Ventilating Adult Cow Facilities Worksheet

1. **Barn dimensions & structural components**

   a. Length, width, sidewall height, ridge height (ft)

   b. Fan location (North wall, East wall, etc.): ______________________

   ![Diagram of barn dimensions](image)

   c. Barn orientation

      i. North-South, East-West or ______________________

   d. Roof pitch (ft)

      \[2 \times \frac{\text{Ridge height (ft)}}{\text{Barn width (ft)}} - \frac{\text{Sidewall height (ft)}}{\text{Barn width (ft)}} \times 12 = \text{Roof pitch (\_ in 12)}\]

   e. Number of cows and stalls in the barn

      \[
      \frac{\text{Total number of cows in barn}}{\text{Total number of stalls in barn}} = \text{Cows per stall}
      \]

   f. Type of ventilation system

      i. Natural, Tunnel, Cross or Hybrid: ______________________
2. **Calculate the volume of the barn**

   **a. Lower barn volume & upper barn volume (ft)**

   ![Diagram of barn volume calculation]

   

   \[
   \text{Barn length} \times \text{Sidewall height} + \text{Barn width} = \text{Lower barn volume} \\
   \text{Barn length} \times \text{Ridge height} - \text{Sidewall height} \times 2 = \text{Upper barn volume} \\
   \text{Barn volume} = \text{Lower barn volume} + \text{Upper barn volume}
   \]

3. **Calculate the cross-sectional area of the barn**

   **a. Tunnel**

   ![Diagram of tunnel area calculation]

   \[
   \text{Sidewall height} \times \text{Barn width} + \text{Ridge height} \times \text{Sidewall height} \times 2 = \text{Tunnel barn cross-sectional area}
   \]

   **b. Cross**

   ![Diagram of cross area calculation]

   \[
   \text{Barn length} \times \text{Baffle height} = \text{Cross ventilated barn cross-sectional area under the baffle}
   \]

   **c. Cross without baffles**

   ![Diagram of cross without baffles area calculation]

   \[
   \text{Barn length} \times \frac{\text{Ridge height} + \text{Sidewall height}}{2} = \text{Cross ventilated barn average cross-sectional area}
   \]
4. **Determine the total fan capacity needed in the barn for winter and summer ventilation rates**

   a. Winter rate (4 air changes per hour (ACH))

      \[
      \text{Barn volume} \times \frac{\text{Desired number of air changes per hour}}{60 \text{ minutes per hour}} = \text{CFM}
      \]

   b. Summer rate (40-60 ACH)

      \[
      \text{Barn volume} \times \frac{\text{Desired number of air changes per hour}}{60 \text{ minutes per hour}} = \text{CFM}
      \]

5. **Calculate the required inlet area to create inlet airspeeds of 500 ft/min in the winter and the summer**

   a. Winter

      \[
      \text{Fan capacity needed} = \frac{\text{Average inlet airspeed}}{\text{Inlet area required}} \text{ ft}^2
      \]

   b. Summer

      \[
      \text{Fan capacity needed} = \frac{\text{Average inlet airspeed}}{\text{Inlet area required}} \text{ ft}^2
      \]
6. **Calculate the existing total fan capacity**

   a. Fan model & fan manufacturer
      
      i. Fan model: ____________________________
      
      ii. Fan manufacturer: ______________________
      
      iii. Fan capacity at 0.10" H₂O static pressure: ________________
      
      iv. Total number of fans: ________________________________

   b. Total fan capacity

   \[
   \text{Number of fans} \times \text{Fan capacity at 0.10 in. H₂O static pressure} = \text{Total fan capacity}
   \]

7. **Determine the existing ACH when all of the fans are running**

   \[
   \frac{\text{Total fan capacity}}{\text{Barn volume}} \times 60 \text{ minutes hour} = \text{ACH}
   \]

8. **Calculate the existing CFM/Cow when the entire system is running**

   \[
   \frac{\text{Total fan capacity}}{\text{Total number of cows in barn}} = \text{CFM/Cow}
   \]
9. **Determine the existing inlets**

<table>
<thead>
<tr>
<th>Inlet Location/Description</th>
<th>Dimensions (ft)</th>
<th>Inlet Area (ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example – South garage door</td>
<td>12 by 10</td>
<td>120</td>
</tr>
</tbody>
</table>

**Total Inlet Area:**

10. **Calculate the existing average inlet airspeed**

\[
\text{Total fan capacity} = \text{Total inlet area} \quad \text{ft/min}
\]

Based on the above calculations, does the mechanical ventilation design meet the following criteria?

1. **Sufficient air changes per hour (ACH)**
   a. 4 to 8 ACH in the winter
   b. 40 to 60 ACH in the summer (Usually ~40 ACH for tunnels, ~50 ACH for cross-ventilated barns)
   c. Linear or staged ramping function between the minimum and the maximum ventilation rates

2. **Sufficient air exchange per unit body weight under peak heat stress (summer)**
   a. 1,500 CFM (2,550 m³/h) per adult cow

3. **Cross-sectional air speed (note 90 ft/min = 1 mph and 0.5 m/s = 2 kph)**
   a. Only useful under certain circumstances such as in cross-ventilation systems where the target air speed beneath the baffle is ~400 to 500 ft/min (2 to 2.5 m/s)
   b. Overall cross-sectional air speed should not be used to specify barn ventilation since the air is not distributed evenly over the building cross section, making the estimate useless

4. **Inlet speed**
   a. Maintain an inlet speed of ~500 to 800 ft/min (2.5 to 4 m/s) to ensure good mixing of air without limiting air flow to the exhaust fans. Limited air flow to the fans is referred to as ‘choking’ the fans.

5. **Barn static pressure maintained at less than 0.15 inches H₂O (37 Pa)**