**Example 1**  Cross-ventilated barn with cooling pads

**Assumptions:**
- 8-row, 800-head freestall
- Dimensions of 210 ft. by 420 ft.
- Baffle height of 8 ft. and one baffle per two rows of stalls
- Design velocity under the baffle of 528 fpm
- Cooling pads result in 0.05 inches of static pressure at air velocity of 400 fpm
- Performance test results show exhaust fan moving 31,000 CFM at 0.12 inches of static pressure

**Calculate cross-sectional area:**
\[ A_{cs} = 8 \text{ ft.} \times 420 \text{ ft.} = 3,360 \text{ sq. ft.} \]

**Calculate volumetric flow rate to meet design velocity and air exchange per cow:**
- Calculate airflow based on velocity: \( Q = 3,360 \text{ sq. ft.} \times 528 \text{ fpm} = 1,774,080 \text{ CFM} \)
- Calculate airflow based on number of cows: \( Q = 800 \text{ cows} \times 1,000 \text{ CFM/cow} = 800,000 \text{ CFM} \)
- Choose larger: \( 1,774,080 \text{ CFM} \)

**Size inlets:**
- \( 1,774,080 \text{ CFM/400 fpm} = 4,435 \text{ sq. ft.} \)
- Find inlet height: \( 4,435 \text{ sq. ft./420 ft.} = 10.56 \text{ ft. high} \)

**Estimate static pressure:**
- Calculate static pressure per baffle (equation 5 in the companion summary article):
  \[ S.P._{\text{baffle}} = \left( \frac{528 \text{ fpm}}{4,000} \right)^2 = 0.0174 \text{ inches of water/baffle} \]
- Sum static pressures: \( 0.05 \text{ in. at inlet + 0.0174 in./baffle \times 4 baffles} = 0.12 \text{ inches of water} \)

**Consider fans needed:**
- Number of fans = \( 1,774,000 \text{ CFM/31,000 CFM/fan} = 57 \text{ fans} \)

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**Example 2**  Estimating the annual electrical cost of operating circulation fans in Madison, Wisconsin

**Assumptions:**
- 40 circulation fans with 1 hp motors in naturally ventilated barn
- 1 hp motor consumes 1 kW of power
- Electricity costs $0.11/kWh
- Set point temperature is 68 °F
- In typical meteorological year, Madison has 1,682 hours with a temperature at or above 68 °F

**Annual electrical costs [$] = (hours over set point \times \text{cost of electricity}) \times \text{number of fans} \times 1 \text{ kW/fan} \times 0.11 \text{kWh} = 1,682 \text{ hours/year} \times 40 \text{ fans} \times 1 \text{ kW/fan} \times 0.11 \text{kWh} = 7,400.80 \text{ dollars/year} \)

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**Example 3**  Estimating the annual water use of a sprinkler system operating in a holding area in Madison, Wisconsin

**Assumptions:**
- Holding area is 400 square feet
- Water is applied at a rate of 0.025 gal per sq. ft. per cycle
- System uses valved nozzles, so water is not wasted between cycles
- Cycles are set to operate 1 minute in: 15 minutes at temperature 68 – 77 °F, 10 minute cycles at temperatures 78 – 88 °F, and 5 minute cycles at temperatures above 88 °F
- Typical meteorological year has 994 hours from 68 – 77 °F, 566 hours from 78 – 88 °F, and 61 hours > 88 °F

**Water per cycle [gal] = square feet \times \text{application rate} = 400 \text{ square feet} \times 0.025 \text{ gal per square foot} = 10 \text{ gal per cycle} \)

**Number of cycles is found by dividing the number of hours by the cycle duration:**

<table>
<thead>
<tr>
<th>Range</th>
<th>Number of hours/yr</th>
<th>Number of cycles/yr</th>
<th>Gallons of water/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>68 – 78 °F</td>
<td>1,171</td>
<td>4,684</td>
<td>46,840</td>
</tr>
<tr>
<td>79 – 88 °F</td>
<td>389</td>
<td>2,334</td>
<td>23,340</td>
</tr>
<tr>
<td>&gt; 88 °F</td>
<td>61</td>
<td>732</td>
<td>7,320</td>
</tr>
</tbody>
</table>

**Annual water use in holding area:** 77,500 gallons

*(note: water can be saved in the holding area by staging sprinklers so they do not operate in the empty portion (or only installing sprinklers in the 75% closest to the parlor, which is occupied a higher percentage of the time). Significant water could also be saved by staging the sprinklers to turn on at THI setpoints instead of temperature setpoints).*