# HAZARDOUS POLLUTION FROM FACTORY FARMS: AN ANALYSIS OF EPA'S NATIONAL AIR EMISSIONS MONITORING STUDY DATA

**ENVIRONMENTAL INTEGRITY PROJECT**[1]
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## Summary

Rural residents have long complained about the stench and air pollution from industrial scale livestock operations. New data just released by the Environmental Protection Agency (EPA) suggest these complaints are well-founded. The results of a two year air monitoring study jointly sponsored by EPA and the livestock industry reveal that the air at some Concentrated Animal Feeding Operations (CAFOs) may be unsafe, with levels of particulate matter, ammonia, or hydrogen sulfide at many sites well above federal health-based standards. Five years ago, EPA suspended enforcement of air pollution laws against CAFOs until the study was complete, and in 2008, EPA exempted CAFOs from most pollution reporting requirements altogether. But the study shows that many CAFOs pollute in quantities large enough to trigger emission reporting laws that have applied to most other large industries for decades, and that Clean Air Act protections may be warranted to protect rural citizens.

### *Particulate Pollution*

Fine particle pollution ($PM_{2.5}$), made up of solid particles and liquid droplets small enough to inhale, as well as slightly larger $PM_{10}$ particles, can damage the lungs and heart and cause premature death. Although based on a limited number of samples, the EPA/industry study measured levels of particle pollution well above Clean Air Act health based limits at some sites:

- Federal air quality standards are designed to limit peak exposure to fine particle concentrations to no more than 35 micrograms per cubic meter (µg/m3) averaged over 24 hours. Fine particle pollution was much higher than that on the worst days at 6 of 15 study sites, including 5 poultry operations in California, Indiana, and North Carolina, and a Washington dairy.

- Peak 24-hour exposures at two henhouses in California and one in Indiana were more than three times higher than EPA's 35 microgram standard. At one Indiana site, short-term limits for fine particles were exceeded on half the days measured, reaching as high as 132 micrograms on the worst day.

- The Clean Air Act is also meant to limit average annual exposure to no more than 15 micrograms per cubic meter. Average fine particle concentrations at all six sites were well above this standard, ranging from 19.8 micrograms to 45.3 micrograms.

- Because particles up to ten microns in size can also irritate the lungs, the law is also supposed to limit exposure to $PM_{10}$ to no more than 150 micrograms per day. The same 6 sites also exceeded this standard on the worst days, as did a California dairy.

***Ammonia***

Ammonia ($NH_3$) can damage the respiratory system and is life-threatening at high concentrations. Federal law requires ammonia sources to report emissions above 100 pounds per day, although EPA has not set air quality standards for this pollutant.

- Based on sampling results, 11 of 14 CAFOs[2] in the study emit more than 100 pounds of ammonia on average days, and some emit thousands of pounds on their worst days. The biggest emitters include hog CAFOs in Indiana, Iowa, Oklahoma, and North Carolina, dairies in Indiana, Washington, and Wisconsin, and egg layer or broiler chicken facilities in California, Indiana, and North Carolina.

- EPA has determined that long-term exposure to levels above 140 parts per billion could pose health risks to sensitive populations. Average ambient concentrations of ammonia at all 15 sites were greater than 140 parts per billion (ppb), and three to ten times higher at ten of the sites.

- The National Institute for Occupational Safety and Health (NIOSH) recommends that workers be exposed to no more than 35 parts per million of ammonia in any fifteen minute period. Ammonia concentrations in the exhaust from swine barns (IA, IN, and NC), and henhouses (CA, IN, NC) were much higher than that *for entire days*, reaching levels above 200 parts per million in two locations. The data suggest that working near these emission points for even a few minutes may be hazardous, although ammonia concentrations are likely to be lower by the time they reach the CAFO property line.

***Hydrogen Sulfide***

Hydrogen sulfide ($H_2S$) also causes respiratory symptoms, damages the eyes, and is fatal at high concentrations. As with ammonia, there are no federal air quality standards for hydrogen sulfide, but federal right-to-know laws require companies to report emissions that exceed 100 pounds per day.

- Study measurements show that a swine CAFO in Iowa released more than 100 pounds a day on certain days of the study, and nearly exceeded the limit from one barn alone. Three dairies in the study also likely exceeded the reporting limit on certain days, based on emissions estimates in the study. While oil refineries are a recognized source of hydrogen sulfide, the data suggest that large hog and dairy CAFOs release comparable amounts of the same pollutant.

- NIOSH recommends limiting occupational exposures to hydrogen sulfide to no more than ten parts per million for ten minutes at a time. Average daily concentrations in the exhaust from one Iowa barn exceeded that amount for three days, and the other barn for two, suggesting workers in the area might be at risk. Other monitoring sites also likely exceeded NIOSH guidelines, but daily averaging of study data prevented EIP from isolating peak, short term exposures.

- Texas has established an enforceable air quality standard of 80 parts per billion of hydrogen sulfide averaged over half an hour, due to the pollutant's effects on those downwind. The air around 7 hog and dairy sites – nearly half of the confinements studied – exceeded this level for entire days during the study. Long-term ambient levels of hydrogen sulfide were also significantly higher than EPA's reference concentration of 1 ppb at most study sites.

**Recommendations**

- CAFOs release as much or more pollution as other large industries, and should be required to report their emissions. EPA should remove Bush Administration actions shielding CAFOs from enforcement of the Clean Air Act and from having to comply with right-to-know laws.

- The Clean Air Act should protect rural residents, not just those living in major metropolitan areas. EPA should set air quality standards for hydrogen sulfide (as Texas has already done), and for ammonia.

- EPA should also take steps to improve the quality and utility of the data for the public:

- The Purdue study identifies daily average pollution levels, but high levels of ammonia and hydrogen sulfide can be hazardous over much shorter periods of time. EPA should use the study's minute-by-minute monitoring data to calculate short-term pollution levels as well as 24-hour averages, and determine whether spikes in pollution in either emissions or the air surrounding CAFOs pose a threat to workers or public health.

- The results may underestimate pollution, as the daily average pollutant concentrations reported include "negative" values that represent erroneous samples. The daily and overall emission averages should be recalculated to remove all negative values and other clearly erroneous data.

- The Purdue data should be thoroughly peer reviewed, with an independent committee established to review both air quality data and estimates of emissions from CAFO test sites. The committee should include representatives from the public health community and advocates for citizens concerned about CAFO air pollution as well as industry. EPA should also establish a docket and make public communications between the agency and any interested party during the study and its later review.

(For further explanation of EPA's methodology and the limitations of the data, see pages 6-7.)

| FACILITY INFORMATION | PM 2.5 (µg/m³) | | | | PM 10 (µg/m³) | | Ammonia (ppm) | | Hydrogen Sulfide (ppb) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Max Daily[1] | Standard[2] | Avg Daily[3] | Standard[4] | Max Daily[5] | Standard[6] | Max Daily[7] | Worker Advisory[8] | Max Daily[9] | Standard[10] |
| CA1B: Broiler (Barn) | **85.7** | | **21.8** | | **262** | | **219** | | 25.4 | |
| CA2B: Egg Layer (Barn) | **112** | | **28.6** | | **363** | | **129** | | 11.4 | |
| CA5B: Dairy (Barn) | 25 | | 11.84 | | **162** | | 1.8 | | **127** | |
| IA4B: Swine (sow) (Barn) | 25.7 | | 9.6 | | 84.2 | | **73.6** | | **215** | |
| IN2B: Egg Layer (Barn) | **132** | | **45.3** | | **1870** | | **204** | | 35.3 | |
| IN2H: High Rise Barns | **119** | | **19.8** | | **583** | | **182** | | 64.9 | |
| IN3B: Swine Finisher | 31.4 | **35 µg/m³/ 24 hours (EPA)** | 13.9 | **15 µg/m³/ Year (EPA)** | 83.8 | **150 µg/m³/ 24 Hours (EPA)** | **58** | **35 ppm/ 15 min (NIOSH)** | **120** | **80 ppb/ 30 min (TX)** |
| IN5B: Dairy Barns | 34.4 | | 13 | | 99 | | 9 | | **87.3** | |
| NC2B: Egg Layer (Barn) | **59.3** | | **23.3** | | **232** | | **73** | | 15.5 | |
| NC3B: Swine Finisher (Barn) | 29.4 | | 10.2 | | 54.6 | | **44.3** | | 56.6 | |
| NC4B: Swine (sow) (Barn) | 12.6 | | 3.4 | | 67 | | 29.1 | | **2400** | |
| NY5B: Dairy (Barn) | 28.2 | | 9.2 | | 93 | | 14.5 | | 32 | |
| OK4B: Swine (sow) (Barn) | 16.7 | | 8.6 | | 133 | | 18.2 | | **1340** | |
| WA5B: Dairy (Barn) | **45** | | **23** | | **487** | | 5.17 | | **217** | |
| WI5B: Dairy (Barn) | 33 | | 9.8 | | 83 | | 7.4 | | **159** | |

[1] Maximum 24 hour average concentration, measured at ambient or inlet monitors.
[2] 40 CFR 50.7(a).
[3] Average of all daily mean measurements, measured at ambient or inlet monitors.
[4] 40 CFR 50.7(a).
[5] Maximum 24 hour average concentration, measured at ambient or inlet monitors.
[6] 40 CFR 50.6(a).
[7] Maximum 24 hour average concentration, measured at exhaust monitors
[8] Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Pocket Guide to Chemical Hazards: Ammonia, http://www.cdc.gov/niosh/npg/npgd0028.html.
[9] Maximum 24 hour average concentration, measured at ambient or inlet monitors.
[10] 30 Tex. Admin. Code § 112.31.

## Background

Newly released research confirms that the large CAFOs, or factory farms, that dominate the nation's meat industry are major sources of ammonia emissions and other dangerous air pollutants. The Bush Administration crafted a backroom deal with the factory farm industry in 2005, offering years of amnesty from enforcement of the Clean Air Act and other air pollution laws in exchange for an industry-funded study of factory farm air emissions.[3] EPA recently released the initial data from this National Air Emissions Monitoring Study (NAEMS),[4] and the results indicate that emissions from many poultry, hog, and dairy operations are substantial and pose a threat to public health.

With industry support and funding, Purdue University conducted the two years of air quality monitoring at 15 livestock confinement sites, 9 livestock waste lagoons, and a dairy corral in 9 states, measuring background concentrations and emissions of ammonia, hydrogen sulfide, particulates, and volatile organic compounds (VOCs). EPA approved Purdue's methods and supervised the study. In January, Purdue presented the results to EPA as a series of site-specific summary reports and data sets that EPA made available to the public without further analysis. Purdue measured background levels and emission levels of air pollutants at one-minute intervals, and then compiled those results into 24-hour averages.[5] The researchers then used airflow rates to extrapolate from these pollution concentrations and estimate daily averages of the total quantity of pollutants emitted by each barn or house.

Environmental Integrity Project (EIP) analyzed these initial reports, comparing CAFO air pollution with established health standards and emissions reporting rules to assess the need for increased public health protections from factory farm emissions.

## Limitations of the Data

NAEMS consisted of two types of monitoring: confinement barn sources, and open sources. This analysis addresses only the data from the 15 confinement sites (referred to in this report as confinements, houses, or barns), and does not address the less comprehensive open source data, which measured emissions of just two pollutants – ammonia and hydrogen sulfide – from manure lagoons and a Texas dairy corral, and which measured these pollutants on far fewer days.

In addition to particulates, ammonia, and hydrogen sulfide, NAEMS monitored volatile organic compounds (VOCs) at barn sites. However, due to limits in the study's methods for monitoring VOCs as well as problematic results, EIP did not consider VOC exposures in this analysis. Purdue conducted extremely limited VOC sampling, and did not collect samples throughout the year to obtain a complete picture of emission trends. For example, at the

California broiler site CA1B, researchers sampled VOCs for only seven days, all of which fell within a three-month period.[6]

Purdue's analysis of this sparse VOC data created further problems. The study estimated total emissions by subtracting inlet VOC concentrations at confinement building air intake points ("inlet" concentrations) from exhaust point concentrations, and then multiplying the concentration of VOCs in the sample by the airflow that passed through it.[7] At certain locations, the samples at inlet points had higher VOC readings than the exhaust samples, which led to a negative total emission calculation. As a result, high VOC levels around CAFO buildings actually served to reduce estimates of total emissions. Rather than acknowledge and attempt to correct these absurd results, Purdue presents the negative emissions results without adequate explanation in its summary reports.[8] While EPA should not use the lack of useful NAEMS VOC data as a reason to delay regulation of VOC pollution from factory farms, the NAEMS VOC monitoring did not provide enough credible data to consider here.

Several additional factors limited EIP's ability to comprehensively assess the health threats posed by CAFO emissions documented in NAEMS, including the averaging of the data. Purdue took measurements at one-minute intervals, but presented the data in 24-hour averages and has not yet made the raw data publicly available.[9] Twenty-four hour averages adequately show overall trends during the two-year study, but obscure short-term variations in pollution levels that could affect the health risks of living or working near a factory farm.

Purdue's analysis also likely underestimates pollution, and more study sites than are identified in this analysis may exceed Clean Air Act and other health standards. Monitoring errors or other unexplained problems with the study resulted in numerous negative values for pollutant emission concentrations, and to a lesser extent inlet concentrations of the pollutants. Purdue neglected to remove these negative values before calculating 24-hour averages and again before compiling the 24-hour averages to establish overall averages for the 2-year study. Because negative concentrations of pollution are clearly impossible, EIP recalculated overall averages by removing negative 24-hour average values.

However, because the raw data points showing pollution concentrations by the minute are not available in the summary reports, EIP was unable to remove individual negative monitoring values from the daily averages. As a consequence, daily average emissions of $PM_{2.5}$, $PM_{10}$, ammonia, and hydrogen sulfide are in some cases under-represented to an undetermined degree. This in turn resulted in calculations of total emissions (e.g. grams per day of particulates) that underestimate CAFO pollution. This report therefore cannot conclusively determine whether some large CAFOs may surpass regulatory limits such as the Clean Air Act permitting thresholds for particulate matter or reporting limits for ammonia and hydrogen sulfide.[10]

## Health Threats from Factory Farm Pollution

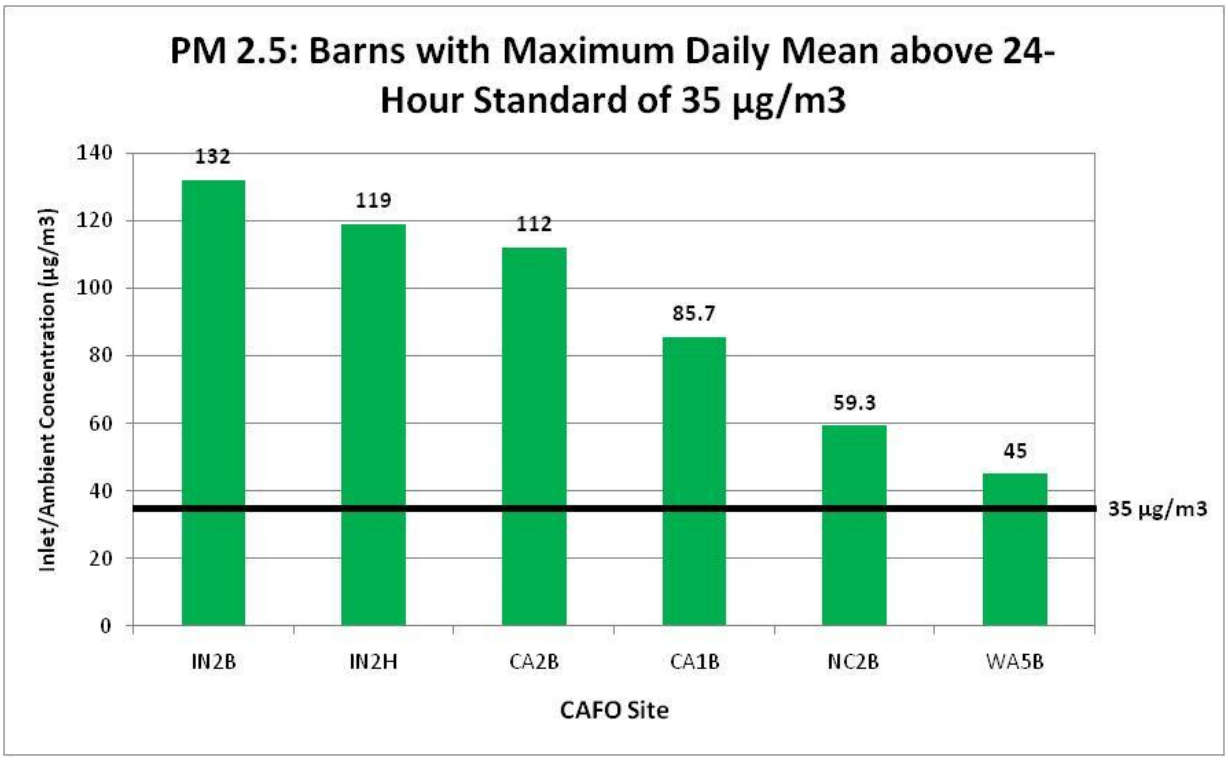
Each of the pollutants monitored in EPA's study poses health threats to individuals exposed to high enough concentrations over a long enough period of time. Ammonia is a respiratory and eye irritant that can cause numerous symptoms ranging from mild cough and sore throat to inflammation, burns, and at very high concentrations, death.[11] Small particulates pose a less obvious threat, lodging deep in the lungs where they may decrease lung function, worsen asthma and respiratory symptoms, and increase risk of heart attacks and premature death.[12] Slightly larger $PM_{10}$ particulates tend to lodge higher in the airway, but contribute to many of the same adverse effects on the heart and lungs as fine particles.[13] Hydrogen sulfide gas, like ammonia, causes respiratory and eye irritation, and at increased levels can also cause nervous system effects, unconsciousness, long-term neurological symptoms, and death.[14]

Because of these risks, EPA and other federal agencies have established health thresholds, Clean Air Act requirements, and emissions reporting requirements meant to inform the public about potential risks and protect human health from these pollutants. Comparisons of the emissions data with these federal benchmarks demonstrate that factory farms pollute on an industrial scale, yet have escaped most air pollution regulations that apply to other large emitters.

## Small and Large Particle Pollution

NAEMS monitored several sizes of particulate matter, including $PM_{2.5}$, which is comprised of solid or liquid particles 2.5 microns or smaller in diameter. EPA regulates fine particles under the Clean Air Act, and has established both short- and long-term health standards for $PM_{2.5}$ in the ambient air. The 24-hour average standard is 35 micrograms per cubic meter ($\mu g/m^3$), and the annual average standard is 15 $\mu g/m^3$.[15]

The emissions study measured $PM_{2.5}$ levels in the ambient air near confinement sites sporadically during the 2-year study, ranging from as few as 32 monitoring days at one site up to 145 monitoring days at another site.[16] Even without continuous monitoring, the inlet/ambient air at several CAFO sites – primarily poultry operations – exceeded the short-term health standard some days. Emissions monitoring of the exhaust air leaving confinement buildings was less frequent, with as few as 21 sampling days at one site, ranging up to 64. Though the study measured $PM_{2.5}$ emissions less frequently than ammonia and hydrogen sulfide, infrequent $PM_{2.5}$ monitoring is common even for regulated $PM_{2.5}$ sources like coal-fired power plants.

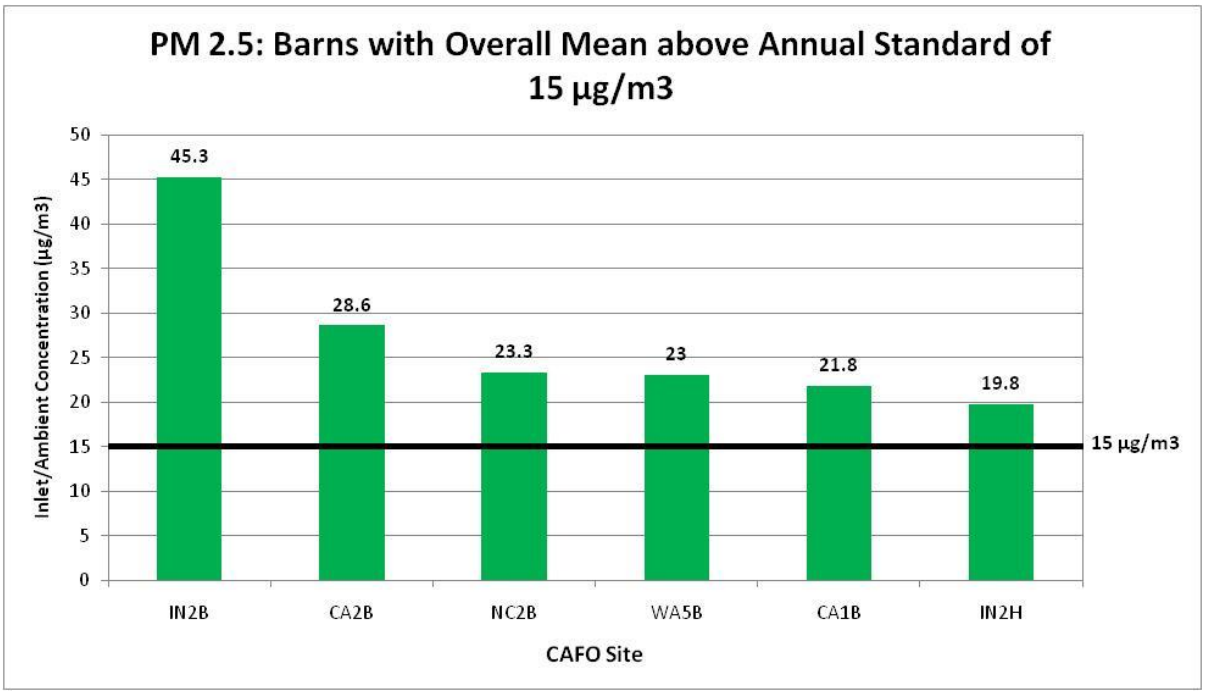



As shown above, six of the fifteen confinement sites exceeded EPA's short-term $PM_{2.5}$ health standard on their worst days. Four of the sites recorded concentrations more than twice that limit, with an Indiana egg laying operation recording an incredible 132 $\mu g/m^3$ – almost four times the short-term Clean Air Act limit. Moreover, five of these six sites – IN2B, IN2H, CA2B, CA1B, and NC2B – are poultry operations, and four – all but the broiler site CA1B – are egg laying operations.

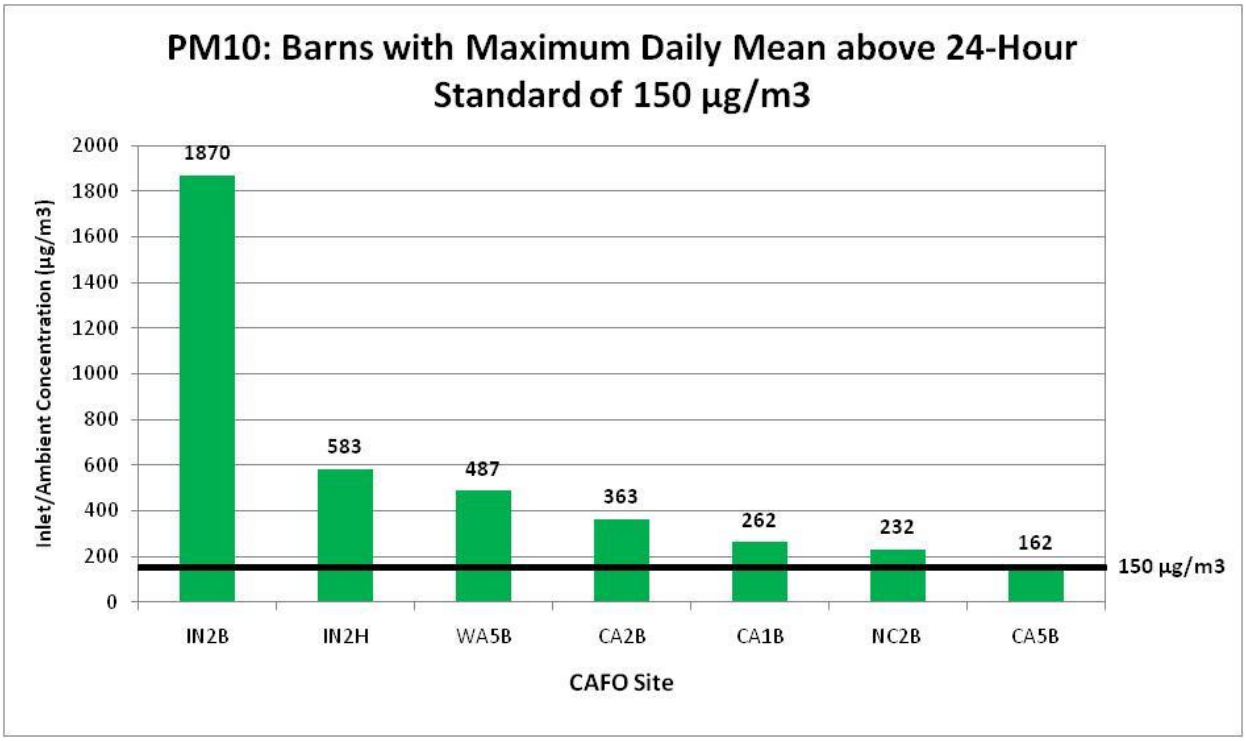
Five of these six facilities exceeded the short-term Clean Air Act standard on multiple occasions, despite the fact that $PM_{2.5}$ monitoring only took place sporadically.

| Site | $PM_{2.5}$ Sampling Days | Days Over Standard | Percent Over Standard |
|---|---|---|---|
| IN2B | 60 | 30 | 50% |
| CA2B | 32 | 6 | 19% |
| WA5B | 37 | 6 | 16% |
| NC2B | 145 | 18 | 12% |
| IN2H | 43 | 4 | 9% |

Intake levels of $PM_{2.5}$ averaged over the entire 2-year study at all of these 6 sites also exceeded the Clean Air Act's long-term exposure standard. Yet again the Indiana layer site set the record, with an average fine particulate concentration more than triple EPA's health standard at its air inlet monitoring locations.




On separate dates, the study also measured larger particulates up to 10 microns in diameter ($PM_{10}$), which also pose significant public health threats. EPA has established a short-term standard of 150 µg/$m^3$ averaged over 24 hours, and seven sites exceeded this standard at some point while $PM_{10}$ monitoring was taking place at the site. These sites include all six sites that exceeded the $PM_{2.5}$ standards, as well as the CA5B dairy.



As shown above, inlet/ambient air at 7 of the 15 sites exceeded the $PM_{10}$ standard, and 4 sites had days with $PM_{10}$ levels more than double the standard. The Indiana egg layer site again had the highest readings. Air entering the IN2B facility reached 1,870 $\mu g/m^3$ on its worst day – more than *12 times* EPA's 24-hour limit. In addition, all 7 of these sites exceeded the $PM_{10}$ standard on more than one sampling day during the study.

| Site | $PM_{10}$ Sampling Days | Days Over Standard | Percent Over Standard |
|---|---|---|---|
| IN2B | 366 | 99 | 27% |
| IN2H | 471 | 89 | 19% |
| WA5B | 449 | 87 | 19% |
| CA2B | 556 | 26 | 5% |
| CA1B | 537 | 18 | 3% |
| NC2B | 536 | 5 | 0.9% |
| CA5B | 588 | 3 | 0.5% |

Purdue elected to take background measurements of particulates at the intake to the confinement buildings, rather than at the property line or elsewhere in the ambient air, at 14 of the 15 sites. Ambient measurements at the fence line or other short distance from the facility would have provided more useful information about the potential health risks to the surrounding community. However, the NAEMS results are still significant for workers and neighbors living close to factory farms, or who may be exposed to emissions from numerous facilities.

Ammonia emissions from the CAFOs mixing with other gases in the surrounding air may explain some of the high small particulate levels recorded outside confinement buildings. Studies have found that ammonia gas reacts readily with acidic compounds in the air, such as nitric acid, hydrochloric acid, and sulfuric acid, forming small particles of ammonium aerosols.[17] These particles of ammonium nitrate and ammonium sulfate have diameters smaller than 2.5 microns, and thus qualify as $PM_{2.5}$. Indeed, EPA recognizes ammonia as a $PM_{2.5}$ precursor pollutant but does not require all states to regulate it under their Clean Air Act programs.[18] As a result, the combination of gases emitted by CAFOs may indirectly increase localized levels of small particulates when they mix with each other as well as with pollutants already in the air, and simultaneously increase health risks to workers and nearby neighbors. EPA staff have stated that the agency does not plan to consider such indirect emissions and pollutant interactions when establishing its emission estimating methodologies for the pollutants studied, but that another EPA office will model the impact of ammonia pollution on $PM_{2.5}$.[19]

Despite serious limitations in both the NAEMS study itself and Purdue's data analysis, the $PM_{2.5}$ and $PM_{10}$ data available show that the air around several CAFO sites contains unsafe levels of particulate pollution. EPA should conduct an independent analysis of the raw data and other existing research to determine whether particulate pollution from factory farms necessitates Clean Air Act permits to protect nearby residents. This analysis should consider the role ammonia plays as a $PM_{2.5}$ precursor pollutant.

## Ammonia

The data confirm that CAFOs are also major sources of ammonia emissions. Two federal right-to-know laws – the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, and the Emergency Planning and Community Right-to-know Act (EPCRA) – require industrial sources of hazardous air pollutants to report emissions when those emissions exceed the pollutant's "reportable quantity." Two such hazardous air pollutants are ammonia and hydrogen sulfide, each of which has a reportable quantity of 100 pounds per day.[20] In a 2008 midnight rule, the Bush Administration EPA exempted the livestock industry from the vast majority of reporting requirements; as a result, only CAFOs with more than a certain number of animals must now report emissions, and only to state and local EPCRA, not federal CERCLA, officials.[21] Moreover, the rule allows CAFOs that do report to use the limited reporting reserved for emissions that do not fluctuate significantly over time.[22]

The results of EPA's emissions study demonstrate the need to overturn the exemption rule, both because it shows that factory farm releases of ammonia frequently exceed the reporting threshold that applies to other industries, and because the results indicate that the quantity of pollution emitted from factory farms varies dramatically throughout the year. Frequent, ongoing emissions reporting is necessary to provide rural communities with accurate information about the pollution to which they are exposed, and the current reporting requirements do not reflect real-world CAFO emissions or protect rural communities.

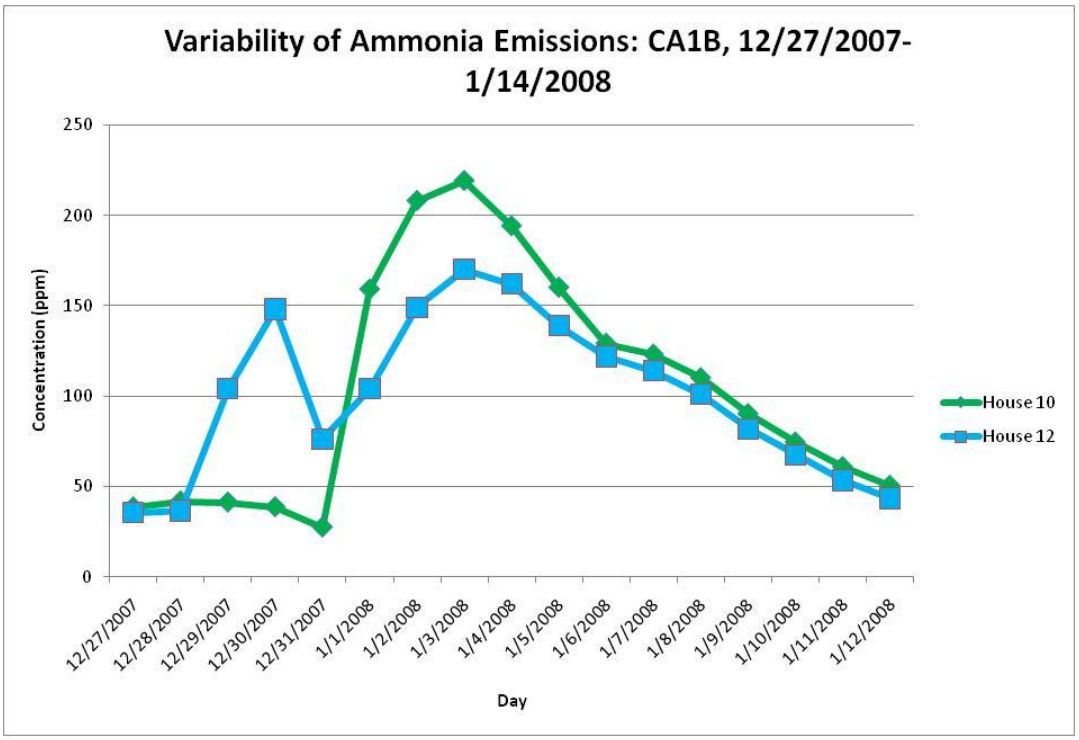
| **CAFOs Emitting > 100 Pounds Ammonia per Average Day** |
|---|
| **CA1B:** California broiler operation with 336,000 bird capacity |
| **CA2B:** California egg laying operation with 912,000 bird capacity |
| **IA4B:** Iowa sow facility with 2,500 head capacity |
| **IN2B/IN2H:** Indiana egg laying operation with 2.9 million hen capacity |
| **IN3B:** Indiana swine finisher with 8,000 hog capacity |
| **IN5B:** Indiana dairy with 3,400 cow capacity |
| **NC2B**: North Carolina egg layer CAFO with 618,000 hen capacity |
| **NC3B:** North Carolina swine finisher with 7,200 hog capacity |
| **OK4B:** Oklahoma swine operation with 2,800 hog capacity |
| **WA5B:** Washington dairy with 5,600 cow capacity |
| **WI5B:** Wisconsin dairy with 1,700 cow capacity |

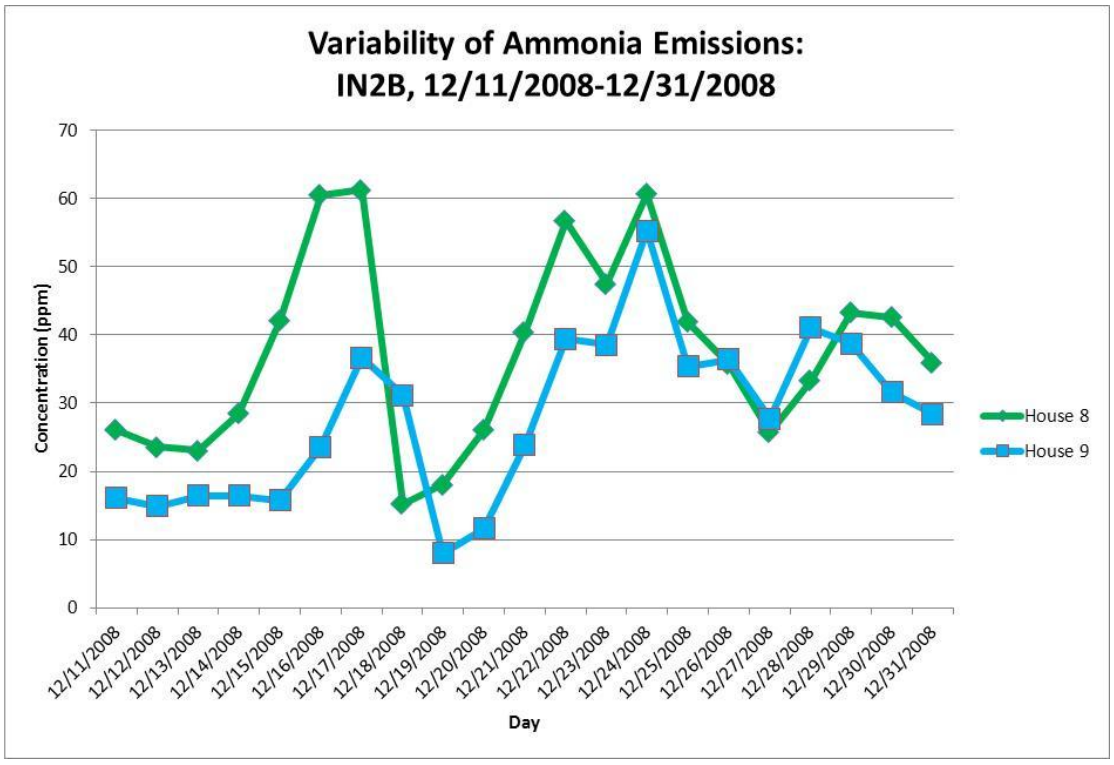
The chart above shows that most CAFOs in EPA's study exceed the reportable quantity of ammonia on an average day. Because the study did not estimate each CAFO's total emissions, but rather only emissions from each barn or house monitored, the conclusions drawn in this report relied on rough extrapolations of the barn emission estimates based on the total animal numbers at each facility. The most dramatic example of high ammonia emissions in EPA's study is again the Indiana egg laying operation, which includes both sites IN2B and IN2H. The CAFO emits more than 2,000 pounds of ammonia on a typical day, several times that on its worst-polluting days, and houses up to 2.9 million hens. However, the data also indicate that not only such enormous operations exceed the reporting threshold.

EPA's current regulations replaced the 100 pound limit that CERCLA and EPCRA impose on every other regulated industry with an arbitrary animal number threshold. As a result, no CAFOs below the size that EPA defines as a "Large CAFO" under its Clean Water Act rule[23] – 1,000 beef cattle, 700 dairy cattle, or 2,500 hogs, for example – have to report emissions under EPCRA. The emissions data demonstrate that some CAFOs under this size do in fact emit more than 100 pounds of ammonia on their highest emitting days, and therefore EPA made incorrect assumptions in drafting its current reporting rule. The following barns or houses are smaller than Large CAFOs, yet emitted more than 100 pounds of ammonia on certain days during the study:

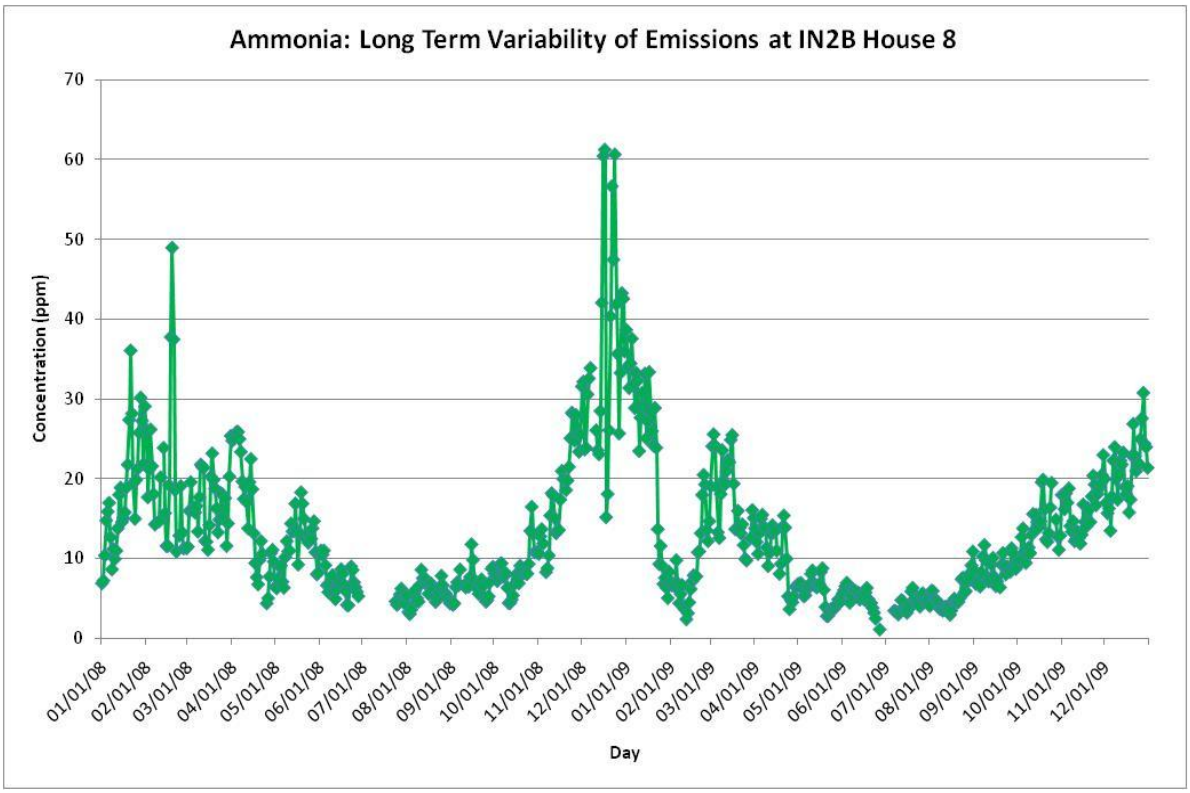
| **Sites Under Reporting Size Emitting > 100 lbs Ammonia Some Days** |
|---|
| CA1B House 10 |
| CA2B House 5 |
| CA2B House 6 |
| IA4B Barn 2 |
| WA5B Barn 2 |
| WA5B Barn 4 |

The data also show huge seasonal, and even daily, variations in ammonia emissions from individual sites. Because Purdue compiled individual data points into 24-hour averages, very short-term spikes in ammonia concentrations cannot be isolated in this analysis. However, the following subsets of data from CA1B and IN2B[24] show that over the course of days and weeks, rural residents near factory farms may be exposed to significant increases in ammonia pollution.

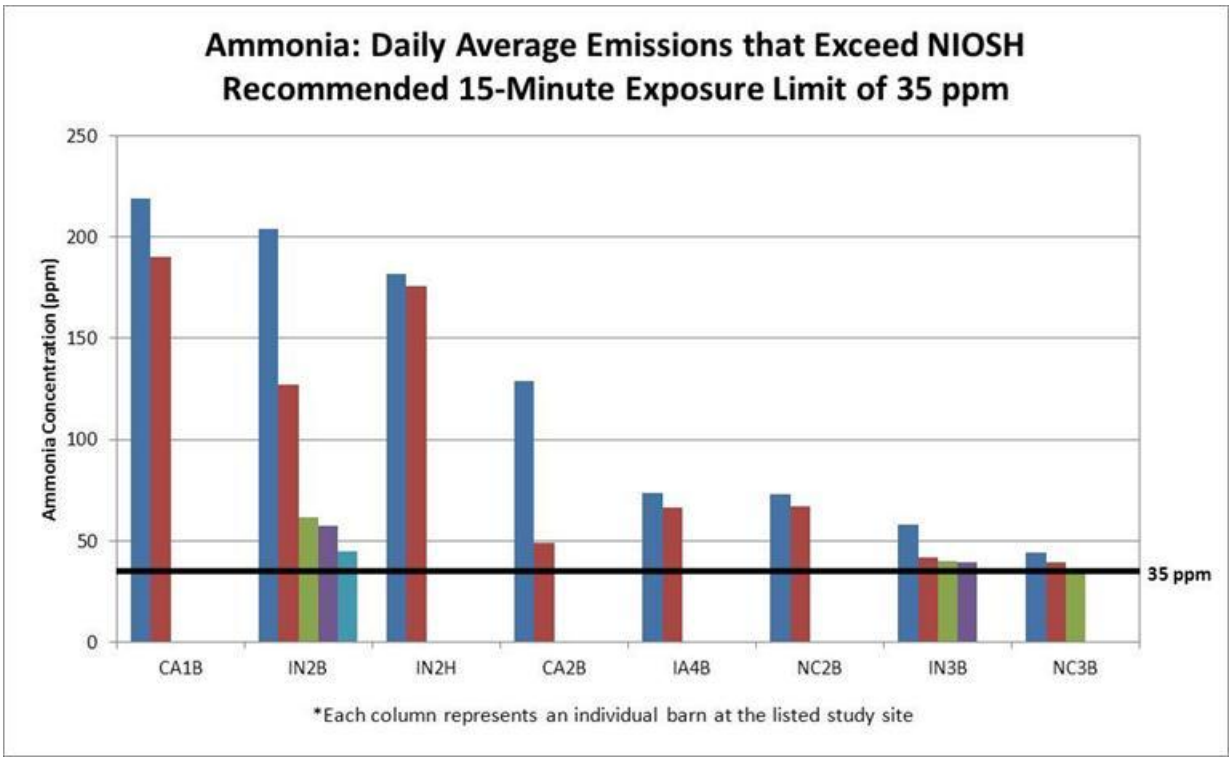



The daily averages Purdue presented in its reports show that ammonia emissions vary over longer intervals as well. The following chart of House 8 of the IN2B Indiana layer hen operation, created with data from Purdue's summary report for the site,[25] shows large seasonal variations in emissions.




Although reporting of total emissions would provide citizens with valuable information, it will not address all problems with factory farm ammonia pollution. The exhaust concentrations of ammonia at some study sites also indicate potential risks to the health of neighbors and workers. The National Institute for Occupational Safety and Health (NIOSH), part of the Centers for Disease Control and Prevention, has recommended that worker exposure to ammonia should not exceed either 25 parts per million averaged over 10 hours or 35 parts per million averaged over 15 minutes.[26] Because Purdue researchers compiled the CAFO data into 24-hour averages, EIP was unable to calculate the total number of 10-hour or 15-minute periods when exhaust concentrations at a monitoring site exceeded the worker health recommendation. However, ammonia emissions at most sites – typically measured inside the barns near a ventilation fan – exceeded the standards even averaged over certain entire 24-hour periods during the study.

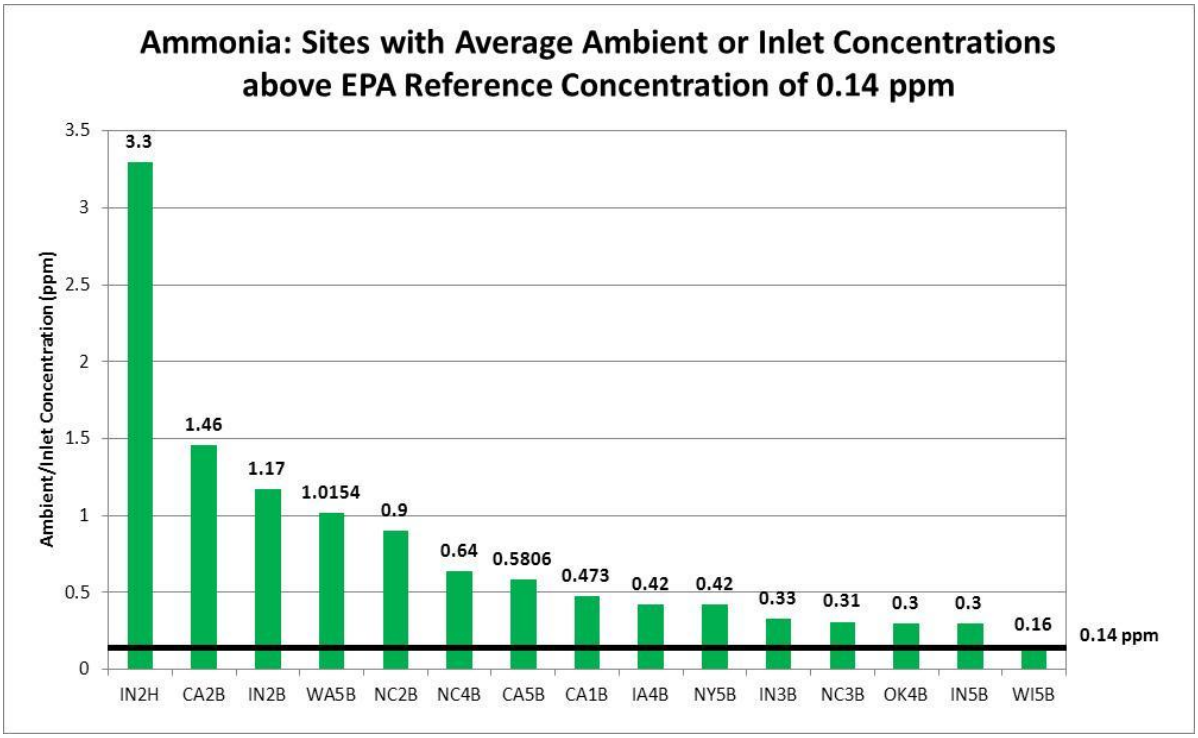



As shown above, 8 of the 15 sites had days when average ammonia concentrations at the exhaust monitors exceeded the NIOSH 15-minute recommendation for the full 24 hours, and all of these sites had multiple monitoring barns that exceeded the standard on some days.

Certain facilities dramatically exceeded the limit for short periods, while others sustained average concentrations above the recommended health level for the entire 2-year monitoring period. Average ammonia levels over the entire 2-year study at both monitored hen houses in the Indiana laying hen operation IN2H exceeded the NIOSH 15-minute recommended health level. The California broiler chicken CAFO had significant spikes in ammonia emission concentrations, averaging more than six times the NIOSH health limit at one house and more than five times the limit at the other monitored house on their worst-polluting days. While these at-the-vent measures cannot be directly translated into downwind concentrations, workers and others near CAFOs during high emissions periods may be exposed to ammonia levels above 35 ppm for durations of 15 minutes or more.

EPA has also established a "reference concentration" of 0.14 parts per million for ammonia,[27] which is meant to estimate an amount of ammonia people can safely be exposed to over the long term. Reference concentrations take vulnerable populations into consideration, and also include a margin of safety to account for unknown effects and incomplete data. Pollutant levels above a reference concentration do not necessarily pose a known health risk, but nonetheless have not been proven safe. As with particulates, the NAEMS study included measurements of ambient or background ammonia levels at some sites, and measures of the inlet ammonia level in the air entering the CAFO at other sites. Comparisons of these background

levels with EPA's reference concentration indicates that high ammonia levels commonly exist around CAFOs, which could threaten the health of nearby neighbors.




Average background or inlet ammonia concentrations exceed EPA's reference concentration at all 15 of the barn sites monitored, and average levels at the IN2H layer site were more than 23 times the reference concentration. These 15 sites include 5 sites with ambient measurements, indicating that ammonia levels do not necessarily dissipate to low levels at a short distance from the facility. The results of the ambient and intake monitoring indicate that CAFOs' nearby neighbors may be exposed to ammonia levels over the reference concentration on a long-term basis.

## Hydrogen Sulfide

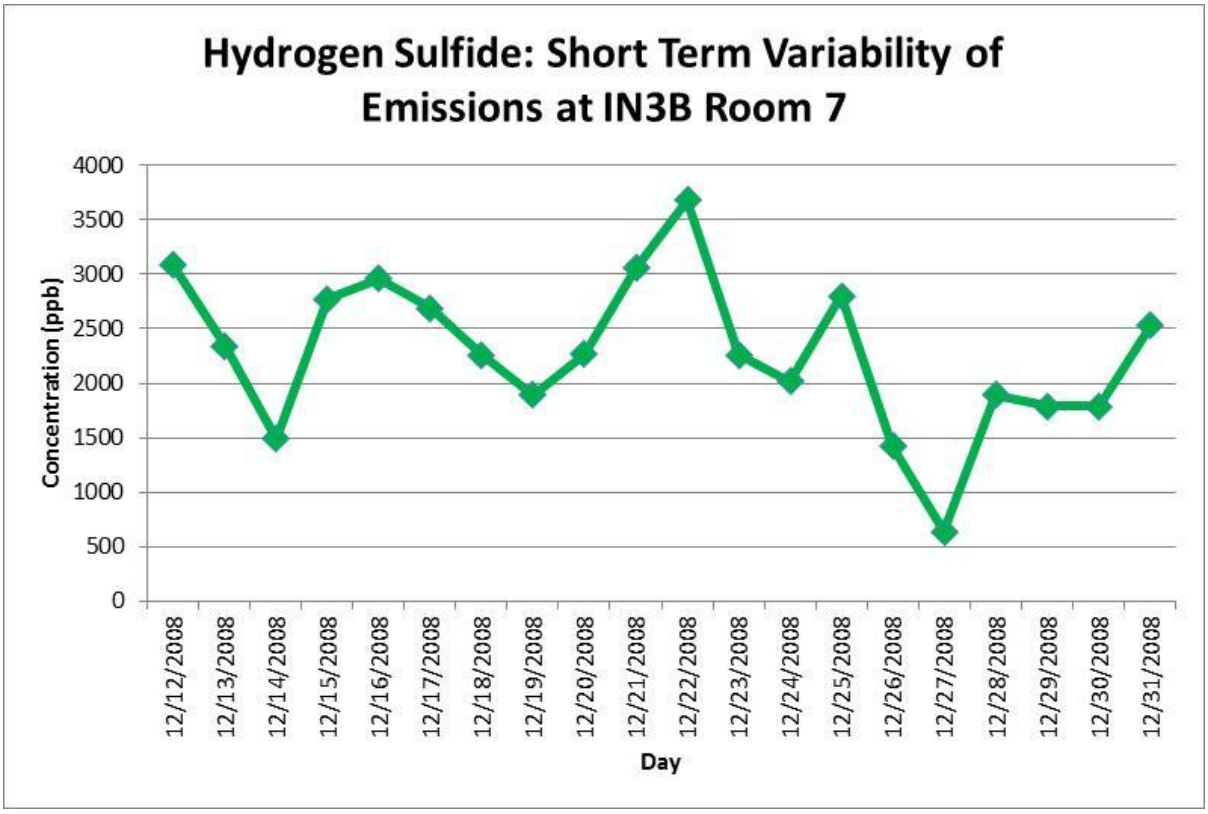
Hydrogen sulfide is responsible for the rotten egg odor surrounding many factory farms. Heavier than air, it can pool and collect in waste storage areas and has caused numerous deaths in and near manure pits over recent years.[28] Other industrial sources of hydrogen sulfide, such as oil refineries, emit the gas from stacks; CAFOs, however, emit hydrogen sulfide at ground level and thereby may prevent it from dissipating to low concentrations as it sinks and spreads.

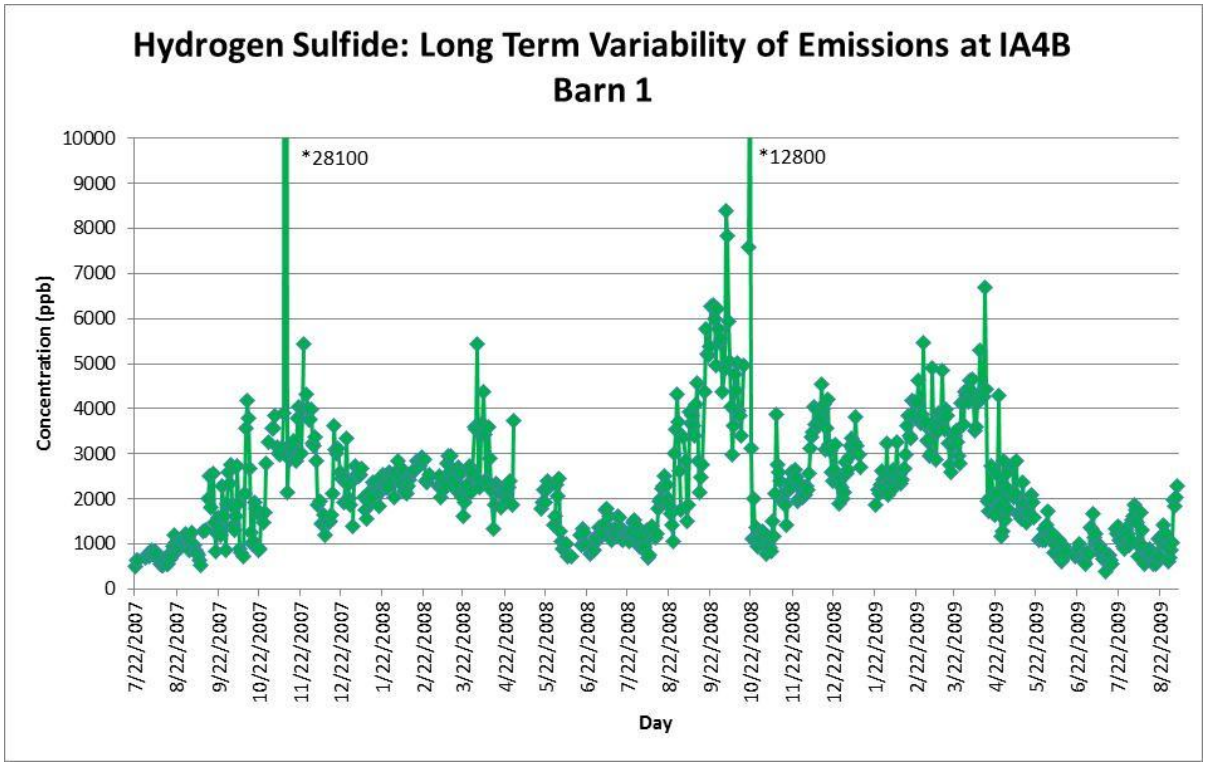
As with ammonia, EPA and other federal agencies have used available research to set hydrogen sulfide health limits for exposed citizens and workers. NIOSH has recommended a worker health protection limit of 10 ppm (10,000 ppb) hydrogen sulfide averaged over just 10 minutes.[29] As with ammonia, some CAFOs exceed the NIOSH recommendation for hydrogen sulfide over entire 24-hour periods. One barn at the Iowa hog confinement site IA4B had 3 24-hour periods averaging emissions of more than 10,000 ppb hydrogen sulfide, and the other barn had 2 24-hour periods averaging over the recommended limit.

Some states have taken further action to protect public health from hydrogen sulfide. Texas, for example, has established an ambient air quality standard of 80 ppb hydrogen sulfide averaged over 30 minutes, if that pollution affects property users downwind.[30] Air around several sites in the NAEMS study exceeded 80 ppb for entire days in the study, including hog barns in Iowa, Indiana, and North Carolina, as well as dairies in California, Indiana, Washington, and Wisconsin. While these inlet measures do not conclusively demonstrate that high pollution levels will exist at the property line or residences downwind at any given time, the fact that such high values persist over such long periods of time suggests that those living and working near hog and dairy facilities may breathe unsafe levels of the pollutant on certain days.

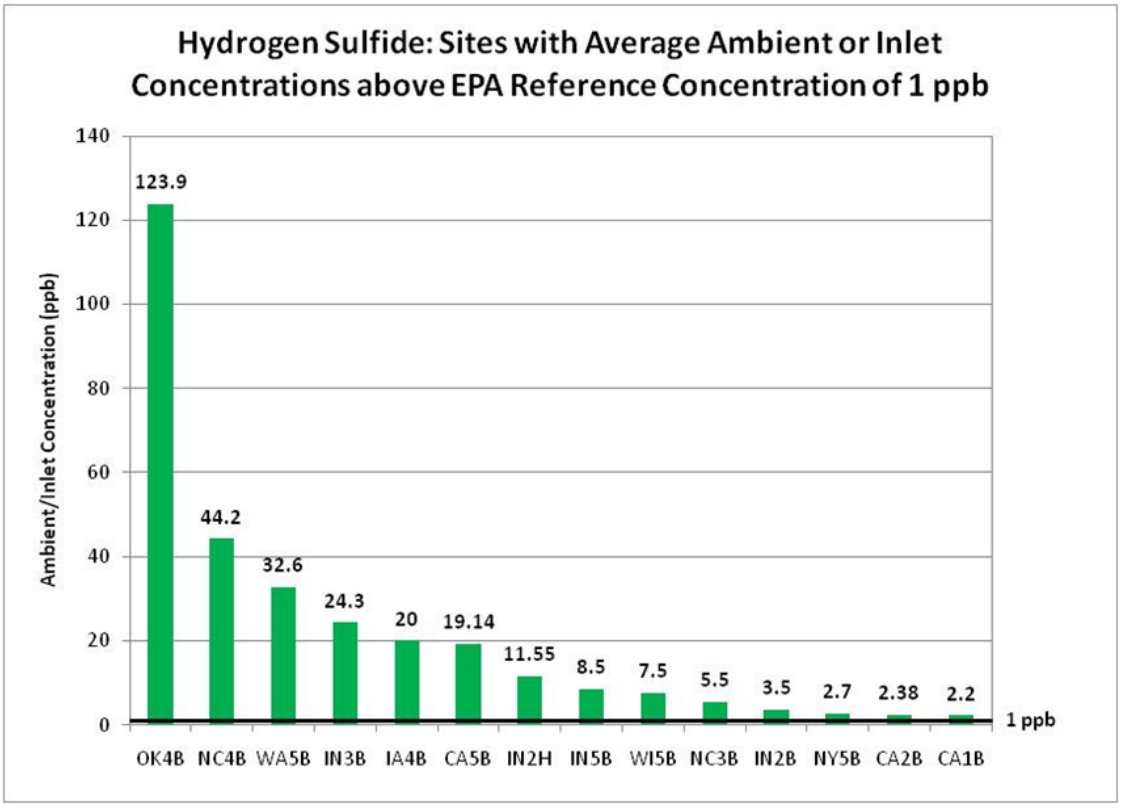
Because it is a "hazardous" pollutant, non-livestock facilities emitting more than 100 pounds of hydrogen sulfide per day must report emissions to federal, state, and local emergency response agencies. The NAEMS results indicate that exceedances of the reporting threshold were less common for hydrogen sulfide than for ammonia at test sites; nonetheless, some CAFOs do emit more than 100 pounds of each on certain days. The Iowa hog CAFO clearly exceeds the reportable amount of hydrogen sulfide on its highest-emitting days, and in fact just one of its two moderately sized hog barns nearly exceeded the reporting threshold on its own on the worst day studied. Thus CAFOs under EPA's "Large CAFO" size reporting limit sometimes emit more than 100 pounds per day of the chemical, again demonstrating the lack of scientific support for EPA's current reporting scheme. Based on EIP's extrapolations from individual barn emission estimates, several other study sites – specifically the IN5B, WA5B, and WI5B dairies – also likely emit more than 100 pounds of hydrogen sulfide per day on certain days, though the study did not estimate daily emissions from the entire CAFO.

The NAEMS results also show that hydrogen sulfide emissions vary on a daily and seasonal basis, and demonstrate that limited emissions reporting for this pollutant does not provide neighbors with adequate information about pollution in their community.


Hydrogen Sulfide: Short Term Variability of Emissions at IN3B Room 7
Concentration (ppb)
4000
3500
3000
2500
2000
1500
1000
500
0
12/12/2008
12/13/2008
12/14/2008
12/15/2008
12/16/2008
12/17/2008
12/18/2008
12/19/2008
12/20/2008
12/21/2008
12/22/2008
12/23/2008
12/24/2008
12/25/2008
12/26/2008
12/27/2008
12/28/2008
12/29/2008
12/30/2008
12/31/2008
Day


Hydrogen Sulfide: Long Term Variability of Emissions at IA4B Barn 1
Concentration (ppb)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
*28100
*12800
7/22/2007
8/22/2007
9/22/2007
10/22/2007
11/22/2007
12/22/2007
1/22/2008
2/22/2008
3/22/2008
4/22/2008
5/22/2008
6/22/2008
7/22/2008
8/22/2008
9/22/2008
10/22/2008
11/22/2008
12/22/2008
1/22/2009
2/22/2009
3/22/2009
4/22/2009
5/22/2009
6/22/2009
7/22/2009
8/22/2009
Day

EPA has established a reference concentration of 1 ppb for hydrogen sulfide. As shown below, 14 of 15 sites examined had average inlet/ambient hydrogen sulfide levels above EPA's reference concentration over the course of the study. Air outside the Oklahoma hog farrowing barn at site OK4B averaged well over 100 times the hydrogen sulfide reference concentration.




**Recommendations**

The monitoring data generated in the air emissions study, along with existing research on factory farm emissions, will allow EPA to establish "emission estimating methodologies" for CAFO air pollution for the first time. These methodologies will enable CAFO operators to estimate their emissions of ammonia, hydrogen sulfide, particulates, and VOCs, and will provide the framework to establish Clean Air Act protections for public health and air quality.

The NAEMS results show that the air surrounding and emitted from factory farms frequently contains high levels of pollutants known to endanger human health. EPA should act quickly to assess the data provided by Purdue University, as well as existing peer-reviewed research, and establish emissions methodologies and Clean Air Act standards that will protect public health from factory farm pollution.

**EIP recommends the following actions:**

- CAFOs release as much or more pollution as other large industries, and should be required to report their emissions. EPA should remove Bush Administration actions shielding CAFOs from enforcement of the Clean Air Act and from having to comply with right-to-know laws.

- The Clean Air Act should protect rural residents, not just those living in major metropolitan areas. EPA should set air quality standards for hydrogen sulfide (as Texas has already done), and for ammonia.

- EPA should also take steps to improve the quality and utility of the data for the public:

    - The Purdue study identifies daily average pollution levels, but high levels of ammonia and hydrogen sulfide can be hazardous over much shorter periods of time. EPA should use the study's minute-by-minute monitoring data to calculate short-term pollution levels as well as 24-hour averages, and determine whether spikes in pollution in either emissions or the air surrounding CAFOs pose a threat to workers or public health.

    - The results may underestimate pollution, as the daily average pollutant concentrations reported include "negative" values that represent erroneous samples. The daily and overall emission averages should be recalculated to remove all negative values and other clearly erroneous data.

    - The Purdue data should be thoroughly peer reviewed, with an independent committee established to review both air quality data and estimates of emissions from CAFO test sites. The committee should include representatives from the public health community and advocates for citizens concerned about CAFO air pollution as well as industry. EPA should also establish a docket and make public communications between the agency and any interested party during the study and its later review.

## Conclusion

Despite significant influence by the regulated community and problems with both monitoring and data analysis, the NAEMS results document high levels of air pollution around factory farms and demonstrate the need for increased public health protection for rural communities. This study adds to a growing body of research showing that factory farms are industrial-scale polluters, and EPA's failure to regulate CAFO pollution under the Clean Air Act and other laws runs afoul of sound science.

EPA should act quickly to use existing emissions research and the results of this study to set emission estimating methodologies that will allow for accurate, site-specific estimates of pollution emitted from the thousands of large CAFOs across the country. Once these methodologies have been established, EPA should protect communities exposed to unsafe levels of particulates, ammonia, hydrogen sulfide, and volatile organic compounds by requiring emissions reporting and the use of technology proven to reduce air pollution.

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[1] Environmental Integrity Project is a nonpartisan nonprofit organization dedicated to enforcement of the nation's anti-pollution laws. Visit EIP's website at www.environmentalintegrity.org.

[2] The study included 15 barn sites, but two of these sites – IN2H and IN2B – are different types of layer hen barns at the same Indiana CAFO.

[3] Animal Feeding Operations Consent Agreement and Final Order, 70 Fed. Reg. 4958, 4959 (Jan. 31, 2005).

[4] *See* Environmental Protection Agency, Agriculture – Air Monitoring, http://www.epa.gov/airquality/agmonitoring/.

[5] *See* Purdue University, NAEMS Frequently Asked Questions, https://engineering.purdue.edu/~odor/NAEMS/faqs.htm; *see also* NAEMS Site Summaries at http://www.epa.gov/airquality/agmonitoring/data.html.

[6] CA1B Summary Report at 13, http://www.epa.gov/airquality/agmonitoring/pdfs/CA1BSummaryReport.pdf.

[7] CA5B Summary Report at 23-24, http://www.epa.gov/airquality/agmonitoring/pdfs/CA5BSummaryReport.pdf.

[8] *Id* at 24. *See* Net Emissions, Table 18.

[9] EPA did provide EIP with the first year of raw NAEMS data pursuant to a Freedom of Information Act (FOIA) request, and at the time of writing this report EIP has submitted a second FOIA for the second year of data.

[10] In polluted areas, sources that may emit more than 70 tons per year of $PM_{10}$ qualify as "major sources" and must adopt pollution-reducing technology. 42 U.S.C. § 7513a(b)(3).

[11] Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Ammonia* at 6 (Sept. 2004), available at http://www.atsdr.cdc.gov/toxprofiles/tp126.pdf.

[12] Environmental Protection Agency, Office of Air and Radiation, Particulate Matter: Health and Environment, http://www.epa.gov/air/particlepollution/health.html.

[13] Environmental Protection Agency, Particulate Matter: Health and Environment, http://www.epa.gov/pm/health.html.

[14] Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Hydrogen Sulfide* at 10 (July 2006), available at http://www.atsdr.cdc.gov/toxprofiles/tp114.pdf.

[15] Environmental Protection Agency, Office of Air and Radiation, National Ambient Air Quality Standards (NAAQS), http://www.epa.gov/air/criteria.html. *See also* 40 C.F.R. §§ 50.6(a), 50.7(a).

[16] NAEMS did not continuously monitor $PM_{2.5}$ or $PM_{10}$, as it did ammonia and hydrogen sulfide, because the PM monitors only measured one size of particulates at a time. The monitors primarily monitored $PM_{10}$. *See, eg.*, Summary Report for site CA1B at 11, http://www.epa.gov/airquality/agmonitoring/pdfs/CA1BSummaryReport.pdf.

[17] Viney P. Aneja et al., *Ammonia Assessment from Agriculture: U.S. Status and Needs*, 37 Envtl. Quality, 2008, at 516.

[18] Rich Damberg, EPA Office of Air Quality Planning and Standards, Policies for Addressing PM2.5 Precursor Emissions (June 20, 2007) at Slide 8.

[19] Conversation with Larry Elmore, William Schrock, and Allison Mayer, EPA, on Jan. 25, 2011.

[20] 40 C.F.R. §§ 302.4–302.5, App. A to § 355 (2008).

[21] CERCLA/EPCRA Administrative Reporting Exemption for Air Releases of Hazardous Substances From Animal Waste at Farms, 73 Fed. Reg. 76,948 (Dec. 18, 2008).

[22] *Id*. These "continuous release" reports require only a single written emissions estimate and a follow-up phone call one year later. 40 C.F.R. § 302.8(c).
[23] 40 C.F.R. § 122.23(b)(4).
[24] *See* CA1B Summary Report at 233-34, http://www.epa.gov/airquality/agmonitoring/pdfs/CA1BSummaryReport.pdf; IN2B Summary Report at 266, http://www.epa.gov/airquality/agmonitoring/pdfs/IN2BSummaryReport.pdf.
[25] IN2B Summary Report at 35, 255, http://www.epa.gov/airquality/agmonitoring/pdfs/IN2BSummaryReport.pdf.
[26] Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Pocket Guide to Chemical Hazards: Ammonia, http://www.cdc.gov/niosh/npg/npgd0028.html.
[27] Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Ammonia* at 163 (Sept. 2004), available at http://www.atsdr.cdc.gov/toxprofiles/tp126.pdf.
[28] Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Workplace Safety & Health Topics: Hydrogen Sulfide, http://www.cdc.gov/niosh/topics/hydrogensulfide/.
[29] Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Pocket Guide to Chemical Hazards: Hydrogen Sulfide, http://www.cdc.gov/niosh/npg/npgd0337.html.
[30] 30 Tex. Admin. Code § 112.31.