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Analysis of Sampling Protocols for the EPA Animal Feeding Operations Consent Agreement

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Consent Agreement

- Two-year, nationwide air emission monitoring study
- Determine compliance of AFOs with the CAA, CERCLA, and EPCRA
- Determine emission rates of specified air pollutants from AFOs

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Consent Agreement

Animal	Facility	Pollutants to be Monitored
Swine	Mechanically Ventilated Barns	NH_3, H_2S, CO_2, TSP, $PM_{2.5}$, PM_{10}, VOC
	Lagoons	NH_3, H_2S, VOC
Laying Hens	Mechanically Ventilated Barns	NH_3, H_2S, CO_2, TSP, $PM_{2.5}$, PM_{10}, VOC
Meat Birds	Mechanically Ventilated Barns	NH_3, H_2S, CO_2, TSP, $PM_{2.5}$, PM_{10}, VOC
	Open Manure Piles	NH_3, H_2S
Dairy	Naturally Ventilated Buildings	NH_3, H_2S, CO_2, TSP, $PM_{2.5}$, PM_{10}, VOC
	Manure Storage Systems	NH_3, H_2S, VOC
	Mechanically Ventilated Buildings	NH_3, H_2S, CO_2, TSP, $PM_{2.5}$, PM_{10}, VOC

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Ammonia Emissions

Mechanically Ventilated Swine, Poultry, and Dairy Barns

- Chemiluminescence
- Photoacoustic Infrared
- Airflow

Manure Storage and Naturally Ventilated Dairy Barns

- FTIR
- UV-DOAS
- Gaussian Modeling
- BLS modeling

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Chemiluminescence

Method:

- Oxidizes ammonia to form excited NO_2
- Measures radiation emitted during reduction

Pros:

- Sensitivity range from 1 ppb to 500 ppm
- Precision of ±3 ppb

Cons:

- Requires frequent and careful calibration
- Does not usually achieve 100% conversion
- Other chemicals are also converted to NO_2
- Cannot measure adsorbed ammonia

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Photoacoustic Infrared

Method:

- Measures absorption of infrared radiation

Pros:

- Selectivity and sensitivity can be enhanced
- Detection range down to 20 ppb
- Effects of temperature and pressure are known

Cons:

- Require frequent and careful calibration
- Sensitivity is not isolated to ammonia
- Cannot measure adsorbed ammonia

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Airflow

Method:

- Fan Assessment Numeration System (FANS)
- Continuously measure static pressure and fan operational status

Pros:

- Yields in situ airflow measurements
- Accounts for changes in performance with static pressure and use

Cons:

- Static pressure can vary across a building
- Cannot perform FANS test in an occupied building
- Time consuming

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FTIR

Method:

- Measures absorption peaks of infrared light
- Interprets peaks using Fourier Transformations

Pros:

- Isolates species of interest
- Detection limit of 1.5 ppb

Cons:

- Requires frequent and careful re-calibration
- Requires costly standard gas mixtures
- Requires an experienced operator to yield good results

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UV-DOAS

Method:

- Measures absorption peaks of UV light
- Compares sampled spectra with a calibrated database of calibrated absorption spectra

Pros:

- Corrections for interfering gases are available

Cons:

- Limited effective measurement distance
- Mixed review of data quality

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Modeling

Gaussian Modeling

- Used by the USEPA for regulatory purposes
- Assumes normal distribution of pollutants
- Accuracy has long been debated

Lagrangian Stochastic Modeling

- Attempts to determine particle trajectories
- Requires fewer sampled data points

"Cross-model" Issue

When emission factors from WindTrax (bLS model) are used in ISCST3 (a Gaussian model), the modeled concentrations are approximately 10 times the measured concentrations (Price et al, 2004)

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PM Emissions

Mechanically Ventilated Swine and Poultry Facilities

- TSP – Isokinetic Multipoint Gravimetric Samplers
- PM_{10} – TEOMs with PM_{10} pre-collectors
- $PM_{2.5}$ – FRM $PM_{2.5}$ Sampler (for at least one month)

Dairy Facilities

- Little specific protocol
- “particle samplers located with a sampling height of 5m”

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TSP Emissions

Sampling

- Isokinetic multipoint gravimetric samplers
- No detail is given on the filter media to be used

Analysis

- No detail is given

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PM_{10} Emissions

Method:

- TEOMs with PM_{10} pre-collectors

Pros:

- USEPA equivalent method
- Continuous monitoring

Cons:

- Uncertainties with airflow measurements
- Significant differences between TEOM and gravimetric sampling concentration data
- Over sampling bias of PM_{10} pre-collectors in agricultural environments

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$PM_{2.5}$ Emissions

Method:

- Gravimetric FRM sampler
- Monitored for at least one month per site

Pros:

- Insufficient details are available

Cons:

- Over sampling bias of $PM_{2.5}$ pre-collectors in agricultural environments
- Limited sampling times will not allow for measurement of temporal variations

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Conclusions

- Amendments should be made to the Consent Agreement's sampling protocol to address deficiencies in the current plan and quantify uncertainties associated with measured and calculated values.

- Data and emission factors derived from sampling under the Consent Agreement should be used cautiously and applied only with an understanding of the limitations of the sampling protocol.