

# City of Brainerd - Building Safety Division

## Mechanical & Energy Code – Ventilation, Makeup and Combustion Air Calculations

Please submit at time of application of a mechanical permit for new construction.

PROJECT ADDRESS	CONTRACTOR
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### SECTION A

<b>Ventilation Quantity</b> (Determine total ventilation rate (cfm) by using the attached Table R403.5.2 or Equation R403.5.2)			
Square Feet of Conditioned Area (including basement, crawl spaces and any unfinished spaces.)		Total Ventilation Rate (cfm)	
Number of Bedrooms		Continuous Ventilation Rate (cfm)	

### SECTION B

<b>Ventilation Method</b>			
<b>System</b>	<b>Manufacture</b>	<b>Model Number</b>	<b>Low / High cfm</b>
<input type="checkbox"/> Heat Recovery Ventilator (HRV) <input type="checkbox"/> Energy Recovery Ventilator (ERV) <input type="checkbox"/> Supply/Exhaust Fans (Balanced)			
<b>Ventilation Fans – Exhaust and Supplemental</b>			
<b>Description</b> (Range Hood, Bath, Utility, etc)	<b>Location</b>		<b>Total cfm</b>

### SECTION C

<b>Make-up Air for Exhaust Appliances in Dwelling Units</b> (A completed copy of worksheet must be provided)		
<input type="checkbox"/> No Make-up Air Required  <input type="checkbox"/> Make-up Air Required (See Table 501.4.2)	<b>CFM Needed</b>	<b>Duct Diameter and Type *</b>

### SECTION D

<b>Combustion Air</b> (A complete copy of worksheet E-1 must be provided)	
<b>Method of Suppling Combustion Air</b>	<b>Duct Diameter and Type *</b>
<input type="checkbox"/> No Combustion Air Required <input type="checkbox"/> All Indoor Air <input type="checkbox"/> All Outdoor Air <input type="checkbox"/> Combination Indoor and Out <input type="checkbox"/> Mechanical Combustion Air Supply <input type="checkbox"/> Engineered Design	

### SECTION E

<b>Gas and Solid Fuel Appliances</b> (Attach sheet for additional appliances)			
<b>Appliance</b>	<b>Fuel Type</b>	<b>BTU's</b>	<b>Vent Type – (Direct, Powered or Draft)</b>

\*- If flexible duct is used, increase the duct diameter by 1 inch.

**SECTION A**  
**TABLE R403.5.2 – VENTILATION QUANTITY**

<b>Bedrooms</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
<b>Conditioned space<sup>1</sup> (in sq. ft.)</b>	<b>Total/ Continuous</b>	<b>Total/ Continuous</b>	<b>Total/ Continuous</b>	<b>Total/ Continuous</b>	<b>Total/ Continuous</b>	<b>Total/ Continuous</b>
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 <sup>2</sup>	150/75	165/83	180/90	195/98	210/105	225/113

1. Conditioned space includes the basement and conditioned crawl spaces.

2. If conditioned space exceeds 6,000 sq. ft. or there are more than 6 bedrooms, use Equation R403.5.2

**Equation R403.5.2**

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

**Equation R403.5.2.1**

Continuous ventilation rate (cfm) = Total ventilation rate/2

## SECTION C

Table 501.4.1

### PROCEDURE TO DETERMINE MAKEUP AIR QUANTITY FOR EXHAUST APPLIANCES IN DWELLING UNITS

Table 501.4.1	ONE OR MULTIPLE POWER VENT OR DIRECT VENT APPLIANCES OR NO COMBUSTION APPLIANCES <sup>A</sup>	ONE OR MULTIPLE FAN-ASSISTED APPLIANCES AND POWER VENT OR DIRECT VENT APPLIANCES <sup>B</sup>	ONE ATMOSPHERICALLY VENTED GAS OR OIL APPLIANCE OR ONE SOLID FUEL APPLIANCE <sup>C</sup>	MULTIPLE APPLIANCES THAT ARE ATMOSPHERICALLY VENTED GAS OR OIL APPLIANCES OR SOLID FUEL APPLIANCES <sup>D</sup>
<b>1. Use the Appropriate Column to Estimate House Infiltration</b>				
a) Pressure factor (cfm/sf)	0.15	0.09	0.06	0.03
b) Conditioned floor area (sf) including unfinished basements				
Estimated House Infiltration (cfm): <b>[1a × 1b]</b>				
<b>2. Exhaust Capacity</b>				
a) Clothes dryer (cfm)	135	135	135	135
b) 80% of largest exhaust rating (cfm): (Not applicable if recirculating system or if powered makeup air is electronically interlocked and matched to exhaust)				
c) 80% of largest exhaust rating (cfm): (Not applicable if recirculating system or if powered makeup air is electronically interlocked and matched to exhaust)	NA			
Total Exhaust Capacity (cfm): <b>[2a+2b+2c]</b>				
<b>3. Makeup Air Requirement</b>				
a) Total Exhaust Capacity (from above)				
b) Estimated House Infiltration (from above)				
Makeup Air Quality (cfm): <b>[3a - 3b]</b> Makeup air not required if negative				
<b>4. For Makeup Air Opening Sizing, refer to attached sheet - Table 501.4.2.</b>				

**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.

## SECTION C

Table 501.4.2

### PROCEDURE TO DETERMINE MAKEUP AIR QUANTITY FOR EXHAUST APPLIANCES IN DWELLING UNITS

TABLE 501.4.2 - MAKEUP AIR OPENING SIZING TABLE FOR NEW AND EXISTING DWELLING UNITS

TYPE OF OPENING OR SYSTEM	ONE OR MULTIPLE POWER VENT OR DIRECT VENT APPLIANCES OR NO COMBUSTION APPLIANCES <sup>A</sup>	ONE OR MULTIPLE FAN-ASSISTED APPLIANCES AND POWER VENT OR DIRECT VENT APPLIANCES <sup>B</sup>	ONE ATMOSPHERICALLY VENTED GAS OR OIL APPLIANCE OR ONE SOLID FUEL APPLIANCE <sup>C</sup>	MULTIPLE APPLIANCES THAT ARE ATMOSPHERICALLY VENTED GAS OR OIL APPLIANCES OR SOLID FUEL APPLIANCES <sup>D</sup>	PASSIVE MAKEUP AIR OPENING DUCT DIAMETER <sup>E, F, G</sup>
	(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 <sup>H</sup>	> 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 *appliances*.

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.

**SECTION D**  
**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 combustion appliance information.**

**Furnace/Boiler:**

_____ Draft Hood (Not fan assisted)	_____ Fan Assisted & Power Vent	_____ Direct Vent	Input: _____ Btu/hr
_____ 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
_____ 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<sup>3</sup>

**Step 3: Determine Air Changes per Hour (ACH)<sup>1</sup>**

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<sup>3</sup>

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<sup>3</sup>

Total Btu/hr 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<sup>3</sup>

Total Required Volume (TRV) = RVFA + RVNFA TRV = \_\_\_\_\_ + \_\_\_\_\_ = \_\_\_\_\_ ft<sup>3</sup>

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<sup>2</sup> CAO A = \_\_\_\_\_ / 3000 Btu/hr per in<sup>2</sup> = \_\_\_\_\_ in<sup>2</sup>

**Step 8: Calculate Minimum CAO A.**

Minimum CAO A = CAO A **multiplied by** RF Minimum CAO A = \_\_\_\_\_ x \_\_\_\_\_ = \_\_\_\_\_ in<sup>2</sup>

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

CAOD = 1.13 **multiplied by the square root of** Minimum CAO A CAOD = 1.13 Minimum CAO A = \_\_\_\_\_ in

<sup>1</sup>If desired, ACH can be determined using ASHRAE calculation or blower door test. Follow procedures in Section G304.

## SECTION D - TABLE E-1

Residential Combustion Air (Required Interior Volume Based on Input Rating of Appliance)

Input Rating (Btu/hr)	Standard Method	Known Air Infiltration Rate Method (KAIR) in cu ft. <sup>(1,2)</sup>			
		Fan Assisted		Non-Fan Assisted	
		1994 to Present	Pre - 1994	1994 to Present	Pre - 1994
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	16,875	8,438	23,625	11,813
230,000	11,500	17,250	8,625	24,150	12,075

1. The 1994 date refers to a dwelling constructed under the 1994 Minnesota Energy Code. The default KAIR used in this section of the table is 0.20 air changes per hour (ACH)

2. This section of the table is to be used for dwelling construction prior to 1994. The default KAIR used in this section of the table is 0.40 ACH.