

# Wintertime Factors Affecting Contaminant Concentration in Farrowing Barns

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## Background

Both acute and chronic respiratory diseases have been identified in workers who are exposed to dusts and waste gases generated by swine inside CAFOs.

In the Midwest, winter swine confinement operations have little ventilation.

Occupational exposure limits exist for contaminants found in CAFOs. However, due to the exposure mixture, industry guidelines have been proposed for swine CAFO workers.

### Contaminant Exposure Limits

Contaminant	ACGIH TLV	Industry Guidelines
Respirable Dust	3 mg/m <sup>3</sup>	0.23 mg/m <sup>3</sup> *
Carbon Dioxide (CO <sub>2</sub> )	5000 ppm	1540 ppm*
Ammonia (NH <sub>3</sub> )	25 ppm	7 ppm*
Hydrogen Sulfide (H <sub>2</sub> S)	1 ppm	---
Carbon Monoxide (CO)	25 ppm	---

\*Donham, et al. 1989

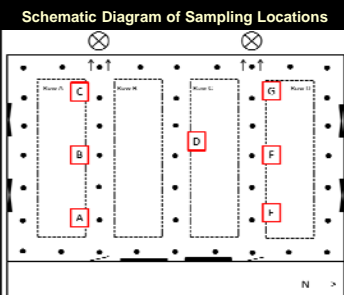
## Objectives

1. Does the pit fan reduce concentrations?
2. Does concentration change throughout the day?
3. What is the most efficient method to characterize concentrations?

## Methods

Measured 5 random days over 3-weeks, in winter, 19-crate farrowing room

- Fixed areas:
  - 7 stations (A-G)
  - Continuously throughout day
- Mobile monitoring for mapping:
  - 43 positions
  - Three 90-minute events per day



### Direct reading instrumentation

- Thermo pDR (respirable dust)
- TSI IAQ monitor (CO<sub>2</sub>, temperature)
- VRae multi-gas monitor (NH<sub>3</sub>, H<sub>2</sub>S, and CO)

## Results

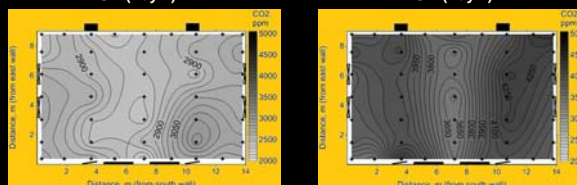
### Objective 1

Mean area contaminant concentration, with the exception of CO, was significantly higher when the pit fan was turned off.

Contaminant	Fan Setting	Mean	p*
Respirable dust, mg/m <sup>3</sup>	Off	0.47	<0.001
	On	0.33	
CO <sub>2</sub> , ppm	Off	3660	<0.001
	On	2920	
NH <sub>3</sub> , ppm	Off	8.36	0.001
	On	3.92	
H <sub>2</sub> S, ppm	Off	0.48	<0.001
	On	0.11	

\*Tukey Method of Multiple Comparisons

Mapping of CO<sub>2</sub> concentrations with pit fan:  
On (Day 1)      Off (Day 2)



### Objective 2

A significant change in area respirable dust and CO<sub>2</sub> mean concentrations occurred over time throughout the course of a sample day.

Throughout the day:

- Dust concentrations *decreased* by 77% (pit fan off) and 87% (pit fan on)
- CO<sub>2</sub> concentrations *increased* 24% (pit fan off)

Contaminant	Pit Fan On				Pit Fan Off			
	Event	Mean	Group	p*	Event	Mean	Group	p*
Respirable dust, mg/m <sup>3</sup>	1	0.38			1	0.50		
	2	0.36	1&2 v 3	<0.001	2	0.51	1&2 v 3	<0.001
	3	0.24			3	0.36		
CO <sub>2</sub> , ppm	1	2840			1	3160		
	2	2980	1 v 2&3	0.011	2	3870	1 v 2&3	<0.001
	3	2950			3	3940		

\*Tukey Method of Multiple Comparisons

### Objective 3

Daily mean respirable dust concentrations in the farrowing room were computed from three data sets.

- All methods nearly resulted in same ranking (high to low)
- Magnitude of concentration estimates varied by method
- Using 7 fixed area monitors resulted in highest mean concentration in nearly all cases

All daily mean respirable dust concentrations exceeded an industry guideline of 0.23 mg/m<sup>3</sup>.

Bolded data indicated concentrations > 0.1 TLV.

### Daily Mean (SD) Respirable Dust Concentrations, mg/m<sup>3</sup>

Day (Fan Setting)	One Fixed-Area Station (n=1)	Multiple Fixed-Area Stations (n=7)	Contaminant Mapping (n=43)
1 (on)	0.263 (0.110) <sup>5</sup>	0.296 (0.120) <sup>5</sup>	0.271 (0.086) <sup>5</sup>
2 (off)	<b>0.470</b> (0.152) <sup>1</sup>	<b>0.539</b> (0.186) <sup>1</sup>	<b>0.520</b> (0.162) <sup>1</sup>
3 (on)	0.271 (0.091) <sup>4</sup>	<b>0.345</b> (0.134) <sup>3</sup>	<b>0.337</b> (0.127) <sup>3</sup>
4 (off)	<b>0.371</b> (0.113) <sup>2</sup>	<b>0.394</b> (0.116) <sup>2</sup>	<b>0.398</b> (0.116) <sup>2</sup>
5 (on)	0.287 (0.092) <sup>3</sup>	<b>0.340</b> (0.110) <sup>4</sup>	0.298 (0.085) <sup>4</sup>

Superscript indicates concentration rank, over all days

## Conclusions

Pit ventilation reduces contaminant concentration in a farrowing barn during winter, but not below industry guidelines for respirable dust, CO<sub>2</sub>, and NH<sub>3</sub>.

Respirable dust and CO<sub>2</sub> concentrations changed significantly over the course of a sample day.

Data collection method chosen may affect decisions on risk: multiple fixed station monitors may provide the best snapshot of in-barn concentrations.

Recommend not to use a single 'central barn' sampler as an indication of average room exposure in a farrowing CAFO.

## Acknowledgements

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