity cfm.
  - HVAC capacity (output) shall be determined in accordance with standard industry practice, such as the following (see Appendix -B-):
    - Air Conditioner Capacity (Tons)
      - The Preston Guide or Carrier Blue Book
      - Model Number Nomenclature
    - Heating System Capacity (KBtuh)
      - Btuh capacity (output) from Appliance Nameplate.

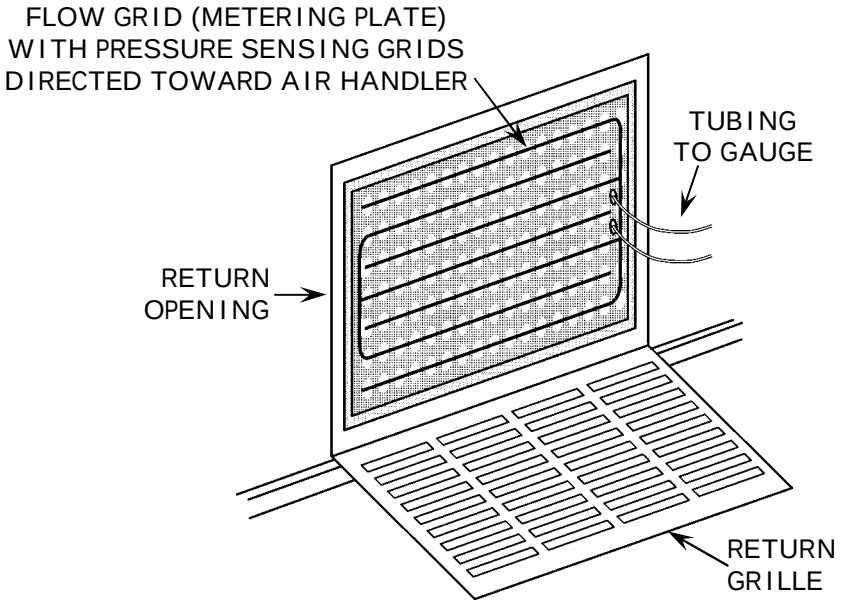


[1] See Mobile Home WIS Appendix -B-, "Methods for Estimating and Measuring Airflow".

2. HVAC SYSTEM AIRFLOW (FAN FLOW) (continued)

- Flow Grid Measurement

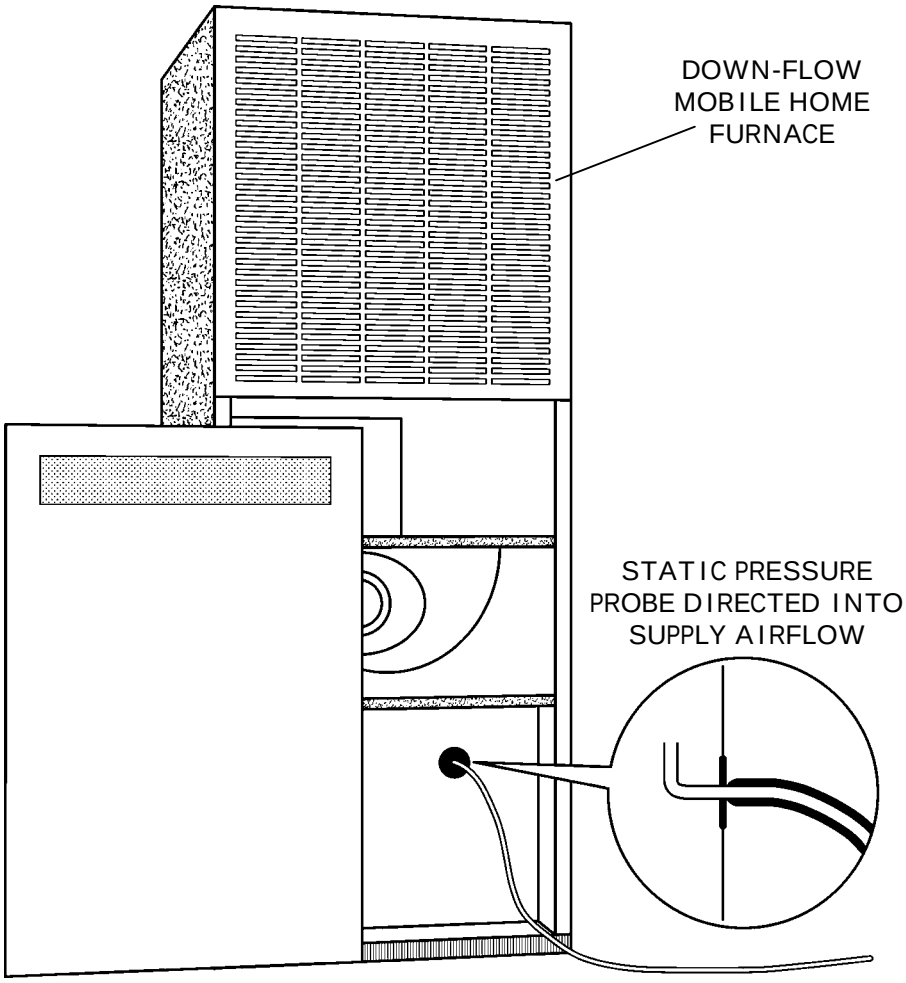
- Equipment used for measurements shall meet the requirements specified in ACM Residential Manual Appendix RE-2005, §RE.3.1.3, "Flow Grid Measurement."
- Measurements shall be in accordance with manufacturer's instructions, which take precedence, and WIS Appendix -B-.



2. HVAC SYSTEM AIRFLOW (FAN FLOW) (continued)

- Plenum Pressure Matching Measurement (Duct Tester Used as a Powered Capture Hood)

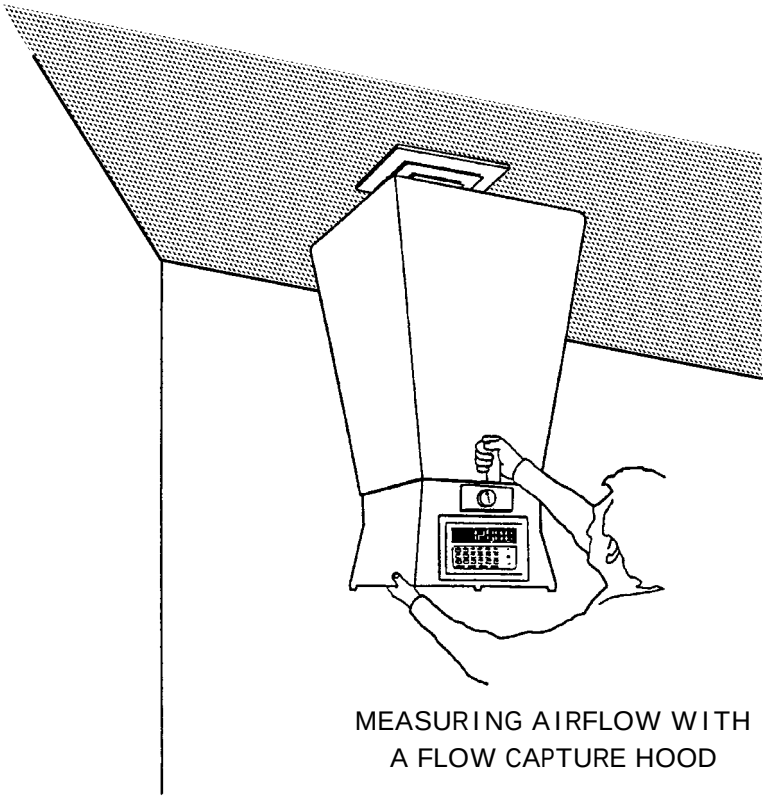
- Equipment used for measurements shall meet the requirements specified in ACM Residential Manual Appendix RE-2005, §RE.3.1.1, "Plenum Pressure Matching Measurement."
- Measurements shall be in accordance with manufacturer's instructions, which take precedence, and WIS Appendix -B-.



2. HVAC SYSTEM AIRFLOW (FAN FLOW) (continued)

- Flow Capture Hood

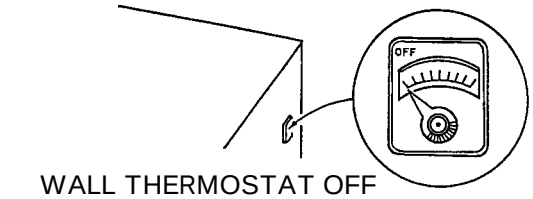
- Equipment used for measurements shall meet the requirements specified in ACM Residential Manual Appendix RE-2005, §RE.3.1.2, "Flow Capture Hood Measurement."
- Measurements shall be in accordance with manufacturer's instructions, which take precedence, and WIS Appendix -B-.



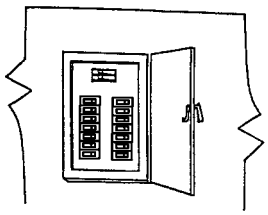
MEASURING AIRFLOW WITH
A FLOW CAPTURE HOOD

3. TEST CONDITIONS FOR ALL DUCT LEAKAGE TESTS

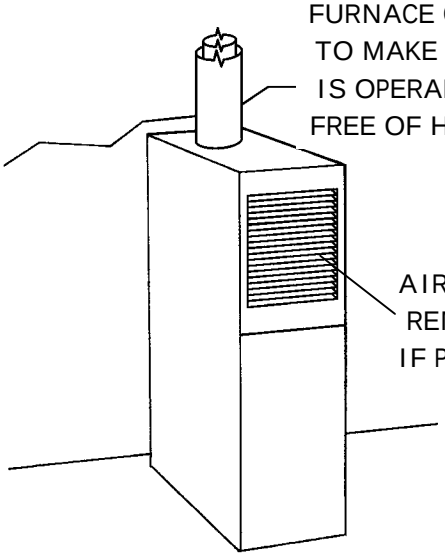
- **Equipment Operation**
  - The HVAC system must be operated briefly to determine that the FAU functions properly prior to performing any duct tests.
  - Duct Testing shall not be performed if:
    - The FAU is inoperable, or
    - A hazardous conditions exists (e.g., burner/flame abnormality, high CO, cracked heat exchanger) that requires service/adjustment or repair/replacement per NGAT standards/policy.
- **Air filters**
  - Filter(s) shall be removed from the duct system.
- **Ventilation Air Intakes**
  - Intakes connected to the duct system (e.g., makeup air, economizer venting damper, etc.) shall be temporarily sealed.
- **All fan-equipped appliances shall be turned off, such as:**
  - HVAC equipment: FAU and room air conditioners.
  - Exhaust devices: fans and clothes dryer vented outdoors.
- **Duct system terminals shall be blocked as applicable.**
  - One return register or air handler access shall remain unblocked for installation of duct tester.
  - All other supply registers and return grilles shall be blocked/sealed per Item 4.



WALL THERMOSTAT OFF



HVAC BREAKER TURNED OFF
IF NO AIR HANDLER DISCONNECT

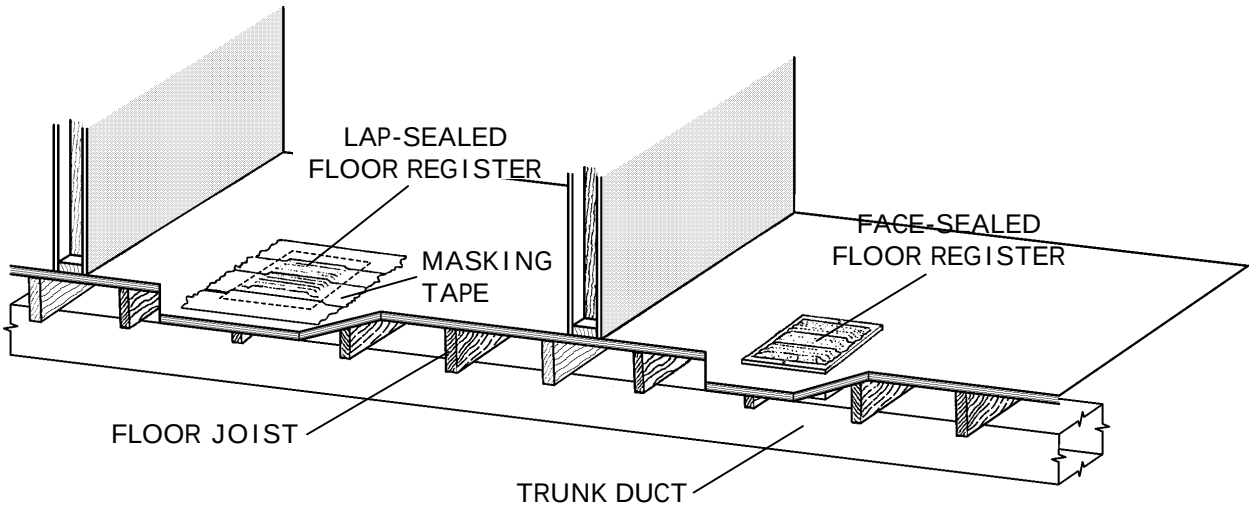


FURNACE CHECKED TO MAKE SURE IT IS OPERABLE AND FREE OF HAZARDS

AIR FILTER REMOVED, IF PRESENT

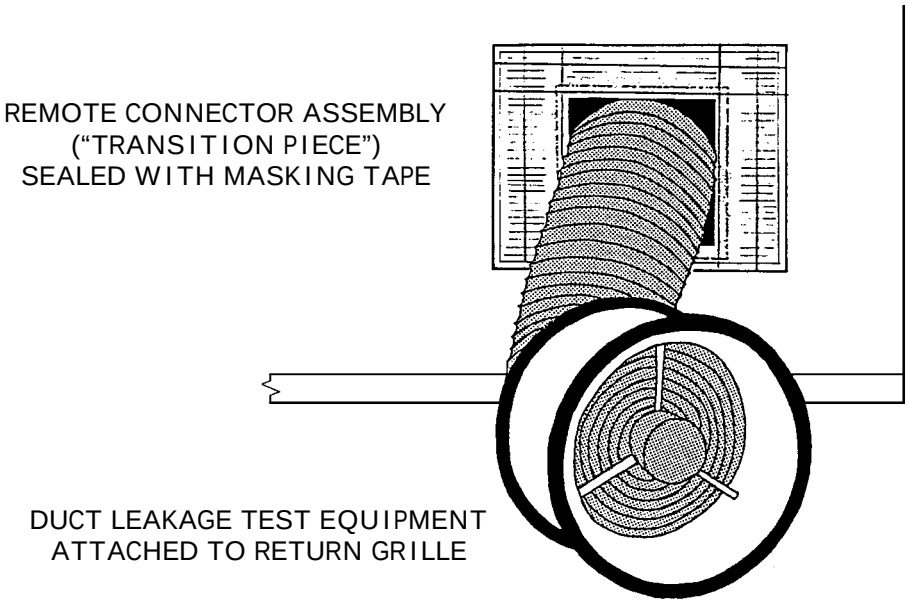
4. BLOCKING SUPPLY AND RETURN DUCT TERMINALS

- **Terminations must be temporarily covered/blocked for tests.**
  - Blocking/sealing methods/materials must not damage home finishes.
  - The same blocking method shall be used for all tests.
  - Blocking material must achieve a complete seal of register/grille.
- **Face Seal Supply Register/Return Grille**
  - The face of the register/grille is covered with a temporary barrier material (register-sealing film, wide masking tape, etc.).
  - Barrier material is restricted to the face of the register/grille.
- **Lap Seal Supply Register/Return Grille**
  - The register/grille is covered with temporary barrier material that laps onto the surrounding surface.
  - This method may not be used where damage to the surrounding surface will occur.
- **Cover Pan Method**
  - The supply/return opening is covered with a sealed pan-shaped device held firmly in place.
  - The edge/flange of the cover pan must be gasketed to achieve a complete seal.
  - This method shall not be used where acoustical texturing is present.



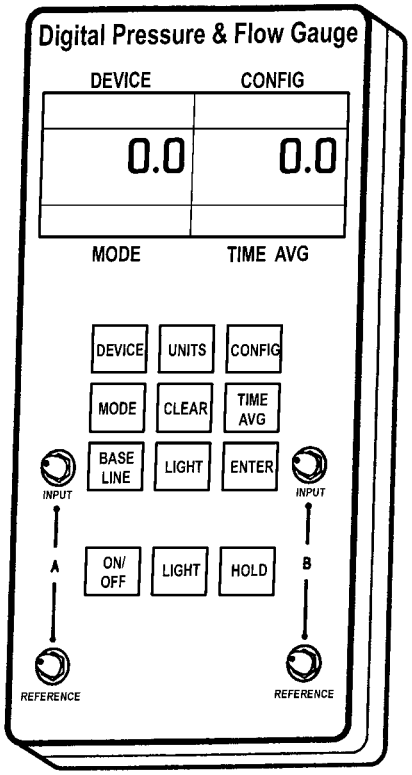
5. DUCT TESTER INSTALLATION

- **Test equipment shall be set up, calibrated, and operated in accordance with manufacturer's instructions.**
- **General Guidelines for Duct Tester Fan Installation**
  - The duct tester fan housing or remote connector assembly (e.g., transition piece) is attached to the HVAC system.
  - The remote connector is attached to the return grille (minimum 1'x1' grille required), or to the air handler access.
  -
  - The fan/connector is secured and sealed completely with temporary tape/film.
  - The duct-pressure sampling hose/probe is installed from the digital pressure gauge to inside the taped register nearest the supply plenum.
  - The Fan Pressure hose is installed from the digital pressure gauge to the duct tester fan pressure tap.



6. TOTAL DUCT LEAKAGE TEST

- **Tests shall be performed in accordance with test equipment manufacturer's instructions.**
- **Test Conditions and Preparation**
  - Test conditions shall be established per Item 3.
  - Supply and return duct terminations shall be blocked per Item 4.
  - Duct tester shall be set per Item 5.
- **Total Duct Leakage Test**
  - To prevent depressurization of the conditioned space by the duct tester fan, an entry door or large window shall be opened.
  - To prevent pressurization of an unconditioned space containing ducts, the space must communicate with outdoors (e.g., by opening vents, access cover/door, etc., as needed).
  - People and objects must be kept away from the front of, and at least one foot to the side of, the duct tester fan inlet during tests.
  - Digital pressure gauge Mode shall be set for one-second averaging, or as recommended by manufacturer.
  - Digital pressure gauge shall be set on high Range, or as recommended by manufacturer.



DIGITAL GAUGE FOR MEASURING PRESSURE AND AIRFLOW

6. TOTAL DUCT LEAKAGE TEST (continued)

- **Pressurization test shall be performed per manufacturer's instructions, using flow control device (e.g., "Flow Ring") as needed.**
  - Duct Tester fan shall be adjusted to pressurize ducts to 25 Pa.
  - Flow control device shall be changed as needed to keep Fan Pressure within an acceptable range, as indicated in Table 10-1 for the Minneapolis Duct Blaster™.
- **Total Duct Leakage**
  - Total Duct Leakage CFM_{25} shall be determined.
  - For digital pressure gauges that do not automatically convert fan pressure to fan flow, manufacturer's conversion tables and procedures shall be utilized to calculate Total Duct Leakage in cfm.
  - Total Duct Leakage in cfm shall be divided by Forced Air System Airflow in cfm and converted to a percentage:

    [Total Leakage ÷ System Airflow] x 100 = % of System Airflow
  - Target Total Duct Leakage is <15% of System Airflow, or as specified in the program P&P (see Item 7).
- **Very Leaky Systems**
  - When a Duct Pressure of 25 Pa cannot be achieved, and the digital gauge does not automatically estimate cfm at 25 Pa, manufacturer's instructions shall be followed.

TABLE 11-1: FAN FLOW CONTROL

Fan Configuration	Flow Range in CFM
Open Fan (no Flow Ring)	600 to 1,500
Ring 1	225 to 800
Ring 2 (smaller opening)	90 to 300
Ring 3 (smallest opening)	20 to 125

7. DUCT SEALING PROTOCOL

- **Start Criteria**
  - Duct repair and sealing work may begin only if the *Initial* Total Duct Leakage satisfies the Start Criteria in the Program Policy & Procedures.
- **Stop Criteria**
  - One of the following LIEE P&P requirements shall be satisfied (per Table 11-2):
    - Target Leakage (stop) criteria, or
    - Economic Stop criteria.
- **Required data shall be recorded on the data form, including:**
  - Total Duct Leakage (or Leakage to Outside) CFM_{25} from the *Initial* test, performed before starting duct repair and sealing work.
  - Total Duct Leakage (or Leakage to Outside) CFM_{25} from the *Final* test performed after completing duct repair and sealing work.

TABLE 11-2: DUCT SEALING TARGET LEAKAGE

MEASUREMENT METHOD	TARGET LEAKAGE (STOP CRITERIA)
(A) Total Duct Leakage	**<15% of System Fan Flow**
(B) Duct Leakage Reduction	**>60% Leakage Reduction[1]**
(C) Prescriptive Default	**Target Not Met but All Accessible Ducts are Sealed[2]**
(D) Economic Stop Criteria	**As prescribed in P&P**

[1]Final duct leakage compared to Initial duct leakage, with a smoke test to confirm that all accessible leaks have been sealed.

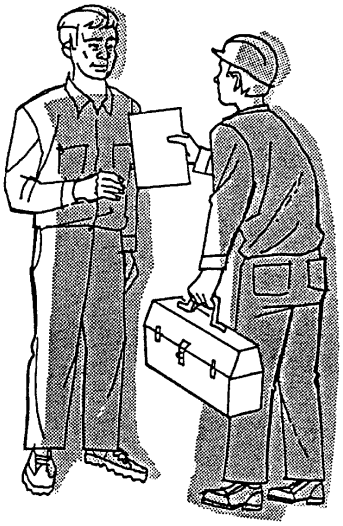
[2]When leakage target cannot be met, all accessible leaks must be sealed, as confirmed by a smoke test.

8. WRAP-UP PROCEDURE

- **Following completion of duct testing, the HVAC system, appliances and the home shall be returned to original condition.**
- **Temporary sealing removed:**
  - All temporary sealing and blocking materials (register-sealing film, temporary tape, foam plugs, etc.) shall be removed.
  - Ventilation air intakes (see Item 3) shall be restored to normal.
- **Air filter(s) reinstalled:**
  - Filters removed for testing shall be reinstalled.
  - Dirty filters shall be cleaned before reinstallation.
- **Appliances and furnishings restored:**
  - Wall thermostat, water heater control, HVAC/air handler power, windows, doors, fans, room air conditioners, etc. returned to pre-test settings.
  - Home furnishings returned to original locations.
  - All test equipment, tools, supplies, and trash removed from the home.

THERMOSTAT RESET

REGISTER SEALS REMOVED



COMMUNICATION WITH CUSTOMER

NONFEASIBILITY CRITERIA FOR DUCT TESTING

1. **Ductwork contains excessive damage or deterioration that would preclude proper testing.**
2. **Ductwork is inaccessible or an unsafe condition exists, causing duct testing to be unfeasible.**
3. **A hazardous condition exists requiring repair or replacement per NGAT policy, and repair/replacement is not feasible.**
4. **Forced air heating unit is inoperative and cannot be repaired.**
5. **Asbestos is present in/on the duct system.**
6. **For ducts requiring undercarriage access:**
   - **Clearance is less than 18" from ground to the floor joist system or girders.**
   - **Sewage waste is on the ground, or excessive ground moisture (standing water or mud) is present.**
7. **The customer refuses.**

DUCT SEALING STANDARDS

APPROVED MATERIALS

1. ALL MATERIALS

- **Surface burning characteristics, per UL 723, ASTM E84, NFPA 255, or UL 2043:**
  - Flame spread rating not to exceed 25.
  - Smoke developed rating not to exceed 50.
- **Only exterior-rated products shall be used outdoors.**
- **UL 181A and 181B listed sealants shall be labeled per Table 17-1.**

2. DUCT MASTIC

- **All Ducts**
  - Mastic shall be:
    - Non-toxic and water resistant.
    - UL listed and labeled per UL 181A or 181B standards.
- **Flexible Metallic and Nonmetallic Ducts**
  - Mastic shall be:
    - UL labeled to include the marking “181B-M”.
    - Compatible with the duct to which it is applied.
- **Rigid Metal Ducts and Components**
  - Mastic shall be UL labeled “181A-M” or “181B-M”.

TABLE 17-1: REQUIRED UL 181 IDENTIFICATION

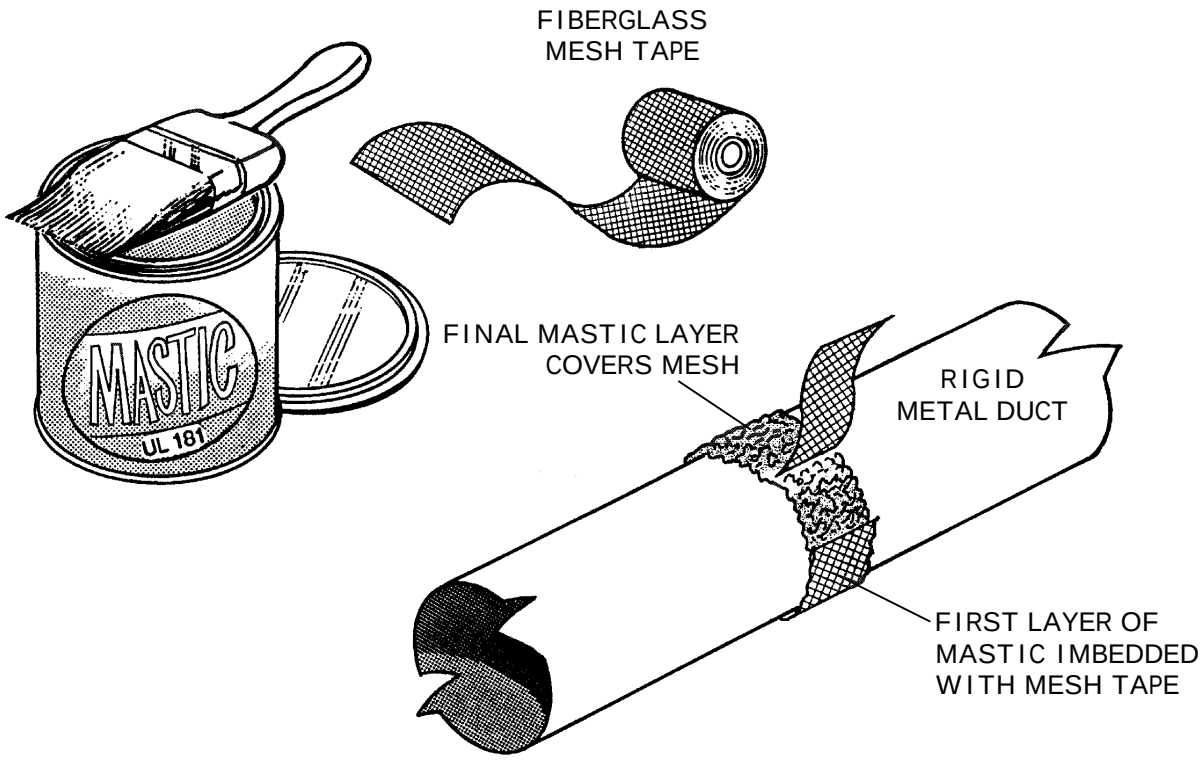
DUCT TYPE	SEALING MATERIAL	UL IDENTIFICATION
RIGID METAL DUCTS AND COMPONENTS	PRESSURE SENSITIVE TAPE	MARKED “181A-P” OR “181A-P/181B-FX”
	HEAT ACTIVATED TAPE	MARKED “181A-H”
	MASTIC	LABELED “181A-M” OR “181A-M/181B-M”
FLEXIBLE DUCTS	PRESSURE SENSITIVE TAPE	MARKED “181B-FX” OR “181A-P/181B-FX”
	MASTIC	LABELED “181B-M” OR “181A-M/181B-M”

3. MESH TAPE

- **All Ducts**
  - Mesh fabric used to reinforce duct mastic shall:
    - Comply with mastic manufacturer's instructions, or
    - Meet the following specifications:
      - Fiberglass mesh tape.
      - Weave per inch: 9 x 9 minimum.
      - Thickness: 0.006" minimum.
- **Flexible Ducts and Rigid Metal Ducts**
  - Mesh tape width: 2" minimum.
- **Rigid Fiberglass Ducts**
  - Mesh tape width: 3" minimum.

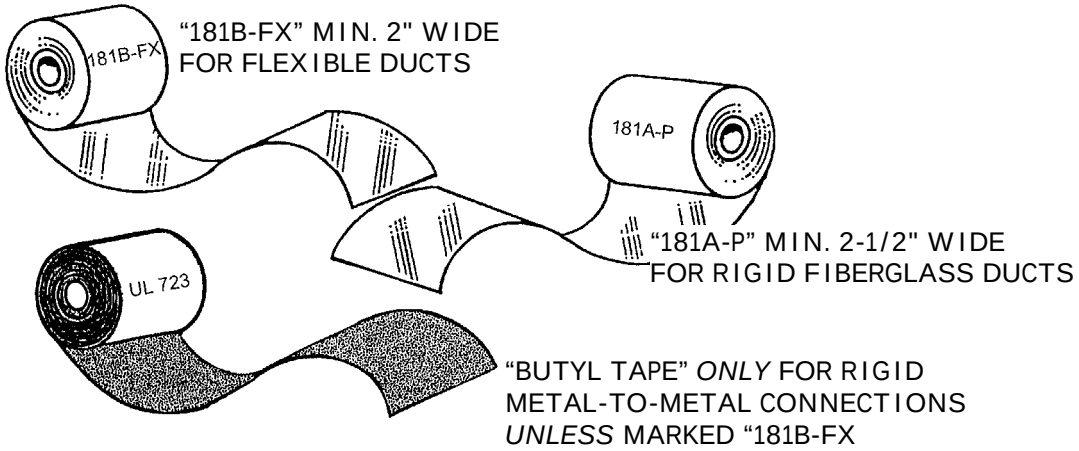
4. CAULKS AND SEALANTS

- **All Materials**
  - Caulk/sealant material and installation criteria prescribed in Section 2, Caulking Standards, shall be followed.
  - Foam sealants are <u>not</u> allowed for duct repair/sealing.



5. PRESSURE SENSITIVE TAPE

- **Approved Tapes**
  - Listed per UL 181A or 181B and marked “181A-P” or “181B-FX”.
  - Metallic pressure sensitive tape: Aluminum foil backing.
  - Plastic pressure sensitive tape: Polypropylene or similar backing.
  - “Butyl Tape” (also known as “Foil Mastic”):
    - Aluminum foil tape with minimum 15 mil butyl adhesive.
    - Marked “UL 723” or “181B-FX”.
    - Butyl tape without “181B-FX” marking shall <u>not</u> be used to seal flexible ducts.
- **Tapes <u>Not</u> Allowed: Cloth-back tapes, even if marked “181B-FX”.**
- **Tapes for Sealing Flexible Nonmetallic and Flexible Metallic Ducts**
  - Tapes with markings that include “181B-FX”, minimum 2" wide.
- **Tapes for Sealing Rigid Metal Ducts and components**
  - Metallic tapes marked “181A-P” and/or “181B-FX”, min. 2" wide.
    - <u>*Exception*</u>: “Butyl tape” without “181A-P” or “181B-FX” markings may be used to seal rigid metal-to-metal connections.
- **Access Panels**
  - Metallic tapes with non-butyl (e.g., acrylic) adhesive.
- **High Temperature Applications**
  - Metallic tapes with non-butyl (e.g., acrylic) adhesive and service temperature rating of at least 265°F.

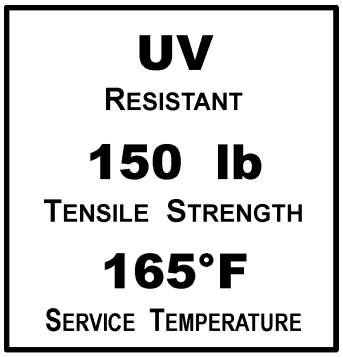


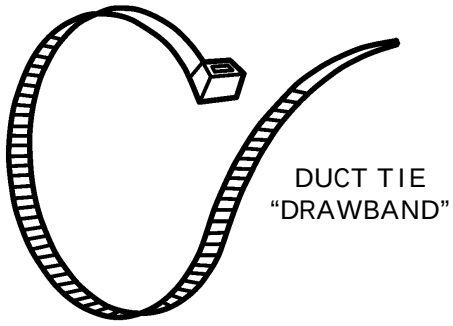
6. DRAWBANDS AND CLAMPS

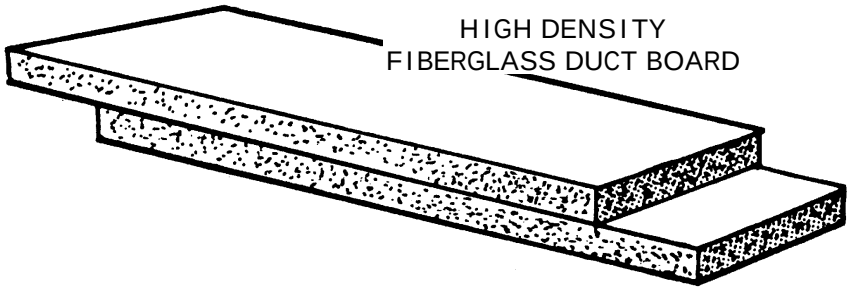
- **Materials**
  - Drawbands and clamps used to secure flexible nonmetallic ducts shall comply with duct manufacturer's installation instructions.
  - Drawbands shall meet the following minimum standards:
    - Weather- and UV-resistant (e.g., black) nylon duct straps/ties rated for outdoor use.
    - Loop tensile strength: 150 pounds minimum.
    - Service temperature rating 165°F minimum.
  - Clamps shall be stainless steel worm-drive clamps.
- **Drawband Installation:**
  - Drawbands shall be tightened with an adjustable tensioning tool in accordance with duct manufacturer's instructions.

7. DUCT BOARD

- **High Density Fiberglass Duct Board**
  - Conformance to ASTM C726, or NFPA 90B, or UL Class 1.
- **Foam Board and Foam Sealant**
  - Not allowed as a barrier material in duct systems.

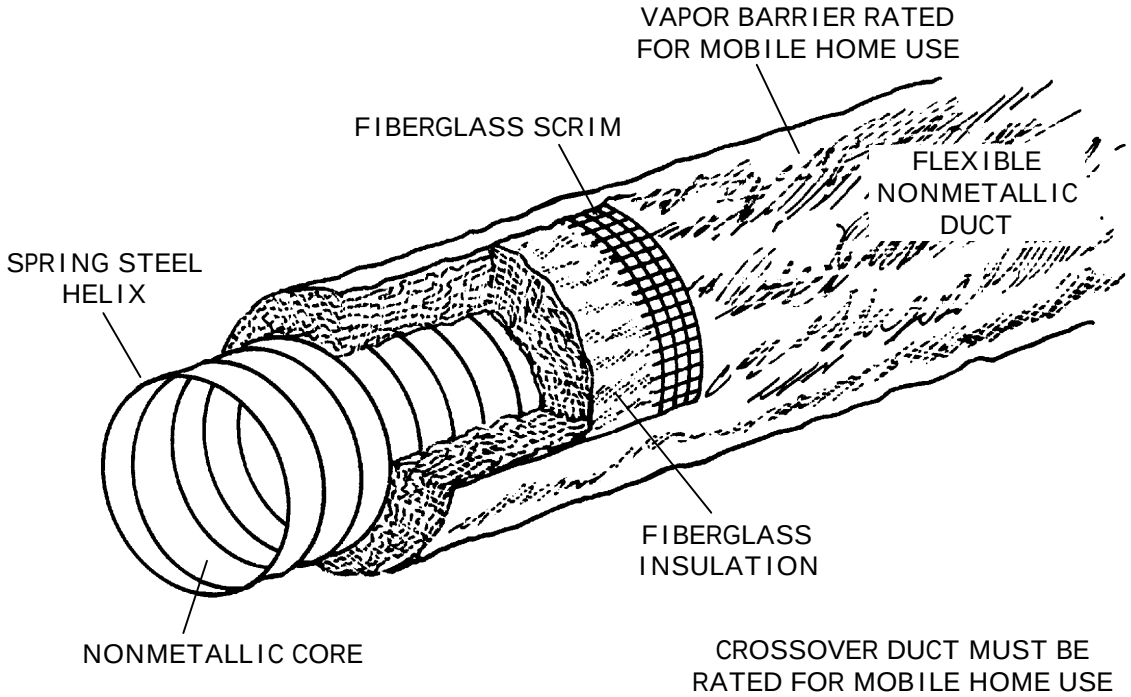






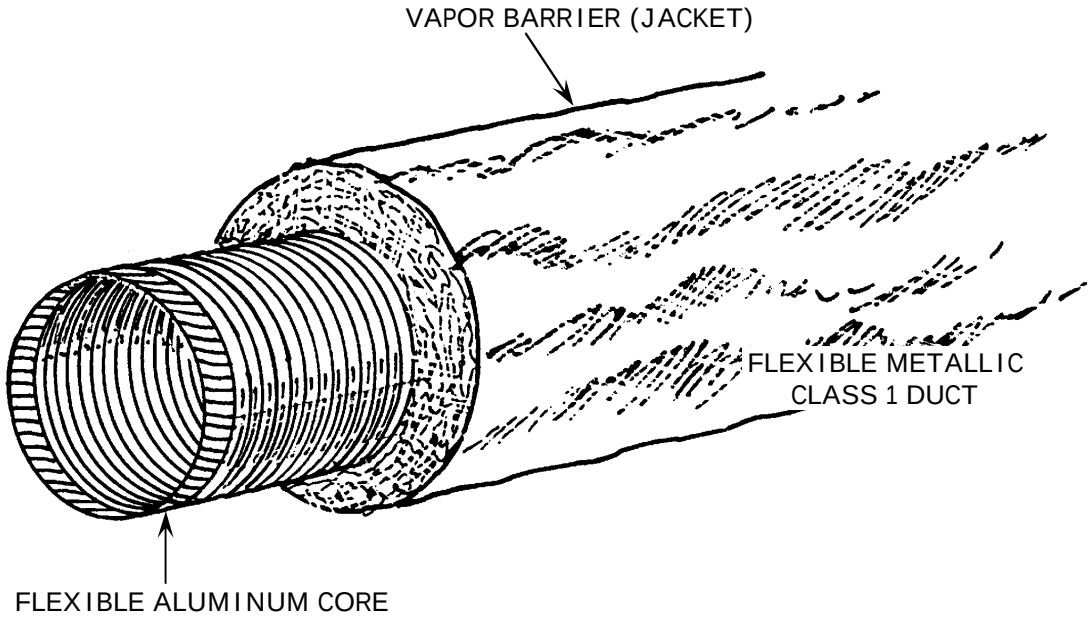
8. FLEXIBLE DUCTS

- **Flexible *Nonmetallic* Ducts**
  - In crawl spaces not accessible to animals, flexible ducts may be used to:
    - Replace damaged or deteriorated flexible ducts (e.g., crossover ducts).
    - Install a new ducted return system.
  - All ducts shall conform to NFPA-90B and UL-181 Class 1.
  - R-value shall be in conformance with Item 10.
  - Nonmetallic flexible duct core shall be fabricated with a with a spring steel helix bonded within nonporous material (e.g., molded composite or two-ply lamination of polyester).
  - Vapor barrier (jacket) shall:
    - Be rated for mobile home use, with HUD markings on the jacket.
    - Have a minimum thickness of 3.5 mils.
    - Have a maximum permeance of 1.0 perm.



8. FLEXIBLE DUCTS (continued)

- **Flexible *Metallic* Ducts**
  - In crawl spaces not accessible to animals, flexible ducts may be used to:
    - Replace damaged or deteriorated flexible ducts (e.g., crossover ducts).
    - Install a new ducted return system.
  - All ducts shall conform to NFPA-90B and UL-181 Class 1.
  - R-value shall be in conformance with Item 10.
  - Metallic flexible duct core shall be fabricated from minimum 0.0065" thick aluminum material or equivalent.
  - Vapor barrier (jacket) shall:
    - Be rated for mobile home use, with HUD markings on the jacket.
    - Have a minimum thickness of 3.5 mils.
    - Have a maximum permeance of 1.0 perm.



9. RIGID METAL DUCTS

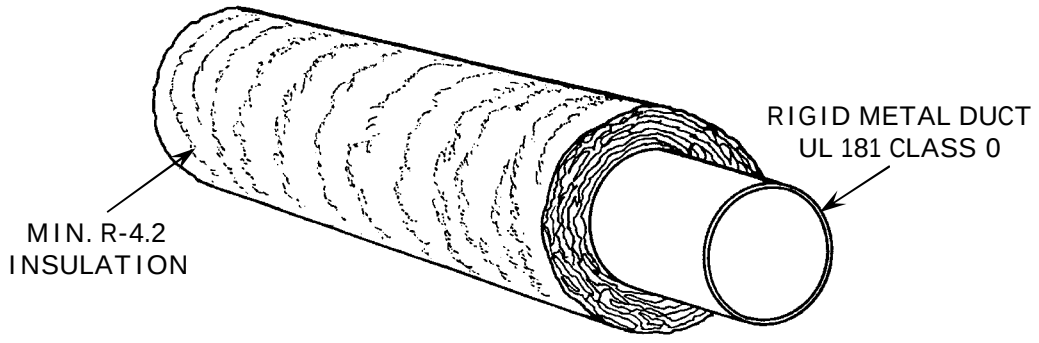
- **Ductwork**
  - Shall conform to NFPA 90B and UL 181 Class 1 or Class 0.
  - Shall be constructed of noncorrosive material.
  - Rectangular metal ducts shall conform to CMC requirements.
  - Round metal ducts shall conform to minimum thickness requirements of the CMC, some of which are shown in Table 17-2.

10. DUCT INSULATION (R-VALUE)

- **R-value shall be as listed below, or as required by the authority having jurisdiction, whichever is greater.**
  - Ducts for Natural Gas Heat:
    - R-4.2 in CEC climate zones (CZ) 6 – 8.
    - R-6 in CZ 1 – 5 and 9 – 13.
    - R-8 in CZ 14 – 16.
  - Ducts for Electric Heat: R-8 in all CZ.

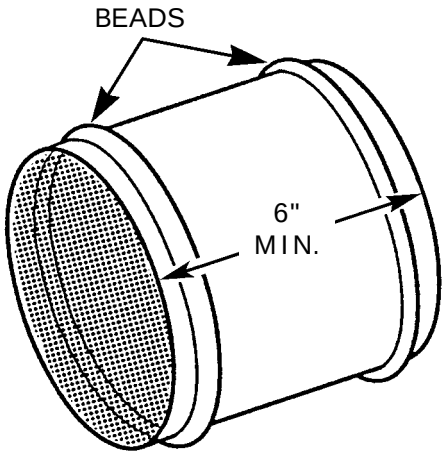
TABLE 17-2: MINIMUM GAGE OF ROUND METAL DUCTS

ROUND METAL DUCTS AT POSITIVE STATIC PRESSURE UP TO 2 IWG (500 PA)		
DIAMETER OF DUCT	**MIN. SHEET GAGE (GALVANIZED STEEL)**	**MIN. B. & S. GAGE (ALUMINUM)**
Up to 14"	**26**	**24**
15" to 23"	**24**	**22**
24" to 37"	**22**	**20**
38" to 51"	**20**	**18**

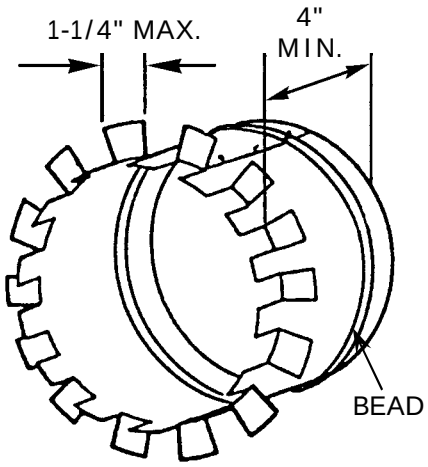


11. SHEET METAL

- **All Rigid Components**
  - Components shall be constructed of noncorrosive materials.
  - Fittings (starting collars, splicing sleeves/couplings, etc.) shall have wall thickness (gage) no thinner than specified for attached ducts (per Item 9 and Table 17-1).
- **New Fittings Used with Flexible <u>Nonmetallic Ducts</u>**
  - The following are minimum standards.
  - Starting Collars
    - 4" sleeve length (6" recommended).
    - 26 gage galvanized steel up to 14" diameter.
  - Splicing Sleeves
    - 6" length (8" recommended).
    - 26 gage galvanized steel up to 14" diameter.
  - All Fittings
    - Fittings shall be beaded at each core connection (e.g., both ends of a sleeve) when flexible nonmetallic ducts are attached.
      - *<u>Exception</u>:* When a preexisting fitting is not beaded, the core's wire coil shall be secured to the fitting as prescribed in Item 22.



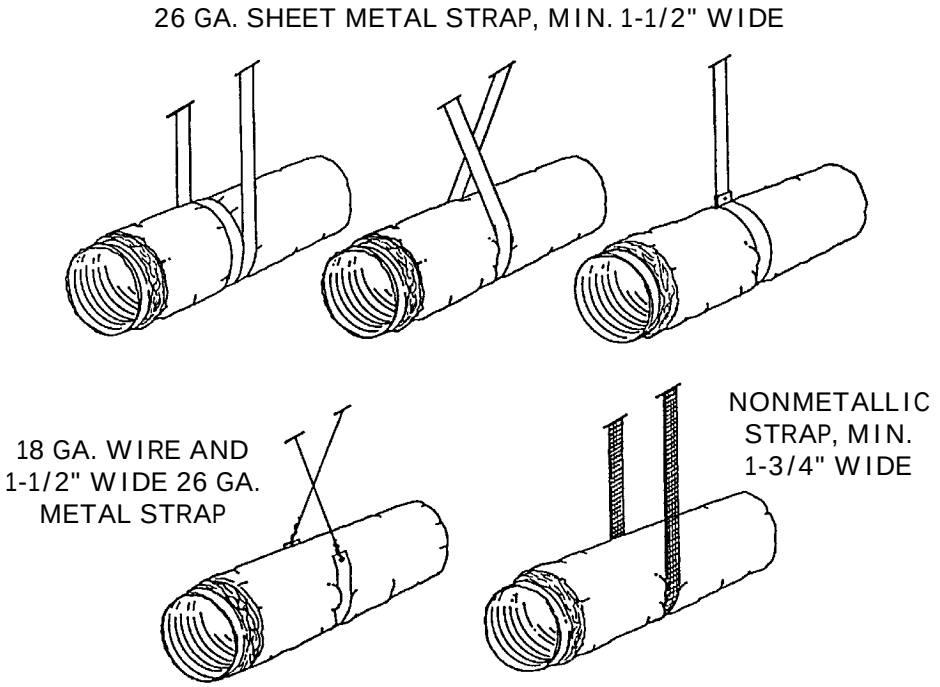
BEADED SLEEVE MINIMUM 6" LONG FOR FLEXIBLE NONMETALLIC DUCTS



SHEET METAL COLLAR (DOVETAIL) MIN. 4" LONG AND BEADED FOR FLEXIBLE NONMETALLIC DUCTS

12. DUCT SUPPORTS

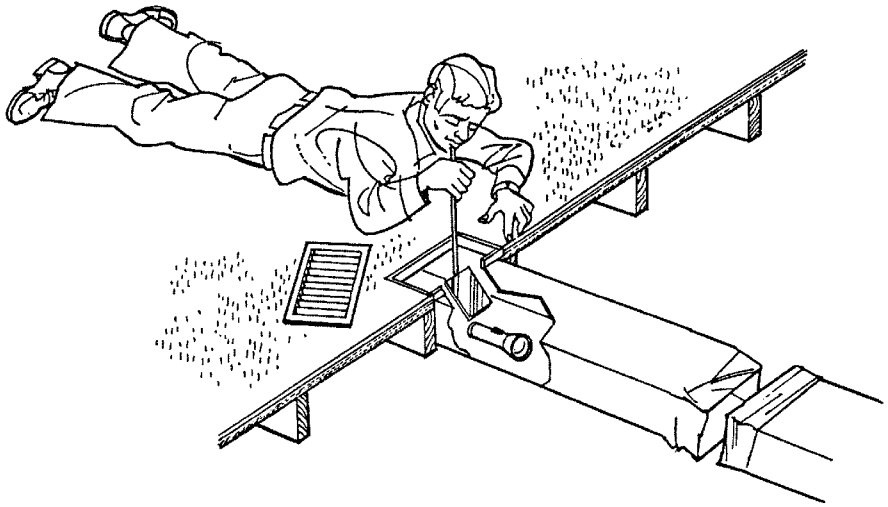
- **Flexible Ducts**
  - Nonmetallic Support Straps
    - Polypropylene monofilament, woven polyester, polyester scrim reinforced vinyl laminate, or equivalent.
      - Minimum width: 1-3/4".
      - Minimum tensile strength: 70 lbs./inch of width.
  - Sheet Metal Support Straps
    - Width: 1-1/2" minimum.
    - Thickness: 26 gage minimum.
- **Horizontal Rigid Round Metal Ducts**
  - Up to 10" Diameter
    - Galvanized steel straps, same gage as duct, 1" minimum width, or
    - 18 gage galvanized steel wire.
  - 11" to 40" Diameter
    - Galvanized steel straps, same gage as duct, 1" minimum width, or
    - 8 gage galvanized steel wire tied to a galvanized steel band, 1" minimum width, surrounding the duct.



DUCT SYSTEM DIAGNOSTICS

13. DUCT SYSTEM INSPECTION AND ANALYSIS

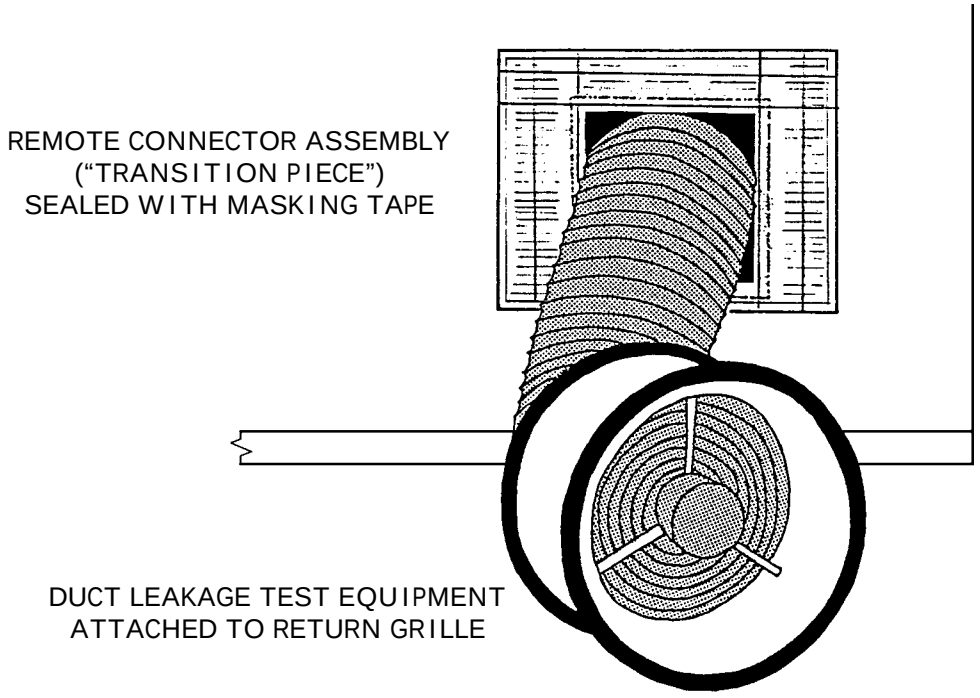
- **Asbestos Caution**
  - When any part of a duct system is known or suspected to be made of or insulated with asbestos, no action shall be taken which will cause such material to be unencapsulated or discharged into the air.
- **Pre-Inspection**
  - Supply registers and return grilles shall be removed to facilitate system inspection and the performance of repair/sealing work.
  - A mirror and light shall be used to perform inspection of:
    - Joints and connections in the boot and riser.
    - Duct termination (dead end) at the register nearest the end of each duct run.
    - Each duct run to locate leaks, disconnections, and other defects.
    - Duct connector under furnace when accessible.
- **Post-Inspection**
  - Internal repair and sealing work (e.g., boot/riser-to-trunk connection) shall be inspected with a mirror to ensure that:
    - Sealants have been applied correctly, and
    - All leaks are completely sealed.



METHOD TO INSPECT FOR LEAKS AND DAMAGE
AND TO VIEW COMPLETED REPAIRS

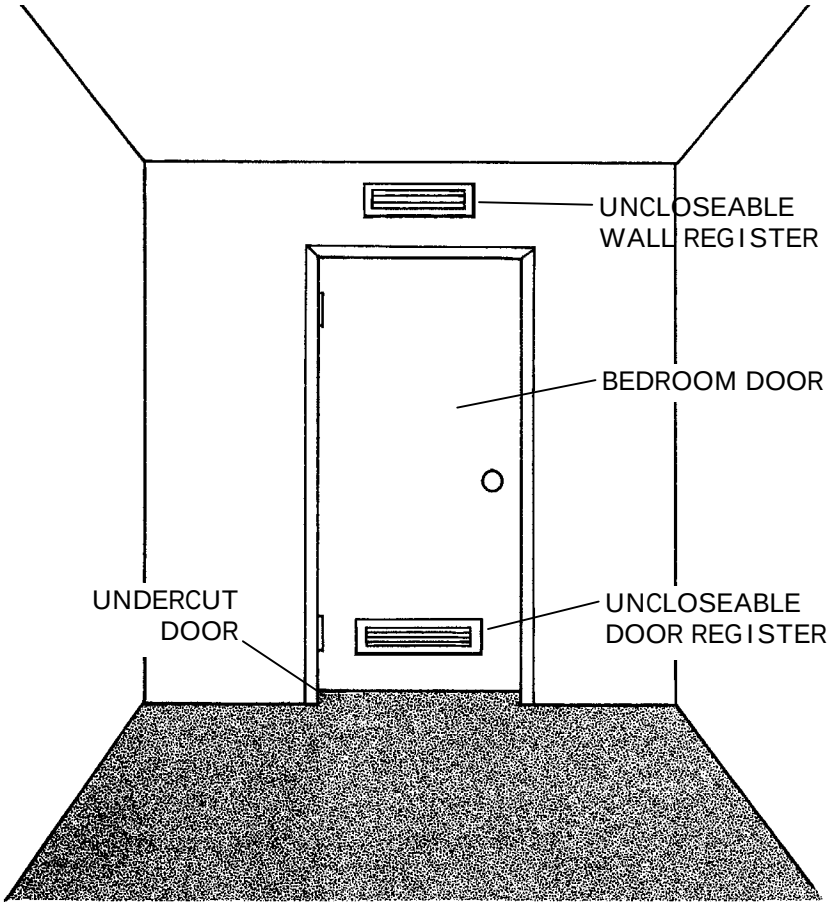
13. DUCT SYSTEM INSPECTION AND ANALYSIS (continued)

- **Pressure Diagnostics**
  - When using a duct pressurization system (duct blaster):
    - Registers/grilles shall be sealed (e.g., with masking tape).
    - Duct tester shall be attached to the return grille nearest the FAU, or as instructed by the manufacturer.
    - Ducts shall be pressurized to 25 Pa (0.1 iwc).
    - Test shall be performed in accordance with manufacturer's instructions, with the result being the measured duct leakage.
  - Duct testing performed to determine whether duct sealing is feasible (initial leakage meets start criteria) and when to stop sealing (final leakage meets stop criteria) shall be performed as prescribed in Section 11, Duct Testing Standards.



13. DUCT SYSTEM INSPECTION (continued)

- **Duct System Balance**
  - Duct systems shall be balanced to provide adequate air movement throughout the living space with interior doors closed.
  - Rooms closed off by doors from the FAU return intake shall be provided with an adequate return air path.
  - The required return air path for each room shall be provided by a permanent means, such as one of the following:
    - Uncloseable grilled or louvered venting in the door or wall.
    - An undercut door leading to the hallway.



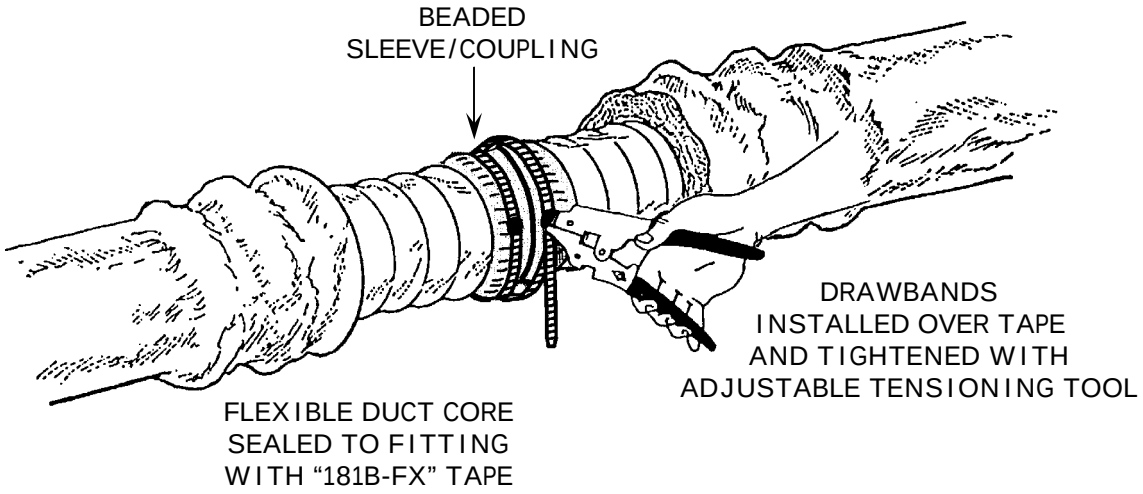
DUCT INSTALLATION

14. GENERAL INSTALLATION CRITERIA

- **New Replacement Ducts**
  - Ducts shall be sized, installed and connected as prescribed in this section and HUD MHCSS Part 3280.715 (also incorporated into the CCR as Title 25, Division 1, Chapter 3, Article 2, Subchapter 3).
- **Surface Preparation**
  - Preparation shall be in conformance with duct and sealant manufacturers' instructions.
  - Surfaces shall be:
    - Cleaned prior to application of tapes and sealants.
    - Free of dust, dirt, oil, grease, moisture and similar substances.
- **Air Handler Operation**
  - Air handler shall:
    - Be off during the application of all tapes and sealants.
    - Remain off for the drying time specified by sealant manufacturer.

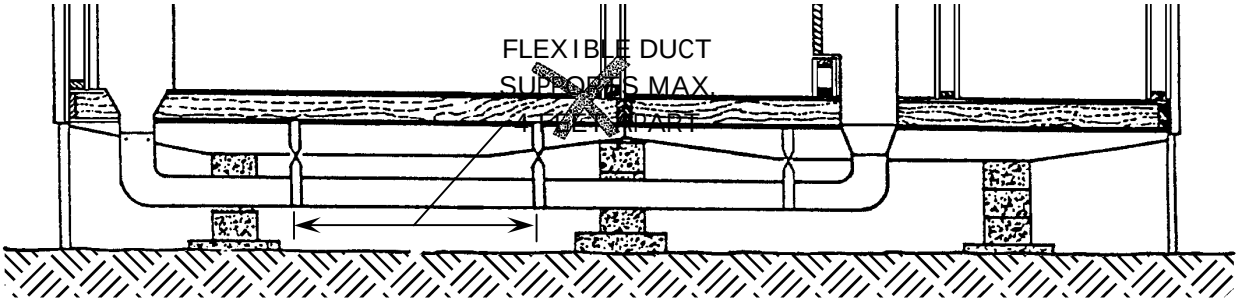
15. DRAWBAND INSTALLATION

- **Drawbands used to secure flexible nonmetallic ducts shall be installed:**
  - In accordance with manufacturer's instructions.
  - Behind the bead when the fitting is beaded.
  - Tightened appropriately with an adjustable tensioning tool.
  - With the excess (tail) removed.
- **Stainless steel worm-drive clamps may also be used.**



16. DUCT SUPPORT AND PROTECTION

- **All Types**
  - Ducts shall be installed and supported above the ground in conformance with manufacturer's instructions and applicable code.
- **Flexible**
  - Supports shall be spaced no more than 4' apart.
  - Maximum sag 1/2" per foot of spacing (total 2") between supports.
- **Rigid**
  - Shall not flex more than 1" between supports.
- **Hangers or Saddles**
  - 1-1/2" minimum width for flexible ducts.
- **Protection**
  - Shall be protected from animals.
  - Shall not be exposed to the weather.



DUCT REPAIR AND SEALING

17. DUCT CLOSURE SYSTEMS

- **All Closure Systems**
  - Sealants shall be applied per manufacturer's instructions.
  - A complete, durable seal shall be achieved.
  - Pressure sensitive tapes shall be marked, and mastic containers shall be labeled, in conformance with:
    - UL 181B for flexible nonmetallic and metallic ducts.
    - UL 181A or 181B for rigid metal ducts and components.
      - *Exception:* Butyl tape without UL 181 markings may be used to seal rigid metal-to-metal connections.
- **Gap Size and Sealing Materials**
  - Sealing materials shall be selected in conformance with Table 17-3.
  - Flexible duct connections with gaps wider than 1/4" shall be replaced with properly-sized duct and/or fitting.
  - Rigid metal duct gaps 1" or wider shall be repaired per Item 26.

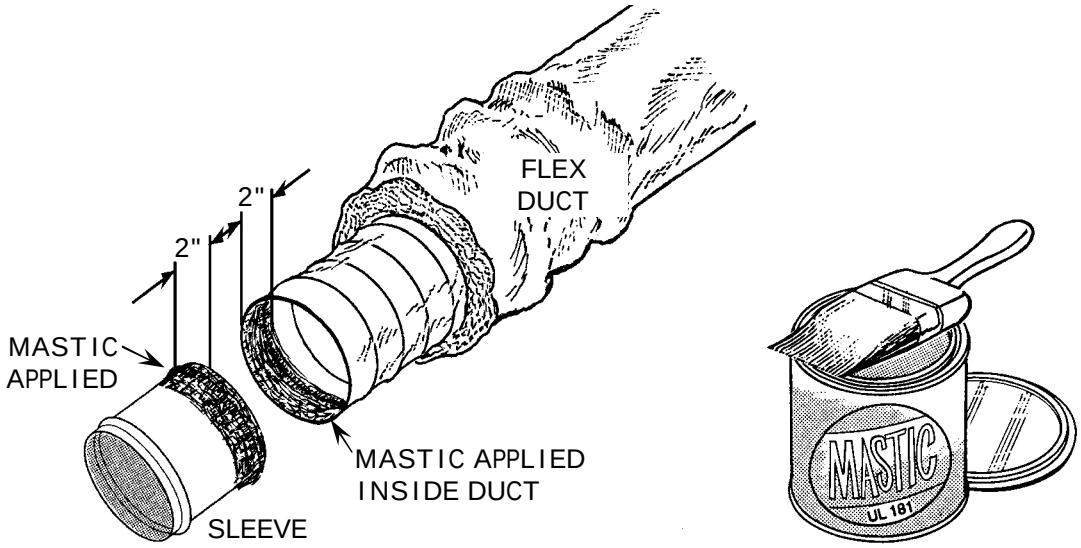
TABLE 17-3: GAP SIZE AND APPROVED SEALING MATERIALS

GAP SIZE	FLEXIBLE METALLIC & NONMETALLIC DUCTS		RIGID METAL DUCT	
	Sealing with MASTIC	Sealing with TAPE	Sealing with MASTIC	Sealing with TAPE
£ 1/4"	Mastic	Tape	Mastic	Tape
> 1/4" - < 1"	Repair Required*	Repair Required*	Mastic & Mesh	Mastic over Tape
1" or more	Repair Required*	Repair Required*	Metal Patch or Sleeve & Mastic	Metal Patch or Sleeve & Tape

***Duct and/or fitting must be replaced with proper size.**

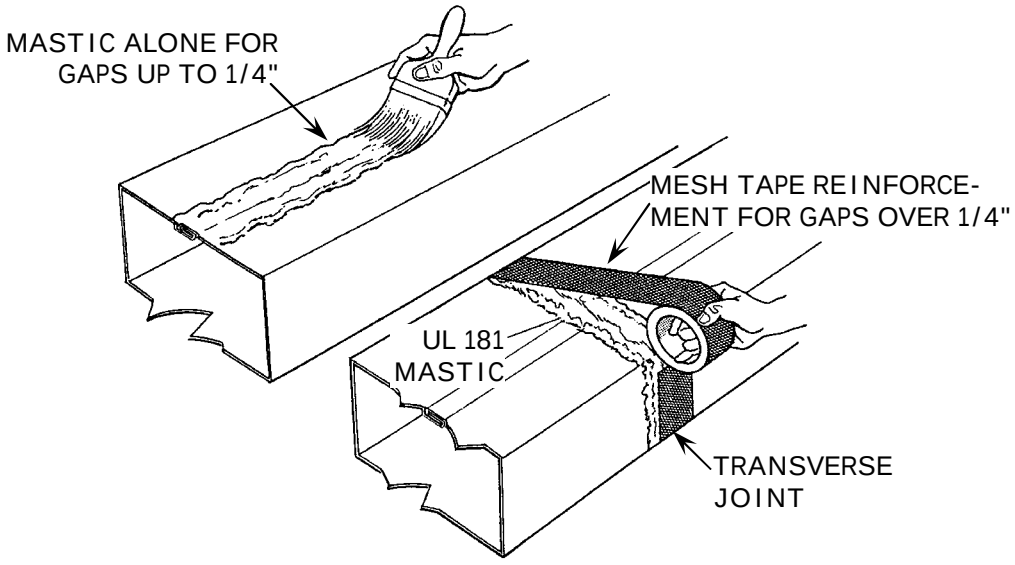
17. DUCT CLOSURE SYSTEMS (continued)

- **Externally-Applied Closure Systems**
  - Sealing materials shall:
    - Be centered over the joint or gap, and
    - Extend at least 1" onto each of the two joined/sealed surfaces.
- **Internally-Placed Mastic Sealant (Core-to-Fitting Joints)**
  - Mastic may be applied either:
    - Inside the duct core, or
    - Onto the rigid component over which the core is attached.
  - Mastic coating shall be at least 1/8" thick and 2" wide.



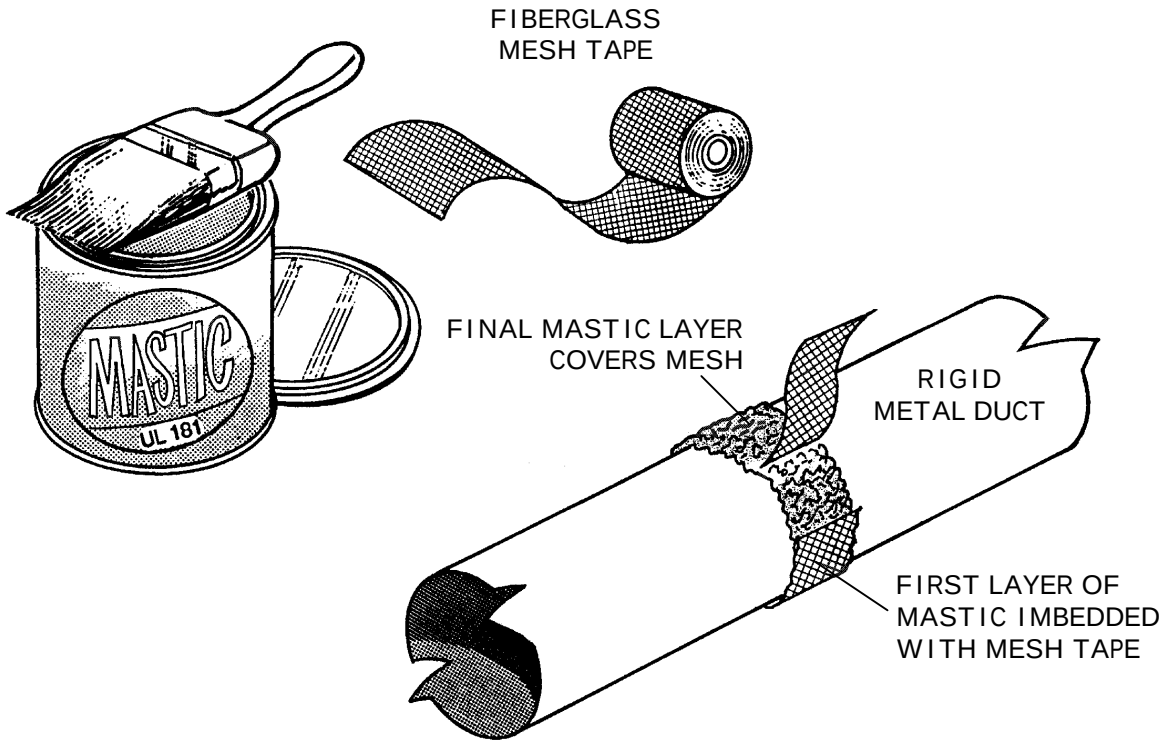
18. SEALING WITH MASTIC

- **Mastic shall be applied as prescribed by manufacturer, including:**
  - Surface preparation/cleaning.
  - Temperature and moisture limitations.
  - Thickness and set-up time.
- **Rigid Metal Ducts and Components**
  - Mastic by itself may be used to seal gaps up to 1/4".
  - Mastic shall be reinforced with fiberglass mesh tape when used to seal gaps larger than 1/4".
  - Gaps 1" or wider shall be repaired and sealed with sheet metal, screws, and sealant (tape, mastic, elastomeric caulk).
- **Flexible Metallic and Nonmetallic Ducts**
  - Mastic used to seal core-to-fitting connections may be:
    - Externally applied over the duct core and rigid fitting, or
    - Internally placed between the core and the fitting.
  - Externally-Applied Mastic
    - Mastic shall be reinforced with fiberglass mesh tape when mastic is used to seal the jacket (vapor barrier).
    - When a gap greater than 1/4" exists between the duct core and the fitting (starting collar, coupling, elbow, wye, etc.), duct and/or fitting must be replaced with the proper size.



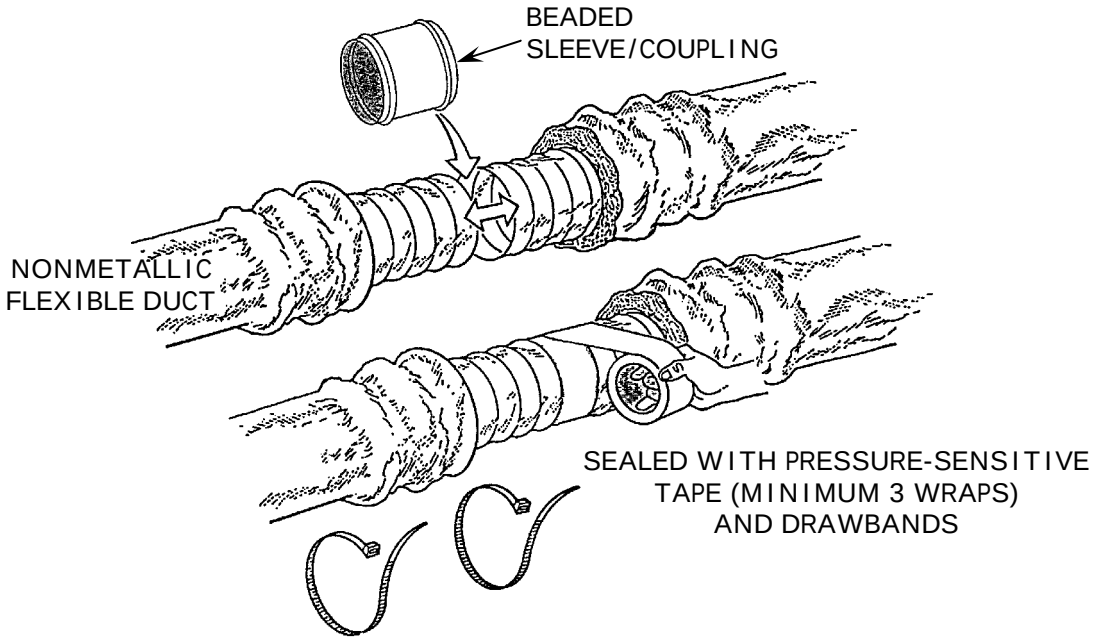
18. SEALING WITH MASTIC (continued)

- **Reinforcement of Mastic with Fiberglass Mesh Tape**
  - Mesh fabric shall be imbedded between two layers of duct mastic to form a mastic closure system.
    - The first layer of mastic shall:
      - Be centered over the joint or gap to be sealed.
      - Extend at least 1" onto each of the joined surfaces.
      - Extend beyond the width of the mesh.
    - The mesh fabric shall be:
      - Embedded in the mastic.
      - Applied at least one layer thick over the entire joint or gap.
      - Wrapped around the entire circumference on transverse joints (e.g., where two sections of duct are joined together).
    - A second layer of mastic shall be installed over the mesh, filling the scrim pattern completely and covering the mesh.



19. SEALING WITH PRESSURE SENSITIVE TAPE

- **All Pressure Sensitive Tapes**
  - Tapes shall be installed as prescribed by manufacturer, including:
    - Surface preparation/cleaning.
    - Application of pressure/rubbing.
    - Temperature and moisture limitations.
  - Successive wraps of tape shall be staggered and should overlap by 50 to 75% of the tape width.
  - At least 3 wraps of tape shall be applied when sealing:
    - Transverse joints at splices and connections in round or rectangular metal ducts.
    - Flexible duct core-to-fitting attachments (with a drawband also installed to secure the core).
    - Jacket (vapor barrier) splices on flexible ducts.
  - When gaps over 1/4" up to <1" wide are sealed with tape:
    - Tape shall be applied as prescribed above and then covered with duct mastic.



19. SEALING WITH PRESSURE SENSITIVE TAPE (continued)

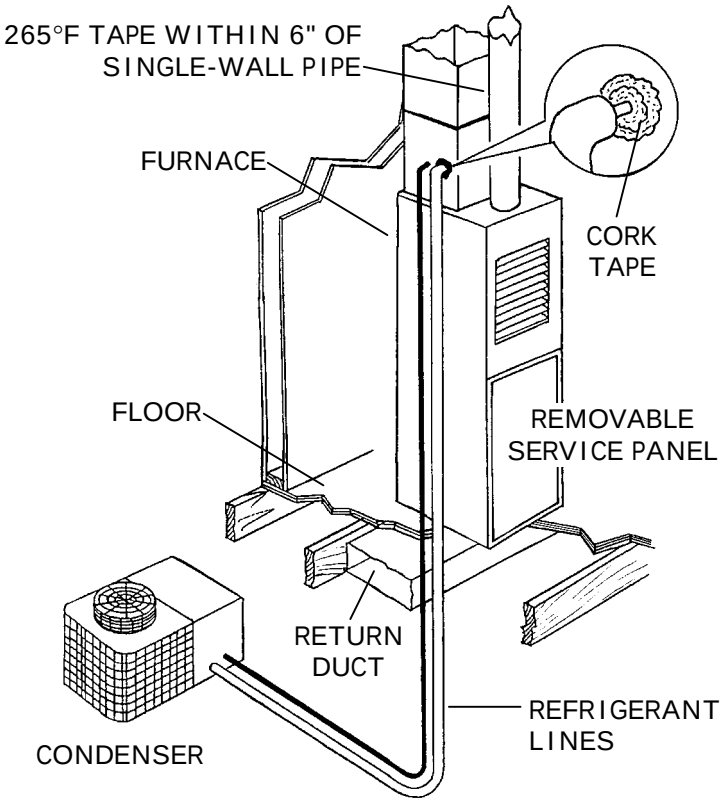
- **Tapes for Rigid Metal Connections**
  - Metallic pressure sensitive tapes shall be used.
- **Tapes for High Temperature Applications**
  - Metallic pressure sensitive tape with a service temperature rating of at least 265°F shall be used when sealing:
    - Within 1" of a double-wall gas flue/vent pipe.
    - Within 6" of a single-wall gas flue/vent pipe.

20. SEALING REFRIGERANT LINES

- **Sealant**
  - Cork tape shall be used for sealing gaps where refrigerant lines penetrate the coil box/plenum.

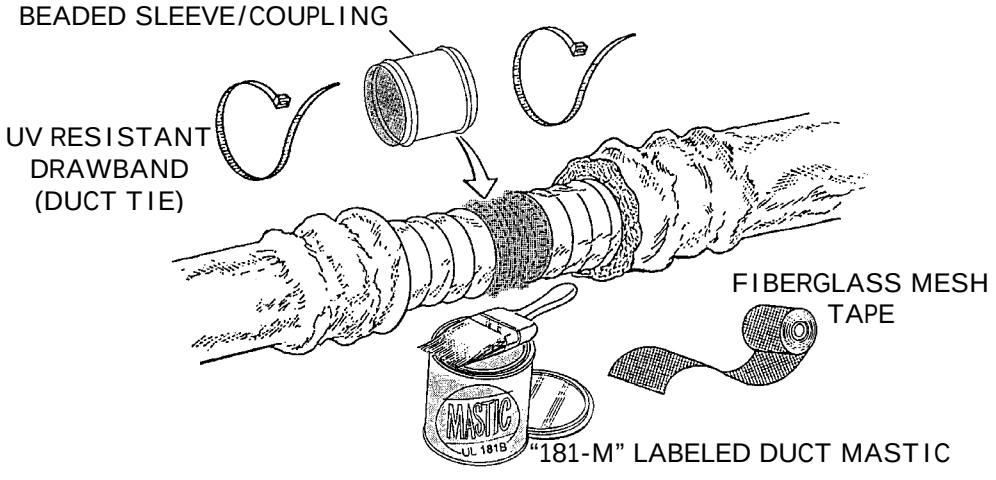
21. SEALING REMOVABLE SERVICE PANELS

- **Sealant**
  - UL 181A or 181B metallic pressure sensitive tape with non-butyl (e.g., acrylic) adhesive shall be used to seal service panels, filter access covers, etc.



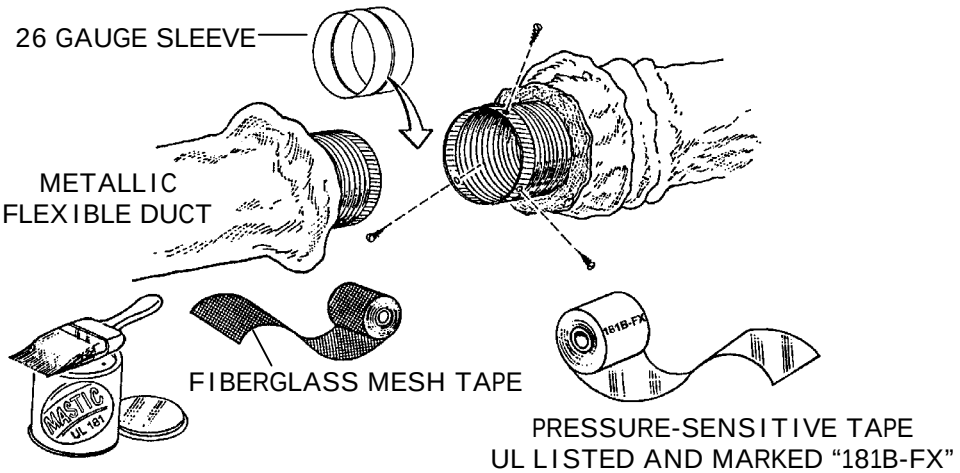
22. REPAIRING AND SEALING FLEXIBLE NONMETALLIC DUCTS

- **Beaded Fittings—Mastic Sealants**
  - A uniform coat of mastic is applied to the outside of the fitting.
  - At least 2" of duct core is pulled onto the fitting, with at least 1" extending past the bead.
  - A drawband (or metal clamp) is installed behind the bead.
  - Mastic is applied externally as needed to ensure a complete seal.
- **Beaded Fittings—Pressure Sensitive Tapes**
  - At least 2" of duct core is pulled onto the fitting, with at least 1" extending past the bead. (Fitting must provide additional 1" surface beyond duct core for application of tape.)
  - A drawband (or metal clamp) is installed behind the bead.
  - Connection is sealed with at least 3 staggered wraps of tape applied uniformly over both the core and the fitting.
- **Non-Beaded Preexisting Fittings—All Sealants**
  - The duct core is secured to the fitting with internally-placed mastic and a drawband, or
  - The duct core's wire coil is secured to the fitting with evenly-spaced #8 sheet metal screws that capture the wire.
    - Screws must penetrate "181B-FX" pressure sensitive tape applied over the duct core to protect it from tearing.
    - 3 screws for diameters up to 12"; 5 screws for diameters over 12".
  - The connection is sealed with duct mastic or 3 staggered wraps of pressure sensitive tape.
- **Core Repairs**
  - Holes/damage in the duct core shall be repaired by removal of the damaged section and insertion of a sleeve/coupling.



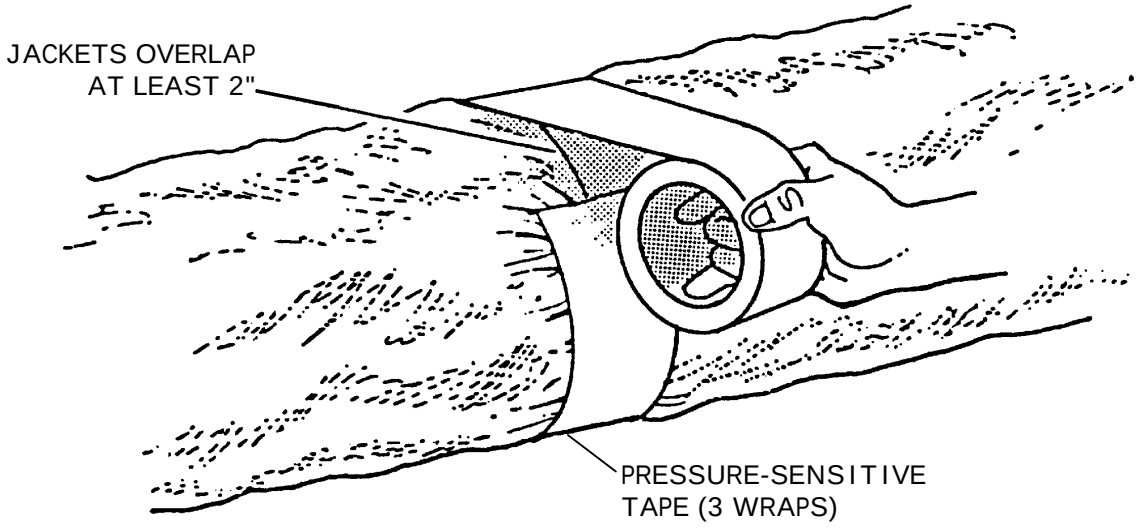
23. REPAIRING AND SEALING FLEXIBLE METALLIC DUCTS

- **Factory-installed Sleeve Present**
  - Joint shall be secured and sealed, like rigid metal ducts, per Item 24.
- **Factory-installed Sleeve Not Present**
  - The end of the core shall be trimmed squarely, then secured and sealed as described below.
  - Sealing with Mastic
    - A uniform coat of mastic is applied to outside of the fitting.
    - At least 1" of duct core is pulled over fitting and secured with screws.
    - Mastic is applied externally as needed to ensure a complete seal.
  - Sealing with Pressure Sensitive Tape
    - At least 1" of duct core is pulled over fitting and secured with screws.
    - Fitting must provide additional 1" surface beyond duct core.
    - Connection is sealed with at least 3 staggered wraps of tape applied uniformly over both the core and the fitting.
  - Installation of Screws
    - The core is secured to the fitting with #8 sheet metal screws positioned at least 1/2" from the end of the core.
    - Screws are equally spaced.
      - 3 screws for duct diameters under 12".
      - 5 screws for diameters 12" and over.
- **Core Repairs**
  - Holes/damage in the duct core shall be repaired by removal of the damaged section and insertion of a sleeve/coupling.



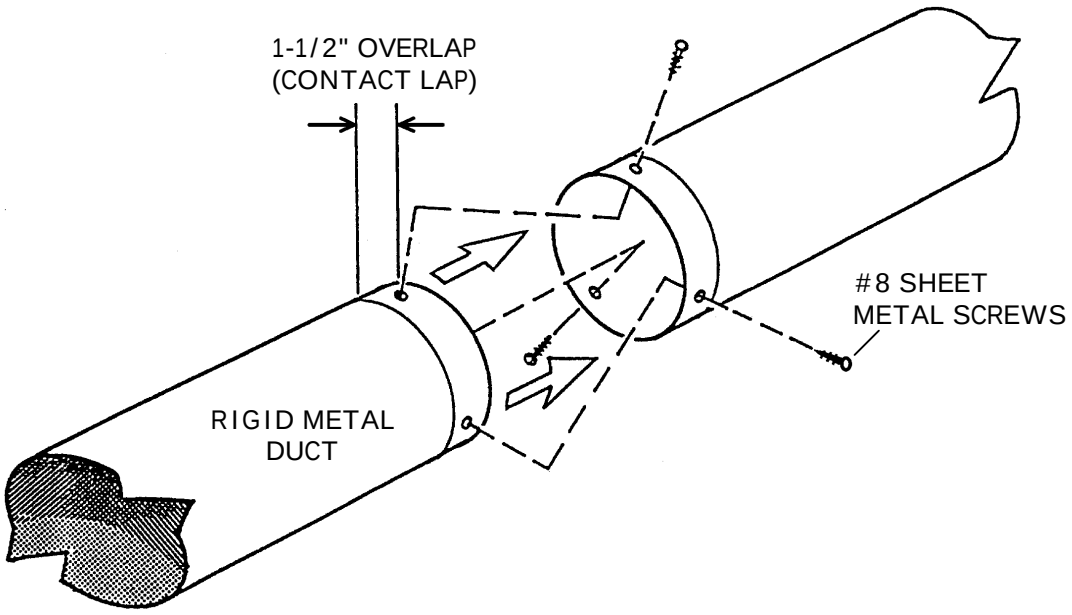
24. FLEXIBLE DUCT INSULATION AND JACKET

- **Insulation shall completely cover the duct core and fitting.**
- **Jacket (Vapor Barrier)**
  - The jacket shall be pulled back over the insulation.
    - The jackets shall overlap at least 2" at splices.
    - Jackets shall be secured/sealed with a drawband and/or 3 staggered wraps of pressure sensitive tape.
- **Jacket Repairs**
  - Rips and holes in the vapor barrier shall be repaired with pressure sensitive tape or with mastic and mesh tape.
  - Ducts with *Air-Permeable* Core:
    - The jackets shall be overlapped at least 2" at splices.
    - Jacket ends at splices and connections shall be secured and sealed with:
      - 3 staggered wraps of minimum 2" pressure sensitive tape, or
      - Mastic applied between the jackets and secured with a drawband.
    - Breaches in the outer vapor barrier shall be sealed with pressure sensitive tape, or mastic and mesh tape.



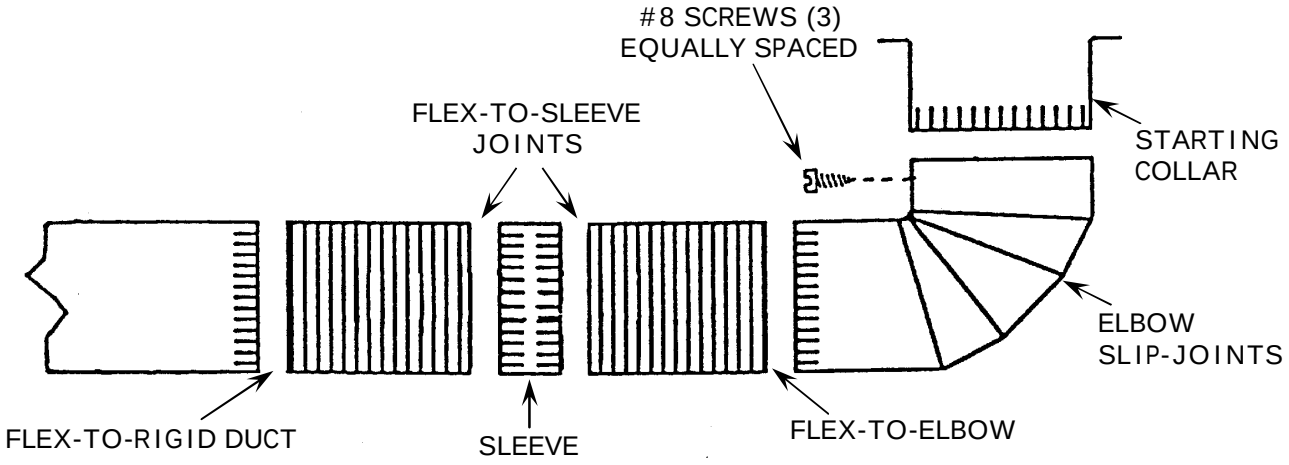
25. REPAIRING AND SEALING RIGID METAL DUCTS

- **Rigid Metal Connection Contact Lap**
  - Crimp joints shall overlap at least 1-1/2" (e.g., connection of duct to fitting, or two sections of duct).
- **Mechanical Fasteners**
  - Rigid metal duct connections shall be secured with equally-spaced #8 sheet metal screws.
  - Round Ducts
    - 3 screws on diameters up to 14".
    - 4 screws on diameters 15" to 19".
    - 5 screws on diameters 20" to 24".
  - Rectangular Ducts
    - At least 1 screw per side.
  - Lapped Seams (Field Fabricated Metal Plenums, etc.)
    - Overlapped surfaces shall be:
      - In substantial contact with each other along the entire seam.
      - Securely fastened together (e.g., with #8 sheet metal screws at intervals of 12" or less).



25. REPAIRING AND SEALING RIGID METAL DUCTS (continued)

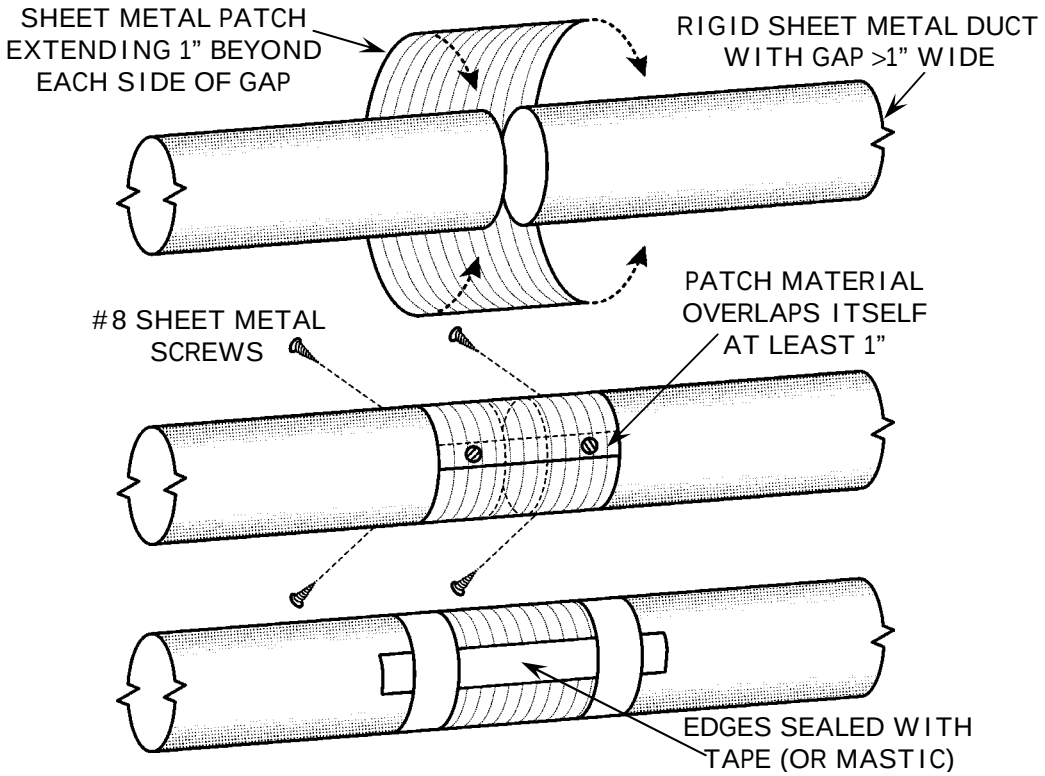
- **Gaps 1/4" or smaller may be sealed with:**
  - Duct mastic, or
  - Metallic pressure sensitive tape.
- **Gaps over 1/4" up to <1" wide shall be sealed with:**
  - Duct mastic with embedded fiberglass mesh, or
  - Metallic pressure sensitive tape covered with mastic.
- **Gaps 1" or wider shall be:**
  - Repaired with a sleeve or a sheet metal patch (per Item 26), and
  - Sealed with mastic or tape.
- **All Connections**
  - Mastic and fiberglass mesh shall be installed per Item 18.
  - Metallic pressure sensitive tapes shall be installed per Item 19.



- TAPE OR MASTIC ON GAPS UP TO 1/4"
- MASTIC & MESH, OR METALLIC TAPE COVERED BY MASTIC, ON GAPS OVER 1/4"

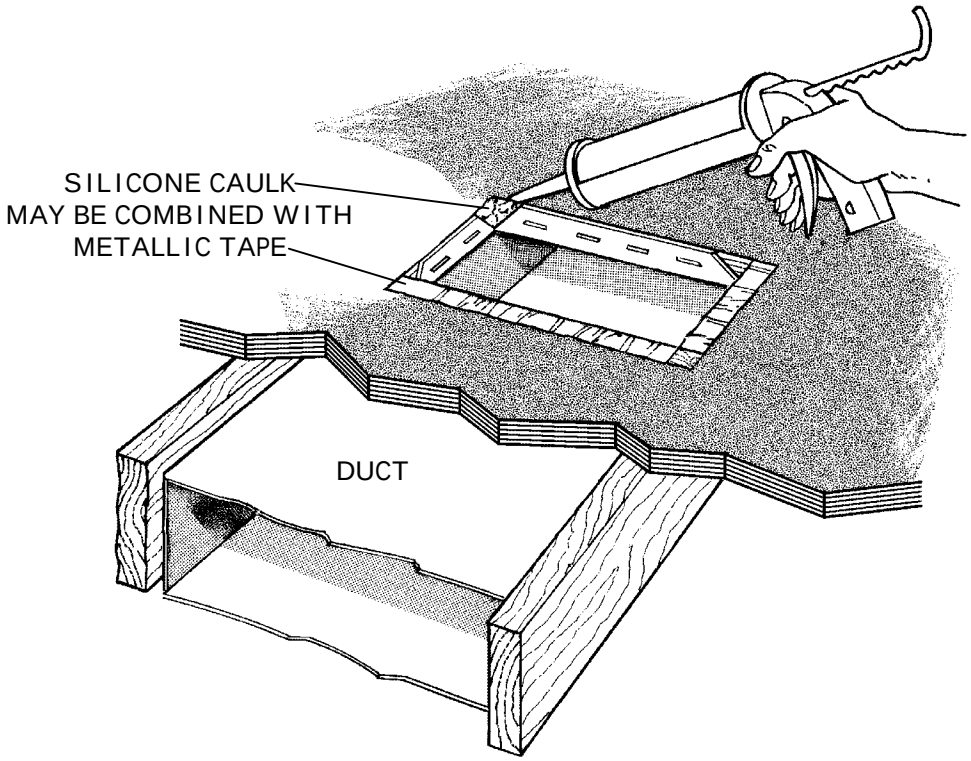
26. SHEET METAL PATCHES FOR RIGID METAL DUCTS

- **Material**
  - Patch material shall match the existing duct material (i.e., galvanized patch for galvanized duct, or aluminum patch for aluminum duct).
  - Gauge of the patch shall equal or exceed gauge of the existing duct.
- **Installation**
  - Patch material shall:
    - Extend at least 1" beyond each edge of the gap, and
    - Overlap itself by at least 1".
  - The patch shall be wrapped tightly around the duct and secured with #8 sheet metal screws.
    - Where the patch overlaps itself, at least 1 screw shall be installed on each side of the gap.
    - At least 2 more screws shall be evenly-spaced around the duct on each side of the gap.
- **Sealing**
  - All patch edges/gaps shall be sealed per Item 25.



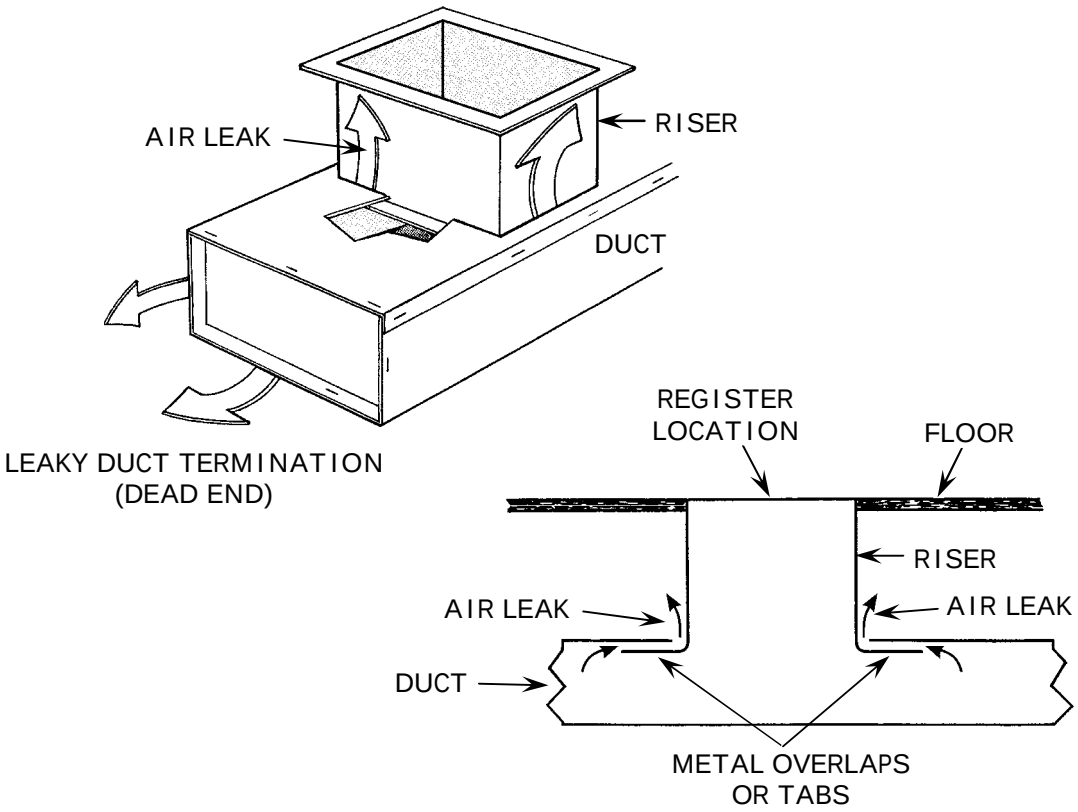
27. REGISTER BOOT/RISER REPAIR AND SEALING

- **Attachment**
  - Duct boots and risers that are loose or detached from the structure be reattached and mechanically secured (e.g., with screws, staples, or nails).
- **Boot/riser termination shall be then be sealed to the floor.**
  - Gaps up to 1/4" wide may be sealed with:
    - Elastomeric caulk (e.g., polyurethane or silicone), or
    - Duct mastic applied at least 1/8" thick.
  - Gaps over 1/4" up to <1" wide:
    - Gaps shall be sealed when possible with butyl tape, or with duct mastic reinforced with mesh tape.
    - Elastomeric caulk and pressure sensitive metallic tape may be used together where a thinner repair is required.
  - Gaps 1" or wider shall be:
    - Patched with sheet metal,
    - Mechanically secured as feasible, and
    - Sealed with tape, mastic, or caulk.



27. REGISTER BOOT/RISER REPAIR AND SEALING (continued)

- **Risers**
  - Risers that are loose or are disconnected from the trunk shall be reattached, secured, and sealed (e.g., with butyl tape).
- **Metal Overlaps/Tabs**
  - Metal overlaps/tabs at joint between the riser and trunk duct shall be repaired and permanently sealed (e.g., with butyl tape).
- **Preparation of Joint**
  - Metal overlaps/tabs shall be bent as needed to achieve the best possible metal-to-metal contact.
  - Dust and dirt shall be removed to the extent feasible from surfaces to which sealant will be applied (e.g., with vacuum cleaner hose/nozzle, with a brush, or with a damp rag).

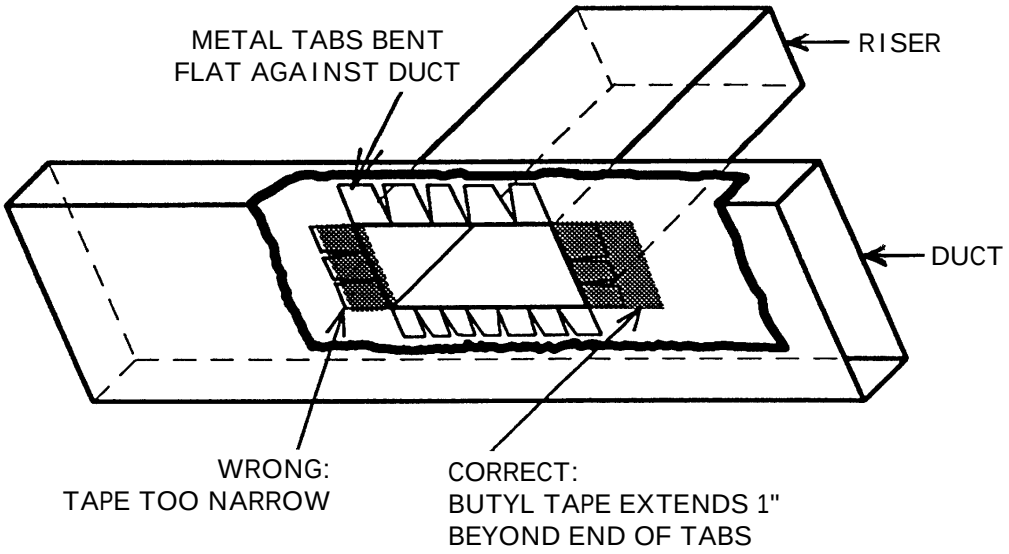


27. REGISTER BOOT/RISER REPAIR AND SEALING (continued)

- **Application of Sealant**
  - Joint overlaps/tabs shall be sealed with:
    - Butyl tape (3" width recommended), or
    - Duct mastic and embedded fiberglass mesh tape.
  - Sealant shall cover all overlaps/tab and extend approximately 1" beyond the ends of the overlaps/tabs.
  - Pre-existing metallic tape:
    - If loose, shall be removed to the extent feasible.
    - If not loose, shall be covered with new sealant to achieve a complete, permanent seal.

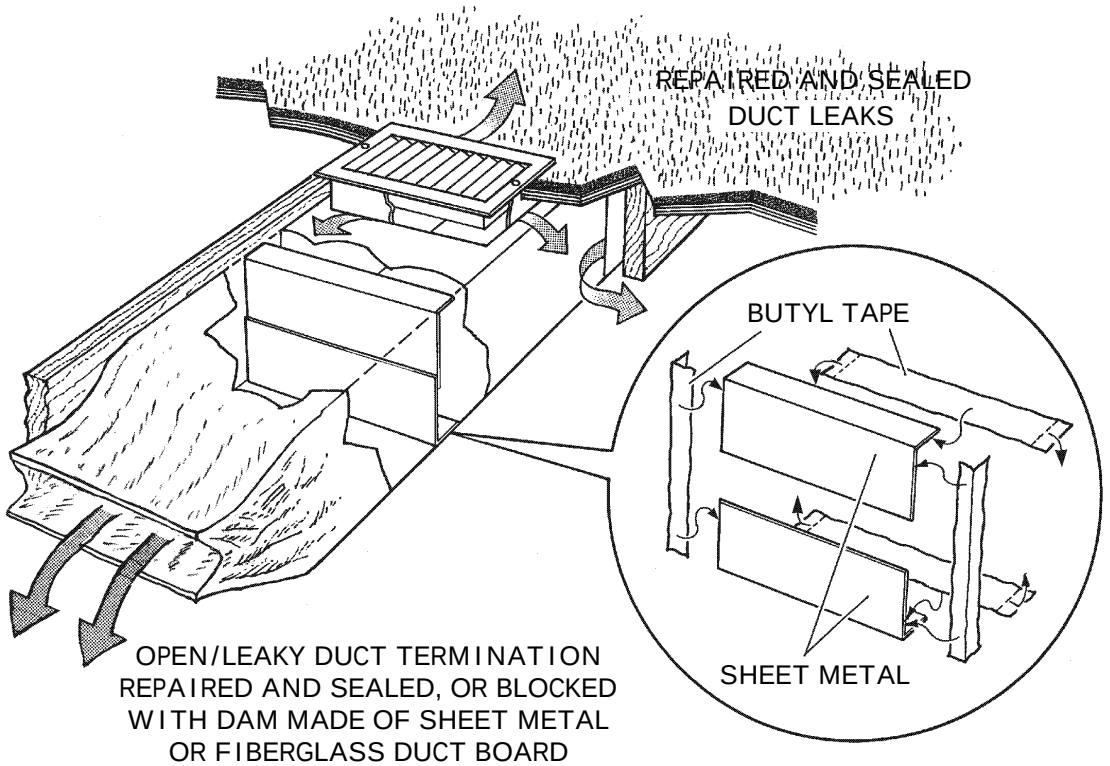
28. SEALING OTHER LEAKS WITHIN REACH

- **Reachable Leaks**
  - Other obvious leaks that can be reached through the register opening shall be sealed utilizing materials and methods prescribed in Items 25 and 26 above.
- **Such leaks may include:**
  - Duct joints/splices and other loose metal overlaps.
  - Duct terminations (dead ends).
  - Leaks in the duct connector underneath the furnace (accessed through removable bottom panel on front of unit).



29. REPAIRING LEAKY DUCT TERMINATIONS

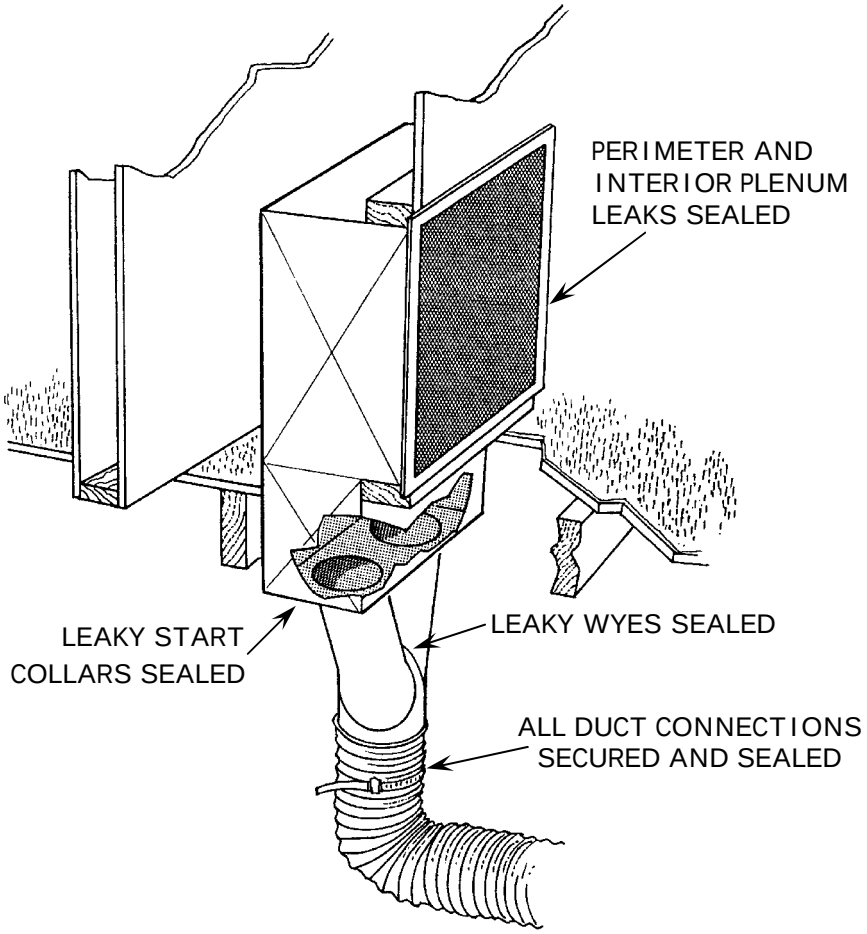
- **A duct termination (dead end) that is very leaky or open shall be:**
  - Repaired and sealed, or
  - Securely blocked (e.g., with a 1-piece or 2-piece sheet metal dam, or a fiberglass duct board dam) and permanently sealed.
- **Sheet Metal Dams**
  - Dams shall be:
    - Placed as far from the register opening as feasible.
    - Attached securely (mechanically when possible).
  - Dams may be attached/sealed with:
    - Butyl tape, or
    - Mastic and mesh tape.



OPEN/LEAKY DUCT TERMINATION
REPAIRED AND SEALED, OR BLOCKED
WITH DAM MADE OF SHEET METAL
OR FIBERGLASS DUCT BOARD

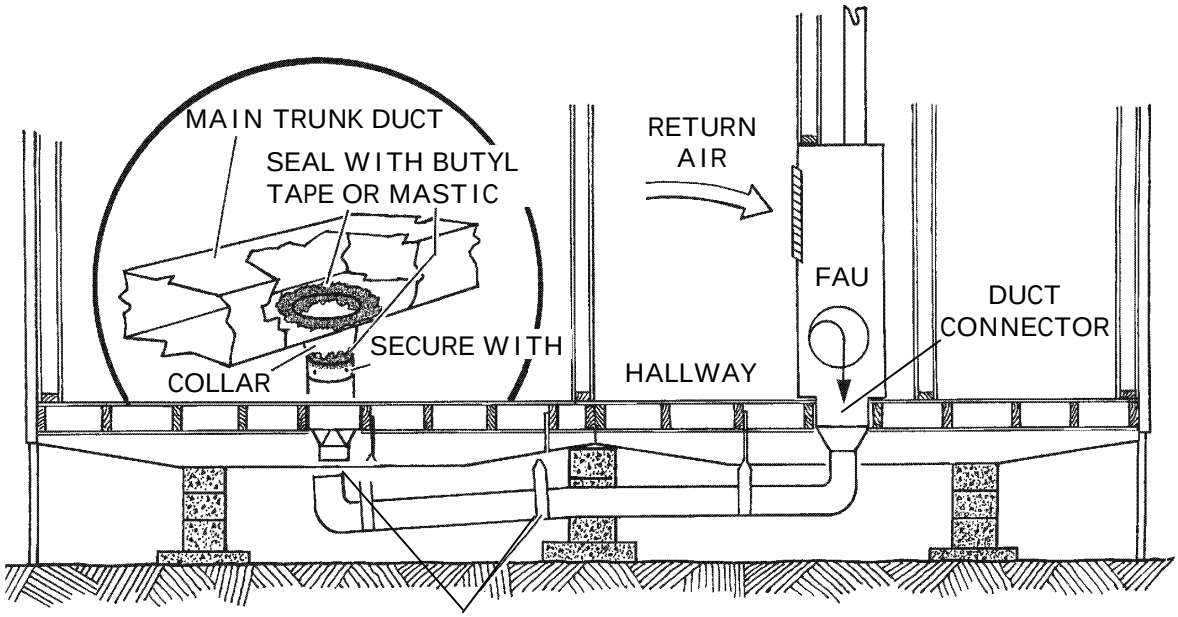
30. DUCTED RETURNS

- **Existing Ducted Returns**
  - All accessible components shall be inspected for decay, damage, and leaks, and shall be repaired as needed.
  - Rodent barrier (bellyboard) sections shall be removed for access as needed.
  - Accessible leaks shall be repaired.
  - Access holes made in the rodent barrier shall be repaired as prescribed in Item 34.



31. CROSSOVER DUCTS

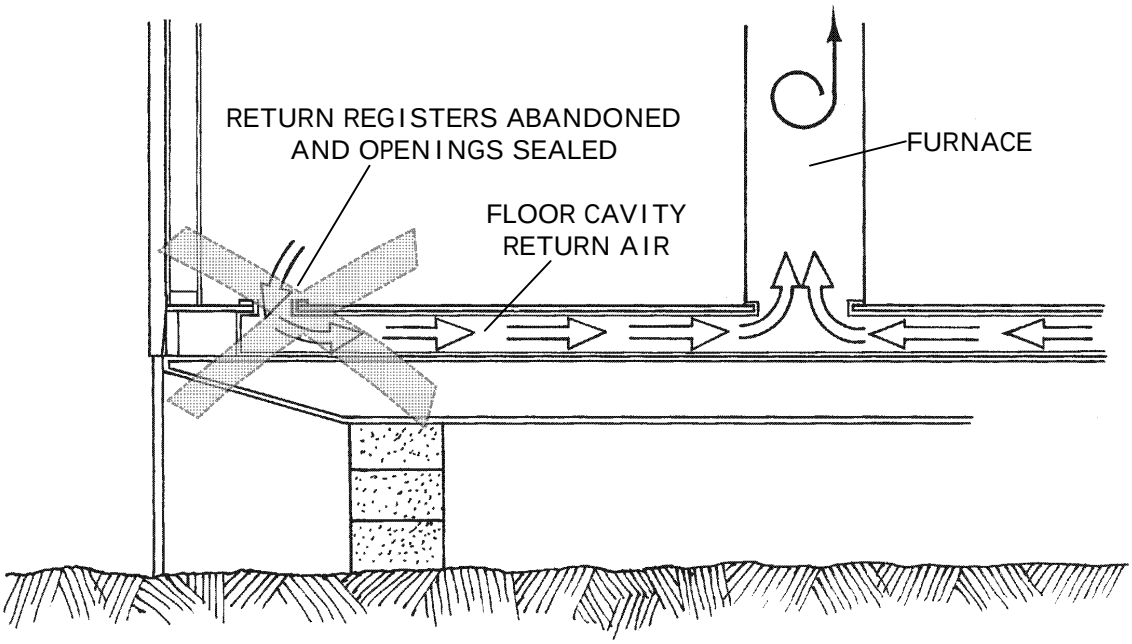
- **Double-Wide Units**
  - Disconnections shall be reconnected, mechanically secured, and sealed.
  - Other major leaks that are repairable shall be repaired and sealed.
  - Disconnected and damaged duct components that cannot be feasibly repaired shall be replaced.
- **Duct Installation**
  - Ducts shall be installed, secured, supported, and sealed as prescribed in this section.
  - Flexible nonmetallic and flexible metallic ducts shall be sealed with UL 181B listed sealants.
    - Mastics: labeling shall include the designation “181B-M”.
    - Pressure sensitive tapes: markings shall include the designation “181B-FX”.
  - Ducts shall be installed above the ground in accordance with Item 16.



DISCONNECTED/DAMAGED CROSSOVER DUCT REPAIRED/REPLACED, LOOSE CONNECTION TO TRUNK REPAIRED AND SEALED

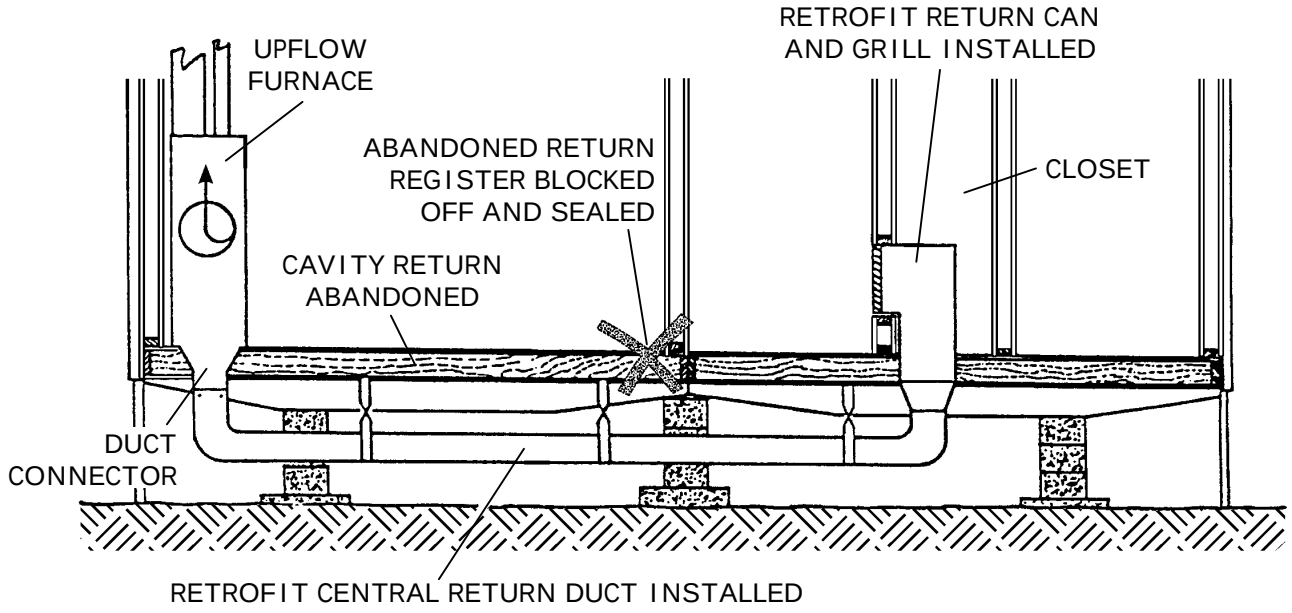
32. NEW CENTRAL RETURN

- **Upflow Furnace with Belly Cavity Return**
  - When installation of a new ducted return is prescribed in the program P&P, it shall be installed, supported, and sealed as prescribed in this section.
  - The system shall:
    - Be properly sized by a qualified HVAC technician.
    - Provide a balanced air flow throughout the mobile home.
  - When a new central return is installed:
    - The existing belly cavity return shall be abandoned.
    - The abandoned register openings shall be blocked off and permanently sealed.



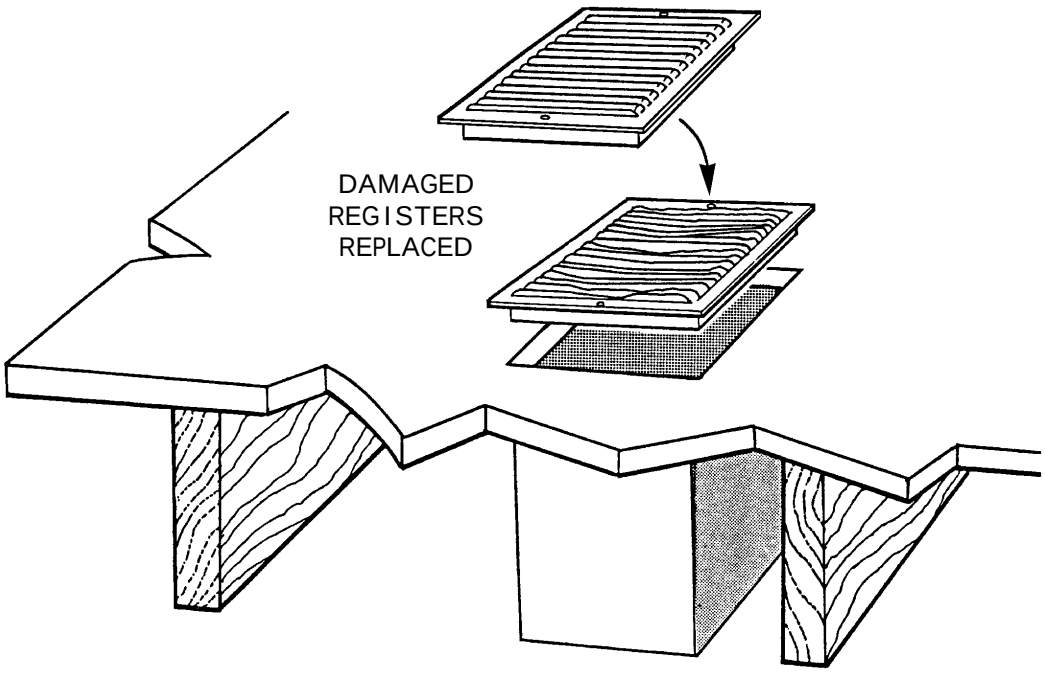
32. NEW CENTRAL RETURN (continued)

- **Upflow Furnace with Belly Cavity Return (continued)**
  - The return grille shall be:
    - Sized to provide a minimum of 2 sq. in. of NFVA for each 1,000 Btu/hr furnace capacity.
    - Installed in the outside wall of a closet when possible, or in the floor when necessary.
    - Located in a hallway or other open area.
    - Centrally located within the mobile home.
  - Proper air flow shall be provided for each room containing a supply register utilizing one of the following methods:
    - An uncloseable grille may be installed in the door or wall which provides a NFVA equal to at least 1 sq. in. for every 5 sq. ft. of total living area in the room.
    - 2" to 2-1/2" may be removed from the door bottom; however, no more than half the NFVA so created shall be counted as return air area.
  - System balance shall be checked and modifications shall be made as needed to provide proper airflow and room pressures.



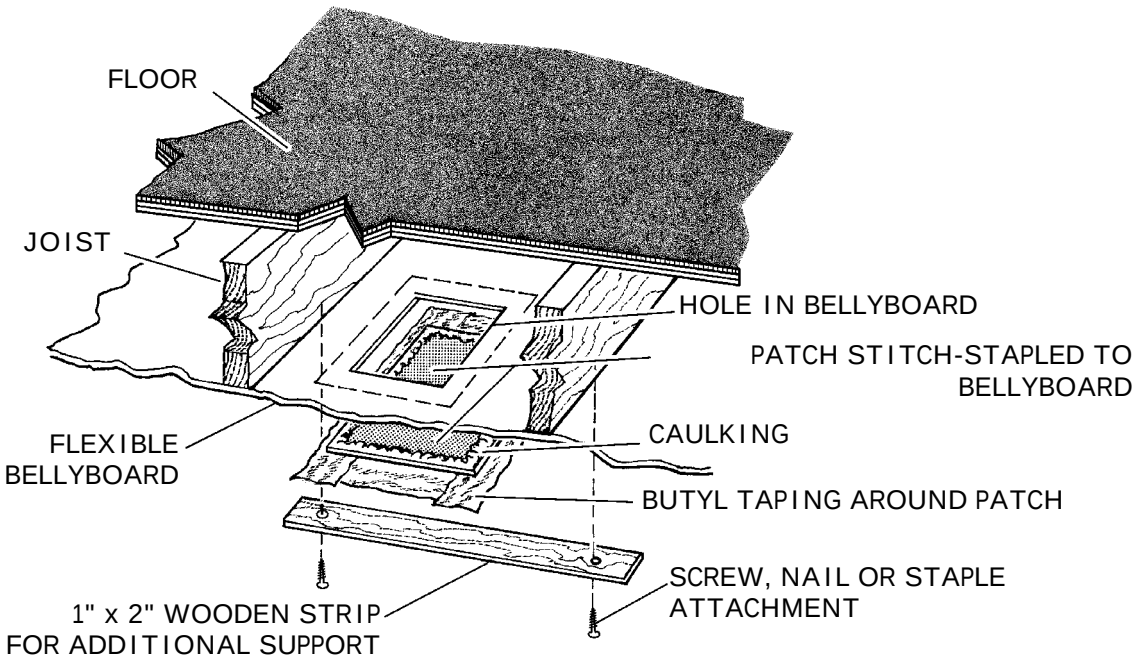
33. REGISTER GRILLES

- **Repair and Replacement**
  - Dampers shall function properly.
  - Dampers which will not open or stay open shall be removed if register replacement is not feasible.
  - Damaged registers which do not allow proper airflow shall be repaired or replaced, in accordance with the program P&P.
- **Removal and Reinstallation**
  - Boot sealing shall not cause any register to be difficult to remove or reinstall.



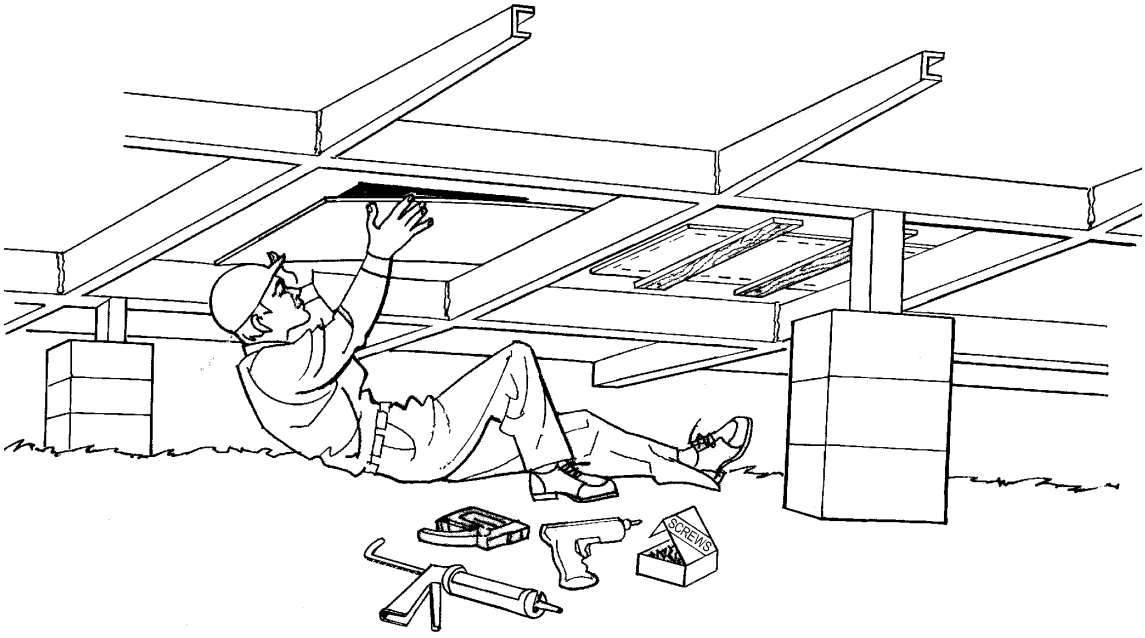
34. RODENT BARRIER (BELLYBOARD) REPAIR

- **Access Holes**
  - Holes in the bellyboard created to access ducts from under the mobile home shall be repaired.
- **Rigid or Flexible Rodent Barrier**
  - All holes shall be repaired with material equivalent or superior to the existing bellyboard.
  - All patches shall be securely and permanently attached and create a complete and permanent seal.
- **Patches in *Flexible* Rodent Barrier**
  - All patches shall be secured and sealed by means of self-adhesive backing, or caulk/adhesive sealant.
  - Patches shall be mechanically secured as needed to ensure permanence, by such means as one or more of the following:
    - Outward clinch (“stitch”) staples, or equivalent, positioned to permanently and securely attach the patch directly to the existing bellyboard.
    - Fasteners penetrating the wooden joists a minimum of 1/2" and spaced a maximum of 4" OC.
    - Wooden strips attached permanently secured (e.g. with screws into floor joists, or wedged above adjacent girders).



34. RODENT BARRIER (BELLYBOARD) REPAIR (continued)

- **Patches in *Flexible* Rodent Barrier (continued)**
  - Tape recommended by barrier manufacturer, butyl tape, or other compatible sealant shall be placed around the perimeter of the flexible patch, as needed, to ensure a complete and permanent seal.
- **Patches in *Rigid* Rodent Barrier**
  - Patches shall be sealed with suitable caulk/adhesive sealant and secured mechanically.
  - Approved mechanical attachments include:
    - Fasteners penetrating the wooden joists a minimum of 3/4" and spaced a maximum of 6" OC.
    - Wooden strip supports spanning beyond the patch and secured mechanically into the framework above.
    - Wedging the patching material between the existing bellyboard and the metal framing of the undercarriage.
    - Fasteners which penetrate only the existing bellyboard, for small patches in high density material.
    - A combination of methods which will provide a stable, permanent repair.



35. LEAD-SAFE WEATHERIZATION

- **Lead-safe practices shall be employed when working with pre-1979 painted materials per state codes T8 Section 1532.1 and T17 Section 36000, et seq.**

36. POST-INSTALLATION REQUIREMENTS

- **Paint dust and chips, scraps, and other debris resulting from duct repair and sealing activities shall be cleaned up and removed from the premises—utilizing lead-safe practices when applicable.**
- **Furniture and other household items moved for duct repair and sealing work shall be returned to their original positions.**

<table>
<tr><td colspan="2">CALIFORNIA DEPARTMENT OF HEALTH SERVICES

 
Childhood Lead Poison Prevention Program
Lead-Related Construction Information Hot-Line
1-800-597-LEAD (1-800-597-5323)
www.childlead.com</td></tr>
<tr><td colspan="2">NATIONAL LEAD INFORMATION CENTER
1-800-424-LEAD</td></tr>
<tr><td>EPA United States Environmental Protection Agency

US EPA Region IX
75 Hawthorne St.
San Francisco, CA 94105

Region IX Contact: Don Lanier
(415) 744-1123</td><td>U.S. Department of Housing and Urban Development
Office of Lead Hazard Control
451 7th Street, S.W., Room B-133
Washington, DC 20410

PH: 202-755-1785
FAX: 202-755-1000</td></tr>
<tr><td>www.epa.gov/lead/index.html</td><td>www.hud.gov/lea/leahome.html</td></tr>
</table>

NONFEASIBILITY CRITERIA FOR DUCT SEALING

1. **Duct leakage is below the threshold leakage per the Duct Testing and Sealing Form.**

2. **A natural gas appliance hazard exists, and repair is not feasible.**

3. **Duct system has been abandoned.**

4. **Duct system is damaged and deteriorated beyond repair.**

5. **A health or safety hazard is present, such as insect infestation, hazardous electrical wiring, or structural hazard, which prevents safe access to the duct system.**

6. **Asbestos is present in/on the duct system.**

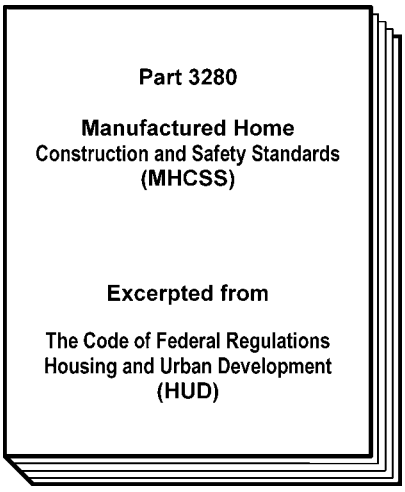
7. **For ducts requiring undercarriage access:**
   - **Clearance is less than 18" from ground to the floor joist system or girders.**
   - **Sewage waste is on the ground, or excessive ground moisture (standing water or mud) is present.**

8. **Customer refuses.**

CENTRAL HIGH EFFICIENCY AIR CONDITIONER REPLACEMENT STANDARDS

1. APPROVED MATERIALS

- **Installed within a manufactured home:**
  - Materials shall be in compliance with California Department of Housing and Community Development (HCD) regulations and HUD MHCSS: Code of Federal Regulations, Chapter XX, Part 3280 (also incorporated into the California Code of Regulations as Title 25, Division 1, Chapter 3, Article 2, Subchapter 3).
- **Installed outside a manufactured home:**
  - Materials shall be in compliance with the authority having jurisdiction: HCD or the local building department.
- **Package Units (Dual Packs)**
  - Minimum SEER of 13 and EER of 11.5.
- **Split Systems**
  - Minimum SEER of 13 and EER of 11.5 with a Thermostatic Expansion Valve (TXV).
  - The EER shall be determined by the coil match as listed in the current ARI Directory.

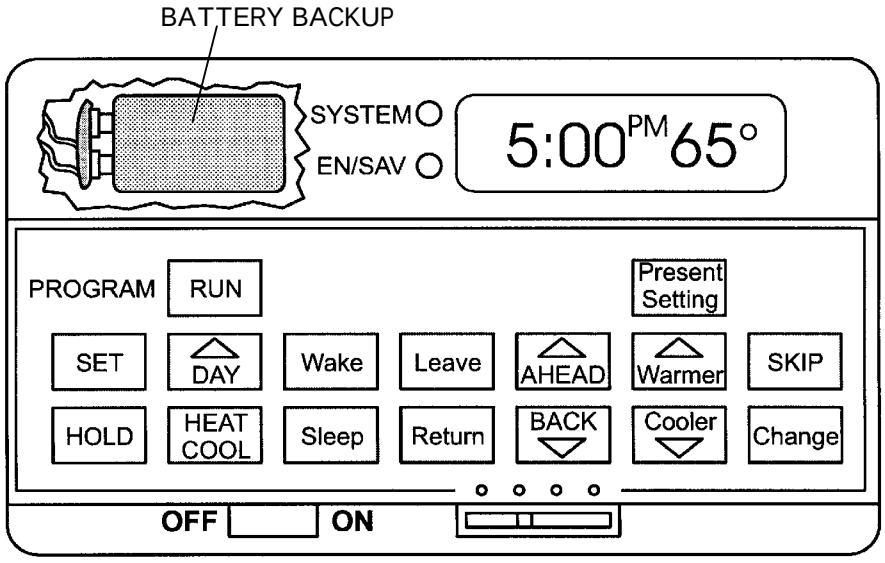


LISTED

MATERIALS INSTALLED
MUST COMPY WITH
HUD MHCSS

1. APPROVED MATERIALS (continued)

- **Programmable Wall Thermostat**
  - ENERGY STAR® qualified.
  - System powered, not battery powered, on 24 volt systems.
  - Digital with anti-short-cycle feature.
  - Minimum setback capability of 10°F.
  - At least two setback periods per 24 hour day, with change cycle increments being no greater than 30 minutes.
  - Manual override and standard alkaline battery backup or other program saving backup system.
  - Positive on/off switch that is easily accessible.
  - Compatible with the HVAC equipment.
- **Standard Wall Thermostat**
  - Alternative when customer refuses programmable thermostat.
  - Digital with built in anti-short-cycle feature.
  - Conforms with manufacturer's instructions.
  - Compatible with the HVAC equipment.
  - Includes a positive on/off switch.



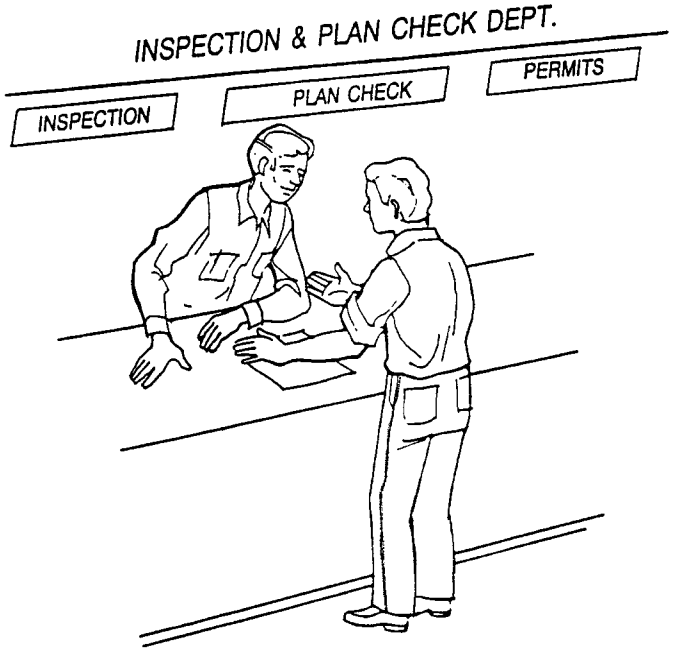
DIGITAL PROGRAMMABLE THERMOSTAT
WITH ON/OFF SWITCH

2. WARRANTY

- **All Installations**
  - Parts and labor shall be covered by a minimum one (1) year written warranty.
  - Compressor warranty shall extend to five (5) years.
  - All written warranty information and manufacturer's operating and maintenance instructions shall be supplied to the customer.

3. GENERAL REQUIREMENTS

- **Permit**
  - A permit shall be obtained from and finalized by:
    - HCD for installations inside the mobile home.
    - HCD, or as applicable, the local building department for installations outside the mobile home.
- **Standards and Specifications**
  - Installation shall be in compliance with manufacturer's instructions and specifications, and as applicable, with requirements of HCD and/or the local building department.
- **Air Filters**
  - All air filters shall be installed and clean.
  - Unframed washable filters shall be properly supported to prevent being drawn into the air handler, as prescribed in Section 16.

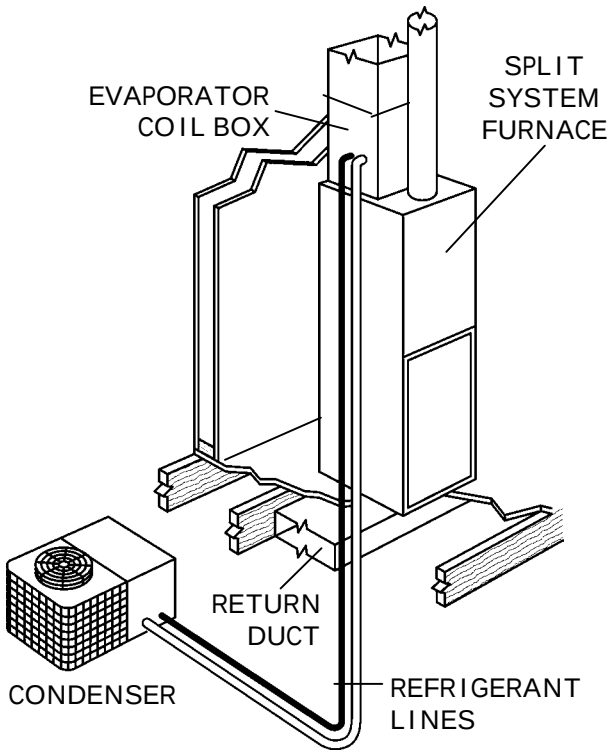


4. SIZING CRITERIA

- **System Size**
  - Unit shall be sized in accordance with Title 24, HCD requirements, or local code, whichever is most stringent.
  - The tonnage of the new system should be equal to or smaller than the existing system.
- **Refrigerant Lines**
  - Shall be properly sized per manufacturer's specifications.
  - Shall provide the rated EER for the combination condenser and evaporator coil match.

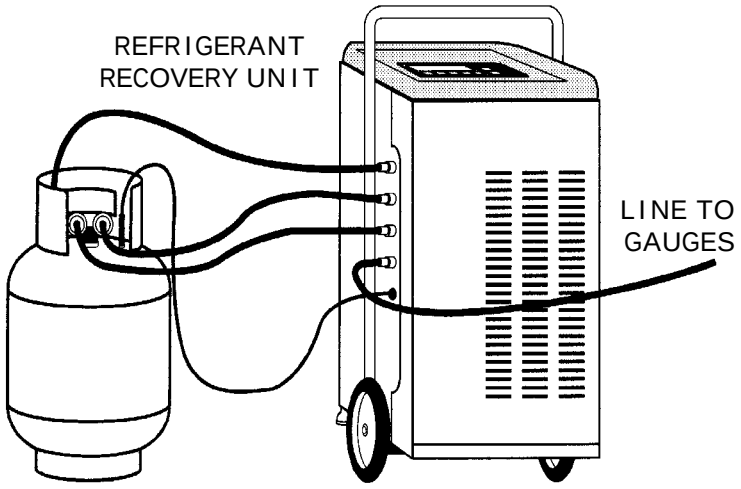
5. EVAPORATOR (INDOOR) COIL AND CONDENSER (OUTDOOR) COIL

- **Split Systems**
  - An evaporator coil shall be installed which is verified to be a rated match with the condenser coil, as listed in current ARI Directory.
  - The coil label shall be visible.
  - Condenser unit and evaporator coil shall be verified to function properly.
  - An access panel shall be provided for cleaning.
- **Evaporator Coil Replacement**
  - Prior to charging, vacuum shall be drawn on the refrigerant lines to test for leaks and remove water vapor.
  - Depth of vacuum and length of time shall be as specified by the manufacturer.



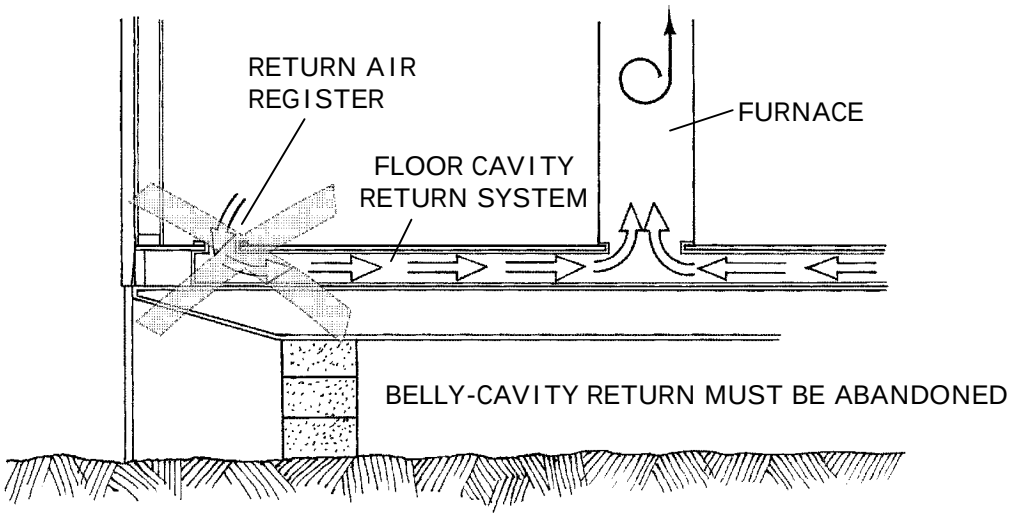
6. OPERATIONAL REQUIREMENTS

- **Air Flow**
  - Air flow through the indoor coil shall be adequate to meet manufacturer's specifications.
- **Programmable Thermostat Control**
  - A new programmable thermostat shall be installed in accordance with Section 16.
  - Thermostat shall be tested and verified to operate properly per manufacturer's instructions.
- **Refrigerant System Charging**
  - Refrigerant system shall be properly charged using methods specified by the manufacturer.
  - Refrigerant recovery shall be performed in accordance with Federal law.
    - A recovery device shall be used.
    - Ventilation to the atmosphere is not allowed.
  - Technicians performing evacuation and charging must have EPA-approved certification as a Type II or Universal technician.



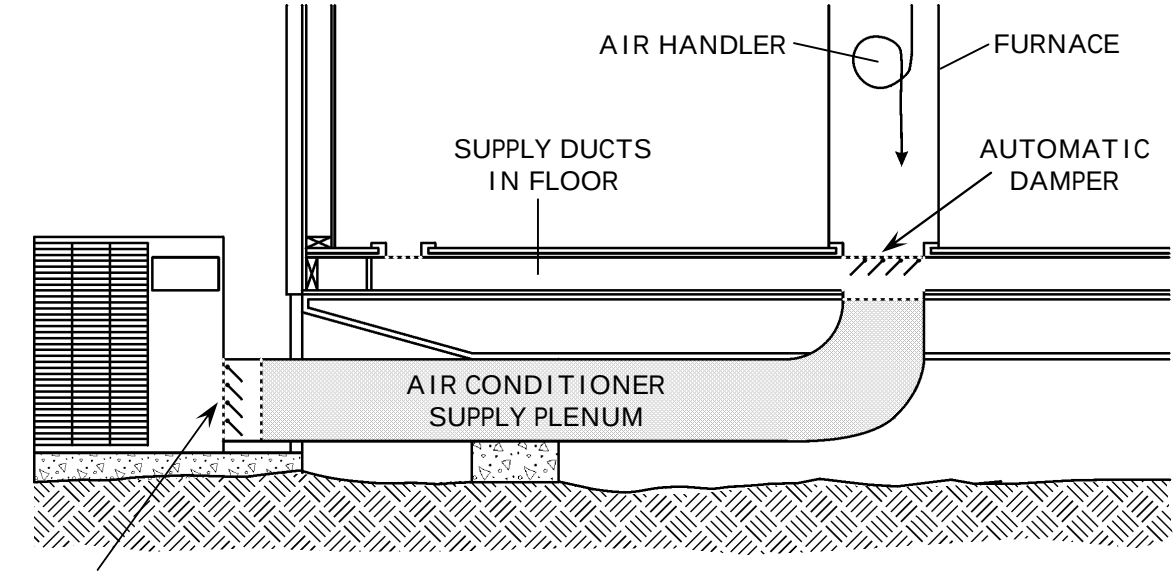
7. AIR DISTRIBUTION SYSTEM

- **Existing Duct System**
  - System shall be examined for leaks and disconnections and repaired as needed in accordance with the program Policy and Procedures.
  - Testing shall be performed in accordance with WIS Section 11, Duct Testing Standards, and duct repairs and sealing shall be made in accordance with WIS Section 17, Duct Sealing Standards.
- **Return System**
  - Belly-Cavity and Roof-Cavity Returns
    - In accordance with the program Policy and Procedures:
      - Existing belly-cavity return shall be abandoned, and a new ducted central return shall be installed.
      - Existing leaky roof-cavity return shall be repaired as applicable, and replaced with a new central return when repair is needed but not feasible.
  - New central return shall be designed and installed in conformance with WIS Section 17 and HCD requirements.
- **Cabinet and Plenum**
  - Components shall be mechanically attached and sealed around the perimeter (cabinet-to-duct connector, cabinet-to-plenum) using materials and methods prescribed in WIS Section 17.
  - Plumbing and wiring penetrations into the evaporator coil box and return air chamber shall be sealed with cork tape.
- **New Ductwork**
  - Components shall be installed in conformance with manufacturer's instructions.



8. SELF-CONTAINED AIR CONDITIONERS

- **Installation of a self-contained air conditioner sharing a common supply duct system with the furnace shall comply with the following requirements:**
  - Automatic Dampers
    - Furnace shall have an automatic damper installed to prevent cold air from entering the furnace when the HVAC system is in cooling mode.
    - Air conditioner shall have an automatic damper installed to prevent hot air from entering the air conditioning unit when the HVAC system is in heating mode.
  - Function Control
    - Controls shall prevent the air conditioner and furnace from coming on at the same time.



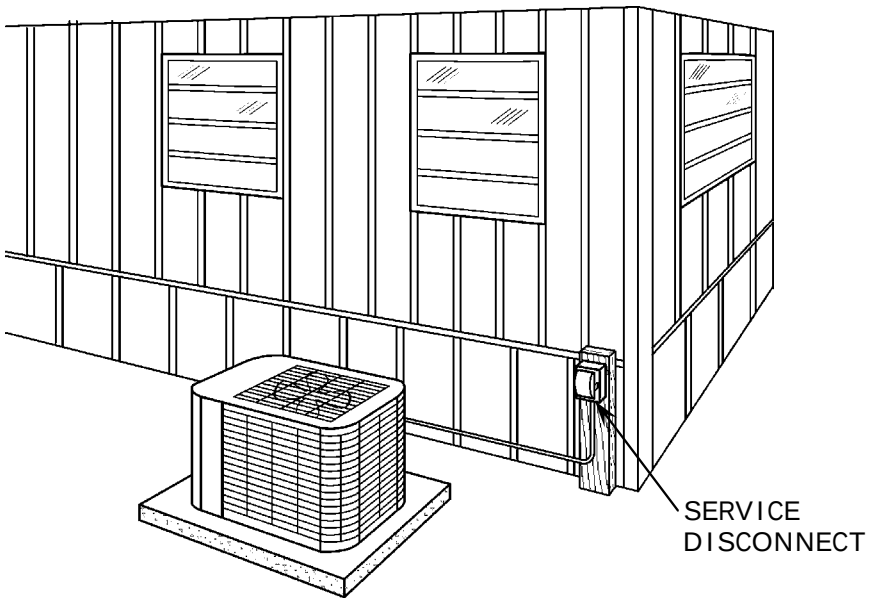
SELF-CONTAINED AIR CONDITIONER WITH SIDE-BY-SIDE SUPPLY & RETURN PLENUMS

9. ELECTRICAL WIRING, GROUNDING, AND ACCESSIBILITY

- **Electrical wiring, grounding, and unit accessibility shall be in conformance with:**
  - Manufacturer's instructions,
  - HUD MHCSS, Section 3280, Subpart I, and/or as applicable
  - Requirements of the local building department.

10. UNIT DISCONNECTING MEANS (SERVICE DISCONNECT)

- **Outdoor Installations (Split System Condenser or Self-Contained Air Conditioner)**
  - A disconnecting means which is capable of disconnecting the air-conditioning equipment from the circuit feeder shall be installed in conformance with NEC Article 440, Part B, Disconnecting Means.
- **Location**
  - The service disconnect:
    - Shall be located within sight from and readily accessible from the air-conditioning equipment or as required by the local jurisdiction.
    - May be installed on or within the air-conditioning equipment.
- **Rating**
  - The rating of the installed fuses or circuit breakers shall not exceed:
    - The overcurrent rating of the installed air-conditioning equipment.
    - The rating of the box in which they are located.



SPLIT SYSTEM REPLACEMENT CONDENSER UNIT

11. BRANCH-CIRCUIT PROTECTION

- **General Requirements**
  - Air-conditioning equipment shall be provided with:
    - Overcurrent protection per NEC Article 240.
    - Disconnecting means per NEC Article 440, Part B.
    - Branch-circuit short-circuit and ground-fault protection per NEC Article 440, Part C.
- **Protection Device Type**
  - The overcurrent protection device shall be the type specified on the air-conditioning equipment nameplate (see Table 21-1).
  - When nameplate specifies an HACR circuit breaker, the installed circuit breaker shall be listed and labeled HACR type (suitable for use with heating, air-conditioning and refrigeration equipment).
- **Protection Device Rating**
  - The branch-circuit protection device shall not exceed the maxi-mum amperage rating specified on the nameplate of the air-conditioning unit.

TABLE 18-1: OVERCURRENT PROTECTION SELECTION GUIDE

HEAT PUMP UNIT NAMEPLATE MARKED:	OVERCURRENT PROTECTION DEVICE* MUST BE:
"Maximum Fuse Size X Amps"	An X Amp Fuse
"Maximum Fuse or HACR Circuit Breaker X Amps"	An X Amp Fuse or HACR-Type Circuit Breaker
"Maximum Fuse, HACR Circuit Breaker, or Circuit Breaker X Amps"	An X Amp Fuse, HACR-Type Circuit Breaker, or Standard Circuit Breaker
"Maximum Overcurrent Protection Device X Amps"	An X Amp Fuse, HACR-Type Circuit Breaker, or Standard Circuit Breaker

***Amperage rating of the device must not exceed that specified on the nameplate.**

12. BRANCH CIRCUIT CONDUCTORS

- **Ampacity and Rating of Conductors**
  - Minimum wire size shall, as applicable, be:
    - Selected from NEC Tables 310-16 through 310-19, or
    - Calculated in accordance with NEC Section 310-15.
- **Voltage Drop and Wire Length**
  - Circuits shall be installed in conformance with NEC Section 210, Branch Circuits and Section 215, Feeders.
  - The voltage drop over the branch-circuit conductor should not exceed 2%. (See NEC Section 210-19(a) (Fine Print Note No. 4).)
  - In 240v circuits, the maximum conductor length should not exceed the values given in the Table 18-2.

TABLE 18-2: MAXIMUM LENGTH OF CIRCUIT (IN FEET)

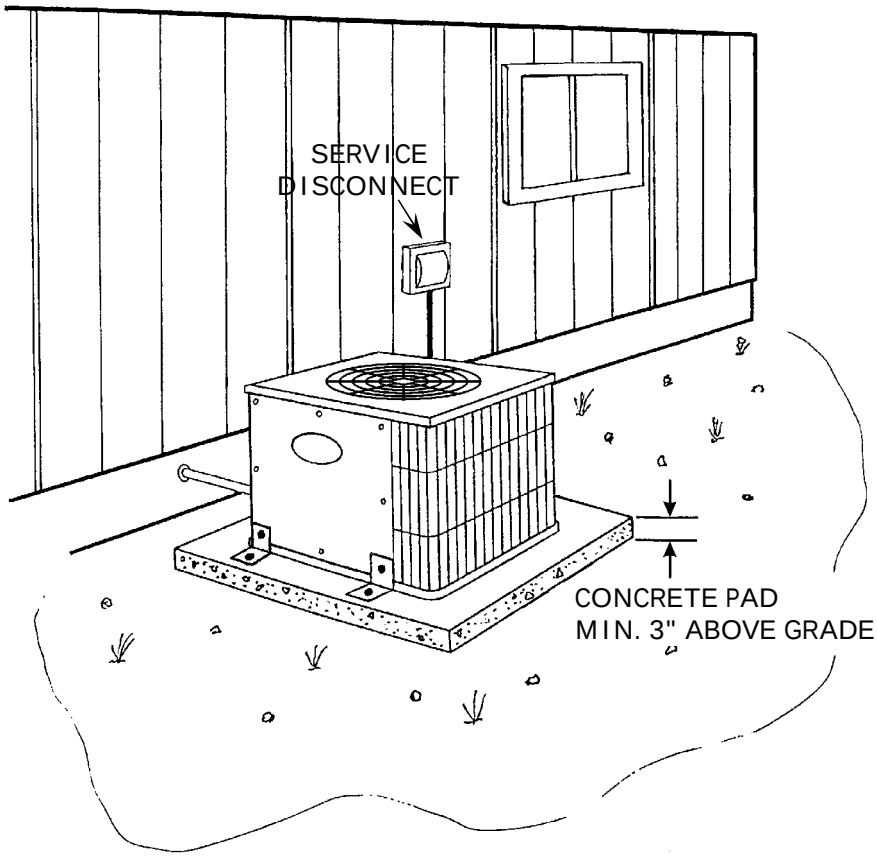
WIRE SIZE	AMPACITY OF CIRCUIT			
AWG	15	20	30	40
12	160'	120'	–	–
10	250'	190'	130'	–
8	300'	225'	150'	115'

Notes:

- **The table is based on a 4.6v drop (230v X 2% = 4.6v).**
- **The table applies to non-plated (uncoated) solid wire copper conductors at 75°C (167°F) ambient temperature.**
- **For alternate conditions or conductors, use applicable CEC Tables (e.g., see Article 210, "Branch Circuits"; Article 215, "Feeders"; and Chapter 9, Table 8, "Conductor Properties").**

13. MOUNTING OF OUTDOOR EQUIPMENT

- **Ground Mount**
  - Air-conditioning equipment shall be installed in conformance with UMC Section 1106.0.
  - The unit shall rest on concrete or other approved base extending at least 3" above the adjoining ground level.
- **Protection**
  - Units subject to mechanical damage shall be protected in conformance with UMC Section 308.
  - Unit shall be attached to base with seismic straps, when required by applicable code.
- **Overhead Clearance**
  - Overhead clearance shall be provided in conformance with manufacturer's specifications and local code.

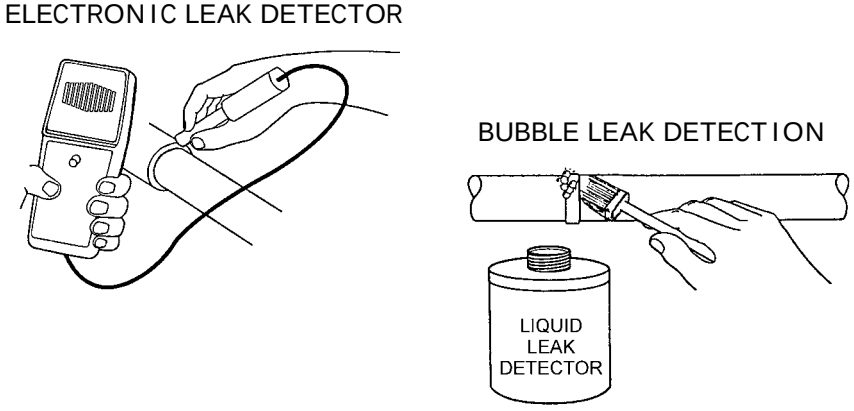


14. FUEL-GAS PIPING

- **All Installations**
  - Gas lines, fittings and valves shall be free of leaks.
  - New lines shall be pressure-tested.

15. COMBUSTION APPLIANCE REQUIREMENTS

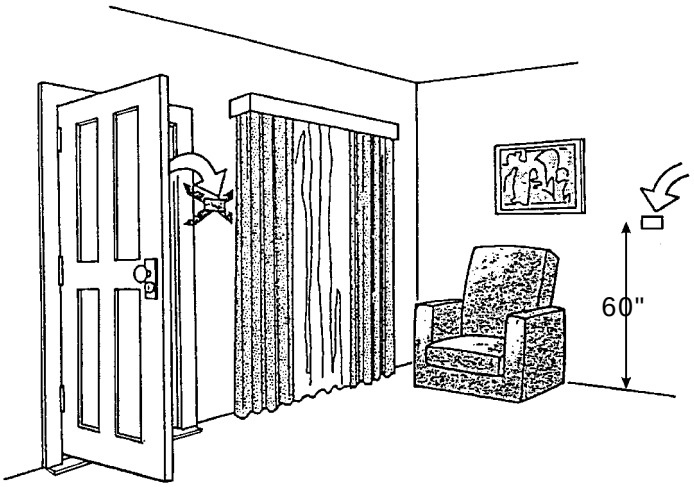
- **Flue and Vent Systems**
  - New flue/vent system shall be selected, installed and secured in conformance with listing specifications, manufacturer's instructions, and HCD requirements.
- **Combustion Air**
  - Combustion air for installed units, and all other appliances sharing the same space/enclosure, shall be supplied in conformance with manufacturer's instructions and HCD requirements.
  - Combustion air vents shall be free of obstructions that interfere with proper venting.



METHODS FOR FINDING LEAKS IN
GAS LINES, FITTINGS, AND VALVES

16. THERMOSTAT INSTALLATION

- **Location and Mounting**
  - New thermostat shall be installed at existing location unless affected by drafts, heat from direct sun, or adjacent appliances.
  - Thermostat installed in a new location:
    - Shall be mounted with the top of thermostat 60" above the floor when occupants are not handicapped.
    - May me installed as low as 48" above the floor when an occupant uses a wheelchair.
  - Thermostat shall be located away from direct sunlight, doors, windows, return/supply air, appliances, and sources of electrical interference.
  - Mounting bracket shall be securely attached to wall with screws for wood, or appropriate anchors for drywall and plaster.
  - Any holes or damage to wall from installation or removal of thermostat shall be repaired in a workmanlike manner.
- **Wiring**
  - All wiring shall be a minimum of 18 gauge and conform to manufacturer's specifications and HCD requirements.
  - Exposed wiring shall be enclosed in a raceway.
- **Programming and Operation**
  - Thermostat shall be cycled to insure proper operation of all functions.
  - Setbacks shall be programmed in accordance with customer's wishes.

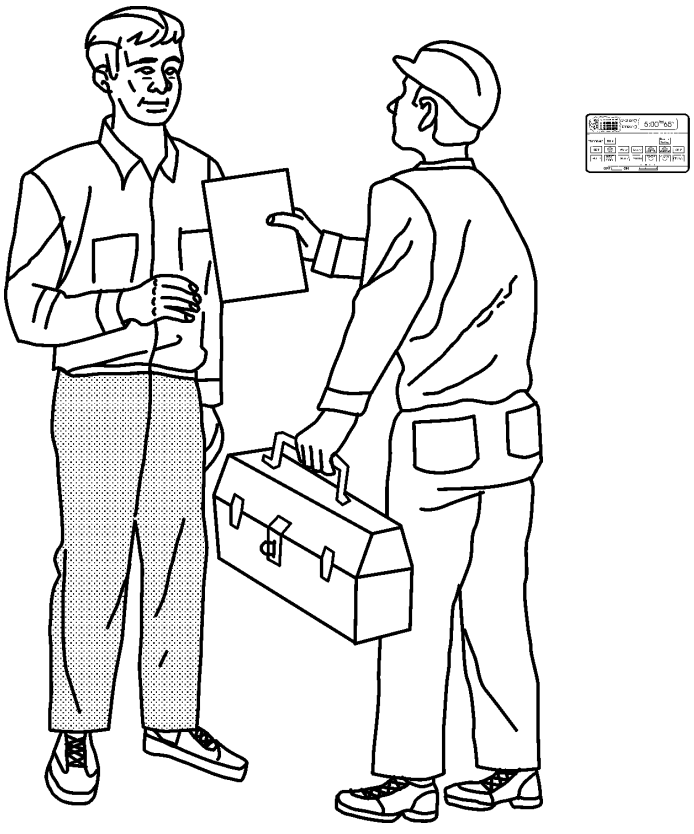


16. THERMOSTAT INSTALLATION (continued)

- **Instructions and Warranty**
  - Customer shall be provided with:
    - A demonstration with verbal instructions for operating the thermostat and installing batteries.
    - The manufacturer's written instructions and warranty.

17. POST-INSTALLATION REQUIREMENTS

- **Appliance Operation**
  - The installed unit shall be tested for proper operation.
  - Proper operation shall be explained and demonstrated to the customer, including:
    - Operation of all user-accessible controls.
    - Filter replacement.
    - Routine maintenance recommended by manufacturer.
  - Manufacturer's written instructions and warranty documents shall be supplied to the customer.



INSTRUCTIONS AND WARRANTY PROVIDED TO CUSTOMER

17. POST-INSTALLATION REQUIREMENTS (continued)

- **Cleanup and Disposal**
  - Paint dust and chips, scraps, and other debris resulting from weatherization activities shall be cleaned up and removed from the premises—utilizing lead-safe practices when applicable.
  - Furniture and other household items moved for weatherization work shall be returned to their original positions.
  - All packing materials and installation debris shall be cleaned up and removed from the premises.
  - All replaced equipment and parts shall be removed from the premises and properly disposed of unless specified otherwise in the home improvement contract.
  - Refrigerant shall be recovered and all hazardous waste materials shall be disposed of in conformance with federal, state and local codes.

INFORMATION ABOUT HANDLING REFRIGERANT AND OTHER HAZARDOUS MATERIALS IS AVAILABLE FROM EPA'S STRATOSPHERIC OONE INFORMATION HOT LINE

18. LEAD-SAFE WEATHERIZATION

- **Lead-safe practices shall be employed when working with pre-1979 painted materials per state codes T8 Section 1532.1 and T17 Section 36000, et seq.**

<table>
<tr><td colspan="2">CALIFORNIA DEPARTMENT OF HEALTH SERVICES

Childhood Lead Poison Prevention Program
Lead-Related Construction Information Hot-Line
1-800-597-LEAD (1-800-597-5323)
www.childlead.com</td></tr>
<tr><td colspan="2">NATIONAL LEAD INFORMATION CENTER
1-800-424-LEAD</td></tr>
<tr><td>US EPA Region IX
75 Hawthorne St.
San Francisco, CA 94105

Region IX Contact: Don Lanier
(415) 744-1123</td><td>U.S. Department of Housing and Urban Development
Office of Lead Hazard Control
451 7th Street, S.W., Room B-133
Washington, DC 20410
PH: 202-755-1785
FAX: 202-755-1000</td></tr>
<tr><td>www.epa.gov/lead/index.html</td><td>www.hud.gov/lea/leahome.html</td></tr>
</table>

NONFEASIBILITY CRITERIA FOR AIR CONDITIONER REPLACEMENT

1. **The existing air conditioner is not operational.**
2. **The central AC has a SEER greater than 9.0.**
3. **The property is renter-occupied.**
4. **Existing system is a combined HVAC unit and the unit has not passed the pre-weatherization NGAT.**
5. **Electrical service requirements cannot be met.**
6. **Ducts cannot be brought into compliance with the Duct Sealing Section of the WIS Manual.**
7. **Existing HVAC unit is a combined fuel unit and the gas is not provided by one of the IOUs.**
8. **Duct system is inadequate.**
9. **Split system refrigerant line set is inadequate.**
10. **Depressurization by the FAU non-ducted return system adversely affects an open combustion appliance, and correction is not feasible.**
11. **Abandonment of a leaky belly-cavity or roof-cavity return is required but not feasible.**
12. **Customer refuses.**

NONFEASIBILITY CRITERIA FOR INSTALLATION REQUIRING UNDERCARRIAGE ACCESS

1. **For ducts requiring undercarriage access:**
   - **Clearance is less than 18" from ground to the floor joist system or girders.**
2. **Any of the following conditions is present in the undercarriage area where access is required:**
   - **Hazardous insect infestation.**
   - **Excessive ground moisture (standing water or mud).**
   - **Sewage waste on ground or other unsanitary conditions posing a health and safety hazard.**

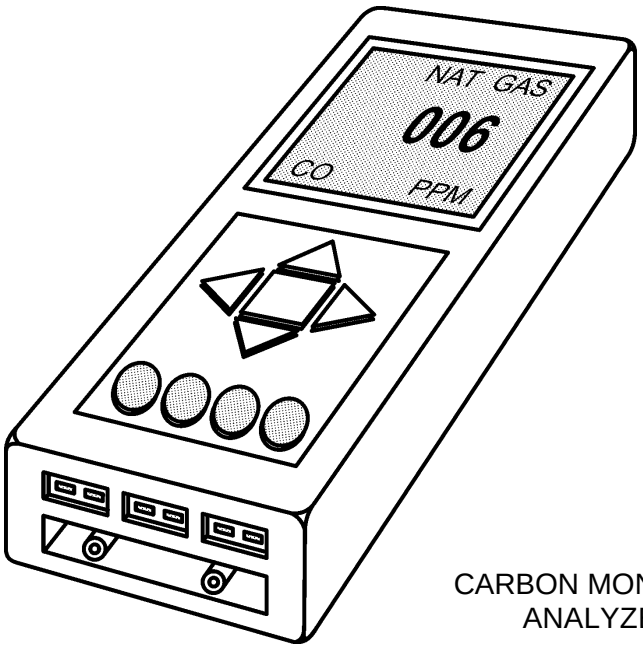
SECTION 1

NATURAL GAS APPLIANCE TESTING (NGAT) STANDARDS

PART 1: GENERAL CRITERIA

1. TEST EQUIPMENT AND ACCESSORIES

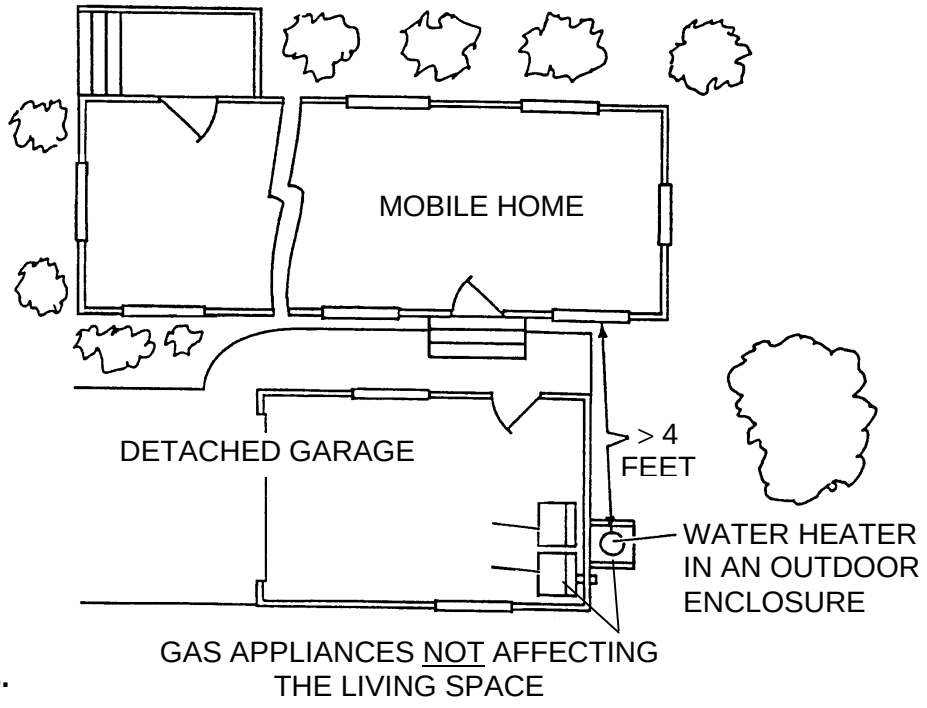
- **Carbon Monoxide Analyzers**
  - **Shall be manufactured under an ISO 9001 quality management system or be ISO 9001 Certified.**
  - **Must, at a minimum, measure CO levels from zero ppm to 999 ppm.**
- **Test Equipment Calibration**
  - **Carbon monoxide analyzers shall be maintained and calibrated in accordance with manufacturer's specifications.**



CARBON MONOXIDE ANALYZER

2. NGAT APPLICABILITY

- **In homes receiving infiltration reduction measures, NGAT shall be conducted when the home:**
  - **Is heated with natural gas, or**
  - **Has one or more other natural gas appliances affecting the living space.**
- **NGAT shall be conducted for all natural gas appliances affecting the living space *except* appliances that are: (a) abandoned*, or (b) inaccessible*.**
- **Natural Gas Appliances Affecting the Living Space**
  - **Appliances affecting the living space are all space heating appliances and other appliances in the following locations:**
    - **Partially or entirely within the living space (including closets located within the envelope but accessed from outdoors).**
    - **An outdoor location within 4' of an operable door or window leading into the living space.**
    - **A location where combustion products from the appliance could infiltrate a forced air duct system (e.g., through a return leak).**
  - **Appliances in all other locations are considered to be appliances not affecting the living space.**
- **Natural Gas Appliances Not Affecting the Living Space**
  - **Only checks for gas leaks are performed.**

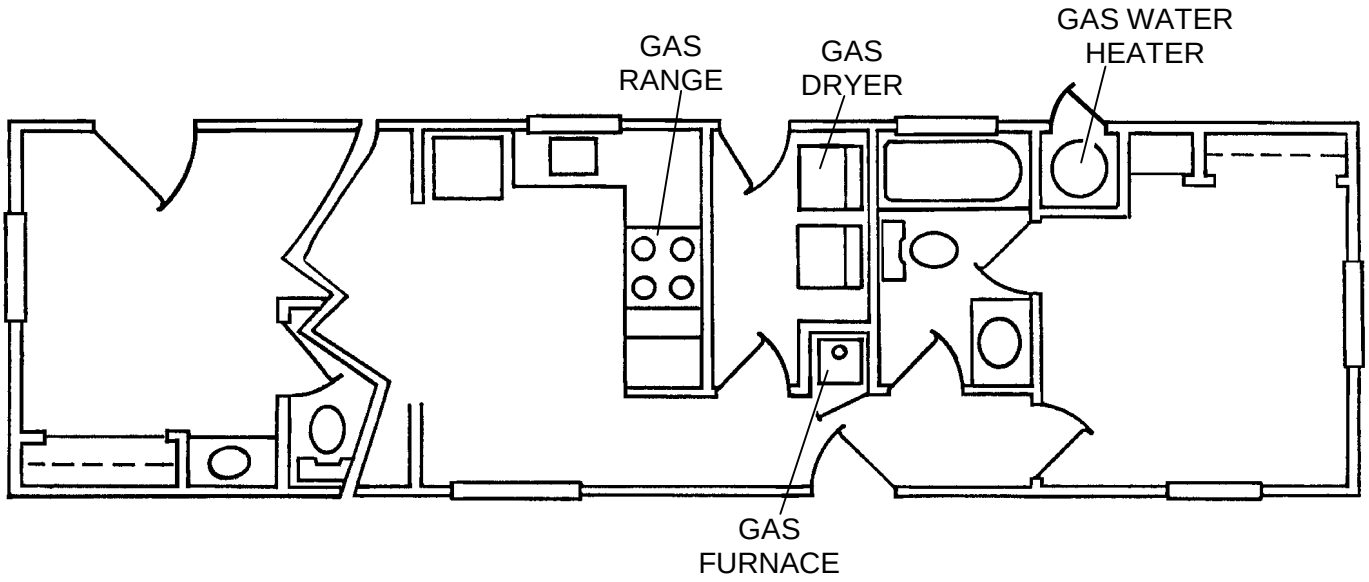


***See Definitions.**

PART 2: PRE-WEATHERIZATION EVALUATIONS

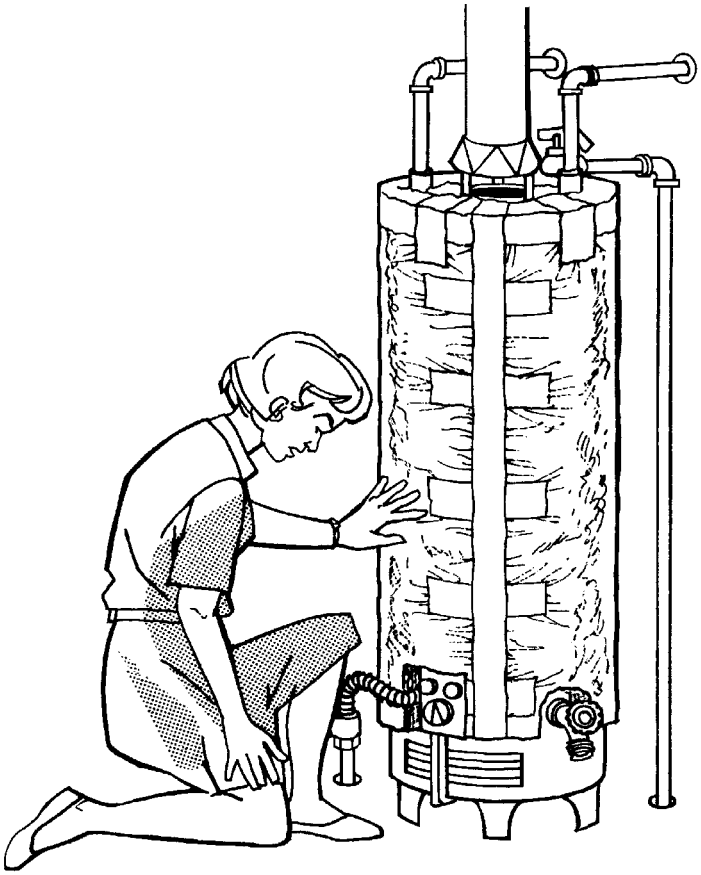
3. PRE-WEATHERIZATION ASSESSMENT

- **The assessment process shall include a check of the following:**
  - **Gas leaks (Item 4)**
  - **Inadequate CVA (Item 5)**
  - **Inadequate clearance between water heater vent termination and evaporative cooler inlet (Item 6)**
  - **Other improper flue/vent terminations (Item 6)**
  - **Inoperable gas appliance (Item 7)**
  - **Gas clothes dryer in the living space not exhausted outdoors (Item 7)**
  - **Unvented combustion space heater in the living space (Item 7)**
  - **Open combustion space or water heating appliance in the living space (Item 7).**
  - **Improper gas-cooking area ventilation (Item 7)**
  - **Defective isolation of return air (Item 7)**
- **Before weatherization work commences, (a) gas leaks shall be repaired, (b) inoperable appliances shall be checked by a utility gas service technician (or designee), and (c) all vent termination clearances/defects and combustion air deficiencies shall be confirmed feasible to correct.**



4. GAS LEAKS

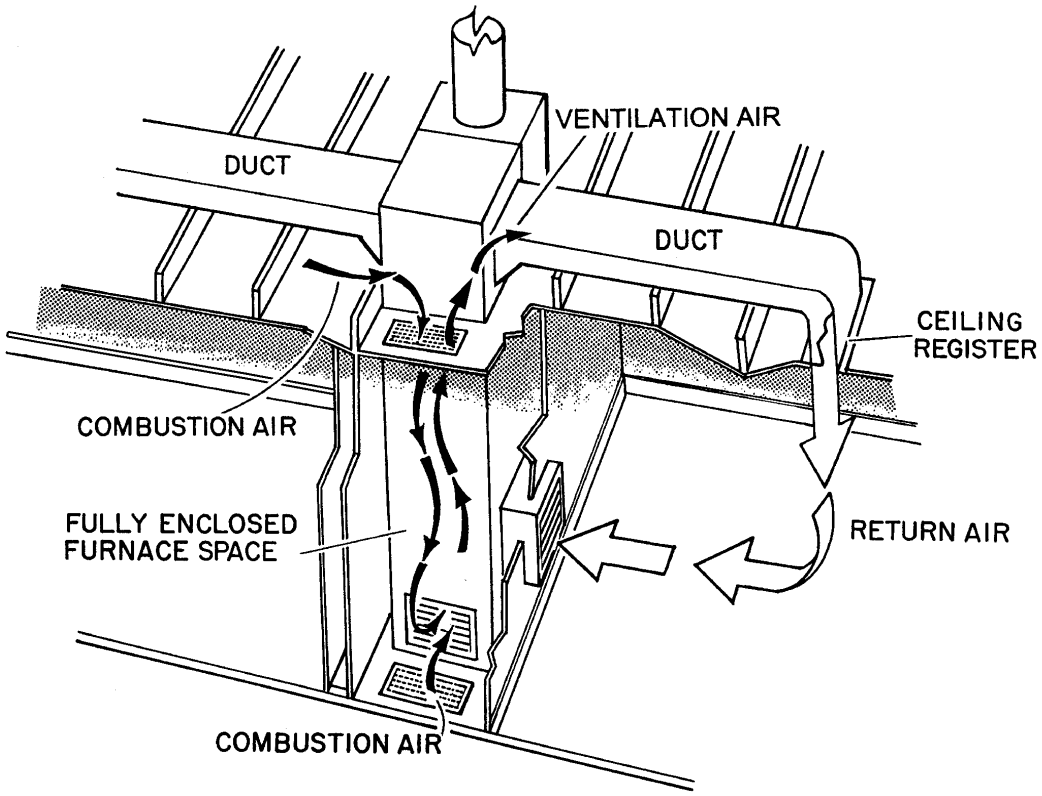
- **Natural gas appliances shall be checked for gas leaks.**
- **Acceptable methods include the following:**
  - **Olfactory (Sniff) Test performed above, but within 2' of, all valves and fittings.**
  - **Application of leak detection liquid to line valves and to fittings on valves, flexible gas connectors, and pipes.**
  - **Air sampling with electronic leak detection equipment near valves, fittings, flexible gas connectors, and pipes.**
- **Gas leaks shall be repaired by a utility gas service technician (or designee).**



CHECKING FOR NATURAL GAS ODOR

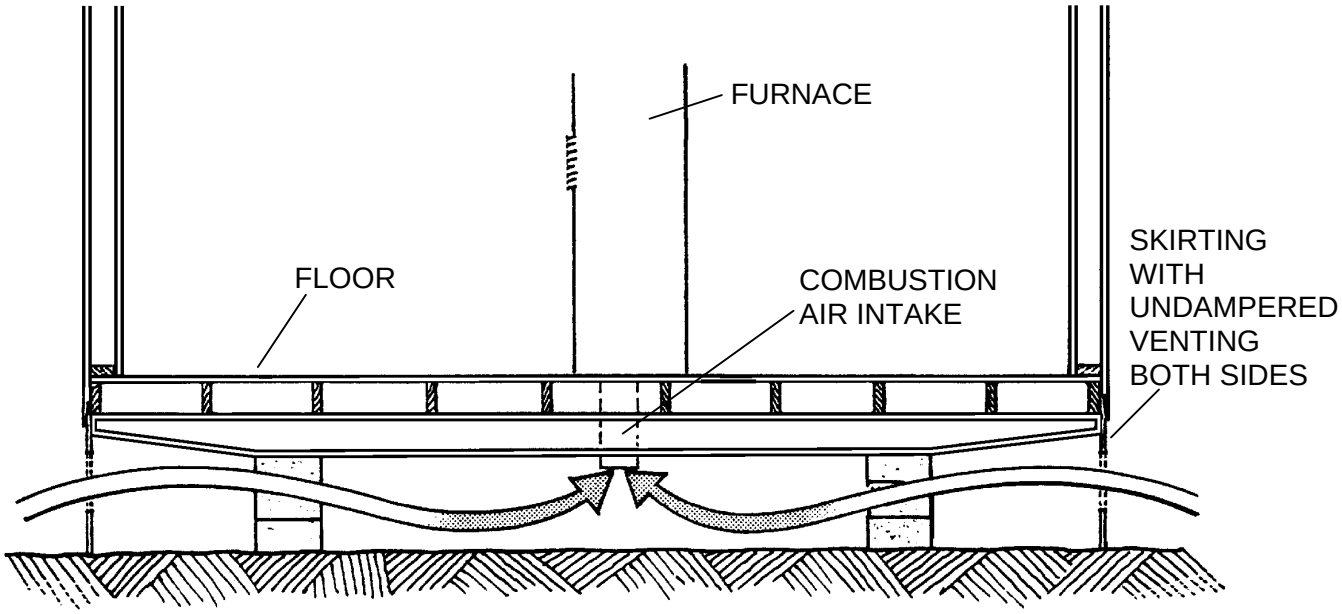
5. COMBUSTION AND VENTILATION AIR (CVA) EVALUATION

- **CVA shall be evaluated for open combustion natural gas heating systems and water heaters (cooking appliances and clothes dryers are *excluded*).**
- **CVA shall comply with these guidelines and Appendix A.**
- **Appliances Drawing *Outdoor* Air through Combustion-Air Openings or Ducts**
  - **An upper opening or duct shall be located above the draft hood, and a lower opening or duct shall be located within 12" of the floor.**
  - **Combustion air openings and vertical ducts shall each provide 1 sq. in. net free venting area (NFVA) per 4,000 Btu/hr of input.**
  - **Horizontal ducts shall each provide 1 sq. in. NFVA per 2,000 Btu/hr of input.**
  - **Combustion air may also be obtained through a single upper vent or duct to outdoors under the following conditions:**
    - **Vent NFVA is at least: (a) 1 sq. in. per 3,000 Btu/hr input, and (b) not less than the sum of the cross-sectional areas of all vent connectors in the space.**
    - **Equipment has clearances of at least 1" sides and back, and 6" in front.**



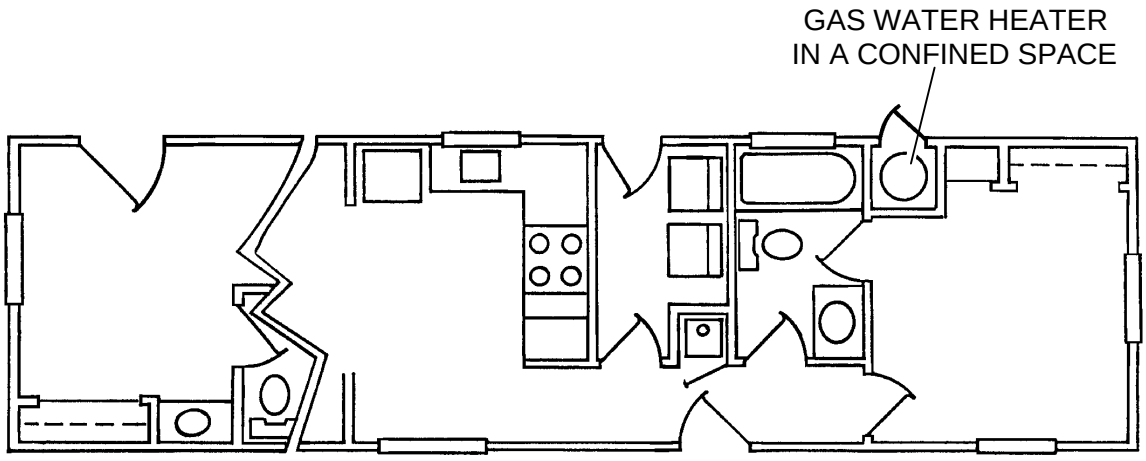
5. COMBUSTION AND VENTILATION AIR (CVA) EVALUATION (continued)

- **When Appliances Draw Combustion Air from Outdoors**
  - **Combustion air may be obtained <u>from outdoors</u> by means of:**
    - **Permanent openings (undampered vents) of the required size directly to outdoors through enclosure floor, roof or walls; <u>or</u>**
    - **Continuous vertical or horizontal ducts of the required cross-sectional area extending from the enclosure to outdoors.**
  - **Combustion air may be obtained <u>from under the floor</u>, provided:**
    - **Undampered venting is present in the skirting.**
    - **Cross-ventilation is present, with venting located on at least two different sides of the mobile home.**
    - **Skirting vents on each side provide at least 1.5 sq. ft. NFVA for each 25 lineal feet of mobile home length.**
  - **Louvers, Grilles, and Screens**
    - **Blocking effects of louvers, grilles, and screens shall be considered when calculating NFVA of an opening (see Appendix A).**



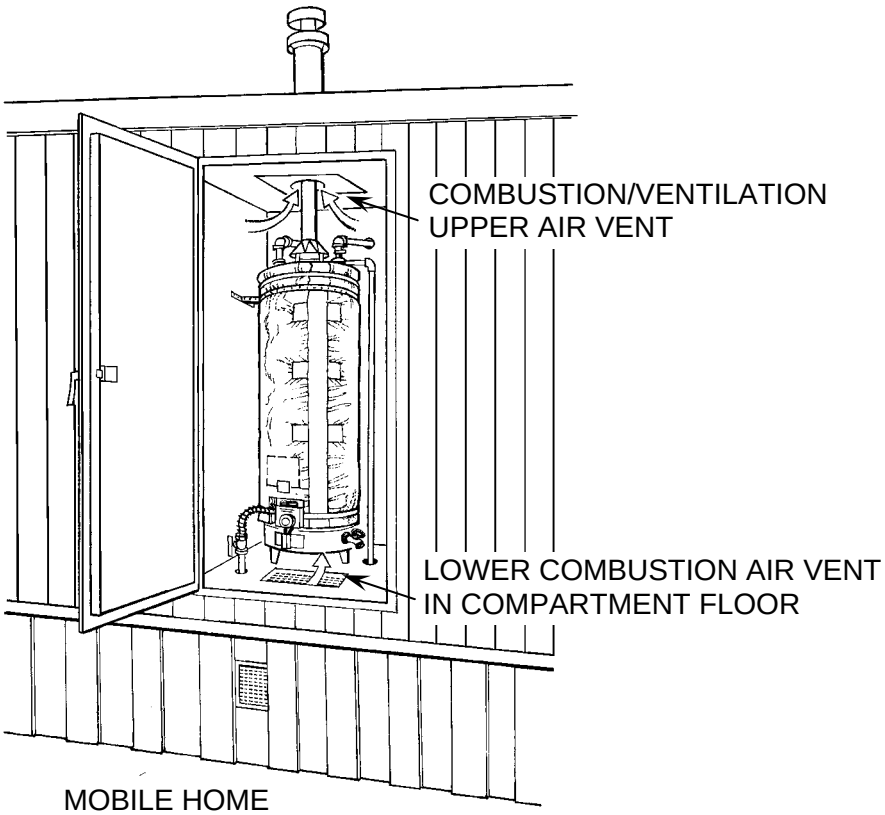
5. COMBUSTION AND VENTILATION AIR (CVA) EVALUATION (continued)

- **When Appliances Draw Combustion Air from <u>Indoors</u>**
  - **Unconfined Space:**
    - **A room/space that has a volume of at least 50 cu. ft. per 1,000 Btu/hr total input rating of the open combustion furnace and/or water heater in that room/space.**
    - **Combustion air <u>is</u> considered adequate.**
  - **Confined Space:**
    - **A room/space that has a volume of <u>less than</u> 50 cu. ft. per 1,000 Btu/hr total input of the open combustion furnace and/or water heater in that room/space.**
    - **Combustion air is <u>not</u> adequate, and**
    - **Proper vent openings to adjacent space(s) must be present.**
  - **Confined spaces outside the mobile home shall not be vented into the living space.**



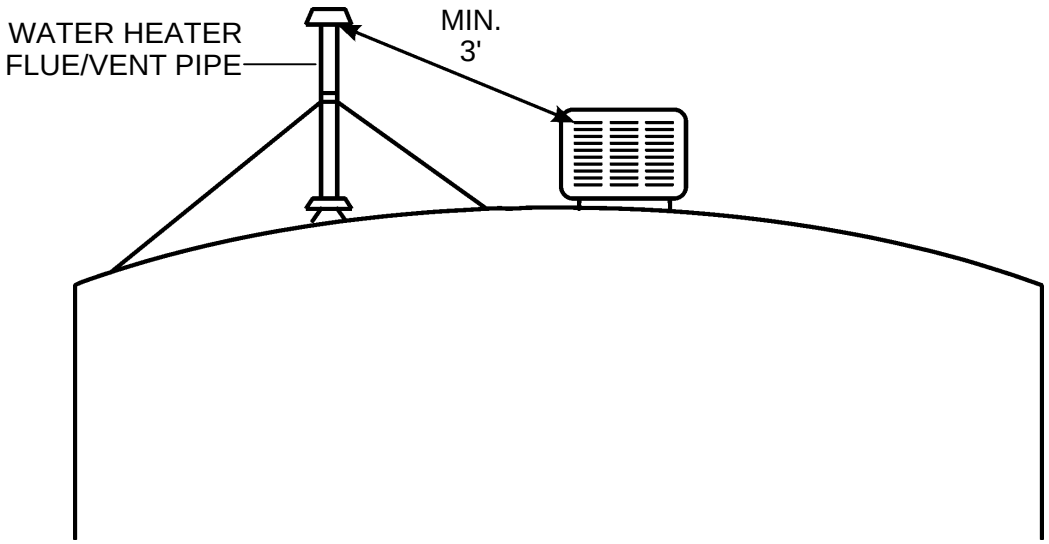
5. COMBUSTION AND VENTILATION AIR (CVA) EVALUATION (continued)

- **Water Heater Combustion Air Venting.**
  - **An *upper* combustion air vent shall be present, which may consist of one of the following:**
    - **A double concentric vent pipe in the ceiling:**
      - **Appliance vent pipe surrounded by air space and a larger-diameter outer pipe.**
      - **NFVA is the cross-sectional area of the larger pipe minus the cross-sectional area of the smaller pipe.**
    - **An undampered vent (screen or grille) installed in the door or outer wall and located higher than the draft hood.**
  - **A *lower* combustion air vent shall be present, which may be an undampered vent (screen or grille) to the outdoors, located in:**
    - **The enclosure floor, or**
    - **The door or wall and located not more than 1' above the floor.**
  - **A continuous duct extending from the enclosure to the outdoors may be used to supply upper or lower combustion air venting.**



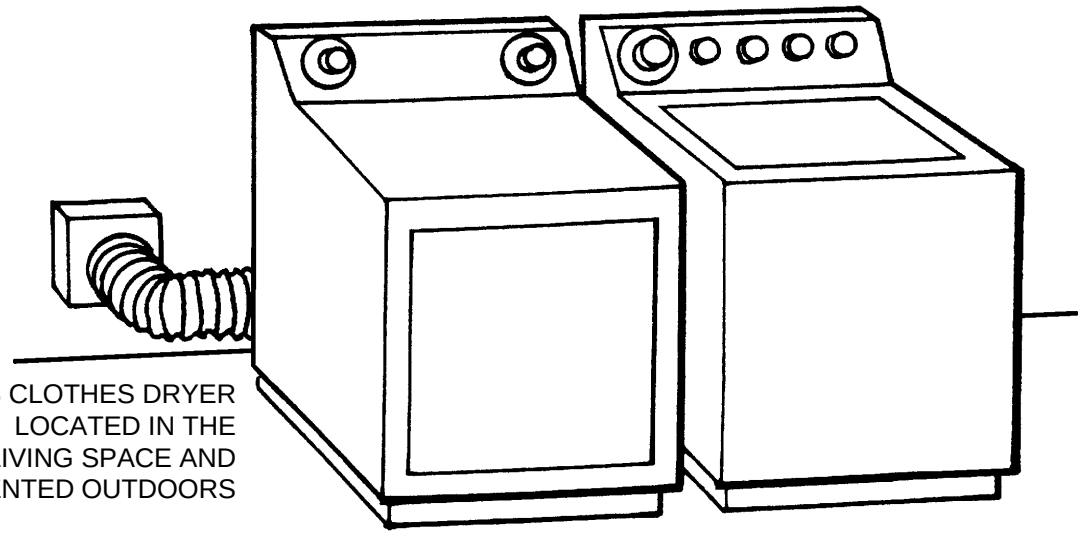
6. FLUE AND VENT SYSTEM EXAMINATION

- **All gas flues and vents:**
  - **Shall terminate outdoors.**
  - **Shall not terminate underneath the mobile home.**
- **Flue and Vent Systems Terminating Near an Evaporative Cooler**
  - **A Water Heater flue/vent pipe shall not terminate within 3' of the cooler air intake.**
  - **A Furnace flue/vent pipe shall not terminate within 3' of the cooler air intake unless:**
    - **All cooler discharge openings are equipped with a vent cover.**
    - **The client is informed of the non-conforming flue/vent and advised to keep cover(s) in place during the heating season.**



7. ADDITIONAL EXAMINATIONS OF NATURAL GAS APPLIANCES

- **Inoperable Gas Appliances**
  - **Inoperable natural gas appliances must be checked by a utility gas service technician (or designee), *unless* they are: (a) abandoned*, or (b) inaccessible*.**
- **Infiltration reduction measures will not be installed if any of the following conditions are present:**
  - **<u>Gas clothes dryer</u> located in the living space but <u>not</u> exhausted outdoors**.**
  - **<u>Return leak</u> present that can draw in combustion products from the FAU or other open combustion appliances (e.g., through a return leak).**
  - **<u>Unvented combustion space heater</u> (e.g., gas or kerosene unit) present in the living space.**
  - **<u>Open combustion furnace or water heater</u> present in*, or drawing combustion air from,* the living space.**
  - ***Inoperable gas appliance.***



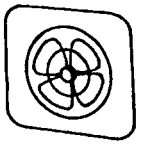
GAS CLOTHES DRYER LOCATED IN THE LIVING SPACE AND VENTED OUTDOORS

See Definitions

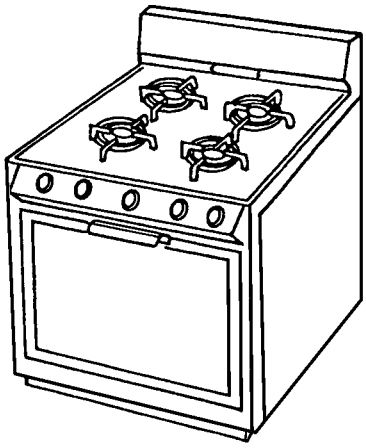
****Termination in the undercarriage space is acceptable when adequate cross-ventilation is present. Any dryer termination in an open combustion appliance enclosure/closet is <u>not</u> acceptable.***

7. ADDITIONAL EXAMINATIONS OF NATURAL GAS APPLIANCES (continued)

- **Cooking Area Ventilation for Gas Appliances**
  - **A functional vent to outdoors must be present above gas cooking appliances:**
    - **In the ceiling or a wall.**
    - **Within 10' of the appliances.**
  - **The vent may be either of the following:**
    - **An operable exhaust fan equipped with an automatic or manual damper.**
    - **A metal duct with a cross-sectional area of at least 12.5 sq. in., and minimum dimension of 2" (e.g., 2" x 6.25" rectangular duct or 4" round duct).**

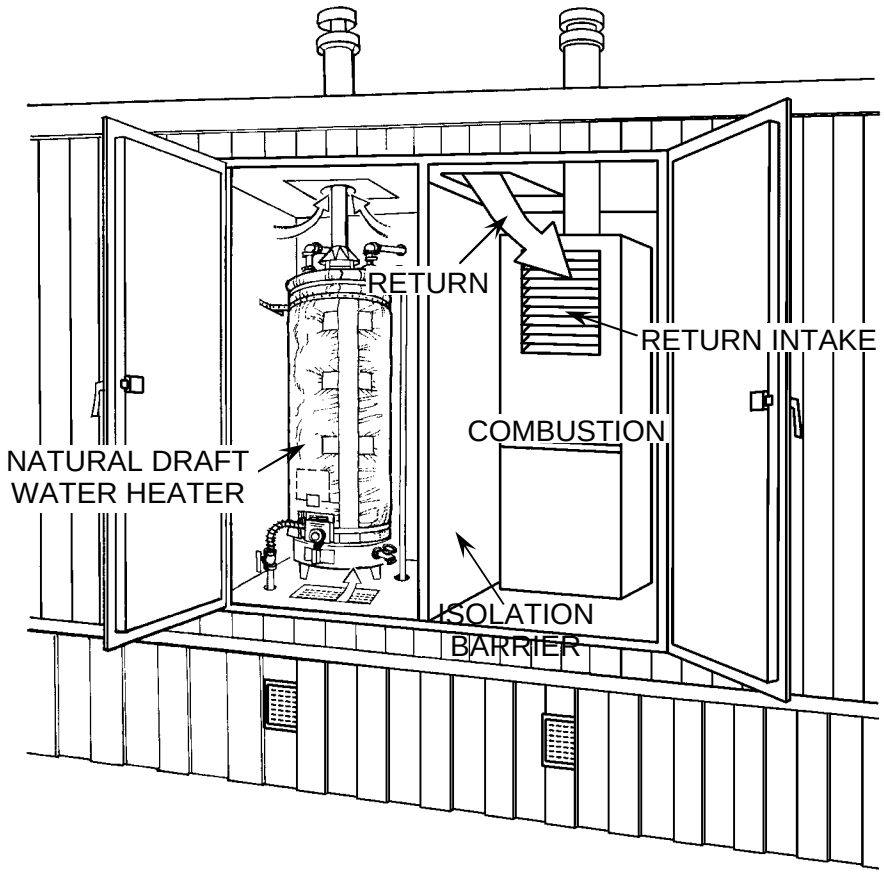


COOKING APPLIANCE VENTILATION PROVIDED BY A FUNCTIONAL EXHAUST FAN



7. ADDITIONAL EXAMINATIONS OF NATURAL GAS APPLIANCES (continued)

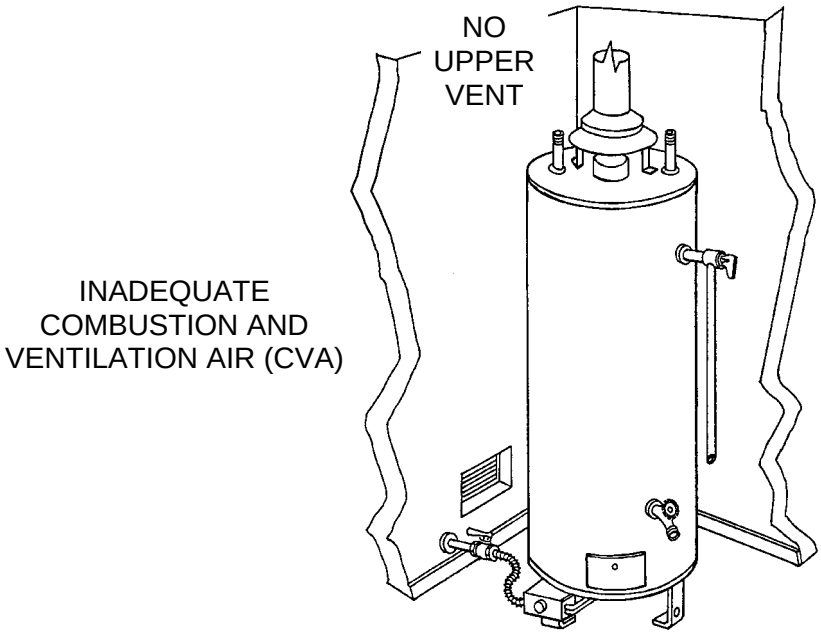
- **Isolation of Return Air**
  - **The return air system shall not have leaks which:**
    - **Depressurize any open combustion appliance enclosure.**
    - **Draw in combustion air or combustion byproducts from any open combustion appliance (e.g., from the furnace itself or a nearby water heater).**
    - **Depressurize or draw air from a space where hazardous chemicals are stored or toxic fumes may be present.**
  - **The following conditions are <u>not</u> allowed:**
    - **An open combustion FAU draws non-ducted return air through an intake in the furnace cabinet.**
    - **A closed combustion FAU is located in an appliance enclosure adjacent to an open combustion water heater when:**
      - **The furnace enclosure is part of the return system, <u>and</u>**
      - **The two appliances are <u>not</u> separated by an airtight barrier.**
  - **Any condition which allows pollutants to be drawn into the FAU return shall be corrected when Infiltration Reduction Measures are installed.**



PART 3: WEATHERIZATION CREW VERIFICATIONS

8. PRELIMINARY VISUAL EVALUATIONS

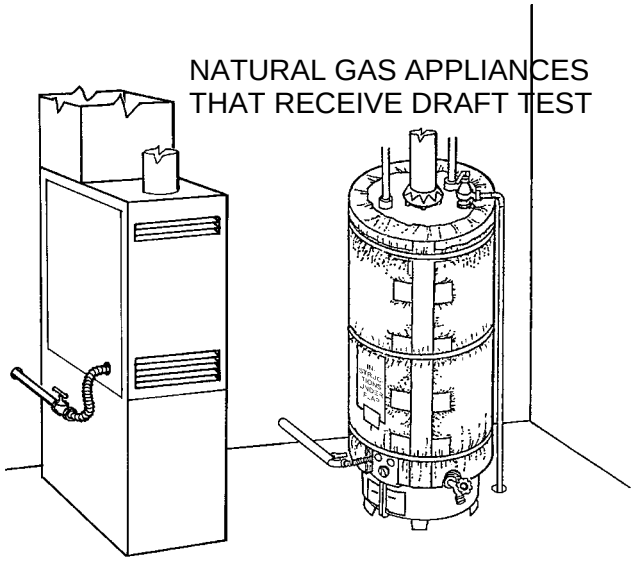
- **A check shall be made for the following conditions, which preclude installation of infiltration measures unless repair is feasible:**
  - **Gas leaks and soldered gas connectors (Item 10)**
  - **Inadequate CVA (Item 11)**
  - **Inadequate clearance between water heater vent termination and evaporative cooler inlet (Item 12)**
  - **Other improper flue/vent terminations (Item 12)**
  - **Draft hood improper—misaligned, missing, or doubled (Item 12)**
  - **Flue/vent hazard, such as disconnection, hole/leak indoors, not extended outdoors (Item 12)**
  - **Flue/vent connection to a solid-fuel chimney (Item 12)**
  - **Inoperable gas appliance (Item 13)**
  - **Appliance components missing or damaged (Item 13)**
  - **Gas clothes dryer located in the living space but <u>not</u> exhausted outdoors (Item 13)**
  - ***Improper gas-cooking area ventilation (Item 13)***
  - **Defective isolation of return air (Item 13)**
  - **Unvented combustion space heater in the living space (Item 13)**
  - **Open combustion space or water heating appliance located in the living space (Item 13)**
  - **When gas log is primary heat source, fireplace damper not blocked partially open (Item 20)**



PART 4: POST-WEATHERIZATION NGAT PROCEDURES

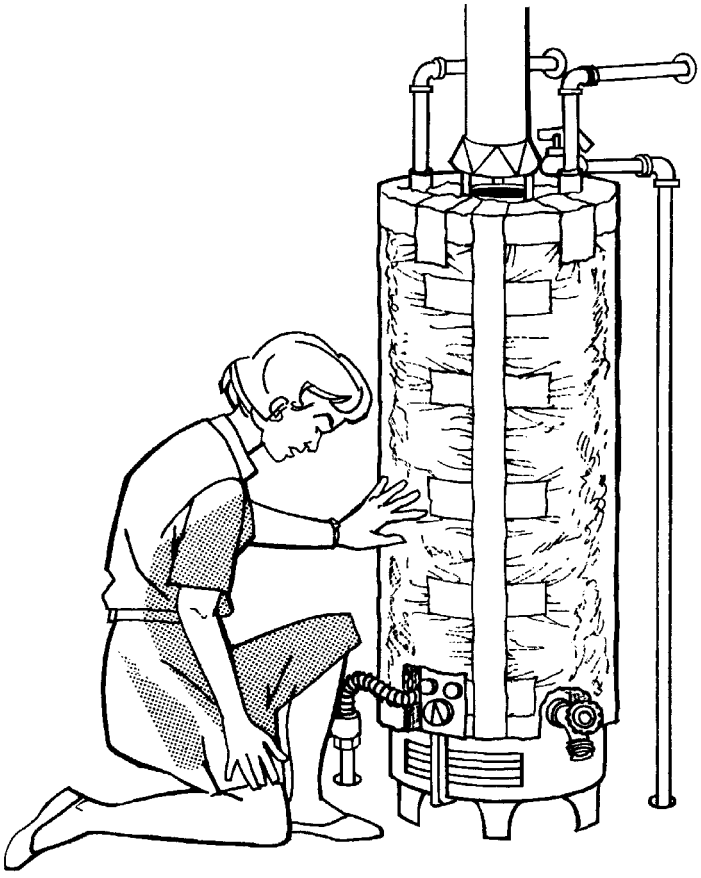
9. POST-WEATHERIZATION NGAT

- **Post-Weatherization NGAT shall be performed, which shall include the following procedures:**
  - **CO Analyzer zeroed outdoors.**
  - **Room Ambient CO Test with gas appliances off.**
  - **Check for gas leaks.**
  - **CVA Evaluation.**
  - **Appliance-off visual inspection of appliances, components, and flue/vent systems.**
  - **Appliance Ambient CO Test with natural gas appliances operated individually.**
  - **Draft Test on natural draft space and water heating appliances.**
  - **Exhaust/flue CO Test and Draft Test on natural gas fireplace logs.**
  - **Appliance-on visual inspection of appliances.**
- **Appliances that Fail NGAT Protocol**
  - **If a Room Ambient or Appliance Ambient CO measurement equals or exceeds the action level of 10 ppm, unit(s) believed to be causing elevated CO reading shall be serviced/adjusted by a utility gas service technician (or designee) and, when applicable, repaired or replaced.**
  - **An appliance that has inadequate draft or is inoperable shall be serviced/adjusted by a utility gas service technician (or designee) and, when applicable, repaired or replaced .**
  - **All units repaired or replaced shall undergo post-repair/replacement testing per Item 23.**



10. GAS LEAKS AND SOLDERED GAS CONNECTORS

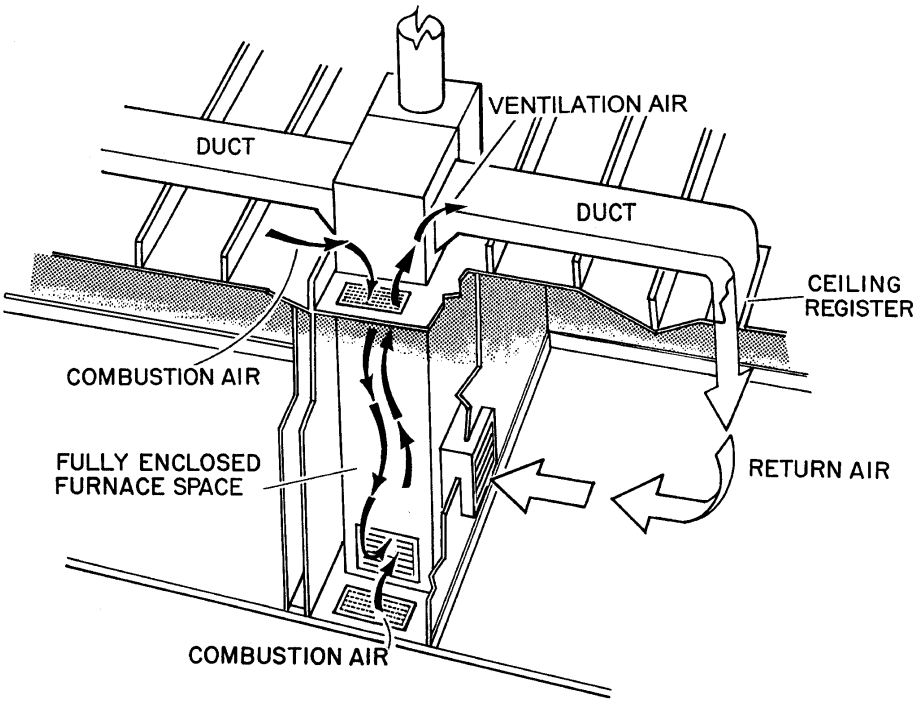
- **Natural gas appliances shall be checked for gas leaks:**
  - **Prior to operating the appliance for testing.**
  - **With combustion appliances and exhaust fans/devices off.**
- **Appliances shall be checked for natural gas leaks using one or more of the following methods:**
  - **Olfactory (Sniff) Test performed above, but within 2' of, all valves and fittings.**
  - **Application of leak detection liquid to line valves and to fittings on valves, flexible gas connectors, and pipes.**
  - **Air sampling with electronic leak detection equipment near valves, fittings, flexible gas connectors, and pipes.**
- **When a gas leak is detected, inspection shall be conducted by a utility gas service technician (or designee).**
- **Leaks shall be repaired by a utility gas service technician (or designee) before appliances are operated for natural gas appliance tests.**
- **When faint gas odors are present, testing may occur; however, appliance shall be checked by a utility gas service technician (or designee).**
- **Soldered Gas Connectors**
  - **Old-style flexible gas connectors with soldered-on fittings shall be replaced with a new listed flexible gas connector.**



CHECKING FOR NATURAL GAS ODOR

11. COMBUSTION AND VENTILATION AIR (CVA) EVALUATION

- **CVA shall be evaluated for open combustion natural gas heating systems and water heaters (cooking appliances and clothes dryers are *excluded*).**
- **CVA shall comply with these guidelines and Appendix A, unless superseded by manufacturer's instructions or HCD requirements.**
- **Appliances Drawing *Outdoor* Air through Combustion-Air Openings or Ducts**
  - **An *upper* opening or duct shall be located within 12" of the enclosure ceiling, and a *lower* opening or duct shall be located within 12" of the floor.**
    ***Exception*: Pre-existing upper openings and ducts are acceptable at any height above the draft hood.**
  - **Combustion air openings and vertical ducts shall each provide 1 sq. in. net free venting area (NFVA) per 4,000 Btu/hr of input.**
  - **Horizontal ducts shall each provide 1 sq. in. NFVA per 2,000 Btu/hr of input.**
  - **Combustion air may also be obtained through a single upper vent or duct to outdoors under the following conditions:**
    - **Vent NFVA is at least: (a) 1 sq. in. per 3,000 Btu/hr input, and (b) not less than the sum of the cross-sectional areas of all vent connectors in the space.**
    - **Equipment has clearances of at least 1" sides and back, and 6" in front.**



11. COMBUSTION AND VENTILATION AIR (CVA) EVALUATION (continued)

- **When Appliance s Draw Combustion Air from Outdoors**
  - **Combustion air may be obtained from outdoors by means of:**
    - **Permanent openings (undampered vents) of the required size directly to outdoors through enclosure floor, roof or walls; or**
    - **Continuous vertical or horizontal ducts of the required cross-sectional area extending from the enclosure to outdoors.**
  - **Combustion air may be obtained from under the floor, provided:**
    - **Undampered venting is present in the skirting.**
    - **Cross-ventilation is present, with venting located on at least two different sides of the mobile home.**
    - **Skirting vents on each side provide at least 1.5 sq. ft. NFVA for each 25 lineal feet of mobile home length.**
- **Combustion-Air Ducts and Sleeves**
  - **Ducts and sleeves shall be a minimum of 26 gage galvanized steel or 24 gage aluminum, and ducts shall have a minimum cross-sectional dimension of 3".**
- **Louvers, Grilles, and Screens**
  - **Covering of 1/4" corrosion-resistant screen mesh is required on combustion air openings to outdoors.**
  - **Blocking effects of louvers, grilles, and screens shall be considered when calculating NFVA of an opening (see Appendix A).**
- **When Appliances Draw Combustion Air from Indoors**
  - **Unconfined Space:**
    - **A room/space that has a volume of at least 50 cu. ft. per 1,000 Btu/hr total input rating of the open combustion furnace and/or water heater in that room/space.**
    - **Combustion air is considered adequate.**

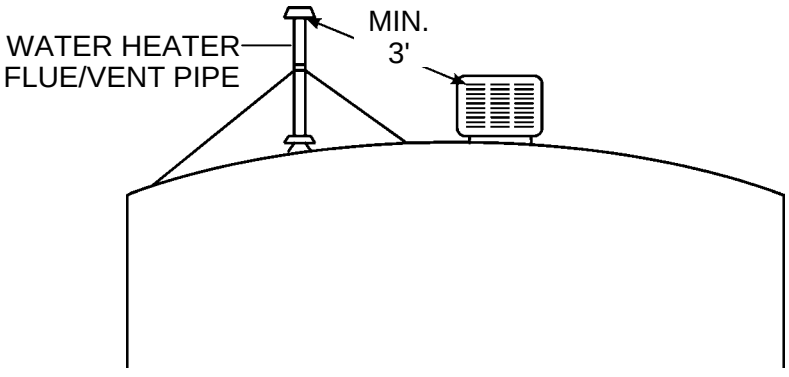
SOURCES OF COMBUSTION AIR	
OUTDOORS	**UNDER FLOOR**
• **Permanent openings with undampered vents or continuous ducts (vertical or horizontal).** • **Vent directly to outdoors.** • **1/4" screen mesh on all combustion-air openings.**	• **Free flow of air.** • **Unobstructed openings to outdoors on each side that provide at least 1.5 sq. ft. NFVA for each 25 lineal feet of the mobile home length.**

11. COMBUSTION AND VENTILATION AIR (CVA) EVALUATION (continued)

- **When Appliances Draw Combustion Air from Indoors (continued)**
  - **Confined Space:**
    - **A room/space that has a volume of less than 50 cu. ft. per 1,000 Btu/hr total input of the open combustion furnace and/or water heater in that room/space.**
    - **Combustion air is not adequate.**
    - **Proper vent openings to adjacent space(s) must be present.**
  - **Confined spaces outside the mobile home shall not be vented into the living space.**

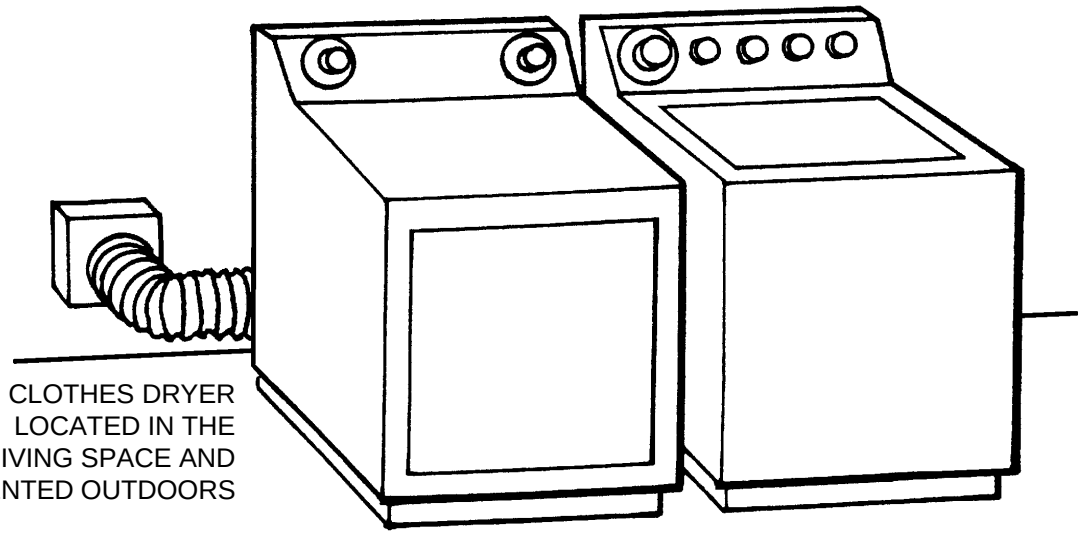
12. FLUE AND VENT SYSTEM EXAMINATION

- **Flue and vent systems shall be free of:**
  - **Draft hood defects:**
    - **Improperly installed or positioned.**
    - **Multiple (stacked) draft hoods on a single appliance.**
    - **Missing (no draft hood at all).**
  - **Disconnections or unsafe joints (e.g., loose, unsecured, etc.).**
  - **Holes or other hazardous conditions requiring repair.**
  - **Connection to a solid-fuel appliance chimney.**
- **All gas flues and vents:**
  - **Shall terminate outdoors.**
  - **Shall not terminate underneath the mobile home (reference HUD Code: 24 CFR, Chapter XX, Part 3280, Subpart H).**
- **Flue and Vent Systems Terminating Near an Evaporative Cooler**
  - **A Water Heater flue/vent pipe shall not terminate within 3' of the cooler air intake.**
  - **A Furnace flue/vent pipe shall not terminate within 3' of the cooler air intake unless:**
    - **All cooler discharge openings are equipped with a vent cover.**
    - **The client is informed of the non-conforming flue/vent and advised to keep cover(s) in place during the heating season.**



13. VISUAL APPLIANCE CHECKS

- **Inoperable Appliances**
  - **Inoperable natural gas appliances must be checked by a utility gas service technician (or designee), *unless* they are: (a) abandoned*, or (b) inaccessible*.**
- **The following conditions are <u>not</u> acceptable when Infiltration Reduction Measures are installed:**
  - **<u>Gas clothes dryer</u> located in the living space but <u>not</u> exhausted outdoors**.**
  - **<u>Return leak</u> present that can draw in combustion products from the FAU or other open combustion appliances.**
  - **<u>Unvented combustion space heater</u> (e.g., gas or kerosene unit) present in the living space.**
  - **<u>Open combustion furnace or water heater</u> present in*, or drawing combustion air from,* the living space.**
  - ***Inoperable gas appliance.***



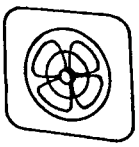
GAS CLOTHES DRYER LOCATED IN THE LIVING SPACE AND VENTED OUTDOORS

***See Definitions**

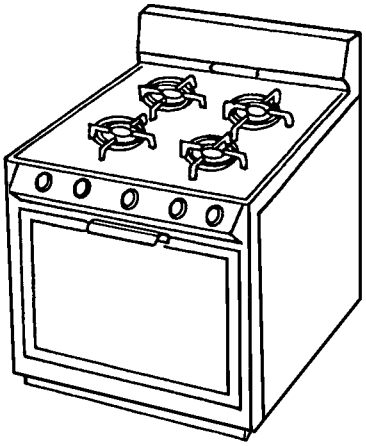
****Termination in the undercarriage space is acceptable when adequate cross-ventilation is present. Any dryer termination in an open combustion appliance enclosure/closet is <u>not</u> acceptable.***

13. VISUAL APPLIANCE CHECKS (continued)

- **Cooking Area Ventilation for Gas Appliances**
  - **A functional vent to outdoors must be present above gas cooking appliances:**
    - **In the ceiling or a wall.**
    - **Within 10' of the appliances.**
  - **The vent may be either of the following:**
    - **An operable exhaust fan equipped with an automatic or manual damper.**
    - **A metal duct with a cross-sectional area of at least 12.5 sq. in., and minimum dimension of 2" (e.g., 2" x 6.25" rectangular duct or 4" round duct).**

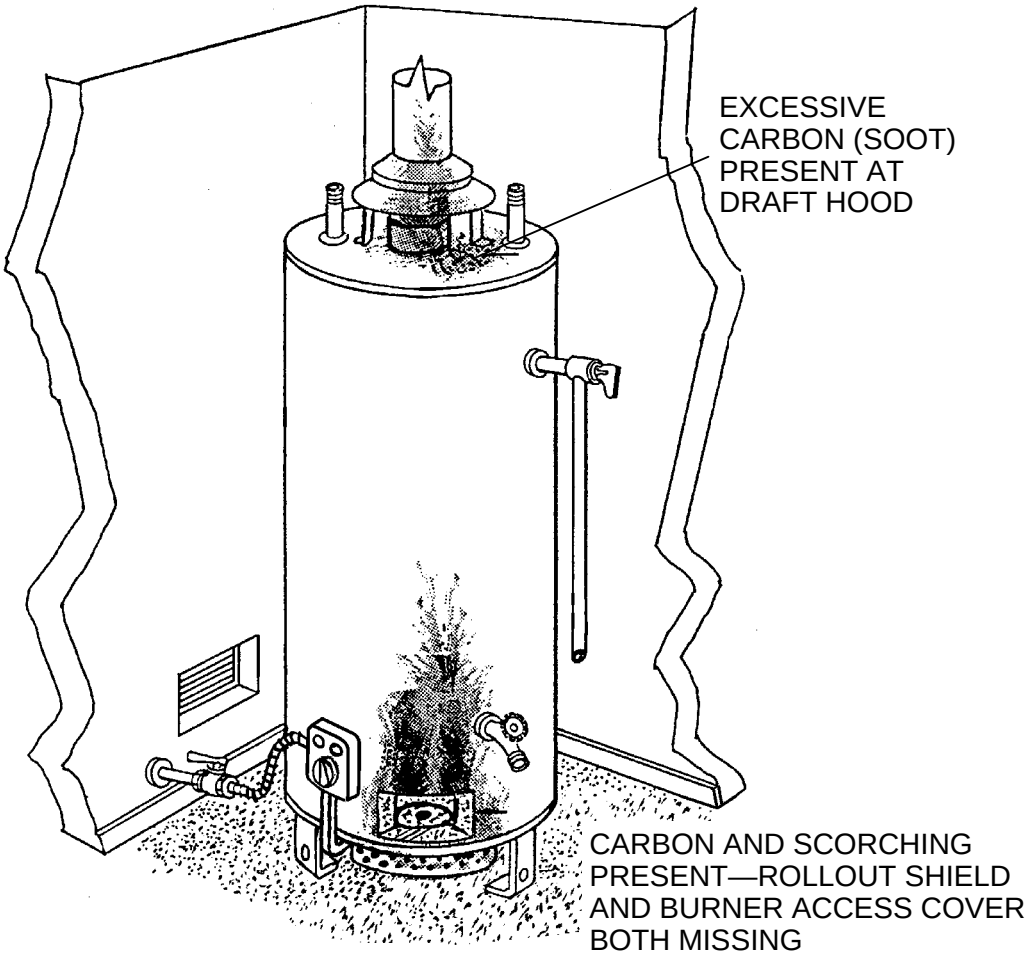


COOKING APPLIANCE VENTILATION PROVIDED BY A FUNCTIONAL EXHAUST FAN



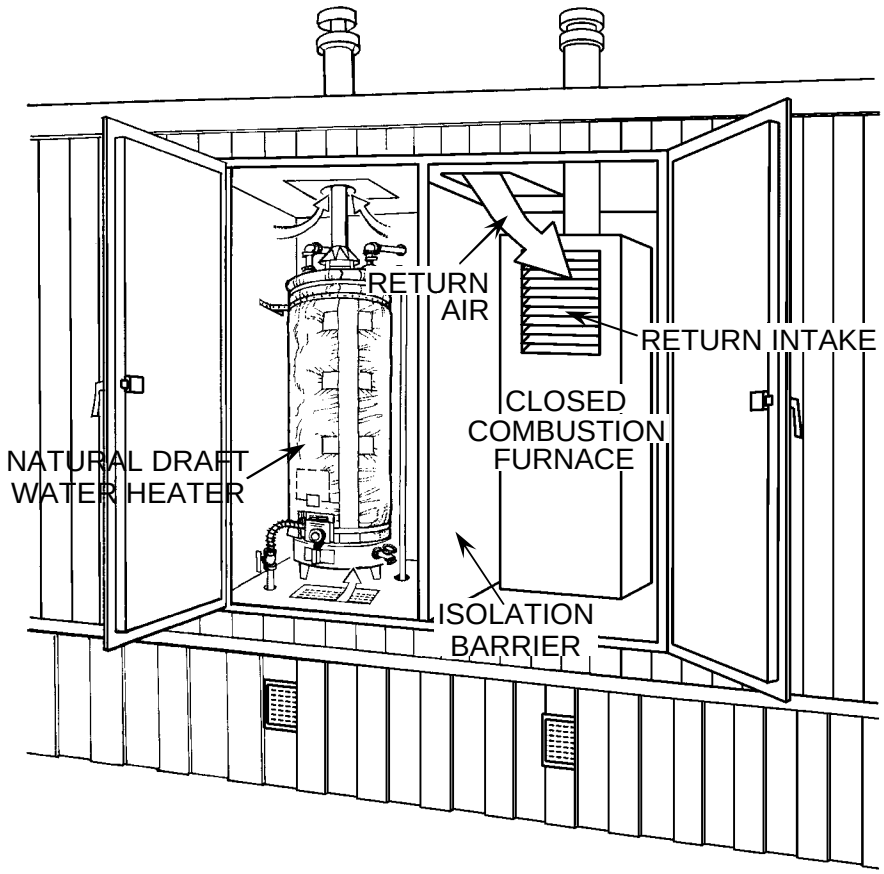
13. VISUAL APPLIANCE CHECKS (continued)

- **Appliance Components**
  - **The following appliance components shall be present:**
    - **Appliance door(s).**
    - **Combustion chamber access door(s).**
  - **Water heater shall have at least one access cover or roll-out shield.**
  - **Roll-out shield required on furnace when the unit was manufactured with a roll-out shield.**
- **Carbon and Rust**
  - **The top of the burner(s), the heat exchanger, draft hood and flue/vent pipe shall be examined for excessive amounts of carbon or rust.**



13. VISUAL APPLIANCE CHECKS (continued)

- **Isolation of Return Air**
  - **The return air system shall not have leaks which:**
    - **Depressurize any open combustion appliance enclosure.**
    - **Draw in combustion air or combustion byproducts from any open combustion appliance (e.g., from the furnace itself or a nearby water heater).**
    - **Depressurize or draw air from a space where hazardous chemicals are stored or toxic fumes may be present.**
  - **The following conditions are <u>not</u> allowed:**
    - **An open combustion FAU draws non-ducted return air through an intake in the furnace cabinet.**
    - **A closed combustion FAU is located in an appliance enclosure adjacent to an open combustion water heater when:**
      - **The furnace enclosure is part of the return system, <u>and</u>**
      - **The two appliances are <u>not</u> separated by an airtight barrier.**
  - **Any condition which allows pollutants to be drawn into the FAU return shall be corrected.**

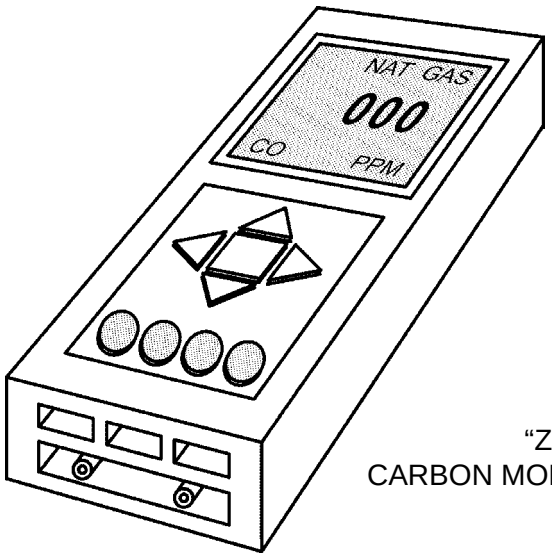


14. TEST CONDITIONS FOR ROOM AMBIENT CO TEST

- **Test shall be performed *prior* to operating any appliances.**
- **Test Conditions**
  - **All gas appliances in the living space turned off (e.g., at the thermostat).**
    ***Exception*: Water heater pilot may be operating, but main burner shall not be operating.**
  - **Air handler and all exhaust fans and air-exhausting devices turned off.**
  - **Exterior doors and windows closed.**
  - **Interior doors:**
    - **All interior room doors open.**
    - **Appliance enclosure doors closed.**
  - **Fireplace damper closed when feasible (no fire or hot coals).**
  - **If an interior cooler cover is available, it shall be in place.**

15. CO ANALYZER "ZEROING"

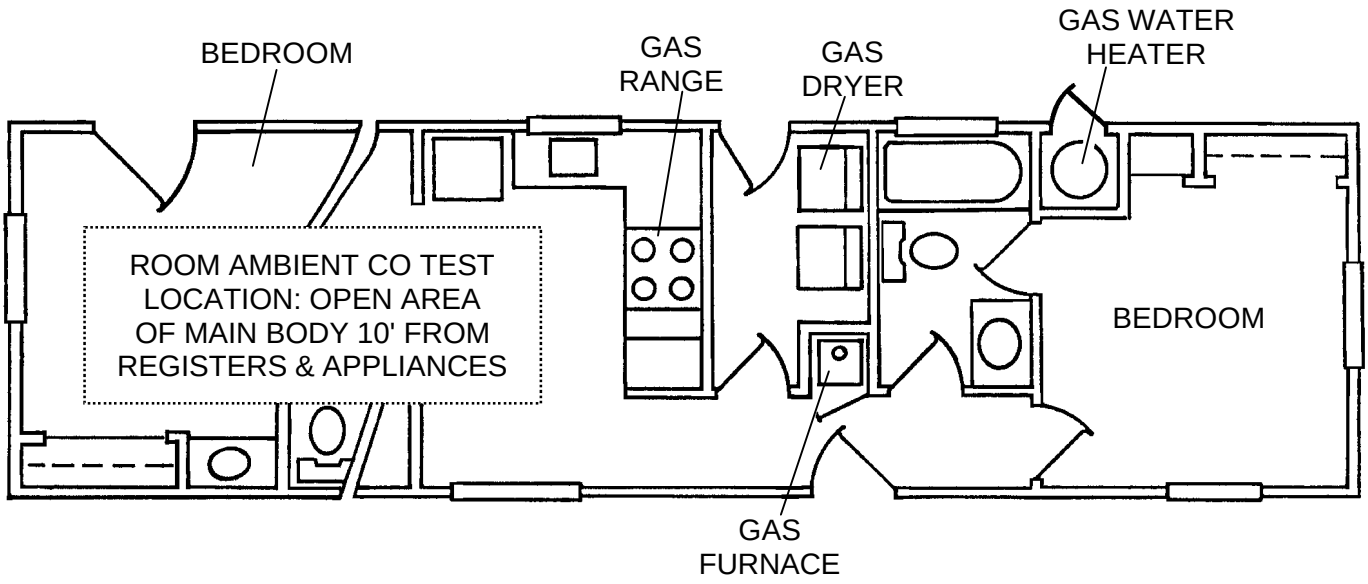
- **Just prior to performing Room Ambient CO Test, the analyzer shall be adjusted outdoors to read zero ppm CO.**
- **CO analyzer shall be protected from outdoor sources of CO and from wind bearing pollutants.**
- **Analyzer shall remain on during entire ambient test sequence when possible.**
- **If turned off during ambient testing, zeroing process shall be repeated before resuming tests.**



"ZEROED"
CARBON MONOXIDE ANALYZER

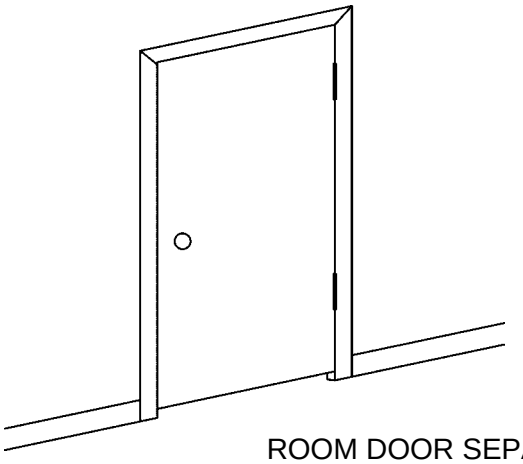
16. CONDUCTING ROOM AMBIENT CO TEST

- **Room Ambient CO Test shall be conducted immediately after zeroing the CO analyzer:**
  - **In an open area in the main body of the living space (e.g., in the center of the living room or living/dining combination area).**
  - **10' away from combustion appliances and supply registers (less than 10' away acceptable in smaller rooms).**
  - **6' above the floor.**
- **If Room Ambient CO Test measurement is 10 ppm or greater:**
  - **The living space shall be ventilated and the test repeated when a condition such as the following exists:**
    - **Heavy smokers are present, or**
    - **Wood-burning or unvented heating/cooking appliances were operating within the preceding half hour.**
  - **Appliance Ambient CO Tests shall be conducted even if CO is 10 ppm or greater after ventilation and repeat of the Room Ambient CO Test.**



17. TEST CONDITIONS FOR APPLIANCE-ON CO AND DRAFT TESTS

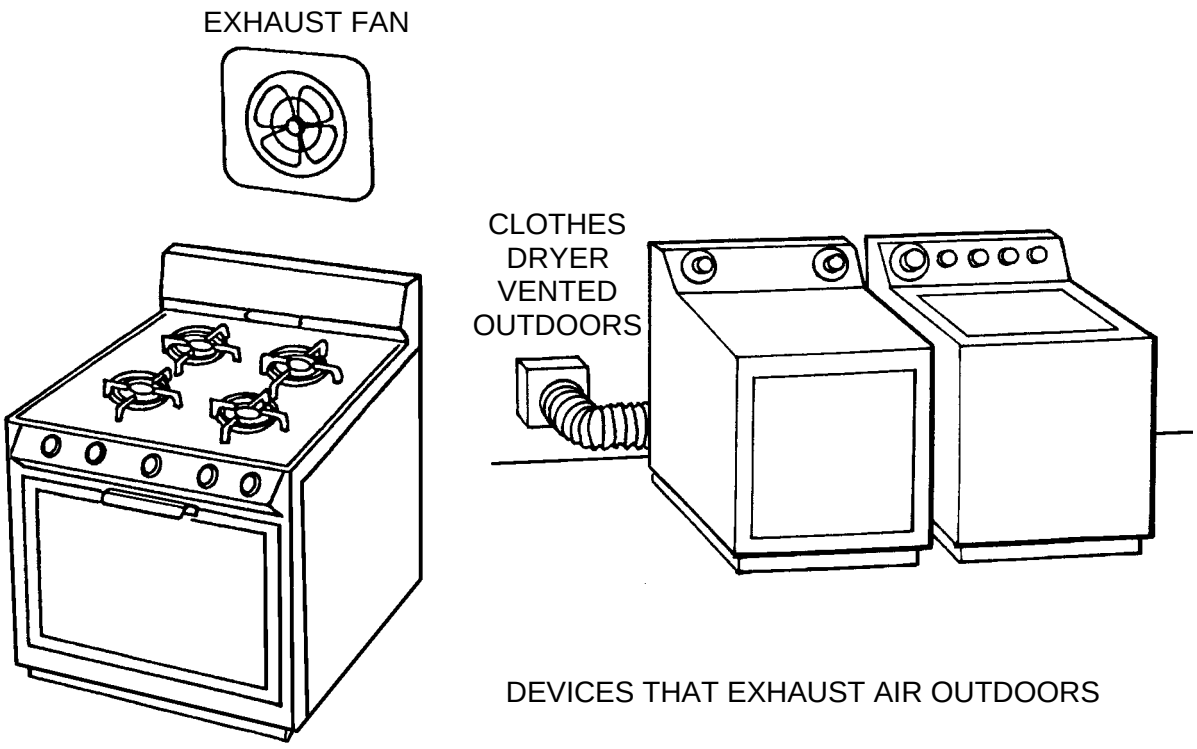
- **The following test conditions shall be established for Appliance Ambient CO Tests and Draft Tests.**
- **Door/Window Positions for Tests in the Living Space**
  - **The following shall be closed:**
    - **All exterior doors and windows.**
    - **Doors to rooms containing a supply register when a central return is outside the room.**
    - **Appliance enclosure doors (except during tests).**
  - **The following shall be open:**
    - **Doors to all other living areas and rooms.**
    - **Door to utility room with clothes dryer exhausted outdoors. Exception: When a natural draft appliance in that room is tested, the door shall be closed.**



ROOM DOOR SEPARATING
SUPPLY REGISTERS
FROM A CENTRAL RETURN

17. TEST CONDITIONS FOR APPLIANCE-ON CO AND DRAFT TESTS (continued)

- **The following must be operating during tests:**
  - **FAU air handler.**
  - **All devices that exhaust air from the space containing an appliance being tested:**
    - **Include kitchen exhaust fans, bathroom and utility room fans, clothes dryer, central vacuum system, and manually-controlled attic ventilators.**
    - **Exclude whole house fan.**
- **FAU air filter(s) must be clean or shall be removed prior to testing.**
- **Clothes dryer lint screen shall be clean.**
- **Supply registers shall be open.**
- **If an interior cooler cover is available, it shall be in place.**



DEVICES THAT EXHAUST AIR OUTDOORS

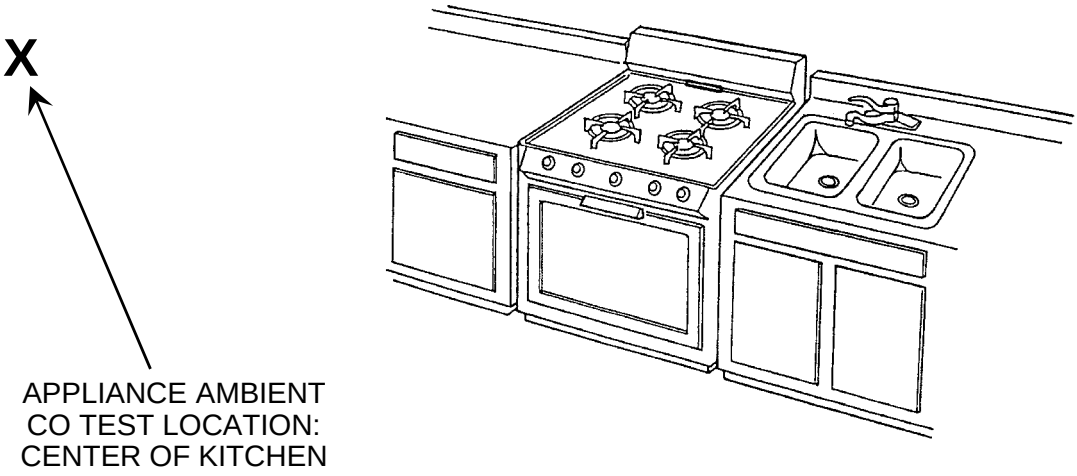
18. TEST PROCEDURES FOR APPLIANCE AMBIENT CO TEST

- Test conditions shall be established as prescribed in Item 17.
- Natural Gas Heating Appliances
  - Heating appliance(s) shall be operated for a minimum of 5 minutes.
  - All other gas appliances shall remain off.
    Exception: Water heater pilot may be operating, but main burner shall not be operating.
  - CO shall be measured in the following locations:
    - Ducted units: In the supply register nearest the furnace.
    - Heaters without ducts (e.g., direct vent furnaces): In the atmosphere directly above the top of the unit.
  - The heating system shall be checked by a utility gas service technician (or designee) if Appliance Ambient CO Test CO ppm is:
    - Higher than Room Ambient CO Test CO ppm, or
    - Above 9 ppm.
- Natural Gas Water Heater
  - Storage water heater shall be operated for a minimum of 5 minutes.
  - Tankless water heaters shall be operated for a minimum of 1 minute.
  - All other gas appliances shall remain off.
  - CO shall be measured in the atmosphere directly above the top of the water heater (and draft hood or inducer, if applicable).
  - The water heater shall be checked by a utility gas service technician (or designee) if Appliance Ambient CO Test CO exceeds 9 ppm.
- Natural Gas Log
  - An exhaust/flue CO test shall be conducted per Item 20.
- Natural Gas Clothes Dryer
  - No CO test required.

APPLIANCE AMBIENT CO TEST CO ANALYZER PROBE LOCATIONS FOR HEATING APPLIANCES AND WATER HEATERS
• DUCTED UNITS: INSIDE SUPPLY REGISTER NEAREST THE FAU WITH TEST PROBE DIRECTED INTO THE AIR FLOW.
• NON-DUCTED HEATERS: IN THE ATMOSPHERE ABOVE THE UNIT.
• WATER HEATERS: IN THE ATMOSPHERE ABOVE THE UNIT AND DRAFT HOOD.

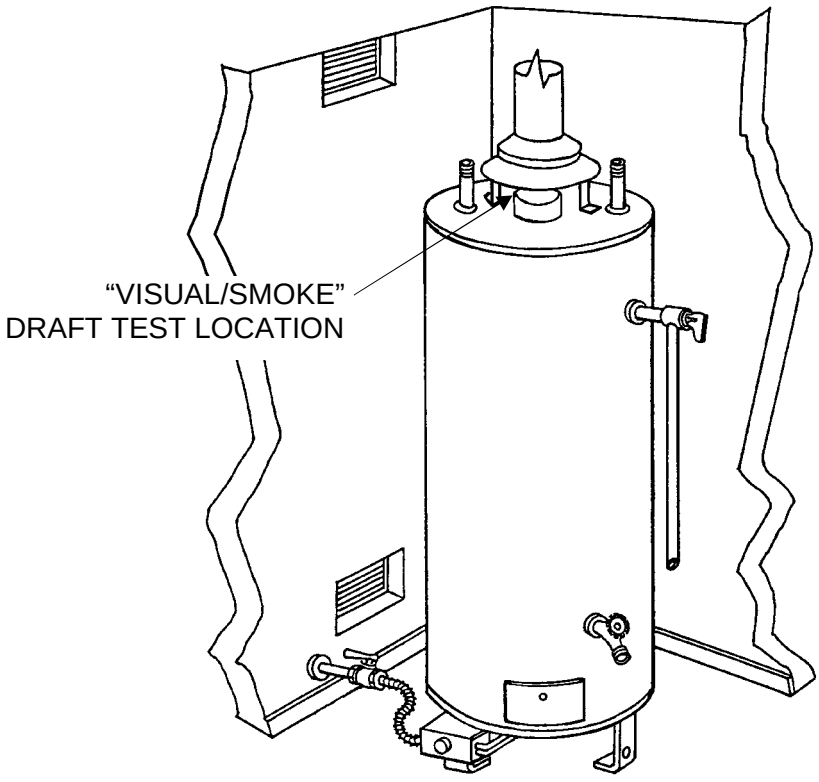
18. TEST PROCEDURES FOR <u>APPLIANCE</u> AMBIENT CO TEST (continued)

- **Natural Gas Kitchen Appliances**
  - **All other gas appliances shall remain off.**
    ***<u>Exception</u>*: Water heater pilot may be operating, but main burner shall <u>not</u> be operating.**
  - **Cooktop:**
    - **With ovens and broilers off, all cooktop burners, and griddle if present, shall be operated on highest setting for one minute.**
    - **CO shall be measured in the center of the kitchen.**
  - **Oven and Broiler Units:**
    - **With cooktop off, each oven shall be operated on highest setting (i.e., "Broil" when applicable) for a minimum or 5 minutes (with separate broiler burner off).**
    - **When a separate broiler burner is present, it shall be operated on highest setting for 5 minutes (with oven burner off).**
    - **CO shall be measured in the center of the kitchen for oven and separate broiler, when present.**
  - **CO Action Level**
    - **The appliance shall be checked by a utility gas service technician (or designee) if Appliance Ambient CO Test CO exceeds 9 ppm.**



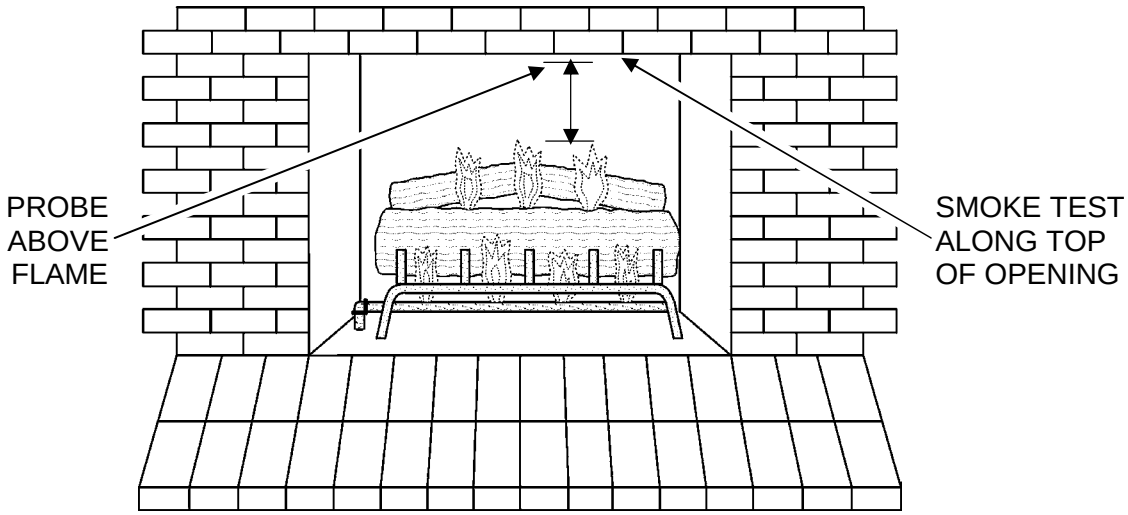
19. DRAFT EXAMINATION

- **Natural Gas Open Combustion Heating Systems and Water Heaters**
  - **Draft tests shall be performed after a minimum of 5 minutes of appliance operation.**
  - **Visual/Smoke Draft Test shall be performed on Natural Draft appliances.**
    - **Smoke shall be applied along the entire draft hood opening.**
    - **Draft is adequate <u>only if</u> smoke is drawn into the draft hood along the entire draft hood opening.**
- **Gas Logs**
  - **Visual/Smoke Draft Test shall be performed as prescribed in Item 20.**
- **All Units**
  - **Corrective action is required when Draft is <u>not</u> adequate.**



20. CO AND DRAFT TESTING FOR NATURAL GAS LOGS

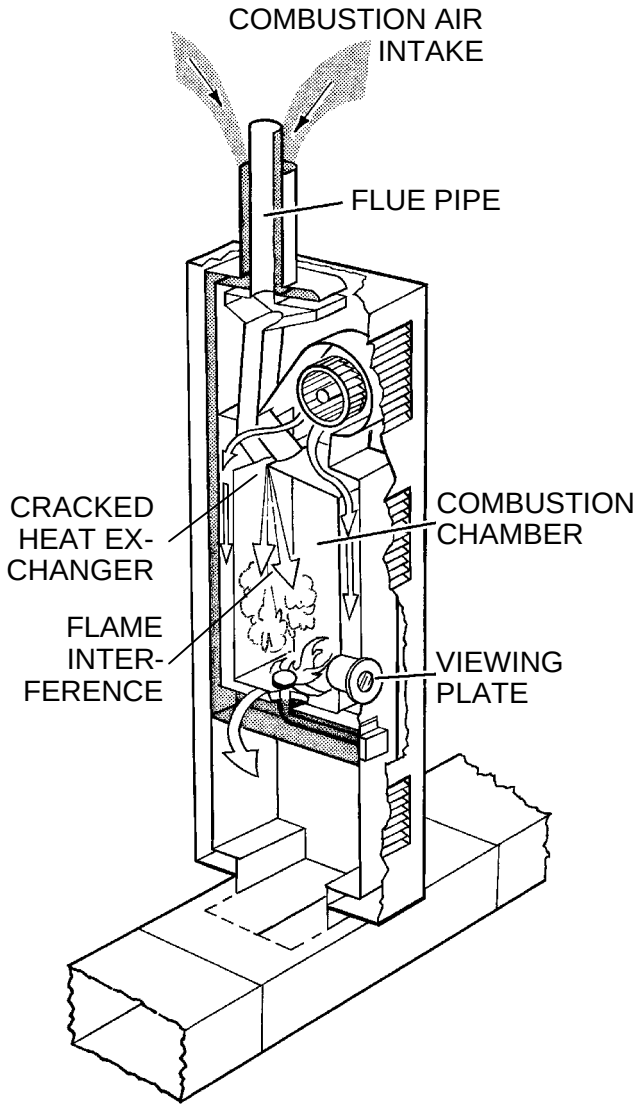
- **When gas log is the *primary* heat source:**
  - **Damper must be blocked partially open (e.g., with a damper clip).**
  - **Opening shall be sufficient to prevent spillage of combustion products into the room.**
- **Fireplace glass doors shall be open during tests.**
- **Exhaust/Flue CO Test**
  - **Gas burner shall be operated for a minimum of 5 minutes before checking CO.**
  - **CO shall be sampled just inside the fireplace opening at least 12" above the flame.**
  - **If CO exceeds action level after 5 minutes, warm up time shall be increased (up to 30 minutes) and unit shall be retested.**
  - **Service by a utility gas service technician (or designee) is required if CO exceeds action level.**
- **CO Action Level***
  - ~~**As established by the utility.**~~
  - ***25 ppm As Measured.***
  - ***400 ppm Air Free.***
- **Visual/Smoke Draft Test**
  - **Smoke shall be applied along the top of the fireplace opening.**
  - **Draft is adequate only if smoke is drawn inward along the entire fireplace opening.**



~~***The CPUC is currently considering a proposed settlement that would set statewide flue testing CO thresholds. This section will be updated when the commission has acted upon the proposed settlement.***~~

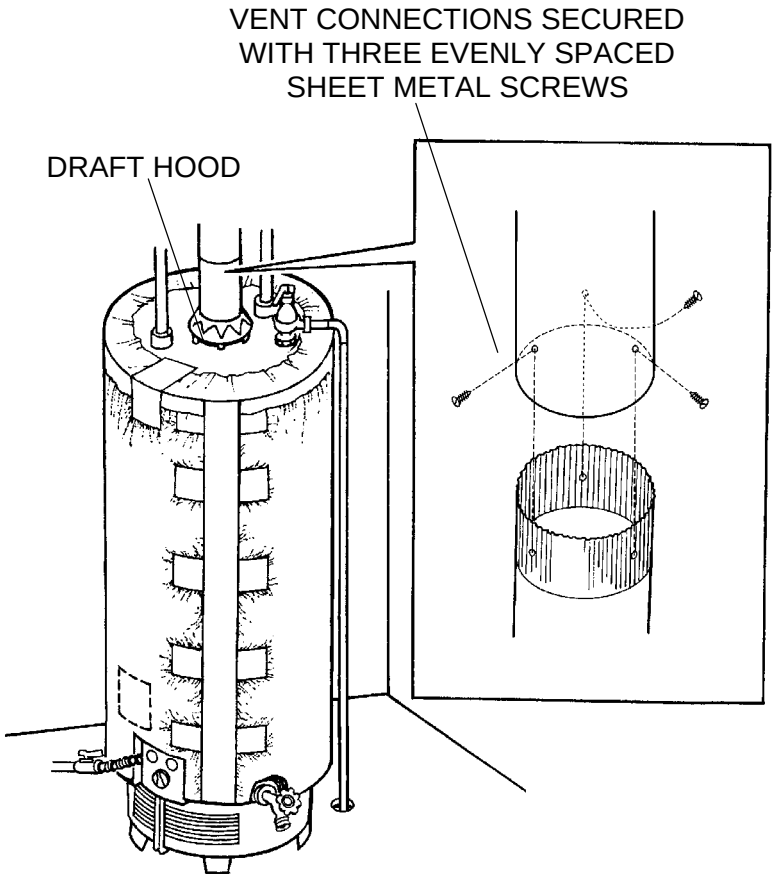
21. ADDITIONAL APPLIANCE EXAMINATIONS

- **Burner Performance**
  - **When the burner(s) ignite, checks shall be made for:**
    - **Delayed ignition.**
    - **Excessive roll-out.**
  - **Burner(s) shall be examined for flame abnormalities, including:**
    - **Large yellow flame (more than 50% yellow).**
    - **Soft lazy flame or smothering flame.**
- **Heat Exchanger Examination on Natural Gas Forced Air Heating Systems**
  - **Each accessible heat exchanger shall be rechecked for cracks with a mirror and strong light.**
  - **The unit shall be further examined/serviced by a utility gas service technician (or designee) if any of the following conditions is present:**
    - **Flame interference caused by the air handler in an FAU.**
    - **A visually-detected crack.**
    - **Other evidence of a defective heat exchanger.**
  - **If a defect exists, the condition shall be corrected by a utility gas service technician (or designee), or designated contractor licensed to repair HVAC appliances.**



22. FLUE AND VENT SYSTEM REPAIR

- **Draft Hoods**
  - **The following conditions must be corrected:**
    - **Improperly installed or positioned draft hood.**
    - **Multiple (stacked) draft hoods on a single appliance.**
    - **No draft hood present where one is required.**
- **Repairing Flue and Vent Systems**
  - **New components shall conform to applicable codes.**
  - **All single-wall flue and vent pipe joints and connections shall be secured with 3 sheet metal screws (spaced as evenly as possible) where:**
    - **New components are installed.**
    - **Existing connections are loose and unsafe.**
  - **Double-wall Class B and BW flue and vent pipes shall <u>not</u> be drilled or have screws installed <u>if</u> doing so is prohibited by the pipe manufacturer or the jurisdiction.**



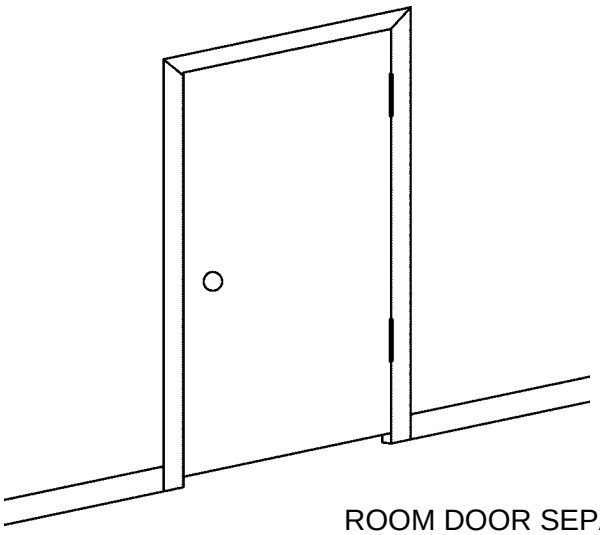
PART 5: POST-REPAIR/REPLACEMENT CHECKS

23. QUALITY ASSURANCE TESTING

- **Natural gas appliances that have been repaired or replaced shall be checked for proper operation, which includes:**
  - **No gas leaks (Item 25)**
  - **Adequate Draft (Item 26).**
  - **Acceptable level of Carbon Monoxide (Item 27).**
- **Problems identified during post-repair/replacement checks must be corrected.**

24. TEST CONDITIONS FOR POST-REPAIR/REPLACEMENT CO AND DRAFT TESTING

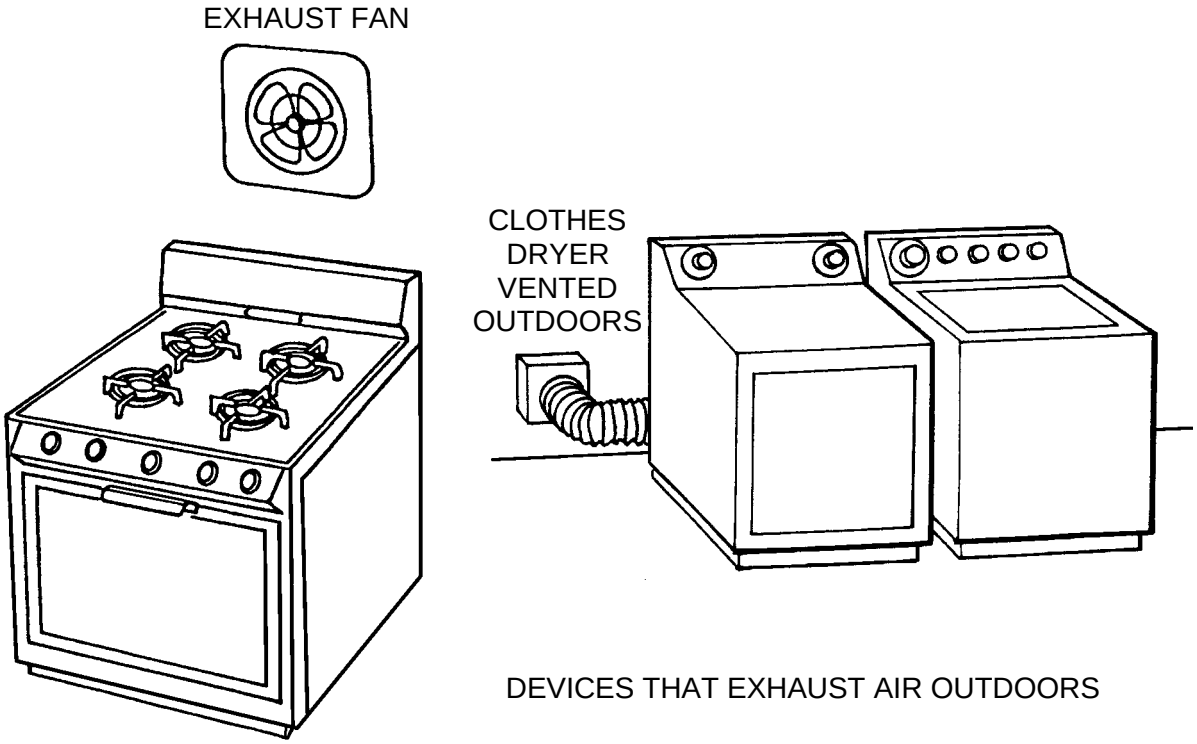
- **Door/Window Positions for Tests in the Living Space**
  - **The following shall be closed:**
    - **All exterior doors and windows.**
    - **Doors to rooms containing a supply register when a central return is outside the room.**
    - **Appliance enclosure doors (except during tests).**
  - **The following shall be open:**
    - **Doors to all other living areas and rooms.**
    - **Door to utility room with clothes dryer exhausted outdoors. *Exception:* When a natural draft appliance in that room is tested, the door shall be closed.**



ROOM DOOR SEPARATING
SUPPLY REGISTERS
FROM A CENTRAL RETURN

24. TEST CONDITIONS FOR POST-REPAIR/REPLACEMENT CO AND DRAFT TESTING (continued)

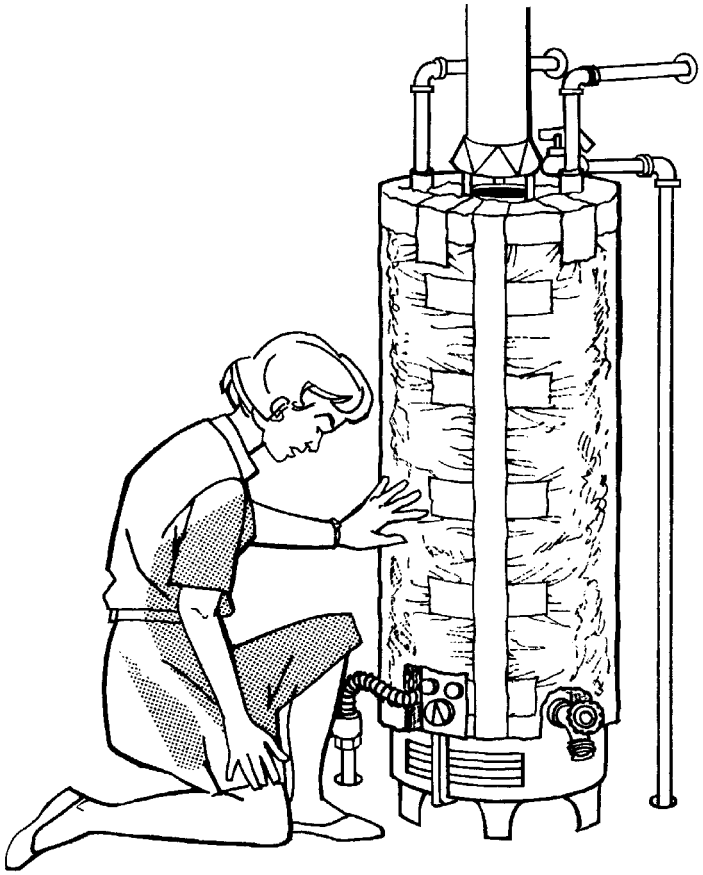
- **The following <u>must</u> be operating during tests:**
  - **FAU air handler.**
  - **All devices that exhaust air from the space containing an appliance being tested (exclude whole house fan).**
- **FAU air filter(s) must be clean or shall be removed prior to testing.**
- **Supply registers shall be open.**
  - ***<u>Exception</u>:* Supply register(s) shall be closed when located in a utility room containing a natural draft appliance.**
- **If an interior cooler cover is available, it shall be in place.**



DEVICES THAT EXHAUST AIR OUTDOORS

25. GAS LEAKS

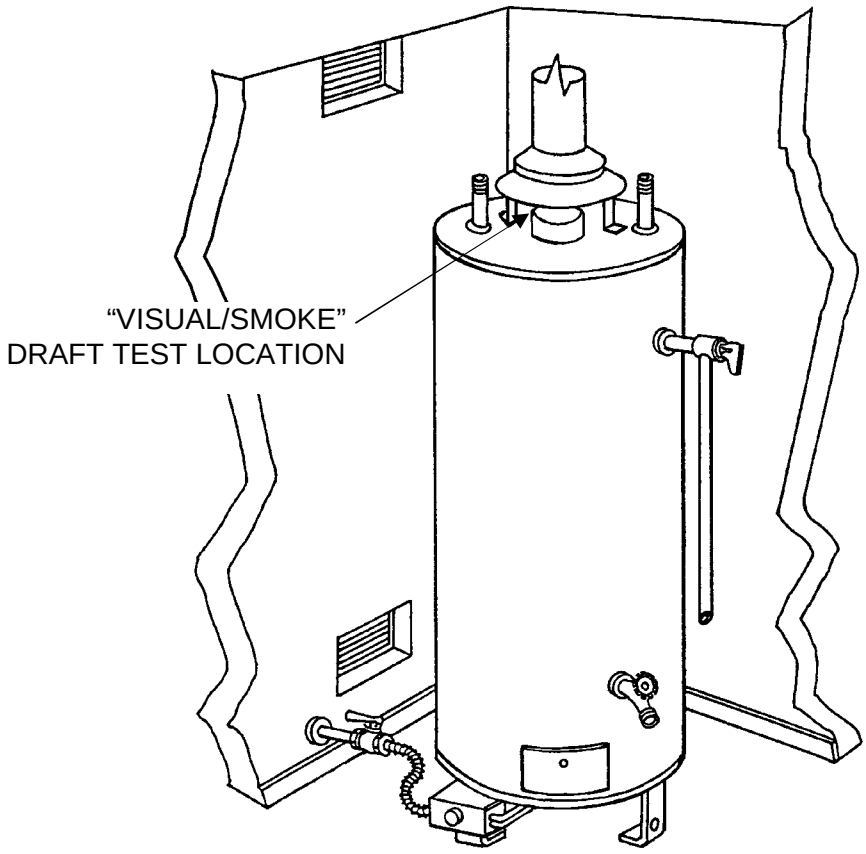
- **Appliances shall be checked for natural gas leaks using one or more of the following methods:**
  - **Olfactory (Sniff) Test performed above, but within 2' of, all valves and fittings.**
  - **Application of leak detection liquid to line valves and to fittings on valves, flexible gas connectors, and pipes.**
  - **Air sampling with electronic leak detection equipment near valves, fittings, flexible gas connectors, and pipes.**
- **Gas leaks shall be repaired.**



CHECKING FOR NATURAL GAS ODOR

26. DRAFT EXAMINATION

- **Natural Gas Open Combustion Heating Systems and Water Heaters**
  - **Test conditions prescribed in Item 24 shall first be established.**
  - **Draft tests shall be performed after a minimum of 5 minutes of appliance operation.**
  - **Visual/Smoke Draft Test shall be performed on Natural Draft appliances.**
    - **Smoke shall be applied along the entire draft hood opening.**
    - **Draft is adequate <u>only if</u> smoke is drawn into the draft hood along the entire draft hood opening.**



27. CO TESTING FOR NATURAL GAS SPACE AND WATER HEATING SYSTEMS

- **Appliance Ambient CO or Flue CO testing shall be performed.**
- **Appliance Ambient CO Tests**
  - **CO Tests shall be conducted per Items 14 – 18.**
- **Flue CO Tests**
  - **Test conditions prescribed in Item 24 shall first be established.**
  - **CO Tests shall be performed after a minimum of 5 minutes of burner operation.**
  - **Flue Gas CO measurements shall be:**
    - **Taken in combustion gases free of dilution air.**
    - **Conducted in accordance with the Table 1-1.**

Table 1-1: Post-Repair/Replacement Flue CO Testing

~~APPLIANCE~~	~~MEASUREMENT LOCATION~~	~~MAXIMUM CO LEVEL~~
~~FURNACES~~		
~~•Natural Draft~~	~~Inside each flue (exhaust port) separately~~	~~*~~
~~•Induced Draft and Closed Combustion~~	~~At flue termination, when accessible from the ground~~	~~*~~
~~WATER HEATERS~~		
~~•Natural Draft~~	~~Inside center tube on each side of the baffle~~	~~*~~
~~•Induced Draft and Closed Combustion~~	~~At flue termination, when accessible from the ground~~	~~*~~

~~*The CPUC is currently considering a proposed settlement that would set statewide flue testing CO thresholds. This section will be updated when the commission has acted upon the proposed settlement. During the interim, the maximum allowable CO level following service or replacement shall be as established by the utility.~~

APPLIANCE	CO MAXIMUM PPM		NATURAL DRAFT MEASUREMENT LOCATION*
	"AS MEASURED"	"AIR FREE"	
Forced Air Furnace	—	400	*Inside each exhaust port separately*
Gravity Furnace	—	400	*Inside each exhaust port separately*
Wall Furnace	—	200	*Inside flue on each side of baffle*
Wall Furnace (Direct Vent)	—	400	*
Floor Furnace	—	400	*Inside each exhaust port separately*
Vented Room Heater	—	200	*Inside each exhaust port separately*
Water Heater	—	200	*Inside flue on each side of baffle*
Oven/Broiler	225	—	*Inside exhaust port*
Top Burner & Griddle	25 (per burner)	—	*Burner: 12" above flame* *Griddle: Inside port opening*
Gas Log	25	400	*Inside top edge of fireplace opening*

**For Induced Draft and Closed Combustion appliances, flue gas CO is measured at the flue termination when it is accessible from the ground.*

NONFEASIBILITY CRITERIA FOR NGAT FOR ENTIRE DWELLING

1. **Non-IOU combustion fuel is used for space heating.**
2. **No infiltration-reduction measures are ~~being~~ installed.**
3. **No natural gas appliance affecting the living space is present.**

NONFEASIBILITY CRITERIA FOR NGAT FOR INDIVIDUAL APPLIANCE

1. **Non-IOU combustion fuel is used.**
   - **Exception: Appliances subject to PG&E-specific policy.**
2. **Appliance is abandoned.***
3. **Appliance is inaccessible.***

***See Definitions.**

APPENDIX -B-

METHODS FOR
ESTIMATING AND MEASURING AIRFLOW

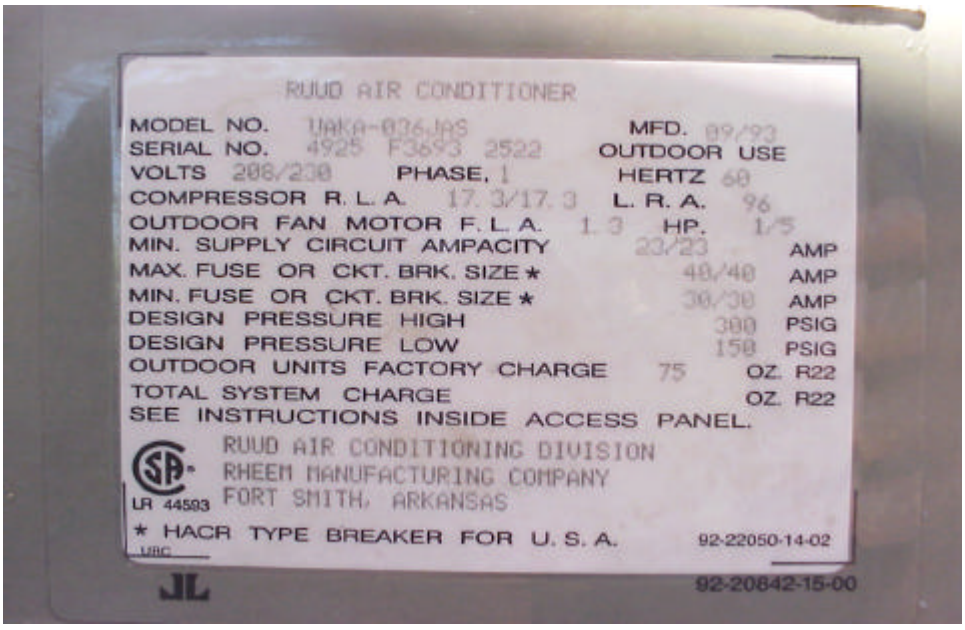
CONTENTS

METHODS FOR ESTIMATING AND MEASURING AIRFLOW

PART I – METHODS FOR *ESTIMATING* AIRFLOW

1. METHODS

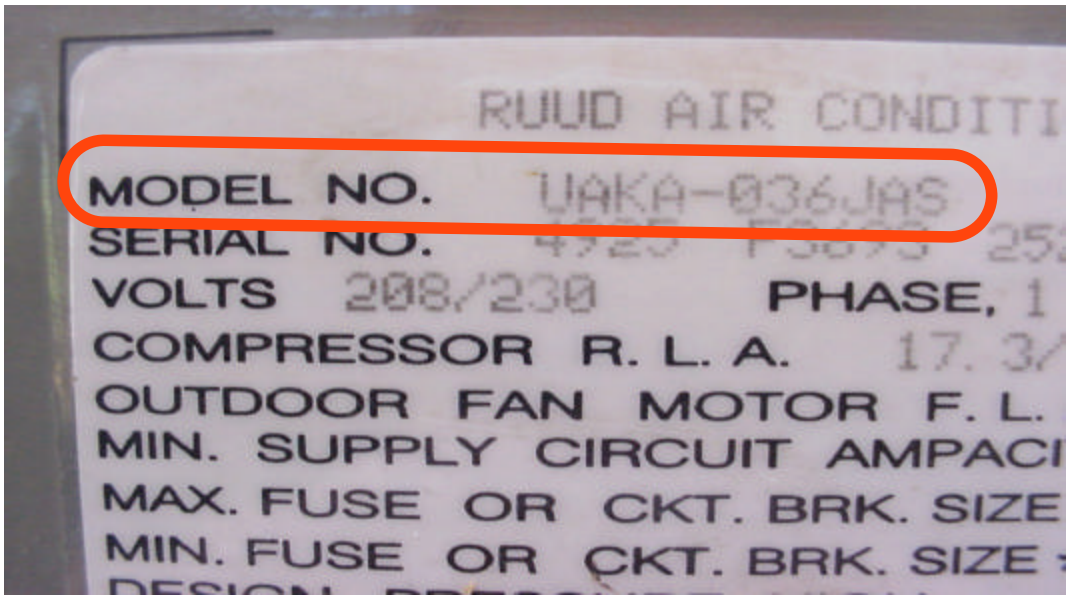
- **The following methods are outlined in this Appendix:**
  - Air Conditioning Capacity (Tons)
    - The Preston Guide or Carrier Blue Book
    - Model Number Nomenclature
  - Heating System Capacity (kBtuh Output)
    - Btuh Output of Gas Furnace
    - Wattage of Electric Furnace
- **Air Conditioner or Heat Pump**
  - AC/HP unit capacity may be determined by the following methods using information obtained from the condenser nameplate:
    - The Preston Guide or Carrier Blue Book
    - Model Number Nomenclature
- **Gas or Electric Furnace**
  - Furnace capacity may be determined by using the unit's Btuh Output.
    - Gas: Directly from the nameplate
    - Electric: Wattage converted to Btuh Output



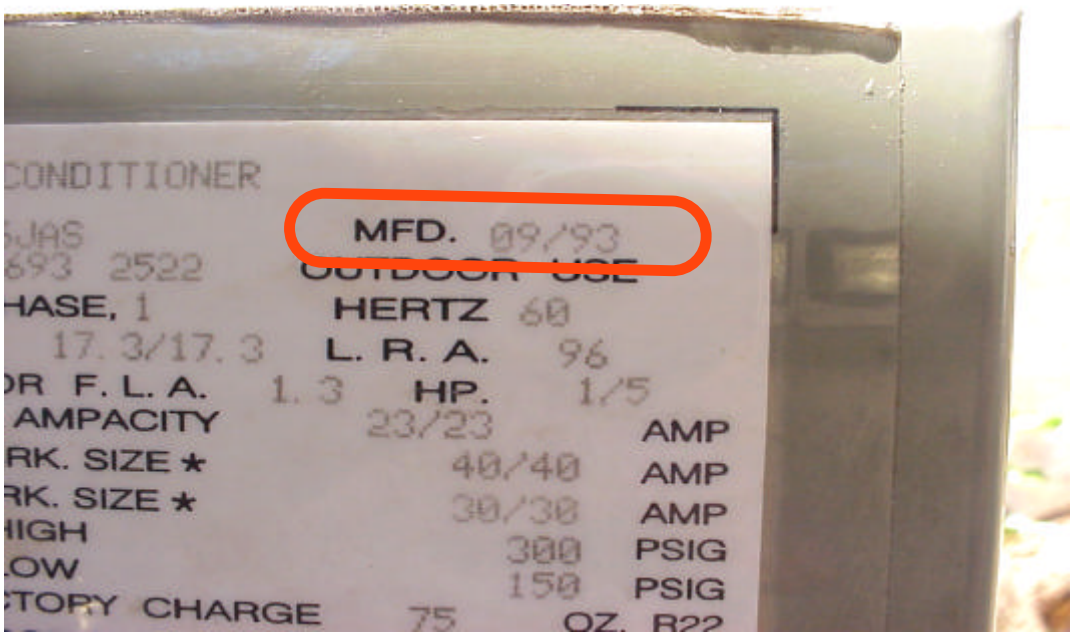
EXAMPLE OF A CONDENSER NAMEPLATE

2. AIR CONDITIONER AND HEAT PUMP UNITS

- **<u>Method A</u>—Preston Guide or Carrier Bluebook**
  - **Step A-1:** Determine the model number and date of manufacture from the condenser nameplate.



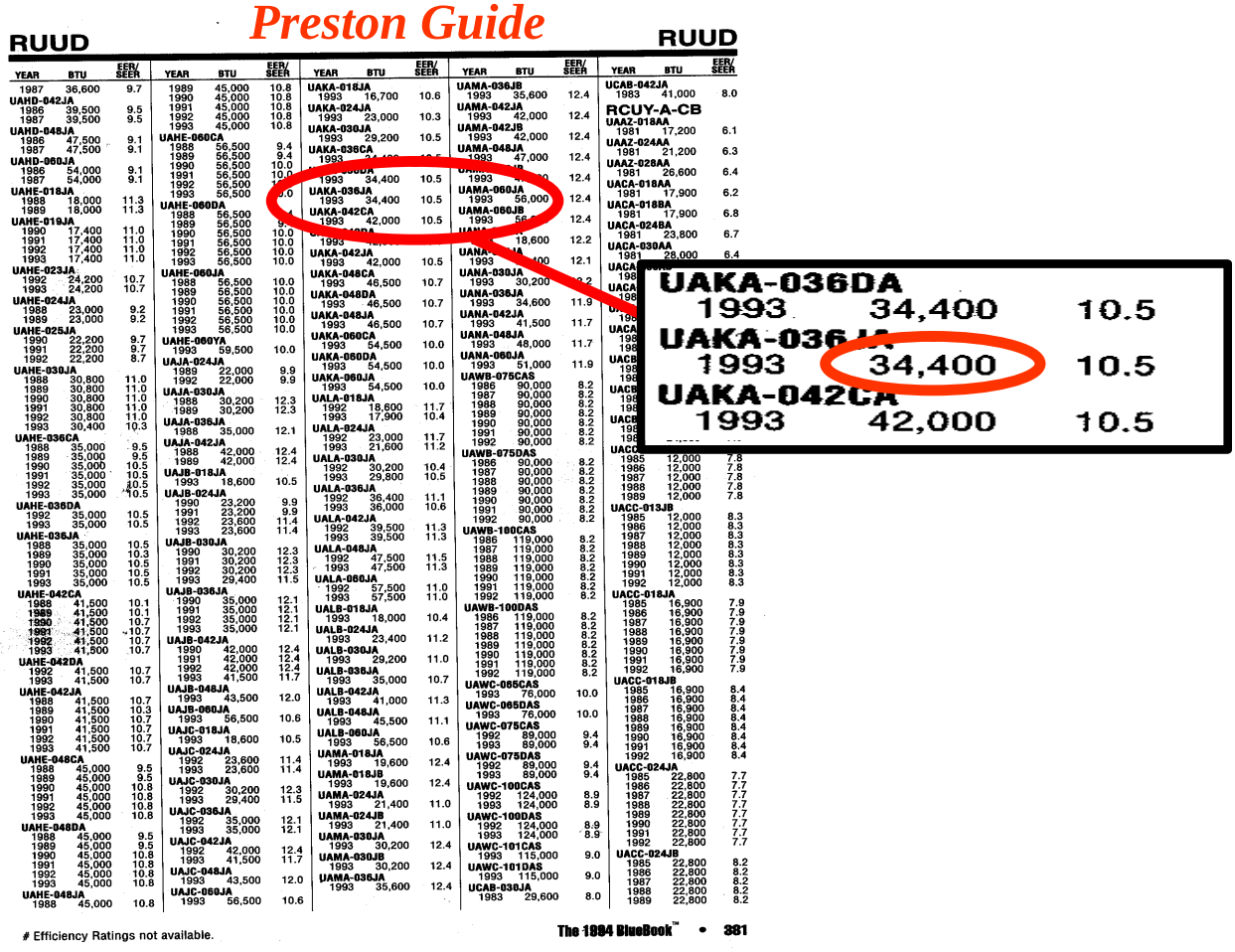
NAMEPLATE SHOWS MODEL NUMBER TO BE “UAKA-036JAS”



NAMEPLATE SHOWS DATE OF MANUFACTURE TO BE “09/93”

2. AIR CONDITIONER AND HEAT PUMP UNITS (continued)

- **Method A—Preston Guide or Carrier Bluebook (continued)**
  - **Step A-2:** Check the Preston Guide (or Carrier Bluebook) to determine cooling capacity of the unit, based on model number and date of manufacture.
    - Find model number UAKA-036JA manufactured in 1993.
    - Find cooling capacity, which in this example is 34,400 Btu.



Preston Guide

RUUD

YEAR	BTU	EER/SEER
1987	36,600	9.7
UAHD-042JA		
1986	39,500	9.5
1987	39,500	9.5
UAHD-048JA		
1986	47,500	9.1
1987	47,500	9.1
UAHD-060JA		
1986	54,000	9.1
1987	54,000	9.1
UAHE-018JA		
1988	18,000	11.3
1989	18,000	11.3
UAHE-019JA		
1990	17,400	11.0
1991	17,400	11.0
1992	17,400	11.0
1993	17,400	11.0
UAHE-023JA		
1992	24,200	10.7
1993	24,200	10.7
UAHE-024JA		
1988	23,000	9.2
1989	23,000	9.2
UAHE-025JA		
1990	22,200	9.7
1991	22,200	9.7
1992	22,200	8.7
UAHE-030JA		
1988	30,800	11.0
1989	30,800	11.0
1990	30,800	11.0
1991	30,800	11.0
1992	30,800	11.0
1993	30,400	10.3
UAHE-036CA		
1988	35,000	9.5
1989	35,000	9.5
1990	35,000	10.5
1991	35,000	10.5
1992	35,000	10.5
1993	35,000	10.5
UAHE-036DA		
1992	35,000	10.5
1993	35,000	10.5
UAHE-036JA		
1988	35,000	10.5
1989	35,000	10.3
1990	35,000	10.5
1991	35,000	10.5
1993	35,000	10.5
UAHE-042CA		
1988	41,500	10.1
1989	41,500	10.1
1990	41,500	10.7
1991	41,500	10.7
1992	41,500	10.7
1993	41,500	10.7
UAHE-042DA		
1992	41,500	10.7
1993	41,500	10.7
UAHE-042JA		
1988	41,500	10.7
1989	41,500	10.3
1990	41,500	10.7
1991	41,500	10.7
1992	41,500	10.7
1993	41,500	10.7
UAHE-048CA		
1988	45,000	9.5
1989	45,000	9.5
1990	45,000	10.8
1991	45,000	10.8
1992	45,000	10.8
1993	45,000	10.8
UAHE-048DA		
1988	45,000	9.5
1989	45,000	9.5
1990	45,000	10.8
1991	45,000	10.8
1992	45,000	10.8
1993	45,000	10.8
UAHE-048JA		
1988	45,000	10.8
1989	45,000	10.8
1990	45,000	10.8
1991	45,000	10.8
1992	45,000	10.8
1993	45,000	10.8
UAHE-060CA		
1988	56,500	9.4
1989	56,500	9.4
1990	56,500	10.0
1991	56,500	10.0
1992	56,500	10.0
1993	56,500	10.0
UAHE-060DA		
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1989	56,500	9.4
1990	56,500	10.0
1991	56,500	10.0
1992	56,500	10.0
1993	56,500	10.0
UAHE-060JA		
1988	56,500	10.0
1989	56,500	10.0
1990	56,500	10.0
1991	56,500	10.0
1992	56,500	10.0
1993	56,500	10.0
UAHE-060YA		
1993	59,500	10.0
UAJA-024JA		
1989	22,000	9.9
1992	22,000	9.9
UAJA-030JA		
1988	30,200	12.3
1989	30,200	12.3
UAJA-036JA		
1988	35,000	12.1
UAJA-042JA		
1988	42,000	12.4
1989	42,000	12.4
UAJB-018JA		
1993	18,600	10.5
UAJB-024JA		
1990	23,200	9.9
1991	23,200	9.9
1992	23,600	11.4
1993	23,600	11.4
UAJB-030JA		
1990	30,200	12.3
1991	30,200	12.3
1992	30,200	12.3
1993	29,400	11.5
UAJB-036JA		
1990	35,000	12.1
1991	35,000	12.1
1992	35,000	12.1
1993	35,000	12.1
UAJB-042JA		
1990	42,000	12.4
1991	42,000	12.4
1992	42,000	12.4
1993	41,500	11.7
UAJB-048JA		
1993	43,500	12.0
UAJB-060JA		
1993	56,500	10.6
UAJC-018JA		
1993	18,600	10.5
UAJC-024JA		
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1993	23,600	11.4
UAJC-030JA		
1992	30,200	12.3
1993	29,400	11.5
UAJC-036JA		
1992	35,000	12.1
1993	35,000	12.1
UAJC-042JA		
1992	42,000	12.4
1993	41,500	11.7
UAJC-048JA		
1993	43,500	12.0
UAJC-060JA		
1993	56,500	10.6
UAKA-018JA		
1993	16,700	10.6
UAKA-024JA		
1993	23,000	10.3
UAKA-030JA		
1993	29,200	10.5
UAKA-036CA		
1993	34,400	10.5
UAKA-036JA		
1993	34,400	10.5
UAKA-042CA		
1993	42,000	10.5
UAKA-042JA		
1993	42,000	10.5
UAKA-048CA		
1993	46,500	10.7
UAKA-048DA		
1993	46,500	10.7
UAKA-048JA		
1993	46,500	10.7
UAKA-060CA		
1993	54,500	10.0
UAKA-060DA		
1993	54,500	10.0
UAKA-060JA		
1993	54,500	10.0
UALA-018JA		
1992	18,600	11.7
1993	17,900	10.4
UALA-024JA		
1992	23,000	11.7
1993	21,600	11.2
UALA-030JA		
1992	30,200	10.4
1993	29,800	10.5
UALA-036JA		
1992	36,400	11.1
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UALA-042JA		
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1993	39,500	11.3
UALA-048JA		
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1993	47,500	11.3
UALA-060JA		
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1993	57,500	11.0
UALB-018JA		
1993	18,000	10.4
UALB-024JA		
1993	23,400	11.2
UALB-030JA		
1993	29,200	11.0
UALB-036JA		
1993	35,000	10.7
UALB-042JA		
1993	41,000	11.3
UALB-048JA		
1993	45,500	11.1
UALB-060JA		
1993	56,500	10.6
UAMA-018JA		
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UAMA-018JB		
1993	19,600	12.4
UAMA-024JA		
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UAMA-024JB		
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UAMA-030JB		
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UAMA-036JA		
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UAMA-036JB		
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UAMA-042JA		
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UAMA-042JB		
1993	42,000	12.4
UAMA-048JA		
1993	47,000	12.4
1993		12.4
UAMA-060JA		
1993	56,000	12.4
UAMA-060JB		
1993		12.4
	18,600	12.2
		12.1
UANA-030JA		
1993	30,200	
UANA-036JA		
1993	34,600	11.9
UANA-042JA		
1993	41,500	11.7
UANA-048JA		
1993	48,000	11.7
UANA-060JA		
1993	51,000	11.9
UAWB-075CAS		
1986	90,000	8.2
1987	90,000	8.2
1988	90,000	8.2
1989	90,000	8.2
1990	90,000	8.2
1991	90,000	8.2
1992	90,000	8.2
UAWB-075DAS		
1986	90,000	8.2
1987	90,000	8.2
1988	90,000	8.2
1989	90,000	8.2
1990	90,000	8.2
1991	90,000	8.2
1992	90,000	8.2
UAWB-100CAS		
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1987	119,000	8.2
1988	119,000	8.2
1989	119,000	8.2
1990	119,000	8.2
1991	119,000	8.2
1992	119,000	8.2
UAWB-100DAS		
1986	119,000	8.2
1987	119,000	8.2
1988	119,000	8.2
1989	119,000	8.2
1990	119,000	8.2
1991	119,000	8.2
1992	119,000	8.2
UAWC-065CAS		
1993	76,000	10.0
UAWC-065DAS		
1993	76,000	10.0
UAWC-075CAS		
1992	89,000	9.4
1993	89,000	9.4
UAWC-075DAS		
1992	89,000	9.4
1993	89,000	9.4
UAWC-100CAS		
1992	124,000	8.9
1993	124,000	8.9
UAWC-100DAS		
1992	124,000	8.9
1993	124,000	8.9
UAWC-101CAS		
1993	115,000	9.0
UAWC-101DAS		
1993	115,000	9.0
UCAB-036JA		
1983	29,600	8.0
UCAB-042JA		
1983	41,000	8.0

RCUY-A-CB

UAAZ-018AA		
1981	17,200	6.1
UAAZ-024AA		
1981	21,200	6.3
UAAZ-028AA		
1981	26,600	6.4
UACA-018AA		
1981	17,900	6.2
UACA-018BA		
1981	17,900	6.8
UACA-024BA		
1981	23,800	6.7
UACA-030AA		
1981	28,000	6.4
UACA-030BA		
1981	28,000	6.4
UACA-036AA		
1981	34,000	6.4
UACA-036BA		
1981	34,000	6.4
UACA-042AA		
1981	40,000	6.4
UACA-042BA		
1981	40,000	6.4
UACA-048AA		
1981	46,000	6.4
UACA-048BA		
1981	46,000	6.4
UACA-060AA		
1981	57,000	6.4
UACA-060BA		
1981	57,000	6.4
UACB-024JA		
1985	12,000	7.8
1986	12,000	7.8
1987	12,000	7.8
1988	12,000	7.8
1989	12,000	7.8
UACC-013JB		
1985	12,000	8.3
1986	12,000	8.3
1987	12,000	8.3
1988	12,000	8.3
1989	12,000	8.3
1990	12,000	8.3
1991	12,000	8.3
1992	12,000	8.3
UACC-018JA		
1985	16,900	7.9
1986	16,900	7.9
1987	16,900	7.9
1988	16,900	7.9
1989	16,900	7.9
1990	16,900	7.9
1991	16,900	7.9
1992	16,900	7.9
UACC-018JB		
1985	16,900	8.4
1986	16,900	8.4
1987	16,900	8.4
1988	16,900	8.4
1989	16,900	8.4
1990	16,900	8.4
1991	16,900	8.4
1992	16,900	8.4
UACC-024JA		
1985	22,800	7.7
1986	22,800	7.7
1987	22,800	7.7
1988	22,800	7.7
1989	22,800	7.7
1990	22,800	7.7
1991	22,800	7.7
1992	22,800	7.7
UACC-024JB		
1985	22,800	8.2
1986	22,800	8.2
1987	22,800	8.2
1988	22,800	8.2
1989	22,800	8.2

UAKA-036DA
1993 34,400 10.5

UAKA-036JA
1993 34,400 10.5

UAKA-042CA
1993 42,000 10.5

Efficiency Ratings not available.

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DATA FROM THE PRESTON GUIDE SHOWS
UNIT'S COOLING CAPACITY TO BE 34,000 BTU

2. AIR CONDITIONER AND HEAT PUMP UNITS (continued)

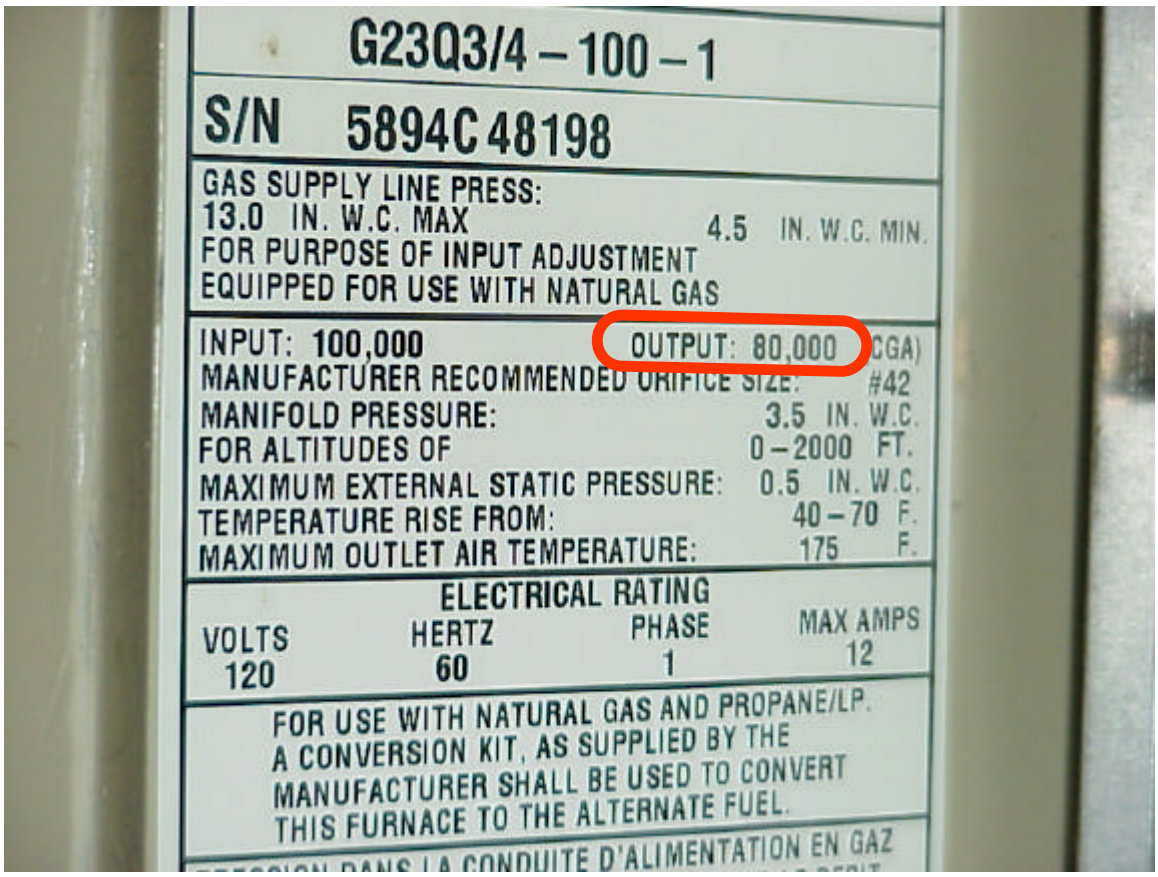
- **Method A—Preston Guide or Carrier Bluebook (continued)**
  - **Step A-3:** Calculate cooling capacity in tons based on KBtu.
    - Per the Preston Guide, unit cooling capacity = 34,400 Btu
    - Divide Unit Capacity by 12,000 Btu/ton to convert Btu to tons: [34,400 Btu ÷ 12,000 Btu/ton = 2.87 tons]
    - Establish tons of cooling capacity:
      - Round up to 3 tons, or
      - Find "Nominal Tons" using the chart in Figure B-1.
- **Method B—Model Number Nomenclature**
  - This method may be used when KBtu can be determined from the model number.
  - **Step B-1:** Locate model number on the condenser name plate.
    - Refer to the nameplate pictured on page B-2 and B3.
    - In this example, the model number is "UAKA-0**36**JAS".
  - **Step B-2:** Establish cooling capacity in Btu.
    - **36** is the capacity of the unit, and
    - That is equivalent to 36,000 Btu.
  - **Step B-3:** Divide unit capacity in Btu by 12,000 Btu/ton to determine cooling capacity in tons:
    - [36,000 Btu ÷ 12,000 Btu/ton = 3 tons]
    - Cooling capacity is 3 tons.

FIGURE B-1: NOMINAL TONS BASED ON UNIT CAPACITY IN BTU

UNIT CAPACITY (BTU)	CALCULATED TONS	NOMINAL TONS
14,000 – 21,999	1.17 – 1.82	1.5
22,000 – 26,999	1.83 – 2.24	2.0
27,000 – 32,999	2.25 – 2.74	2.5
33,000 – 38,999	2.75 – 3.24	3.0
39,000 – 44,999	3.25 – 3.74	3.5
45,000 – 53,999	3.75 – 4.49	4.0
54,000 – 62,999	4.50 – 5.24	5.0

3. FURNACES

- **System G: Determining Estimated Airflow for Gas Furnaces**
  - **Step G-1:** Determine Btuh output from unit name plate.
    - Locate Btuh output on the nameplate (see picture below).
      - Output is 80,000 Btuh in this example.
    - If only Input is listed, Output = Input x (% efficiency).
      - Example: (100 kBtuh Input) x (0.80 AFUE) = 80 kBtuh.
  - **Step G-2:** Convert Btuh output to estimated airflow in cfm.
    - Assume 21.7 cfm per kBtuh.
    - Use the following equation to determine estimated airflow: [Output kBtuh x 21.7 cfm/kBtuh = cfm system airflow]
    - Example: [80 (kBtuh) x 21.7 (cfm/KBtu) = 1,736 cfm system airflow]



EXAMPLE OF A GAS FURNACE NAMEPLATE SHOWING HEATING CAPACITY (OUTPUT) OF 80,000 BTUH

3. FURNACES (continued)

- **System E: Determining Estimated Airflow for Electric Furnaces**
  - **Step E-1:** Determine wattage from unit name plate.
    - Locate heating capacity (in kilowatts) on the nameplate (see graphic below).
    - Heating Capacity (output) is 20 kilowatts in this example
    - **Step E-2:** Convert kilowatts to kBtuh output to estimated airflow in cfm, assuming 3.413 kBtuh per kilowatt and 95% efficiency.
    - Use the following formula to convert wattage to kBtuh output:
      - [(watts x 3.413 x 0.95) ÷ 1,000 = kBtuh output] or
      - [(kilowatts x 3.242) = kBtuh output]
      - In this example:
        [20 (kW) x 3.242 = 64.84 kBtuh output].
  - **Step E-3:** Convert kBtuh output to estimated airflow in cfm.
    - Assume 21.7 cfm per kBtuh.*
    - Use the following equation to determine estimated airflow:
      [kBtuh x 21.7 cfm/kBtuh = cfm system airflow]
    - Example:
      [64.84 (kBtuh) x 21.7 (cfm/KBtu) = 1407 cfm system airflow]

ELECTRIC FURNACE
SIMULATED NAMEPLATE

MANUFACTURED BY XYZ FURNACE CORP.

MODEL # 000000000 SERIAL # 00000000

HEATING CAPACITY: 20 KILOWATTS

EXAMPLE OF AN ELECTRIC FURNACE NAMEPLATE
SHOWING HEATING CAPACITY OF 20 KILOWATTS

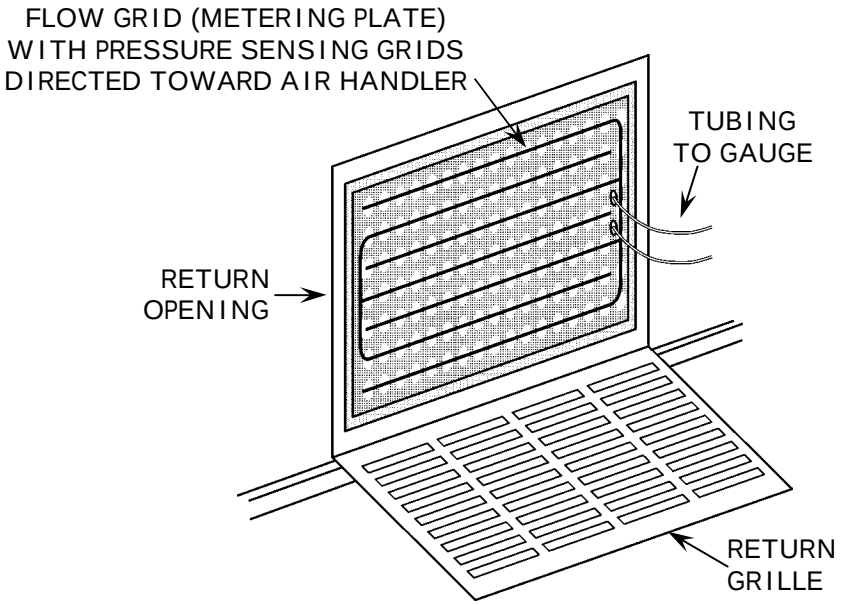
*May be used until CEC determines cfm/kBtuh default for electric furnaces.

PART II – METHODS FOR *MEASURING* AIRFLOW

Methods for measuring HVAC system airflow (fan flow) presented in this appendix are methods approved by the California Energy Commission and described in Appendix RE-2005 of the Title 24 "Residential Alternative Calculation Method (ACM) Approval Manual for the 2005 Building Energy Efficiency Standards for Residential and Nonresidential Buildings" — Publication 400-03-003F, available online at: http://www.energy.ca.gov/title24/2005standards/index.html

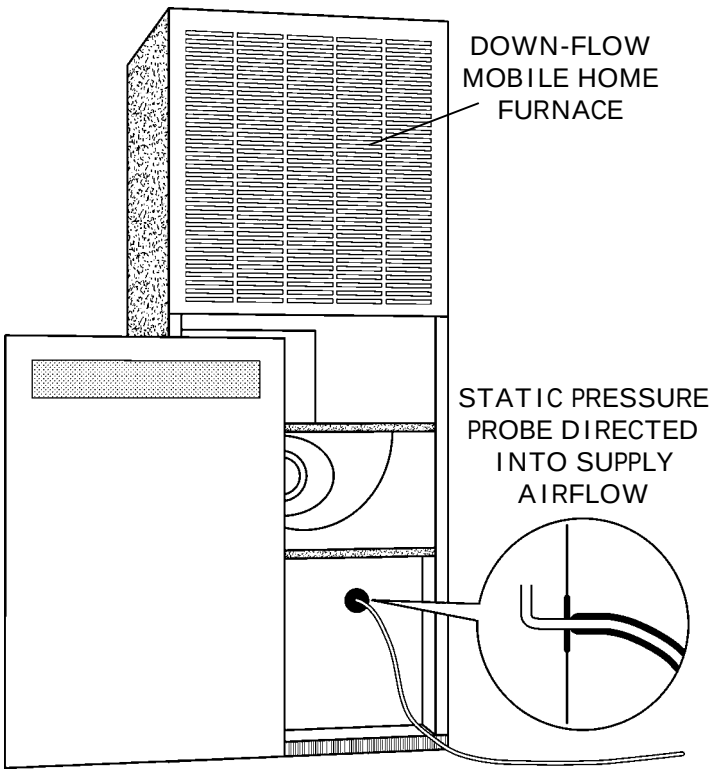
1. FLOW GRID MEASUREMENT

- **Overview**
  - This method uses a "metering plate" containing "pressure sensing grids", which are directed toward the air handler.
  - The metering plate temporarily replaces the filter in a typical air handler system during the air flow measurement procedure.
    - If the filter location is directly adjacent to the air handler, the metering plate will measure the total air handler flow.
    - If the filter is located remotely at a single central return, the metering plate will measure the air flow through the central return. Airflow measurement through the central return will be very close to the total air handler air flow only if the return duct is very tight.



1. FLOW GRID MEASUREMENT (continued)

- **Protocol**
  - Equipment used for measurements shall meet the requirements specified in ACM Residential Manual Appendix RE-2005, §RE.3.1.3, "Flow Grid Measurement."
  - The following general guidelines are for reference only; measurement shall be:
    - Performed in accordance with test equipment manufacturer's instructions, and
    - In harmony with ACM Residential Manual Appendix RE-2005, §RE.4.1.3, "Diagnostic Fan Flow Using Flow Grid Measurement".
- **General Guidelines**
  - **Step 1:** System operating pressure shall be measured with the air handler operating at maximum speed used in the system.
    - Using a digital pressure gauge, pressure difference in Pa shall be measured between the supply plenum and the conditioned space (**P**sp) using a static pressure probe pointing into the air stream.
    - Probe may be placed in the nearest supply duct when access to the supply plenum is unavailable.
    - Probe shall be adjusted to achieve the highest pressure and then secured in place during the fan flow test.



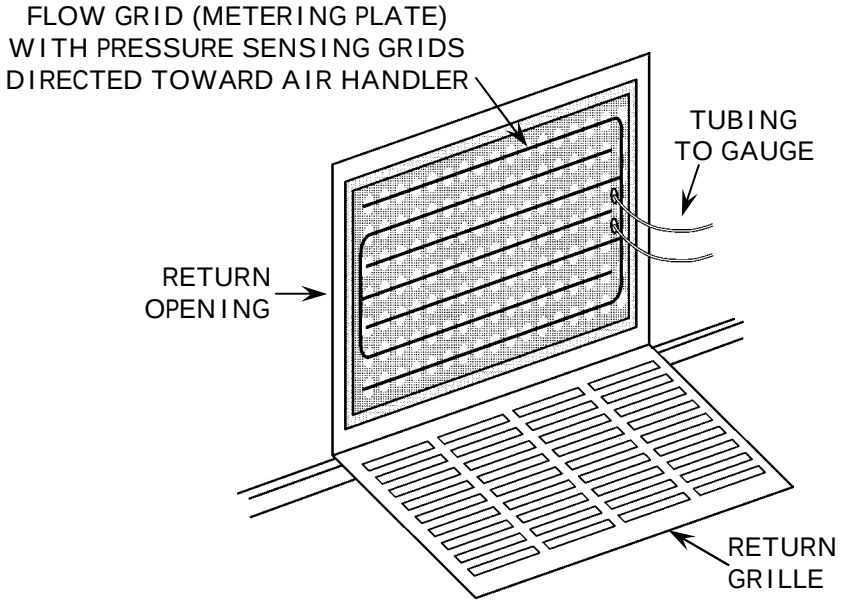
1. FLOW GRID MEASUREMENT (continued)

- General Guidelines (continued)

- **Step 2:** With the air handler off, the flow grid measurement sensor (metering plate) shall be installed, with the pressure sensing grids directed toward the air handler, and with no obstructions within 6" upstream or 2" downstream of the metering plates, in the best available location (filter slot or filter grille) where all system airflow passes through the flow grid.

(A) When Using DG-700 Fully-Automated Digital Gauge

- **Step A-3:** Air handler shall be operated again at the same speed as used in Step 1, and time averaging shall be lengthened as needed to maximize accuracy when readings are fluctuating.
- **Step A-4:** Measured system airflow (**Q**ah) shall be obtained from the digital pressure gauge and recorded.
- **Step A-5:** When the flow grid is installed in a remote filter grille, manufacturer's correction factor shall be used to increase accuracy.



1. FLOW GRID MEASUREMENT (continued)

- **General Guidelines (continued)**

(B) When Using DG-3 Digital Gauge

- **Step B-3:** With air handler operating again at the same speed as in Step 1, measurements shall be made with the flow grid in place:
  - System operating pressure re-measured (**P**test).
  - Airflow through the flow grid measured (**Q**grid).
- **Step B-4:** System Airflow (**Q**ah) shall be calculated by:
  - Multiplying **Q**grid by equipment manufacturer's Flow Resistance Correction Factors (sample shown below), or
  - Applying the following equation to readings obtained in Steps 1 and B-3:

  System Airflow (Air Handler Flow) = **Q**ah = **Q**grid x (**P**sp/**P**test)$^{0.5}$
- **Step B-5:** When the flow grid is installed in a remote filter grille, manufacturer's correction factor shall be used to increase accuracy.

All Gauges

- **Step 6:** Adjusted Airflow shall be calculated (to correct for differences in system operating pressures measured in Steps 1 and 3) using manufacturer's flow resistance correction procedure.

Appendix B **Flow Resistance Correction Factors**

Table B.1 Flow Resistance Correction Factors (using Pascals)

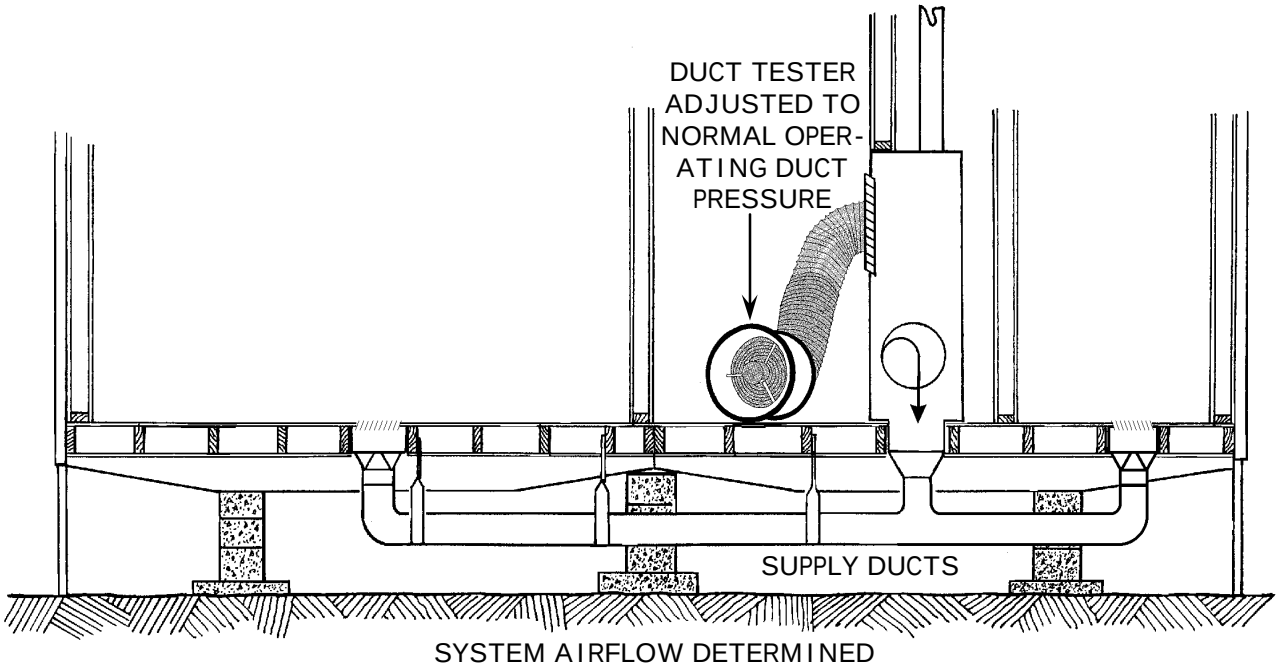
Normal System Operating Pressure in Pascals (NSOP)

TrueFlow System Operating Pressure in Pascals (TFSOP)	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
10	1.00	1.10	1.18	1.26	1.34	1.41	1.48	1.55	1.61	1.67	1.73	1.79	1.84	1.90	1.95	2.00	2.05	2.10	2.14	2.19	2.24
12	0.91	1.00	1.08	1.15	1.22	1.29	1.35	1.41	1.47	1.53	1.58	1.63	1.68	1.73	1.78	1.83	1.87	1.91	1.96	2.00	2.04
14	0.85	0.93	1.00	1.07	1.13	1.20	1.25	1.31	1.36	1.41	1.46	1.51	1.56	1.60	1.65	1.69	1.73	1.77	1.81	1.85	1.89
16	0.79	0.87	0.94	1.00	1.06	1.12	1.17	1.22	1.27	1.32	1.37	1.41	1.46	1.50	1.54	1.58	1.62	1.66	1.70	1.73	1.77
18	0.75	0.82	0.88	0.94	1.00	1.05	1.11	1.15	1.20	1.25	1.29	1.33	1.37	1.41	1.45	1.49	1.53	1.56	1.60	1.63	1.67
20	0.71	0.77	0.84	0.89	0.95	1.00	1.05	1.10	1.14	1.18	1.22	1.26	1.30	1.34	1.38	1.41	1.45	1.48	1.52	1.55	1.58
22	0.67	0.74	0.80	0.85	0.90	0.95	1.00	1.04	1.09	1.13	1.17	1.21	1.24	1.28	1.31	1.35	1.38	1.41	1.45	1.48	1.51
24	0.65	0.71	0.76	0.82	0.87	0.91	0.96	1.00	1.04	1.08	1.12	1.15	1.19	1.22	1.26	1.29	1.32	1.35	1.38	1.41	1.44
26	0.62	0.68	0.73	0.78	0.83	0.88	0.92	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21	1.24	1.27	1.30	1.33	1.36	1.39
28	0.60	0.65	0.71	0.76	0.80	0.85	0.89	0.93	0.96	1.00	1.04	1.07	1.10	1.13	1.16	1.20	1.22	1.25	1.28	1.31	1.34
30	0.58	0.63	0.68	0.73	0.77	0.82	0.86	0.89	0.93	0.97	1.00	1.03	1.06	1.10	1.13	1.15	1.18	1.21	1.24	1.26	1.29
32	0.56	0.61	0.66	0.71	0.75	0.79	0.83	0.87	0.90	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.17	1.20	1.22	1.25
34	0.54	0.59	0.64	0.69	0.73	0.77	0.80	0.84	0.87	0.91	0.94	0.97	1.00	1.03	1.06	1.08	1.11	1.14	1.16	1.19	1.21
36	0.53	0.58	0.62	0.67	0.71	0.75	0.78	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.05	1.08	1.11	1.13	1.15	1.18
38	0.51	0.56	0.61	0.65	0.69	0.73	0.76	0.79	0.83	0.86	0.89	0.92	0.95	0.97	1.00	1.03	1.05	1.08	1.10	1.12	1.15
40	0.50	0.55	0.59	0.63	0.67	0.71	0.74	0.77	0.81	0.84	0.87	0.89	0.92	0.95	0.97	1.00	1.02	1.05	1.07	1.10	1.12
42	0.49	0.53	0.58	0.62	0.65	0.69	0.72	0.76	0.79	0.82	[illegible]	0.87	0.90	0.93	0.95	0.98	1.00	1.02	1.05	1.07	1.09
44	0.48	[illegible]	0.56	0.60	0.64	0.67	0.71	0.74	0.77	[illegible]	[illegible]	[illegible]	0.88	0.90	0.93	0.95	0.98	1.00	1.02	1.04	1.07
46	0	[illegible]	[illegible]	0.59	0.63	0.66	0.69	0.73	[illegible]	[illegible]	[illegible]	[illegible]	0.86	0.88	0.91	0.93	0.96	0.98	1.00	1.02	1.04
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.61	0.65	0.68	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.87	0.89	0.91	0.94	[illegible]	[illegible]	1.00	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.87	0.89	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

EXAMPLE OF FLOW RESISTANCE CORRECTION FACTORS USED TO CALCULATE ADJUSTED AIRFLOW

2. PLENUM PRESSURE MATCHING MEASUREMENT

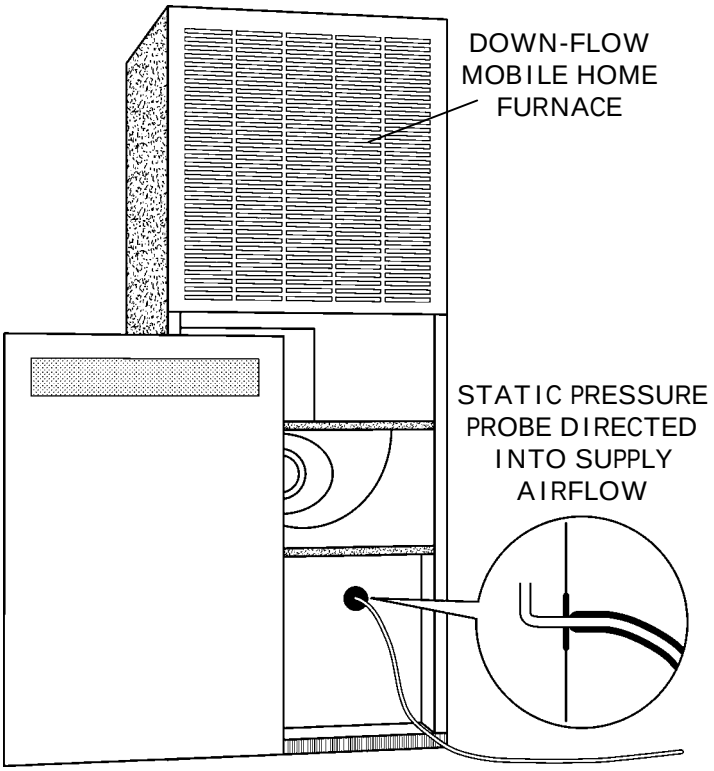
- **Overview**
  - This procedure is also known as “Duct Tester Used as a Powered Capture Hood.”
  - The duct tester is used to pressurize the system to equal the pressure created by the air handler, so that airflow through the duct tester represents system airflow (fan flow).
- **Protocol**
  - Equipment used for measurements shall meet the requirements specified in ACM Residential Manual Appendix RE-2005, §RE.3.1.1, “Plenum Pressure Matching Measurement.”
  - The following general guidelines are for reference only; measurement shall be:
    - Performed in accordance with test equipment manufacturer’s instructions, and
    - In harmony with ACM Residential Manual Appendix RE-2005, §RE.4.1.2, “Diagnostic Fan Flow Using Plenum Pressure Matching”.



SYSTEM AIRFLOW DETERMINED BY DUCT TESTER FAN FLOW

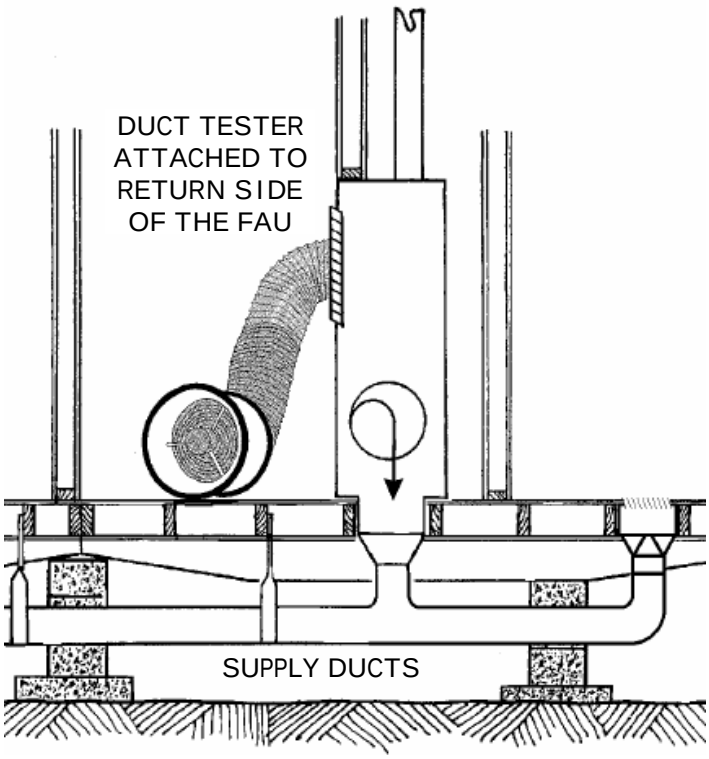
2. PLENUM PRESSURE MATCHING MEASUREMENT (continued)

- **General Guidelines**
  - **Step 1:** Supply plenum pressure test set-up:
    - Air handler shall be off.
    - Doors, windows, etc. shall be open to prevent pressure changes in the space containing the handler (e.g., outside door/window for air handler in conditioned space; or access doors, vents, etc. for air handler in garage, attic, etc.).
    - All supply and return registers shall be open, and filter(s) clean.
    - Static pressure probe, directed into the airflow, shall be inserted into the supply plenum or in a supply trunk nearby. It shall be adjusted (rotated) to achieve the highest pressure and securely attached.
    - Tubing from the probe shall be attached to **Channel A Input** tap of the digital pressure gauge, and the **Reference** tap shall be open to the conditioned space.
  - **Step 2:** With the air handler fan operating at the maximum speed used in the system (e.g., cooling speed when air conditioning is present), the pressure difference in Pa between the supply plenum and the conditioned space (**P**sp) shall be measured. **P**sp, the normal operating duct pressure, is the target pressure to be maintained during the system airflow (fan flow) tests.



2. PLENUM PRESSURE MATCHING MEASUREMENT (continued)

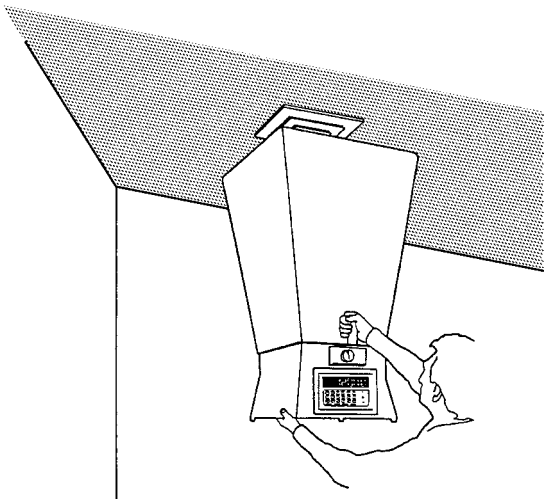
- **General Guidelines for Down-Flow FAU with Central Return***
  - **Step 3:** Duct Tester set-up at air handler access:
    - The Duct Tester shall be installed on, or in place of, the louvered air handler cover panel.
    - Tubing shall connect the Duct Tester to the **Channel B Input** tap on the digital pressure gauge, and the **Reference** tap shall be open to space where the Duct Tester is located.
  - **Step 4:** With the air handler operating,
    - Duct Tester shall be turned on and adjusted until the duct pressure on **Channel A** equals the normal operating duct pressure (**P**sp) measured in Step 2.
    - Airflow through the Duct Tester shall be determined (calculated or measured using the digital gauge fan flow feature), which is the estimated cfm system airflow through the air handler (**Q**ah).
  - **Step 5:** Correction shall be made when Duct Tester cannot adequately pressurize the system to equal the normal operating duct pressure (Psp) recorded in Step 2:
    - With the Duct Tester producing the maximum attainable duct pressure on **Channel A** (**P**max), the airflow through the Duct Tester (**Q**max) shall be determined.
    - System airflow at normal operating duct pressure (**P**sp) shall be estimated using the following equation:
    - System (Air Handler) Airflow = **Q**ah = **Q**max x (**P**sp/**P**max)$^{0.5}$



*For Up-flow furnaces, use procedures in Conventional Home Appendix D.

3. USING A FLOW CAPTURE HOOD

- **Overview**
  - The procedure utilizes a "capture flow hood" to directly measure airflow through the return or supply system.
  - The flow hood covers the entire register/grille and captures the airflow going into it.
- **Protocol**
  - Equipment used for measurements shall meet the requirements specified in ACM Residential Manual Appendix RE-2005, §RE.3.1.2, "Flow Capture Hood Measurement."
  - The following general guidelines are for reference only; measurement shall be:
    - Performed in accordance with test equipment manufacturer's instructions, and
    - In harmony with ACM Residential Manual Appendix RE-2005, §RE.4.1.1, "Diagnostic Fan Flow Using Flow Capture Hood."
- **General Guidelines**
  - **Step 1:** Fan switch shall be set to "On" position with system air handler operating on maximum speed for the unit. To get highest speed in systems without a fan "On" switch, unit must be run in:
    - Cooling mode for heating and air conditioning systems.
    - Heating mode for heating-only systems.
  - **Step 2:** System airflow (fan flow) shall be measured at the return grille(s) with a calibrated Flow Capture Hood. When multiple return grilles are present, airflow at each shall be measured.
  - **Step 3:** The Total System Airflow in cfm (**Q**ah) shall be the sum of the measured return flows.



MEASURING AIRFLOW WITH A FLOW CAPTURE HOOD