Ventilating Calf Barns in Winter
“Designing Facilities to Enhance Air Quality for the Calf”
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Take Home Message

- Ventilation is only one part of a complete calf housing system
- Management of the calf environment should focus on excellent air quality without draft
- A positive pressure supplemental ventilation system can improve air quality in naturally ventilated calf barns
The Options for calf housing and management are endless

Calf Management Plan

- Define the desired management groups
- Define the number of animals in each group
  - Grouping based on:
    - Comfort and environmental needs
    - Nutrition needs
    - Health needs
    - Reproductive status
    - Movement between groups
- Define the management protocols (chores)
- List Needs (and wants) of the Owner
- Determine facility features that will allow implementation of the management plan
- Prioritize the list of features
Calf Management Plan
“Needs of the calf”

- Provide a safe, comfortable, & healthy environment
  - Space to rest and walk
  - Clean & dry resting space
  - Avoid nose to nose contact
  - Fresh air (ventilation without a draft)
  - Adequate feed and water
  - Manage temperature extremes

Calf Hutch
Limitations of hutch system

- Melting snow and rain wet the bedding
- Snow removal from hutch area
- Alternate housing during extreme cold
- Inclement weather working conditions
- Increased labor during inclement weather
- Inefficient labor during inclement weather

Calf Management Plan
“Needs of the Owner”

- Safe & Labor efficient
  - Observation, feeding, cleaning, handling & treatment
  - Comfortable work environment
- Effectively utilize a farm’s resources
  - Capital
  - Labor
- Environmentally friendly
Calf Barn Design Challenge

- Provide a suitable environment for the calf
- Provide a suitable environment for the caretaker

Pen Design

- Space
- Weather
- Ventilation
- Pen Sides
- Pen Microclimate
- Bedding
- Building Design
Top Rear Panel Open 0.7 m (30 inches)

Front Panel Extended

Lower Rear Panel Closed 0.5 m (18 inches)

Solid Side Panel

Front Panel Bedding Retainer

Open Front Panel

Not to Scale
Winter Ventilation Design

- Minimal air exchange
- Positive pressure system design
- Even air distribution
- Control draft
- Temperature control?
## Ventilation Recommendations

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Air flow per calf</th>
<th>Building Air Volume Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold</td>
<td>7 l/s (15 cfm)</td>
<td>4 air changes per hour</td>
</tr>
<tr>
<td>-23 ºC to -7 ºC, (-10 ºF to +20 ºF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>24 l/s (50 cfm)</td>
<td>15 air changes per hour</td>
</tr>
<tr>
<td>-7 ºC to 10 ºC (+20 ºF to +50 ºF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm</td>
<td>56 l/s (120 cfm)</td>
<td>60 air changes per hour</td>
</tr>
<tr>
<td>&gt; 10 ºC (+50 ºF)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Ventilation recommendations for calf barns (Midwest Plan Service)
Fan Air Flow Capacity

Fan Diameter cm (inches)

Fan Capacity (L/s)

Fan Capacity (cfm)
### Polyethylene Duct Air Flow Capacity

<table>
<thead>
<tr>
<th>Duct Diameter cm (inches)</th>
<th>Duct Air Flow Capacity</th>
<th>Duct Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Air flow l/s (cfm)</td>
<td>Number Calves</td>
</tr>
<tr>
<td></td>
<td>2 m/s (400 fpm)</td>
<td></td>
</tr>
<tr>
<td>15 (6)</td>
<td>37 (79)</td>
<td>5</td>
</tr>
<tr>
<td>20 (8)</td>
<td>66 (140)</td>
<td>9</td>
</tr>
<tr>
<td>25 (10)</td>
<td>103 (218)</td>
<td>15</td>
</tr>
<tr>
<td>30 (12)</td>
<td>148 (314)</td>
<td>21</td>
</tr>
<tr>
<td>40 (16)</td>
<td>263 (559)</td>
<td>37</td>
</tr>
<tr>
<td>45 (18)</td>
<td>333 (707)</td>
<td>47</td>
</tr>
<tr>
<td>50 (20)</td>
<td>412 (873)</td>
<td>58</td>
</tr>
<tr>
<td>60 (24)</td>
<td>593 (1257)</td>
<td>84</td>
</tr>
<tr>
<td>75 (30)</td>
<td>926 (1963)</td>
<td>131</td>
</tr>
</tbody>
</table>

m/s = meter per second, fpm = feet per minute, l/s = liter per second, cfm = cubic feet per minute.
Number Calves based on 7 l/s (15 cfm) per calf.
## Outlet Hole Air Flow Capacity

<table>
<thead>
<tr>
<th>Hole Diameter (mm)</th>
<th>3 m/s (600 fpm) l/s (cfm)</th>
<th>4 m/s (800 fpm) l/s (cfm)</th>
<th>5 m/s (1000 fpm) l/s (cfm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 (0.5)</td>
<td>0.4 (1)</td>
<td>0.5 (1)</td>
<td>0.6 (1)</td>
</tr>
<tr>
<td>25 (1.0)</td>
<td>1.5 (3)</td>
<td>2.0 (4)</td>
<td>2.5 (5)</td>
</tr>
<tr>
<td>38 (1.5)</td>
<td>3.4 (7)</td>
<td>4.6 (10)</td>
<td>5.7 (12)</td>
</tr>
<tr>
<td>50 (2.0)</td>
<td>6.1 (13)</td>
<td>8.2 (17)</td>
<td>10.2 (22)</td>
</tr>
<tr>
<td>63 (2.5)</td>
<td>9.6 (20)</td>
<td>12.7 (27)</td>
<td>15.9 (34)</td>
</tr>
<tr>
<td>75 (3.0)</td>
<td>13.8 (29)</td>
<td>18.4 (39)</td>
<td>22.9 (49)</td>
</tr>
</tbody>
</table>

m/s = meter per second, fpm = feet per minute, l/s = liter per second, cfm = cubic feet per minute
## Throw Distance to still air

<table>
<thead>
<tr>
<th>Air Velocity</th>
<th>3 m/s (600 fpm)</th>
<th>4 m/s (800 fpm)</th>
<th>5 m/s (1000 fpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hole diameter</td>
<td>25mm 1 inch</td>
<td>50mm 2 inch</td>
<td>75mm 3 inch</td>
</tr>
<tr>
<td>Throw distance to still air</td>
<td>1.1 m</td>
<td>2.1 m</td>
<td>3.2 m</td>
</tr>
<tr>
<td></td>
<td>3.4 ft</td>
<td>6.9 ft</td>
<td>10.3 ft</td>
</tr>
</tbody>
</table>

m/s = meter per second, fpm = feet per minute
Duct

Trajectory of Air Stream

Air Velocity @ Hole Exit
700-1000 ft/min

Hole Angle

Height

Air Velocity @ calf level
<50 ft/min

Calf Pen

Pen Length

Alley Width

Pen Length

Horizontal Distance

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• **Technical points**

  - Fans mounted in wall, not inside barn
  - Sized at ~15 cfm / calf
  - One tube per ~25 ft of building width
  - Holes sized so the air exits at ~ 800 fpm
  - Holes punched at correct position depending on height of tube
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