STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

Department of General Administration

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STATE BUILDING CODE INTERPRETATION NO. 10-05

CODE: 2009 IRC
2009 IMC

SECTION: Table M1508.3 Ventilation Effectiveness for Intermittent Fans
Table 403.8.5.1 Ventilation Effectiveness for Intermittent Fans

QUESTION: There is a rumor going around that the intermittent ventilation calculation tables provided in the state amendments to the IRC and IMC are incorrect and will result in an oversized system, but if the calculation from a more current version of ASHRAE 62.2 is used, it will be correct. What calculation should be used to correctly size a whole house ventilation fan? Is it allowable to use ASHRAE 62.2-2010 as an alternate?

ANSWER: **Yes, it is allowable to use an alternate. The whole house ventilation required under M1508 and IMC 403.8.5 is intended to require a continuously operating system based on ASHRAE 62.2-2007. For an intermittently operating system, the rates become very onerous, especially if you assume an operation time under 35%. Shortly after this requirement was adopted by the Council, ASHRAE published an addendum revising the calculation factors for intermittent fans which lowered the sizing requirements in most instances. In the 2010 edition, ASHRAE revised the formula once again. This latest revision adjusted some of the rates back up. The IRC and IMC codes both consider the 2007 edition of ASHRAE 62.2 as an allowable alternate. This would also include the addendums. The building official also has the authority to approve a later edition of this standard as an allowable alternate.** ***(See attachment for variations in language and examples showing the variation of rated for different run times/frequencies.)***

SUPERSEDES: None

REQUESTED BY: Thurston County

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: $Q_f = Q_r/(\varepsilon f)$ (4.2) where Q_f = fan flow rate during the on-cycle, Q_r = ventilation air requirement (from Table 4.1a or Table 4.1b), T_{cyc} = 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: $Q_f = Q_r/(\varepsilon f)$ (4.2) where Q_f = fan flow rate during the on-cycle, Q_r = ventilation air requirement (from Table 4.1a or Table 4.1b), T_{cyc} = 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]

<table>
<tr><th>2009 Washington State Amendments</th><th>ASHRAE 62-2-2007, Addendum b</th><th>ASHRAE 62.2-2010</th></tr>
<tr>
<td>
TABLE 403.8.5.1
VENTILATION EFFECTIVENESS FOR INTERMITTENT FANS
<table>
<tr><th>Daily Fractional Operation Time, f</th><th>Ventilation Effectiveness, ε</th></tr>
<tr><td>f ≤ 35%</td><td>0.33</td></tr>
<tr><td>35% ≤ f < 60%</td><td>0.50</td></tr>
<tr><td>60% ≤ f < 80%</td><td>0.75</td></tr>
<tr><td>80% ≤ f</td><td>1.0</td></tr>
</table>
</td>
<td>
TABLE 4.2
Ventilation Effectiveness for Intermittent Fans
<table>
<tr><th>Fractional On-Time, f</th><th colspan="4">Cycle Time, T_{cyc} (hours)</th></tr>
<tr><th></th><th>0 to 6</th><th>8</th><th>12</th><th>24</th></tr>
<tr><td>0.1</td><td>1.00</td><td>0.87</td><td>0.65</td><td>*</td></tr>
<tr><td>0.2</td><td>1.00</td><td>0.90</td><td>0.76</td><td>*</td></tr>
<tr><td>0.3</td><td>1.00</td><td>0.93</td><td>0.83</td><td>*</td></tr>
<tr><td>0.4</td><td>1.00</td><td>0.95</td><td>0.88</td><td>0.46</td></tr>
<tr><td>0.5</td><td>1.00</td><td>0.96</td><td>0.92</td><td>0.68</td></tr>
<tr><td>0.6</td><td>1.00</td><td>0.98</td><td>0.95</td><td>0.81</td></tr>
<tr><td>0.7</td><td>1.00</td><td>0.99</td><td>0.97</td><td>0.90</td></tr>
<tr><td>0.8</td><td>1.00</td><td>0.99</td><td>0.99</td><td>0.96</td></tr>
<tr><td>0.9</td><td>1.00</td><td>1.00</td><td>1.00</td><td>0.99</td></tr>
<tr><td>1.0</td><td>1.00</td><td>1.00</td><td>1.00</td><td>1.00</td></tr>
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*Condition not allowed since no amount of intermittent ventilation will provide equivalent indoor air quality.
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<tr><td>0.1</td><td>1.00</td><td>0.79</td><td>*</td><td>*</td></tr>
<tr><td>0.2</td><td>1.00</td><td>0.54</td><td>0.56</td><td>*</td></tr>
<tr><td>0.3</td><td>1.00</td><td>0.89</td><td>0.71</td><td>*</td></tr>
<tr><td>0.4</td><td>1.00</td><td>0.92</td><td>0.81</td><td>0.20</td></tr>
<tr><td>0.5</td><td>1.00</td><td>0.94</td><td>0.87</td><td>0.52</td></tr>
<tr><td>0.6</td><td>1.00</td><td>0.97</td><td>0.92</td><td>0.73</td></tr>
<tr><td>0.7</td><td>1.00</td><td>0.98</td><td>0.96</td><td>0.86</td></tr>
<tr><td>0.8</td><td>1.00</td><td>0.99</td><td>0.98</td><td>0.94</td></tr>
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<td>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</td>
<td>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</td>
<td>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</td>
</tr>
<tr>
<td rowspan="2">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</td>
<td>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</td>
<td>So for the 2010 version of 62.2 with the same protocols:
60 cfm / (0.20 x 0.40) = 750 cfm</td>
</tr>
<tr>
<td>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</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
<td>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</td>
</tr>
</table>

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.