Comparison of Intermittent Whole House Fan Calculations

2009 Washington State Amendments	ASHRAE 62-2-2007, Addendum b	ASHRAE 62.2-2010
403.8.5.1 Outdoor air. Outdoor air shall be distributed to each habitable space. Where outdoor air supply intakes are separated from exhaust vents by doors, means shall be provided to ensure airflow to all separated habitable spaces by installing distribution ducts, installed grilles, transoms, doors undercut to a minimum of 1/2-inch above the surface of the finish floor covering, or other similar means where permitted by the International Building Code. The mechanical system shall operate continuously to supply at least the volume of outdoor air required in Table 403.3 or Table 403.8.1. **EXCEPTION:** Intermittently operating ventilation systems: The mechanical system shall have controls for intermittent operation per Section 403.8.2 and shall supply at least the volume of outdoor air required for intermittent operation based on the combination of its delivered capacity (from Table 403.3 or Table 403.8.1), its ventilation effectiveness (from Table 403.8.5.1) and its daily fractional operation time (from Table 403.8.5.1) using the formula: $Qf = Qr/(\varepsilon f)$ Where: Qf = Outdoor air flow rate Qr = Ventilation air requirement (from Table 403.3 or 403.8.1) ε = Ventilation effectiveness (from Table 403.8.1) f = Fractional operation time (from Table 403.8.5.1)	**4.4 Delivered Ventilation.** The delivered ventilation rate shall be calculated as the larger of the total supply or total exhaust and shall be no less than specified in Section 4.1 during each hour of operation. **Exception:** The effective ventilation rate of an intermittent system is the combination of its delivered capacity, ~~its daily~~ fractional on-time, cycle time, and the ventilation effectiveness from Table 4.2. The fan flow rate required to achieve an effective ventilation rate that is equivalent to the continuous ventilation requirement shall be calculated from the following equation: $Qf = Qr/(\varepsilon f)$ (4.2) where Qf = fan flow rate during the on-cycle, Qr = ventilation air requirement (from Table 4.1a or Table 4.1b), $Tcyc$ = fan cycle time, defined as the total time for 1 on-cycle and 1 off-cycle (used in Table 4.2) ε = ventilation effectiveness (from Table 4.2), and f = fractional on time, defined as the on-time for one cycle divided by the cycle time. ~~If the system runs at least once every three hours, 1.0 can be used as the ventilation effectiveness.~~ Interpolation in Table 4.2 is not allowed. For values not listed, use the next higher value for Cycle Time or the next lower value for Fractional On-Time. The maximum allowed Cycle Time is 24 hours and the minimum allowed Fractional On-Time is 0.1. [in other works, the system must run at least once a day, and for a total minimum of 2.5 hours per day]	**4.4 Delivered Ventilation.** The delivered ventilation rate shall be calculated as the larger of the total supply or total exhaust and shall be no less than specified in Section 4.1 during each hour of operation. **Exception:** The effective ventilation rate of an intermittent system is the combination of its delivered capacity, fractional on-time, cycle time, and the ventilation effectiveness from Table 4.2. The fan flow rate required to achieve an effective ventilation rate that is equivalent to the continuous ventilation requirement shall be calculated from the following equation: $Qf = Qr/(\varepsilon f)$ (4.2) where Qf = fan flow rate during the on-cycle, Qr = ventilation air requirement (from Table 4.1a or Table 4.1b), $Tcyc$ = fan cycle time, defined as the total time for 1 on-cycle and 1 off-cycle (used in Table 4.2) ε = ventilation effectiveness (from Table 4.2), and f = fractional on time, defined as the on-time for one cycle divided by the cycle time. For values not listed, use the next higher value for Cycle Time or the next lower value for Fractional On-Time. Linear interpolation is allowed for intermediate Fractional On-Times. The maximum allowed Cycle Time is 24 hours and the minimal allowed Fractional On-Time is 0.1. [in other works, the system must run at least once a day, and for a total minimum of 2.5 hours per day]

GRAYS HARBOR COUNTY
PLANNING AND BUILDING DIVISION
DEVELOPMENT ASSISTANCE BULLETIN

23

VENTILATION AND INDOOR AIR QUALITY (COMPLIANCE WORK-SHEET

Owner's Name: _____ **Permit #:** _____

JOB TYPE	OCCUPANCY	# OF BEDROOMS	DUCTED FURNACE
[ ] New	[ ] Single Family	[ ] 2 or less	[ ] YES
[ ] Remodel	[ ] Multi-Family	[ ] 3	[ ] NO
[ ] Addition		[ ] 4	
		[ ] ___	

FURNACE WITHIN COND. SPACE	DUCTS WITHIN COND. SPACE
[ ] Yes	[ ] Yes
[ ] No	[ ] No

VENTILATION OPTION:

[ ] A: Compliance by Calculations or Testing (IRC Section M1508.3/ASHRAE 62.2-2010/ASHRAE 62.2-2007 Addendum 6). See attached explanation.
[ ] B: Intermittent Whole House Ventilation Using Continuously Operating Exhaust Fans (IRC Section M1508.4)
[ ] C: Intermittent Whole House Ventilation Integrated with a Forced-Air (ducted) Furnace (IRC Section M1508.5)
[ ] D: Intermittent Whole House Ventilation Using a Supply Fan (IRC Section M1508.6)
[ ] E: Intermittent Whole House Ventilation Using a Heat Recovery Ventilation System (IRC Section M1508.7)

REQUIRED PLAN PAGE ANNOTATIONS (as applicable):

[ ] Size (CFM) and Location of Whole House Fan or note adjacent to furnace on plan.
[ ] Type and Location of Fan Controls (Label: WHOLE HOUSE VENTILATION FAN)
[ ] Location of Air intakes (Individual Room / Furnace Return-Air Duct)
[ ] Location / Size (CFM) of Source Specific Exhaust Fans (Kitchen, Bathroom, Water Closet, Laundry, Pool, Spa, Other)
[ ] Exterior Termination Location of Exhaust Fan(s) Wall / Roof Cap
[ ] Annotation of Minimum Insulation Level (R-4) for Ducts Located In Unconditioned Spaces

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M1508.2 Continuously Operating Exhaust Ventilation Systems. Continuously operating exhaust ventilation systems shall provide the minimum flow rates specified in Table M1508.2.

Table M1508.2

	Bedrooms				
	0-1	**2-3**	**4-5**	**6-7**	**>7**
<1500	30	45	60	75	90
1501-3000	45	60	75	90	105
3001-4500	60	75	90	105	120
4501-6000	75	90	105	120	135
6001-7500	90	105	120	135	150
>7500	105	120	135	150	165

PRESCRIPTIVE INTEGRATED FORCED AIR SUPPLY DUCT SIZING

Required Flow (CFM) Per Table 3-2	Minimum Smooth Duct Diameter	Minimum Flexible Duct Diameter	Maximum Length[1]	Maximum Number of Elbows[2]
50 - 80	6"	7"	20'	3
80 - 125	7"	8"	20'	3
115 - 175	8"	10"	20'	3
170 - 240	9"	11"	20'	3

1. For lengths over 20 feet increase duct diameter 1 inch.
2. For elbows numbering more than 3 increase duct diameter 1 inch.

M1508.6.2
PRESCRIPTIVE SUPPLY FAN DUCT SIZING

Supply Fan Tested CFM at 0.40" WG		
Specified Volume from Table 3-2	Minimum Smooth Duct Diameter	Minimum Flexible Duct Diameter
50 – 90 CFM	4 inch	5 inch
90 - 150 CFM	5 inch	6 inch
150 - 250 CFM	6 inch	7 inch
250 - 400 CFM	7 inch	8 inch

2009 Washington State Amendments

TABLE 403.8.5.1
VENTILATION EFFECTIVENESS FOR INTERMITTENT FANS

Daily Fractional Operation Time, f	Ventilation Effectiveness, ε
f ≤ 35%	0.33
35% ≤ f < 60%	0.50
60% ≤ f < 80%	0.75
80% ≤ f	1.0

Example: A fan operated 50% of the time with a ventilation air requirement of 60 cfm (two bedrooms, 1500-3000 ft2). The ventilation effectiveness will be 50% (0.50 from Table 403.8.5.1), and the fan flow will have to equal or exceed 240 cfm.
60 cfm / (0.50 × 0.50) = 240 cfm

Under the previous code, a fan would be required to operate a minimum of 8 hours, 33% of the time, with a ventilation rate of 65 to113 cfm depending on size.

Using the above method, the ventilation requirement would be:
60 cfm / (0.33 x 0.33) = 551 cfm

ASHRAE 62-2-2007, Addendum b

TABLE 4.2
Ventilation Effectiveness for Intermittent Fans

Fractional On-Time, *f*	Cycle Time, T_{cyc} (hours)			
	0 to 6	8	12	24
0.1	1.00	0.87	0.65	*
0.2	1.00	0.90	0.76	*
0.3	1.00	0.93	0.83	*
0.4	1.00	0.95	0.88	0.46
0.5	1.00	0.96	0.92	0.68
0.6	1.00	0.98	0.95	0.81
0.7	1.00	0.99	0.97	0.90
0.8	1.00	0.99	0.99	0.96
0.9	1.00	1.00	1.00	0.99
1.0	1.00	1.00	1.00	1.00

*Condition not allowed since no amount of intermittent ventilation will provide equivalent indoor air quality.

Example: A fan operated 50% of the time with cycle times of 24 hours (one cycle per day) with a ventilation air requirement of 60 cfm (two bedrooms, 1500-3000 ft2). The ventilation effectiveness will be 68% (0.68 from Table 4.2), and the fan flow will have to equal or exceed 176 cfm.
60 cfm / (0.68 × 0.50) = 176 cfm

So, a fan operated 8 hours a day, one time per day, in the same house as above, would not be allowed. The minimum allowable would be 9.6 hours, or 40%.
60 cfm / (0.46 x 0.40) = 326 cfm

Example 2:
Same home as above, fan operated 4 hours twice a day, 0.30 fractional on time
60 cfm / (0.83 x 0.30) = 241 cfm

Example 3:
Same home as above, fan operated 3 hours three times a day, 0.30 fractional on time

60 cfm / (0.93 x 0.30) = 215 cfm

ASHRAE 62.2-2010

TABLE 4.2
Ventilation Effectiveness for Intermittent Fans

Fractional On-Time, *f*	Cycle Time, T_{cyc} (hours)			
	0-4	8	12	24
0.1	1.00	0.79	*	*
0.2	1.00	0.54	0.56	*
0.3	1.00	0.89	0.71	*
0.4	1.00	0.92	0.81	0.20
0.5	1.00	0.94	0.87	0.52
0.6	1.00	0.97	0.92	0.73
0.7	1.00	0.98	0.96	0.86
0.8	1.00	0.99	0.98	0.94
0.9	1.00	1.00	1.00	0.99
1.0	1.00	1.00	1.00	1.00

*Condition not allowed since no amount of intermittent ventilation will provide equivalent indoor air quality.

Example: A fan operated 50% of the time with cycle times of 24 hours (one cycle per day) with a ventilation air requirement of 60 cfm (two bedrooms, 1500-3000 ft2). The ventilation effectiveness will be 52% (0.52 from Table 4.2), and the fan flow will have to equal or exceed 231 cfm.
60 cfm / (0.52× 0. 50) = 231cfm

So for the 2010 version of 62.2 with the same protocols:
60 cfm / (0.20 x 0.40) = 750 cfm

Example 2:
Same home as above, fan operated 4 hours twice a day, 0.33 fractional on time (interpolation allowed)
60 cfm / (0.71 x 0.33) = 256 cfm

Example 3:
Same home as above, fan operated 3 hours three times a day, 0.375 fractional on time

60 cfm / (0.89 x 0.375) = 180 cfm

You can see that by increasing the number of times per day the fan runs, even if the total run time is the same, the cfm requirements will go down. The theory is that pollutants build up in the air over time and it takes more to disperse them the longer the air is stagnant.