Factsheet 1

April 2007

Principles of Measuring Indoor Air Quality

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EVALUATING LIVESTOCK HOUSING ENVIRONMENTS

To maintain a healthy environment for animals and pleasant working conditions for producers, environmental parameters inside livestock buildings should be measured correctly and carefully monitored. Measurement and control of these parameters are important, not only to maximize animal well-being and production as well as workers health and safety, but also to prolong the life of livestock building structures.

Many producers may not be aware of the implications and potential effect of poor indoor air quality (IAQ) on human and animal health, or on the deterioration of equipment and building components. At the end of the day, the incorrect assessment of IAQ may also have significant financial implications. Measurement and monitoring of IAQ are needed to guide producers in making decisions about their livestock operations and to provide them with better tools to effectively manage their operations.

Benefits for improving air quality:

- Improves the health, well-being and production performance of the animals.
- Improves the health and safety of producers and workers.
- Reduces emissions of harmful pollutants to the outside environment which helps reduce nuisance complaints.
- Results in significant energy and economic savings.
- Prolongs the life of building structures.

Elements to Measure

When evaluating IAQ in livestock housing, a number of known issues must be controlled to optimize the air quality:

- **Temperature**
- **Surrounding surface temperatures:** Surfaces need to be warm in the winter and not too hot in the summer.
- **Effective Environmental Temperature (EET):** The EET must be calculated and provides a good evaluation of the temperature the animal is effectively living in.
- **Relative Humidity (RH):** In winter, air that is too dry or too moist is harmful to animals. Excessive moisture can also cause structural damage.
- **Carbon Dioxide (CO_2):** Excessive CO_2 is harmful as it displaces oxygen and is an indicator of inadequate ventilation.
- **Carbon Monoxide (CO):** CO in barn air is caused by poorly operating heating systems that vent exhaust air back into the barn.
- **Ammonia (NH_3):** NH_3 released from manure causes respiratory challenges in humans and animals.
- **Hydrogen Sulfide (H_2S):** H_2S released from manure causes health problems in humans and animals and at certain levels can cause death. H_2S also increases equipment deterioration.
- **Dust:** Dust from feed, dander, concrete, etc. causes respiratory problems.

Temperature is the main environmentally controlled parameter. It is also the easiest to measure but tends to be the least understood. The temperature of walls and floors will affect animal comfort, as will cold air drafts. A process that takes into account multiple factors to determine if an environment is comfortable for the animals is called Effective Environmental Temperature (EET). It accounts for the combination of air and surrounding building surface temperatures plus the effect of air moving over the animals.

The ventilation system operation, which is responsible for many major aspects of IAQ, should also be evaluated. This is the topic of the third factsheet in this series, *Optimizing Ventilation System Performance*. System characteristics that are easily measured include, temperature and relative humidity control, static pressure differences that the fans operate at and the impact on overall airflow rates and air speed at inlet

openings. However, instruments must be used properly to obtain measurements that truly represent the system. Airflow visualization is a useful tool to evaluate environmental conditions and the ventilation system's air distribution.

There are other gases and issues that equally affect the indoor environment. Each farm needs to determine what these may be and how to monitor and record these environmental parameters. Examples include the static pressure lighting and even factors such as wind shelters.

▲ Air distribution, heating, fans, lighting and even the surroundings such as penning in the barn affect the environment.

▲ Lighting, summer cooling and ventilation must be carefully controlled in dairy environments.

What makes one indoor animal environment better than another? Instruments allow producers to objectively evaluate and quantify environmental parameters. Instrument readings can be compared to recommended environmental levels. The second factsheet in this series, *Instruments for Measuring Indoor Air Quality*, describes different types of instruments and how to take proper measurements.

An evaluation IAQ must emphasize the animal environment, which is not necessarily the same environment in which a human would feel comfortable. IAQ characteristics are most important in the zone where the animals are confined. Animal health and comfort must be the primary concern in livestock facilities.

Principles of Measuring

1. Measure the right thing, in the right place.

Measure characteristics of air the animals are breathing and/or the air blowing over their bodies. If cow comfort is the issue, get in with the cows and measure the air quality in their zone. Get down to the level of the pig's nose. Go into the sleeping areas of penned animals and within or at least between the cages of layer hens. Air characteristics such as temperature, humidity, and particularly levels of contaminant gases such as ammonia can vary greatly within a livestock confinement zone. Compare measurements taken in resting, eating, and manure handling areas.

Note: *each room or zone in a facility must be individually checked.*

2. What is the instrument measuring?

Instruments can only measure what they are exposed to. In most cases, it will take several minutes for the device to accurately read the actual condition. Always spend some time when you first get a new device and check it in a known environment such as the barn office or in your home. Other issues can affect readings, for example, an air draft over the glass tube can affect the readings of some gas detection devices. Light meters will be affected by your shadow.

Decide what it is that you want to measure and position the instrument to most appropriately measure that quantity.

3. Understand how your instrument works.

Most low cost digital devices cannot be recalibrated. Once the number shown is incorrect, you must either replace it (recommended) or note how far out it is and adjust the readings (check with the manufacturer or an engineer before adjusting readings).

Some instruments may work well for a while in livestock buildings but then go out of calibration. The best way to check the calibration of a digital thermometer is against a standard bulb type thermometer in a location where temperature changes are small, such as the barn lunchroom or in the house. Most other digital devices need to be compared to a device that measures the same air characteristic. Livestock housing is too dusty, humid, or dirty for some instruments to work properly. Check to be sure the device is recommended for use before purchasing.

4. Question each reading.

Once you have started to use a device, make sure the reading makes sense. You may need to take more than one reading or multiple readings in different areas to get a picture of what is happening.

5. Record your readings and observations.

For many barns, it makes good sense to record the readings from both the device and from a controller setting (if applicable). If the difference is significant, for example, the controller temperature says 21°C but your device reads 19°C, then further investigation is required to correct the problem. Be aware that day-to-day and even hourly differences occur for many reasons such as outside conditions and animal activity during the reading. Whenever possible, use a recording data logger or device with maximum/minimum recall or simply more than one "reading session" to correctly characterize an environment.

Table 1. Suggested monitoring frequency and type

Measured Parameter	Monitoring Frequency	Monitoring Type			Comments
		Spot Reading	Max/Min Reading	Data Log Reading	
Temperature	Daily		✓	✓	Data log a production cycle once
Surrounding surface temperatures	Annually	✓			To identify insulation and leakage issues
Relative humidity	Heating season	✓		✓	Data log a production cycle once
Carbon dioxide	Heating season	✓			Usually in coldest weather
Carbon monoxide	Heating season	✓			Only when using direct fired, unvented heaters
Ammonia	Monthly	✓			Usually in cold weather
Hydrogen sulfide	When moving manure	✓			Recommended to take H_2S Awareness course
Dust	Seasonally			✓	Requires knowledgeable professional

Now What?

Once measurements are taken, the numbers should be compared to desirable or target conditions (see factsheet 2). Improvements to environmental quality can then be pursued with more certainty about current conditions and future achievements. Desirable air quality characteristics depend on animal species and age.

Within livestock housing, a range of temperature and humidity levels are acceptable. Contaminant gases and dust levels need to be kept below a threshold. For young animals, air speed is kept below a certain level to avoid chilling while for adult livestock during hot weather, there will be a minimum desired air speed for cooling effect. These recommended air quality characteristics are the goals for a productive animal environment. With instruments, producers can evaluate current conditions and after analysis make recommendations for improvement.

Factsheets in this Series

Factsheet 1 Principles of Measuring Indoor Air Quality

Factsheet 2 Instruments for Measuring Indoor Air Quality

Factsheet 3 Optimizing Ventilation System Performance

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