## 3-13 Minimum Ventilation Rate

Engineered ventilation is required when a structure is so tight, the normal infiltration rate is unable to provide adequate comfort and air quality. In other words, infiltration may not dilute odors, gases and smoke; may not, help control indoor humidity during the heating season; may not provide adequate make-up air for exhaust fans; and may not provide adequate combustion air for gravity vented appliances.

- Local code determines the minimum outdoor air Cfm value for engineered ventilation.
- If a local code specifies a fresh air requirement (typically an air change per hour value or outdoor air Cfm value), do not assume that normal infiltration will satisfy this requirement.
- If a local code has no engineered ventilation requirement, do not assume that normal infiltration will provide an adequate amount of fresh air.
- When local code allows credit for infiltration, the infiltration calculations shall not be manipulated to make it appear that infiltration satisfies the code's ventilation requirement (i.e., do not use the code ventilation ACH or Cfm requirement as the input for an infiltration calculation.
- Bath and kitchen exhaust systems that are not part of an engineered ventilation system, shall be ignored when calculating infiltration loads and ventilation loads.
- If local code has no engineered ventilation requirement, Table 8A provides a surrogate Cfm value for load calculations.
- Current industry standards for indoor air quality and engineered ventilation always supercede Table 8A guidance.
- If local code has no engineered ventilation requirement, the system designer/installer has a professional and legal responsibility for the comfort, health and safety of the occupants, and is solely responsible for decisions pertaining to the use of, and amount of, outdoor air for engineered ventilation.
- If an unbalanced engineered ventilation system is installed in a dwelling, the pressure in the conditioned space will be greater or less than the outdoor ambient pressure and the infiltration rate will decrease or increase. The full version of ***Manual J*** addresses this issue and adjusts the infiltration estimate for the pressure condition caused by an engineered ventilation system(per Worksheet E).

## 3-14 A Ventilation Load may be a System Load or a Space Load

A n engineered ventilation load is a system load when outdoor air is routed to the return-side of the equipment. An engineered ventilation load is a space load when an exhaust fan pulls outdoor into a conditioned space. This distinction is important because the output of the Table 7 duct load procedures (per Worksheets G and G1) are applied to space loads, but not to system loads, per Lines 12, 14, and 16 on Form J1.

### *Engineered Ventilation that Produces a System Load*

For a system load scenario, Worksheet H determines the ventilation loads for heating and cooling, then these values go to Line 16 on Form J1. If the flow of outdoor air Cfm is not balanced by an equal amount of exhaust air Cfm, the space will be pressurized or depressurized, and this will decrease or increase the neutral pressure infiltration Cfm, per Worksheet E procedures.

- For MJ8AE calculations, the outdoor air Cfm value shall not exceed 50 Cfm, and the infiltration load procedure defaults to no space pressure effect.
- Note that 50 Cfm of outdoor air may not comply with local code, or current industry standards for indoor air quality and engineered ventilation.
- For the infiltration procedure used by the full version of ***Manual J***, the outdoor air Cfm and the exhaust air Cfm values from Worksheet H are ported to Worksheet E. Then Worksheet E uses these values to adjust the neutral pressure infiltration loads for the space pressure effect.

### *Engineered Ventilation that Produces a Space Load*

For this scenario, Worksheet H determines the outdoor air Cfm for engineered ventilation, and these values go to Worksheet E. If the flow of outdoor air Cfm is not balanced by an equal amount of exhaust air Cfm, the space will be pressurized or depressurized, and this will decrease or increase the neutral pressure infiltration Cfm, per Worksheet E procedures.

- MJ8AE shall not be used when an exhaust fan draws ventilation air into the conditioned space.
- For the full version of ***Manual J***, there is no ventilation load (no load values on Line 16 of FormJ1), because the flow of outdoor air is equivalent to a space infiltration load.
- For the infiltration procedure used by the full version of ***Manual J***, the outdoor air Cfm and the exhaust air Cfm values from Worksheet H are ported to Worksheet E. Then Worksheet E uses

these values to adjust the neutral pressure infiltration loads for the space pressure effect.

- For the infiltration procedure used by the full version of ***Manual J***, Worksheet E procedures provides values for net infiltration Cfm, then Worksheet E converts the net infiltration Cfm values for heating and cooling to heating and cooling loads. These loads go to Line 12 on Form J1.

## 3-15 Powerful Range Hoods

A powerful range hood (150 Cfm or more) may produce an unsafe condition, and/or may have an adverse affect on comfort, may significantly increase the infiltration load for relatively short periods of time, and may have an adverse effect on central comfort equipment performance.

- Range hood operation shall not cause any furnace vent, combustion appliance vent, dryer vent, or fireplace, to back draft. Therefore, make-up air is required when a kitchen has a powerful range hood.
- Introducing a large amount of raw outdoor air to the kitchen space (via an open window, or dedicated supply air fan/duct/damper) will cause local space temperature and humidity excursions, and drafts, and may cause a comfort problem for surrounding spaces, or for the entire living space.
- Comply with requirements dictated by local code. If code is silent on this issue, refer to relevant industry standards.
- Per ASHRAE 62-2-2013: When atmospheric burners and/or solid fuel-burning appliances (logically including gas or solid fuel fireplaces), take combustion air from the conditioned space (pressure boundary), the full-capacity Cfm for the two largest exhaust fans that draw air from the space shall not exceed 15 Cfm per 100 SqFt of conditioned space floor area.

Sizing central equipment to compensate for short-term spikes in the kitchen heating load, sensible cooling load, and latent cooling load (if applicable) is unacceptable. Therefore, ***Manual J*** load calculation procedures, and ***Manual S*** equipment selection/sizing procedures shall not be used to select and size central comfort system equipment when there is no engineered make-up air system to reconcile the space air-balance and comfort issues produced by a powerful range hood that simply exhaust a large amount of kitchen air (i.e., has no make up-air feature).

One solution is to use a range hood design that exhausts kitchen air, and also routes outdoor air, to the perimeter of the range hood. This way, most of the raw outdoor air is captured and expelled to the outdoors, which means that the effect on the kitchen heating and cooling loads is negligible, or minimized. Controls for co-ordinating make-up air use and Cfm with exhaust air use and Cfm are part of the OEM's exhaust hood package.

Ancillary make-up air equipment may supply conitioned make-up air to the kitchen when a powerful exhaust hood does not have a make-up air feature. The make-up air shall be heated during winter, and cooled and dehumidified (for latent load climates) during summer. Provide a system that process the outdoor air and distributes the conditioned air to kitchen space without causing a draft complaint. Operation of the make-up air equipment shall be co-ordinated with the operation of the hood, as far as on-off, and exhaust air Cfm are concerned.

## 3-16 Fireplaces and Space-Heating Stoves

A fireplace, or a space heating stove may produce an unsafe condition, and/or may have an adverse affect on comfort, and/or may significantly increase the infiltration load for relatively short periods of time.

- Operation of a fireplace and/or space-heating stove shall not cause any combustion appliance vent, dryer vent, space-heating stove vent, or fireplace, to back draft. Therefore, make-up air may be required when a dwelling has one or more fireplaces, and/or one or more space heating stoves.
- Introducing a large amount of raw outdoor air to a living space (via an open window, or dedicated supply air fan/duct/damper) will cause local space temperature and humidity excursions, and drafts, and may cause a comfort problem for surrounding spaces, or for the entire living space.
- Comply with requirements dictated by local code. If code is silent on this issue, refer to relevant industry standards, and OEM engineering guidance.
- For fireplaces and engineered stoves, refer to:

  *ASHRAE Standard 62.2-2013, Section 6.4.*

  *NFPA 211, Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances.*

  *2012 Inteerrnational Residential Code, Section R1001 Masonry Fireplaces.*

  *OEM design and installation guidance for engineered wood and coal stoves.*

- Also refer to fireplace/chimney design requirements and procedures provided by Buckley

Rumford Fireplaces, which include, in part, documents that address these subjects:

*Chimney Draft (Chminey design build procedures.)*

*Exterior Air (Proper methods for introducing outdoor air for firebox combustion, space pressure control, smoke control and ash control; undesirable effects from routing outdoor air directly to a firebox.)*

*Smoky Fireplace Checklist (Firebox, throat and file design/construction, chimney design/construction. Calculations and assumptions for determining outdoor air requirements for fireplaces. Factors that influance draft.)*

*Venting Fireplaces with Gas Logs (The National Fuel Gas Code, as well as all gas log manufacturers require gas logs to be installed only in code-compliant fireplaces; details and discussion.)*

*Make-Up Air Systems (Packaged make-up air system; see also similar products from other manufacturers.)*

# Table 8A

## Default Ventilation Rate

**Ventilation Rate for Heating and Cooling Load Estimates**
**Outdoor Air CFM Processed by the Heating and Cooling Equipment**

Step 1 — Determine the default outdoor air CFM requirement for occupants ($CFM_{occ}$):

***$CFM_{occ}$ = 0.03 x Floor Area of Conditioned Space + 7.5 x (Bedrooms + 1)***

If the heated floor area and air conditioned floor area are not equal, use the largest value.

Step 2 — Determine the outdoor air CFM for a furnace and / or water heater equipped with atmospheric burner ($CFM_{comb}$) .

***$CFM_{comb}$ = 0.50 x (Furnace Input BTUH + Water Heater Input Btuh) / 1,000***

Use zero input BtUH when combustion air comes directly from the outdoors.

Step 3 — Select the larger of the two CFM values to determine the default outdoor air CFM requirement.

***Table 8 Outdoor Air CFM Requirement = Maximum ($CFM_{occ}$ , $CFM_{comb}$ )***

**Infiltration CFM Adjustment**

The Step 3 value shall not be adjusted for building envelope leakage (see Note 3).

1) Table 8A supports the ***Manual J*** procedure for estimating heating and cooling loads. Local codes and regulations may mandate a different ventilation rate. If no codes and regulations apply, the National Fuel Gas Code and ASHRAE Standard 62.2 provide consensus guidance for determining the minimum ventilation rate.

2) If no codes or regulations apply, the design value for the ventilation rate is determined by the system designer.

3) ASHRAE Standard 62.2, 2013 may allow an adjustment for envelope leakage. Refer to this Standard for guidance on this issue.

**Table 8A**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Name of Room** | | | | | | **Entire House** | | | | | | | |
| 2 | **Running Feet of Exposed Wall** | | | | | | | | | | | | | |
| 3 | **Ceiling Height (Ft) and Gross Wall Area (SqFt)** | | | | | | | | | | | | | |
| 4 | **Room Dimensions (Ft) and Floor Plan Area (SqFt)** | | | | | | | | | | | | | |
| 5 | **Ceiling Slope (Deg.) and Gross Ceiling Area (SqFt)** | | | | | | | | | | | | | |
| **Type of Exposure** | | | **Const.. Number** | **Panel Faces** | **HTM** | | **Area or Length** | **Btuh** | | | **Area or Length** | **Btuh** | | |
| | | | | | **Htg.** | **Clg.** | | **Heating** | **S-Clg.** | **L-Clg.** | | **Heating** | **S-Clg.** | **L-Clg.** |
| 6a | **Windows and Glass Doors** | a | | | | | | | | | | | | |
| | | b | | | | | | | | | | | | |
| | | c | | | | | | | | | | | | |
| | | d | | | | | | | | | | | | |
| | | e | | | | | | | | | | | | |
| | | f | | | | | | | | | | | | |
| | | g | | | | | | | | | | | | |
| | | h | | | | | | | | | | | | |
| | | I | | | | | | | | | | | | |
| | | j | | | | | | | | | | | | |
| 6b | **Skylights** | a | | | | | | | | | | | | |
| | | b | | | | | | | | | | | | |
| | | c | | | | | | | | | | | | |
| 7 | **Wood and Metal Doors** | a | | | | | | | | | | | | |
| | | b | | | | | | | | | | | | |
| | | c | | | | | | | | | | | | |
| 8 | **Above Grade Walls and Partitions** | a | | | | | | | | | | | | |
| | | b | | | | | | | | | | | | |
| | | c | | | | | | | | | | | | |
| | | d | | | | | | | | | | | | |
| | | e | | | | | | | | | | | | |
| | | f | | | | | | | | | | | | |
| | | g | | | | | | | | | | | | |
| 9 | **Below Grade Walls** | a | | | | | | | | | | | | |
| | | b | | | | | | | | | | | | |
| | | c | | | | | | | | | | | | |
| 10 | **Ceilings** | a | | | | | | | | | | | | |
| | | b | | | | | | | | | | | | |
| | | c | | | | | | | | | | | | |
| 11 | **Floors** | a | | | | | | | | | | | | |
| | | b | | | | | | | | | | | | |
| | | c | | | | | | | | | | | | |
| | | d | | | | | | | | | | | | |
| 12 | **Infiltration** | **Heating Load (Btuh)** | | | Efect. ACH | | **WAR** 1.00 | | | | **WAR** | | | |
| | | **Sensible Load (Btuh)** | | | | | | | | | | | | |
| | | **Latent Load (Btuh)** | | | | | | | | | | | | |
| 13 | **Internal** | a | **Occupants at 230 and 200 Btuh** | | | | | | | | | | | |
| | | b | **Scenario Number** | | | | | | | | | | | |
| | | c | **Default Adjustments** | | | | | | | | | | | |
| | | d | **Custom Appliances** | | | | | | | | | | | |
| | | e | **Plants** | | | | | | | | | | | |
| 14 | **Subtotals** | Sum lines 5 through 12 | | | | | | | | | | | | |
| 15 | **Duct Loads** | **EHLF & ESG** | | | | | | | | | | | | |
| | | **ELG** | | | | | | | | | | | | |
| 16 | **Ventilation Loads** | **Vent Cfm** | | | **E Cfm** | | | | | | | | | |
| 17 | **Winter Humidification load** | **Gal / Day** | | | | | | | | | | | | |
| 18 | **Piping Load** | | | | | | | | | | | | | |
| 19 | **Blower Heat** | | | | | | | | | | | | | |
| 20 | **AED Excursion & Latent Moisture Migration Load** | | | | | | | | | | | | | |
| 21 | **Total Load** | Sum Lines 13 Through 19 | | | | | | | | | | | | |

**Form J1**

## Worksheet H
## Ventilation Loads

**Local Code Value for Outdoor Cfm**

1) Air changes per hour (ACH) specified by local code: [ ] or —> Cfm specified by local code. —> [ ]
2) Above grade volume (AGV) from Worksheet E: [ ] < Largest value for heating or cooling.
3) Outdoor air Cfm value for code ACH requirement: [ ] < *ACH x AGV / 60*
4) Code value for outdoor air Cfm: [ ] < Largest Cfm value from line 1 or line 3.
5) Code Cfm ***may*** be provided by any combination of infiltration Cfm and engineered ventilation Cfm: [ ] < Yes or No
6) Code Cfm ***shall*** be provided by engineered ventilation only: [ ] < Yes or No
7) Credit for infiltration Cfm: [ ] < As allowed by local code. Enter 0 Cfm if local code does not provide guidance.
8) Code outdoor Cfm requirement: [ ] < If line 5 = Yes, Cfm = Line 4 - Line 7 – or – if Line 6 = Yes, Cfm = Line 4 value

**Design Outdoor Air Cfm Value for Engineered Ventilation**

9) Code Cfm value: [ ] < From line 8 above
10) Table 8A Cfm: [ ] < Enter value from Table 8A, Step 3.
11) Practitioner-specified VCFM: [ ] < Code value is a mandatory minimum. The system designer may use a larger value.

**Ventilation Loads**

| **Type of Load** | **VCFM or $CFM_{dish}$** Note 1 | **SER LER** for Heat Recovery Ventilator Note 2 | **Condition of Air Leaving Ventilation Dehumidifer** Note 3 | | **For VDH Only Indoor Grains for Site Elevation** | **Table 1 Outdoor Condition $T_o$ and Grains** | **HTD and CTD** From Wrksht A | **$LAT_{loss}$ $LAT_{gain}$ V-Grains** for ventilation air Note 4 | **Site Elevation Ft Table 10A ACF** | **Ti Indoor Drybulb** | **Vent. Loads (Btuh)** Note 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat Load** | | | **$LAT_{VDH}$** | | **Table 12** | | | | | | |
| **Sen Load** | | | **$LAT_{VDH}$** | | | | | | | | |
| **Lat Load** | | | **$Grain_{VDH}$** | | | | | | | | |

Note 1: Ventilation Cfm is typically the same for heating and cooling, but two values may be used. For no ventilating dehumidifer, use VCFM from line 11. For a ventilation dehumidifier, $CFM_{dish}$ is provided by manufacturer's performance data.

Note 2: Sensible effectiveness ratings ($SER_{loss}$, $SER_{gain}$) and latent effectiveness rating (LER) shall be provided by manufacturer's engineering data. For sensible-only equipment, LER = 0.

Note 3: Obtain leaving air temperature ($LAT_{VDH}$) and leaving grains ($Grain_{VDH}$) from the equipment manufacturer's engineering data or technical service.

Note 4: For no recovery device or ventilating dehumidifer: $LAT_{loss}$ = Winter To; $LAT_{gain}$ = Summer To and V-Grains = Table 1 Grains.
For ventilation dehumidifer: $Lat_{loss}$ = $LAT_{VDH}$ for heating; $LAT_{gain}$ = $LAT_{VDH}$ for cooling and V-Grains = $Grain_{VDH}$ - Table 12 Grains
For heat recovery unit: $LAT_{loss}$ = Winter To + $SER_{loss}$ x HTD; $LAT_{gain}$ = Summer To - $SER_{gain}$ x CTD; V-Grains = Table 1 Grains x (1 - LER)

Note 5: Heat Loss = 1.1 ACF x (VCFM or $CFM_{dish}$) x (Ti - $LAT_{loss}$); Sensible Load = 1.1 ACF x (VCFM or $CFM_{dish}$) x ($LAT_{gain}$ - Ti)
Latent Load = 0.68 x ACF x (VCFM or $CFM_{dish}$) x R-Grains

## Worksheet E
## Infiltration Loads

| HTD = | CTD = | Design Grains = | Table 10A ACF = |
|---|---|---|---|

**Step 1, Option 1 — Infiltration Loads for Neutral Space Pressure Based on Table 5 ACH Values**

| Operating Mode | Floor Area (SqFt) | Table 5 Leakage Catagory | Space ACH | AGV (CuFt) | Space ICFM | Fireplace ICFM | Total ICFM (Note 1) (Note 2) |
|---|---|---|---|---|---|---|---|
| Heating | | | | | | | |
| Cooling | | | | | | | |

1) For default estimates use Table 5A or 5B to find ICFM values for the conditioned space and fireplace.
2) The component leakage area method or the blower door method may be used to estimate ICFM values.

Worksheet D determines above grade wall area, and the above grade volume.
Total ICFM = Space ICFM + FP ICFM
Space ICFM = ACH x AGV / 60

**Step 1, Option 2 — Infiltration Loads for Neutral Space Pressure Based on Component Leakage Area Method**

| Operating Mode | HTD and CTD | Wind Velocity (MPH) | Table 5C $ELA_4$ (SqIn) | Table 5D | | | ICFM |
|---|---|---|---|---|---|---|---|
| | | | | $C_s$ | Shielding Class | $C_w$ | |
| Heating | | | | | | | |
| Cooling | | | | | | | |

Default heating season velocity = 15 MPH
Default cooling season velocity = 7.5 MPH

Detail from Worksheet E1

$$ICFM = ELA_4 \times (C_s \times TD + C_w \times V^2)^{0.50}$$

**Step 1, Option 3 — Infiltration Loads for Neutral Space Pressure Based on Blower Door Method**

| Operating Mode | HTD and CTD | Wind Velocity (MPH) | Blower Door $ELA_4$ | Table 5D | | | ICFM |
|---|---|---|---|---|---|---|---|
| | | | | $C_s$ | Shielding Class | $C_w$ | |
| Heating | | | | | | | |
| Cooling | | | | | | | |

Default heating season velocity = 15 MPH
Default cooling season velocity = 7.5 MPH

Provided by field test

$$ICFM = ELA_4 \times (C_s \times TD + C_w \times V^2)^{0.50}$$

**Step 2 — Infiltration Loads on Central Equipment (Adjusted for Space Pressure)**

| Type of Load | VCFM Line 11, Worksheet H | OA CFM Flowing to Space | CFM Exhausted from Space | $CFM_{imb}$ | ICFM (Option __ ) | Net Infilt. CFM NCFM | H & C Loads (Btuh) |
|---|---|---|---|---|---|---|---|
| Heat Load | | | | | | | |
| Sens Load | | | | | | | |
| Lat Load | | | | | | | |

OA CFM flowing to space via return-side of equipment, or through HRV or ERV. CFM exhausted from space via space exhaust fan, or through HRV or ERV.

$CFM_{imb} = CFM_{exhaust} - CFM_{space}$
$NCFM = (ICFM^{1.5} \pm CFM_{imb}^{1.5})^{0.67}$
*Use + if* $CFM_{imb}$ is positive, use - if $CFM_{imb}$ is negative.
NCFM = 0 if $(ICFM^{1.5} - CFM_{imb}^{1.5}) < 0$

Heat Load = 1.1 x ACF x NCFM x HTD
***Sensible Load = 1.1 x ACF x NCFM x CTD***
***Latent Load = 0.68 x ACF x NCFM x Grains***
HRV =- Heat recovery ventilator; ERV = Energy recovery ventilator.

1) The room infiltration load equals the block infiltration load on the central equipment multiplied by the gross wall area ratio (WAR).
2) WAR = Gross room wall area / Gross wall area for all rooms served by the central equipment.