## 1346.6012 IFGC APPENDIX E, WORKSHEET E-1.

**IFGC Appendix E, Worksheet E-1**

Residential Combustion Air Calculation Method
(for Furnace, Boiler, and/or Water Heater in the Same Space)

**Step 1:** Complete vented combution appliace information:

Furnace/Boiler:
____ Draft Hood (Not fan Assisted) ____ Fan Assisted & Power Vent ____ Direct Vent Input: _____Btu/hr

Water Heater:
____ Draft Hood ( Not fan Assisted) ____ Fan Assisted & Power Vent ____ Direct Vent Input: _____Btu/hr

**Step 2:** Calculate the volume of the Combustion Appliance Space (CAS) containing combustion appliances.

The CAS includes all spaces connected to one another by code compliant openings. CAS volume:_____ft$^3$

**Step 3:** Determine air Changes per Hour (ACH)[1]

Default ACH values have been incorporated into Table E-1 for use with Method 4b (KAIR Method). If the year of construction or ACH is not known, use method 4a (Standard Method).

**Step 4:** Determine Required Volume for Combustion Air.

**4a.** Standard Method

Total Btu/hr input of all combustion appliances (DO NOT COUNT DIRECT VENT APPLIANCES) Input: _____Btu/hr

Use Standard Method column in Table E-1 to find Total Required Volume (TRV) TRV: _____ ft$^3$

If CAS Volume (from Step 2) ***is greater than*** TRV then no outdoor openings are needed.

If CAS Volume (from Step 2) ***is less than*** TRV then go to **STEP 5.**

**4b.** Known Air Infiltration Rate (KAIR) Method

Total Btu/hr input of all fan-assisted and power vent appliances (DO NOT COUNT DIRECT VENT APPLIANCES) Input: _____Btu/hr

Use Fan-Assisted Appliances column in Table E-1 to find Required Volume Fan Assisted (RVFA) RVFA: _____ ft$^3$

Total Btu/hr input of all non-fan-assisted appliances Input: _____Btu/hr

Use Non-Fan-Assisted Appliances column in Table E-1 to find Required Volume Non-Fan-Assisted (RVNFA) RVNFA: _____ ft$^3$

Total Required Volume (TRV) = RVFA + RVNFA TRV = _____ + _____ = _____ ft$^3$

If CAS Volume (from Step 2) ***is greater than*** TRV then no outdoor openings are needed.

If CAS Volume (from Step 2) ***is less than*** TRV then go to **STEP 5.**

**Step 5:** Calculate the ratio of available interior volume to the total required volume.

Ratio = CAS Volume (from Step 2) ***divided by*** TRV (from Step 4a or Step 4b) Ratio = __ / __ = __

**Step 6:** Calculate Reduction Factor (RF).

RF = 1 ***minus*** Ratio RF = 1 - _____ = _____

**Step 7:** Calculate single outdoor opening as if all combustion air is from outside.

Total Btu/hr input of all Combustion Appliances in the same CAS (EXCEPT DIRECT VENT) Input: _____Btu/hr

Combustion Air Opening Area (CAOA):
Total Btu/hr ***divided*** by 3000 Btu/hr per in$^2$ CAOA = _____ /3000 Btu/hr per in$^2$ = _____ in$^2$

**Step 8:** Calculate Minimum CAOA.

Minimum CAOA = CAOA ***multiplied by*** RF Minimum CAOA = _____ x _____ = _____ in$^2$

**Step 9:** Calculate Combustion Air Opening Diameter (CAOD)

CAOD = 1.13 ***multiplied by the square root of*** Minimum CAOA CAOD = 1.13 x $\sqrt{\text{Minimum CAOA}}$ = _____in

[1]If desired, ACH can be determined using ASHRAE calculation or blower door test. Follow procedures in Section 304.

## 1346.6014 IFGC APPENDIX E, TABLE E-1.

| IFGC Appendix E, Table E-1<br>Residential Combustion Air Required Volume (Required Interior Volume Based on Input Rating of Appliances) | | | | | |
|---|---|---|---|---|---|
| | | Known Air Infiltration Rate (KAIR) Method ($ft^3$) | | | |
| Input Rating | Standard Method | Fan Assisted | | Non-Fan-Assisted | |
| (Btu/hr) | ($ft^3$) | 1994[1] to Present | Pre 1994[2] | 1994[1] to Present | Pre 1994[2] |
| 5,000 | 250 | 375 | 188 | 525 | 263 |
| 10,000 | 500 | 750 | 375 | 1,050 | 525 |
| 15,000 | 750 | 1,125 | 563 | 1,575 | 788 |
| 20,000 | 1,000 | 1,500 | 750 | 2,100 | 1,050 |
| 25,000 | 1,250 | 1,875 | 938 | 2,625 | 1,313 |
| 30,000 | 1,500 | 2,250 | 1,125 | 3,150 | 1,575 |
| 35,000 | 1,750 | 2,625 | 1,313 | 3,675 | 1,838 |
| 40,000 | 2,000 | 3,000 | 1,500 | 4,200 | 2,100 |
| 45,000 | 2,250 | 3,375 | 1,688 | 4,725 | 2,363 |
| 50,000 | 2,500 | 3,750 | 1,875 | 5,250 | 2,625 |
| 55,000 | 2,750 | 4,125 | 2,063 | 5,775 | 2,888 |
| 60,000 | 3,000 | 4,500 | 2,250 | 6,300 | 3,150 |
| 65,000 | 3,250 | 4,875 | 2,438 | 6,825 | 3,413 |
| 70,000 | 3,500 | 5,250 | 2,625 | 7,350 | 3,675 |
| 75,000 | 3,750 | 5,625 | 2,813 | 7,875 | 3,938 |
| 80,000 | 4,000 | 6,000 | 3,000 | 8,400 | 4,200 |
| 85,000 | 4,250 | 6,375 | 3,188 | 8,925 | 4,463 |
| 90,000 | 4,500 | 6,750 | 3,375 | 9,450 | 4,725 |
| 95,000 | 4,750 | 7,125 | 3,563 | 9,975 | 4,988 |
| 100,000 | 5,000 | 7,500 | 3,750 | 10,500 | 5,250 |
| 105,000 | 5,250 | 7,875 | 3,938 | 11,025 | 5,513 |
| 110,000 | 5,500 | 8,250 | 4,125 | 11,550 | 5,775 |
| 115,000 | 5,750 | 8,625 | 4,313 | 12,075 | 6,038 |
| 120,000 | 6,000 | 9,000 | 4,500 | 12,600 | 6,300 |
| 125,000 | 6,250 | 9,375 | 4,688 | 13,125 | 6,563 |
| 130,000 | 6,500 | 9,750 | 4,875 | 13,650 | 6,825 |
| 135,000 | 6,750 | 10,125 | 5,063 | 14,175 | 7,088 |
| 140,000 | 7,000 | 10,500 | 5,250 | 14,700 | 7,350 |
| 145,000 | 7,250 | 10,875 | 5,438 | 15,225 | 7,613 |
| 150,000 | 7,500 | 11,250 | 5,625 | 15,750 | 7,875 |
| 155,000 | 7,750 | 11,625 | 5,813 | 16,275 | 8,138 |
| 160,000 | 8,000 | 12,000 | 6,000 | 16,800 | 8,400 |
| 165,000 | 8,250 | 12,375 | 6,188 | 17,325 | 8,663 |
| 170,000 | 8,500 | 12,750 | 6,375 | 17,850 | 8,925 |
| 175,000 | 8,750 | 13,125 | 6,563 | 18,375 | 9,188 |
| 180,000 | 9,000 | 13,500 | 6,750 | 18,900 | 9,450 |
| 185,000 | 9,250 | 13,875 | 6,938 | 19,425 | 9,713 |
| 190,000 | 9,500 | 14,250 | 7,125 | 19,950 | 9,975 |
| 195,000 | 9,750 | 14,625 | 7,313 | 20,475 | 10,238 |
| 200,000 | 10,000 | 15,000 | 7,500 | 21,000 | 10,500 |
| 205,000 | 10,250 | 15,375 | 7,688 | 21,525 | 10,763 |
| 210,000 | 10,500 | 15,750 | 7,875 | 22,050 | 11,025 |
| 215,000 | 10,750 | 16,125 | 8,063 | 22,575 | 11,288 |
| 220,000 | 11,000 | 16,500 | 8,250 | 23,100 | 11,550 |
| 225,000 | 11,250 | 16,857 | 8,438 | 23,625 | 11,813 |
| 230,000 | 11,500 | 17,250 | 8,625 | 24,150 | 12,075 |

[1]The 1994 date refers to dwellings constructed under the 1994 Minnesota Energy Code. The default KAIR used in this section of the table is 0.20 ACH.
[2]This section of the table is to be used for dwellings constructed prior to 1994. The default KAIR used in this section of the table is 0.40 ACH.

| Table 501.3.1<br>**Procedure to Determine Makeup Air Quantity for Exhaust Equipment in Dwellings**<br>Use the Appropriate Column to Estimate House Infiltration | | | | |
|---|---|---|---|---|
| | One or multiple power vent or direct vent appliances or no combustion appliances[A] | One or multiple fan-assisted appliances and power vent or direct vent appliances[B] | One atmospherically vented gas or oil appliance or one solid fuel appliance[C] | Multiple atmospherically vented gas or oil appliances or solid fuel appliances[D] |
| 1a) pressure factor (cfm/sf) | 0.15 | 0.09 | 0.06 | 0.03 |
| b) conditioned floor area (sf) (including unfinished basements) | | | | |
| Estimated House Infiltration (cfm): [1a x 1b] | | | | |
| 2. Exhaust Capacity<br>a) continuous exhaust-only ventilation systems (cfm): (not applicable to balanced ventilation systems such as HRV) | | | | |
| b) clothes dryer | 135 | 135 | 135 | 135 |
| c) 80% of largest exhaust rating (cfm): (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust) | | | | |
| d) 80% of next largest exhaust rating (cfm): (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust) | not applicable | | | |
| Total Exhaust Capacity (cfm): [2a+2b+2c+2d] | | | | |
| 3. Makeup Air Requirement<br>a) Total Exhaust Capacity (from above) | | | | |
| b) Estimated House Infiltration (from above) | | | | |
| Makeup Air Quantity (cfm): [3a – 3b] (if value is negative, no makeup air is needed) | | | | |
| 4. For Makeup Air Opening Sizing, refer to Table 501.3.2 | | | | |

[A] Use this column if there are other than fan-assisted or atmospherically vented gas or oil appliances or if there are no combustion appliances.

[B] Use this column if there is one fan-assisted appliance per venting system. Other than atmospherically vented appliances may also be included.

[C] Use this column if there is one atmospherically vented (other than fan-assisted) gas or oil appliance per venting system or one solid fuel appliance.

[D] Use this column if there are multiple atmospherically vented gas or oil appliances using a common vent or if there are atmospherically vented gas or oil appliances and solid fuel appliances.

| Table 501.3.2<br>Makeup Air Opening Sizing Table for New and Existing Dwellings | | | | | |
|---|---|---|---|---|---|
| | One or multiple power vent or direct vent appliances or no combustion appliances[A] | One or multiple fan-assisted appliances and power vent or direct vent appliances[B] | One atmospherically vented gas or oil appliance or one solid fuel appliance[C] | Multiple atmospherically vented gas or oil appliances or solid fuel appliances[D] | Passive makeup air opening duct diameter[E,F,G] |
| Type of opening or system | (cfm) | (cfm) | (cfm) | (cfm) | (inches) |
| Passive Opening | 1-36 | 1-22 | 1-15 | 1-9 | 3 |
| Passive Opening | 37-66 | 23-41 | 16-28 | 10-17 | 4 |
| Passive Opening | 67-109 | 42-66 | 29-46 | 18-28 | 5 |
| Passive Opening | 110-163 | 67-100 | 47-69 | 29-42 | 6 |
| Passive Opening | 164-232 | 101-143 | 70-99 | 43-61 | 7 |
| Passive Opening | 233-317 | 144-195 | 100-135 | 62-83 | 8 |
| Passive Opening with Motorized Damper | 318-419 | 196-258 | 136-179 | 84-110 | 9 |
| Passive Opening with Motorized Damper | 420-539 | 259-332 | 180-230 | 111-142 | 10 |
| Passive Opening with Motorized Damper | 540-679 | 333-419 | 231-290 | 143-179 | 11 |
| Powered Makeup Air[H] | >679 | >419 | >290 | >179 | not applicable |

A Use this column if there are other than fan-assisted or atmospherically vented gas or oil appliances or if there are no combustion appliances.

B Use this column if there is one fan-assisted appliance per venting system. Other than atmospherically vented appliances may also be included.

C Use this column if there is one atmospherically vented (other than fan-assisted) gas or oil appliance per venting system or one solid fuel appliance.

D Use this column if there are multiple atmospherically vented gas or oil appliances using a common vent or if there are atmospherically vented gas or oil appliances and solid fuel appliance(s).

E An equivalent length of 100 feet of round smooth metal duct is assumed. Subtract 40 feet for the exterior hood and ten feet for each 90-degree elbow to determine the remaining length of straight duct allowable.

F If flexible duct is used, increase the duct diameter by one inch. Flexible duct shall be stretched with minimal sags.

G Barometric dampers are prohibited in passive makeup air openings when any atmospherically vented appliance is installed.

H Powered makeup air shall be electrically interlocked with the largest exhaust system.

Equation 11-1:

Total ventilation rate (cfm) = (0.02 x square feet of conditioned space) + [15 x (number of bedrooms + 1)]

**N1104.2.1 Continuous ventilation.** A minimum of 50 percent of the total ventilation rate, but not less than 40 cfm, shall be provided, on a continuous rate average for each one-hour period according to Table N1104.2 or Equation 11-2. The portion of the mechanical ventilation system that is intended to be continuous may have automatic cycling controls providing the average flow rate for each hour meeting the requirements of Section N1104.2.1.

Equation 11-2:

Continuous ventilation (cfm) = total ventilation rate/2

**N1104.2.1.1 Ventilation rate.** The continuous ventilation system shall be balanced in accordance with Section N1104.4.2.

**Exception:** If the local ventilation requirements according to IRC Section R303.3 are being met by the continuous ventilation system, it shall be capable of operating at a rate not more than 100 percent greater than required by Section N1104.2.1.

**N1104.2.2 Intermittent ventilation.** The difference between the total ventilation rate and the continuous ventilation rate shall be based on flow rates as designed or as installed.

Table N1104.2

Total and Continuous Ventilation Rates (in cfm)

| | Number of Bedrooms | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6[2] |
| Conditioned space[1] (in sq. ft.) | Total/ Continuous | Total/ Continuous | Total/ Continuous | Total/ Continuous | Total/ Continuous | Total/ Continuous |
| 1000-1500 | 60/40 | 75/40 | 90/45 | 105/53 | 120/60 | 135/68 |
| 1501-2000 | 70/40 | 85/43 | 100/50 | 115/58 | 130/65 | 145/73 |
| 2001-2500 | 80/40 | 95/48 | 110/55 | 125/63 | 140/70 | 155/78 |
| 2501-3000 | 90/45 | 105/53 | 120/60 | 135/68 | 150/75 | 165/83 |
| 3001-3500 | 100/50 | 115/58 | 130/65 | 145/73 | 160/80 | 175/88 |
| 3501-4000 | 110/55 | 125/63 | 140/70 | 155/78 | 170/85 | 185/93 |
| 4001-4500 | 120/60 | 135/68 | 150/75 | 165/83 | 180/90 | 195/98 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4501-5000 | 130/65 | 145/73 | 160/80 | 175/88 | 190/95 | 205/103 |
| 5001-5500 | 140/70 | 155/78 | 170/85 | 185/93 | 200/100 | 215/108 |
| 5501-6000[2] | 150/75 | 165/83 | 180/90 | 195/98 | 210/105 | 225/113 |

[1] Conditioned space includes the basement.

[2] If conditioned space exceeds 6000 sq. ft. or there are more than 6 bedrooms, use Equation 11-1 from Section N1104.2 to calculate total ventilation rate.

**N1104.3 Ventilation system requirements.** The mechanical ventilation system shall be one of three types: exhaust according to Section N1104.3.1; balanced, and HRV/ERV according to Section N1104.3.2; or other method according to Section N1104.3.3.

**N1104.3.1 Exhaust systems.** Fans used to comply with the continuous ventilation part of the mechanical ventilation system shall:

1. meet the minimum continuous ventilation rate in Section N1104.2.1 at the point of discharge;

2. be designed and certified by the equipment manufacturer as capable of continuous operation at the rated cfm;

3. have a maximum 1.0 sone per HVI Standard 915 for surface mounted fans;

4. be permitted to use a required overcurrent protection device as a disconnect per the National Electric Code, incorporated by reference in Minnesota Rules, chapter 1315; and

5. comply with the Minnesota Mechanical Code, chapter 1346, which may require additional make-up air.

Fans used to comply with the intermittent ventilation part of the mechanical ventilation system shall have a maximum 2.5 sone per HVI Standard 915.

**N1104.3.2 Balanced, and HRV/ERV systems.** A heat recovery ventilator (HRV) or energy recovery ventilator (ERV) shall meet either:

1. the requirements of HVI Standard 920, 72 hours minus 13 degrees Fahrenheit cold weather test; or

2. certified by a registered professional engineer and installed per manufacturer's installation instructions.

An HRV or ERV intended to comply with both the continuous and total ventilation rate requirements shall meet the rated design capacity of the continuous ventilation rate in Section N1104.2.1 under low capacity and meet the total ventilation rate in Section N1104.2.2 under high capacity.

**Exception:** The balanced, and HRV/ERV system may include exhaust fans to meet the intermittent ventilation rate. Surface mounted fans shall have a maximum 2.5 sones per HVI Standard 915.

**N1104.3.3 Other methods.** Any mechanical ventilation system consisting of exhaust fans, supply fans, or a combination of both, complying with Section N1104, shall be allowed. A mechanical ventilation system specifically identified in Section N1104.3.1 or N1104.3.2 shall not conflict with Sections N1104.3.1 and N1104.3.2. For the purposes of this section, the delivered

# New Construction Energy Code Compliance Certificate

Per R401.3 Certificate. A building certificate shall be posted on or in the electrical distribution panel.

| Date Certificate Posted |
|---|
| |

| Mailing Address of the Dwelling or Dwelling Unit | City |
|---|---|
| | |
| **Name of Residential Contractor** | **MN License Number** |
| | |

## THERMAL ENVELOPE

| Insulation Location | Total R-Value of all Types of Insulation | Type: Check All That Apply | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Non or Not Applicable | Fiberglass, Blown | Fiberglass, Batts | Foam, Closed Cell | Foam Open Cell | Mineral Fiberboard | Rigid, Extruded Polystyrene | Rigid, Isocynurate |
| Below Entire Slab | | | | | | | | | |
| Foundation Wall | | | | | | | | | |
| Perimeter of Slab on Grade | | | | | | | | | |
| Rim Joist (1st Floor) | | | | | | | | | |
| Rim Joist (2nd Floor+) | | | | | | | | | |
| Wall | | | | | | | | | |
| Ceiling, flat | | | | | | | | | |
| Ceiling, vaulted | | | | | | | | | |
| Bay Windows or cantilevered areas | | | | | | | | | |
| Floors over unconditioned area | | | | | | | | | |
| Describe other insulated areas | | | | | | | | | |

| **Building envelope air tightness:** | | **Duct system air tightness:** | |
|---|---|---|---|

| **Windows & Doors** | | **Heating or Cooling Ducts Outside Conditioned Spaces** |
|---|---|---|
| Average U-Factor (*excludes skylights and one door*) U: | | Not applicable, all ducts located in conditioned space |
| Solar Heat Gain Coefficient (SHGC): | | R-value |

## RADON CONTROL SYSTEM

- Passive (*No Fan*)
- Active (*With fan and monometer or other system monitoring device*)

Location (or future location) of Fan:

Other Please Describe Here:

## MECHANICAL SYSTEMS

| Appliances | Heating System | Domestic Water Heater | Cooling System |
|---|---|---|---|
| Fuel Type | | | |
| Manufacturer | | | |
| Model | | | |
| Rating or Size | Input in BTUS: | Capacity in Gallons: | Output in Tons: |
| Efficiency | AFUE or HSPF% | | SEER /EER |
| **Residential Load Calculation** | **Heating Loss** | **Heating Gain** | **Cooling Load** |
| | | | |

**Make-up Air** *Select a Type*

- Not required per mech. code
- Passive
- Powered
- Interlocked with exhaust device. Describe:
- Other, describe:

Location of duct or system:

- Cfm's
- " round duct OR
- " metal duct

## MECHANICAL VENTILATION SYSTEM

Describe any additional or combined heating or cooling systems if installed: (e.g. two furnaces or air source heat pump with gas back-up furnace):

***Select Type***

| | | | | | |
|---|---|---|---|---|---|
| | Heat Recover Ventilator (HRV) Capacity in cfms: | Low: | | High: | |
| | Energy Recover Ventilator (ERV) Capacity in cfms: | Low: | | High: | |
| | Balanced Ventilation capacity in cfms: | | | | |

Location of fan(s), describe:

Capacity continuous ventilation rate in cfms:

Total Ventilation (intermittent + continuous) rate in cfms:

**Combustion Air** *Select a Type*

- Not required per mech. code
- Passive
- Other, describe:

Location of duct or system:

- Cfm's
- " round duct OR
- " metal duct