ETV and Animal Feeding Operations

The U.S. EPA Environmental Technology Verification (ETV) Program provides credible performance information for commercial-ready environmental technologies for the benefit of purchasers, regulators, and vendors/developers.[1] ETV has verified or is planning verification tests of technologies for air and water monitoring, waste treatment and management, and energy production related to animal feeding operations (AFOs). These include:

- ambient ammonia(NH_3) air monitors
- hydrogen sulfide air monitors
- waste solids separators
- waste-to-energy distributed electricity generation systems
- innovative anaerobic digestion of animal manure.

This brief provides summaries of verification activities for these technology types.

Ambient Ammonia Sensors

The ETV Advanced Monitoring Systems (AMS) Center, operated by Battelle under cooperative agreement with EPA, has verified seven ambient ammonia (NH_3) air monitors in collaboration with the U.S. Department of Agriculture (USDA) at swine and cattle AFOs in central Iowa. These monitors can be used to measure airborne NH_3 in and around AFO facilities. Airborne NH_3 is a precursor to $PM_{2.5}$ (a designation referring to fine particulate matter that is 2.5 micrometers in diameter and smaller) and can enter natural water systems through atmospheric deposition. Livestock agriculture is thought to be the primary source of atmospheric NH_3 in the U.S., accounting for approximately 70% of NH_3 emissions. The ETV-verified monitors were evaluated for relative accuracy, linearity, precision, response time, calibration and zero drift, interference effects, comparability, ease of use, and data completeness. Verification reports and summary statements can be found at http://www.epa.gov/etv/verifications/vcenter1-30.html.

Hydrogen Sulfide Monitors

The ETV AMS Center has also verified the performance of two hydrogen sulfide (H_2S) air monitors in collaboration with the USDA at a swine AFO near Ames, IA. H_2S is formed at AFOs during the bacterial decomposition of sulfur-containing organic compounds present in animal manure. H_2S produces strong odors and, at high levels (> 500 parts per million), can cause death from even brief exposure. The ETV-verified monitors were evaluated for accuracy, bias, precision, linearity, span and zero drift, response time, interference effects, comparability, data completeness, and operational factors. Verification reports and summary statements can be found at http://www.epa.gov/etv/verifications/vcenter1-33.html.

Animal Feeding Operations at a Glance

EPA defines animal feeding operations (AFO) as agricultural operations where animals are kept and raised in confined situations. Feed is brought to the animals rather than the animal grazing for or seeking food (i.e., in pastures, fields, or on rangelands). EPA estimates that there are approximately 450,000 AFOs in the United States.

AFOs can have significant environmental and human health impacts, as pollutants from these operations can impact surface water, ground water, air and soil. Animal waste and wastewater from operations can enter surface or ground waters from both the AFO production areas and areas where manure is applied to land. Animal manure can also be a significant source of nutrient contamination in surface waters and ground water. Under the Clean Water Act, AFOs that meet the regulatory definition of a concentrated animal feeding operation (CAFO) are regulated as point sources of pollution to waters of the U.S. under the National Pollutant Discharge Elimination System (NPDES)

AFOs also can be a significant source of odorous and potentially harmful air emissions, such as NH_3 and H_2S. In January 2005, EPA announced the Air Quality Compliance Agreement to address emissions from certain AFOs. The goals of the agreement are to: reduce pollution, ensure compliance with the Clean Air Act and other regulatory acts, monitor and evaluate emissions from AFOs, and promote a national consensus on methods for measuring emissions from AFOs (U.S. EPA, Animal Feeding Operations).

An Ambient Ammonia Monitor at an AFO

[1]The ETV Program operates largely as a public-private partnership through competitive cooperative agreements with non-profit research institutes. The program provides objective quality-assured data on the performance of commercial-ready technologies. Verification does not imply product approval or effectiveness. ETV does not endorse the purchase or sale of any products and services mentioned in this document.

www.epa.gov/etv

Animal Waste Solids Separation

The ETV Water Quality Protection Center, operated by NSF International under cooperative agreement with EPA, has verified three animal waste treatment solids separators at a swine farm. The technologies (an inclined screen, an inclined drag screen and gravity clarifier, and a solid bowl centrifuge) were evaluated for their ability to separate manure solids from flushed swine waste. The analyses performed included solids (total, suspended, and volatile), total organic carbon, nutrients, metals, pH, conductivity, bulk density, *E. coli* and total coliform. Energy consumption was also measured. Verification reports and summary statements can be found at http://www.epa.gov/etv/verifications/vcenter9-4.html.

Waste-to-Energy Distributed Generation

The ETV Greenhouse Gas Technology (GHG) Center, operated by Southern Research Institute under cooperative agreement with EPA, has verified five waste-to-energy fueled distributed generation (DG) energy systems in collaboration with the Colorado Governors Office and the New York State Energy Research and Development Authority (NYSERDA) . The systems are: three technologies for utilizing anaerobic digester gas to fuel on-site generation energy systems, and two technologies for improving gas quality (primarily by removing H_2S and other sulfur species) to make it amenable for use by DG energy systems. Fuels utilized in testing of three of the systems were generated from anaerobic digestion of swine waste at an AFO; the other two systems were verified at other sites, but verification data are relevant to AFOs. Verification reports and summary statements can be found at http://www.epa.gov/etv/verifications/vcenter3-17.html and http://www.epa.gov/etv/verifications/vcenter3-13.html. In 2007, verification testing of additional DG energy systems, an internal combustion engine-based combined heat and power system (fueled by biogas from a dairy farm), and a Stirling engine power generation system fueled by anaerobic digester gas, will be conducted in collaboration with NYSERDA.

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ETV Case Studies: Demonstrating Program Outcomes

ETV has published two reports, *ETV Case Studies: Demonstrating Program Outcomes, Volumes I and II*, to highlight how verification information generated by ETV translates into potential and actual environmental and human health impacts. These case studies provide descriptions of the verification test, verified technologies, actual outcomes based on evidence (e.g., regulatory agencies responses), and potential outcomes based on various market penetration scenarios. Two types of verified technologies related to animal feeding operations have been featured in these case study documents: ambient ammonia sensors and microturbine/combined heat and power technologies. Both case study documents are available on the ETV Web Site at www.epa.gov/etv/index.html.

Environmental and Sustainable Technology Evaluations (ESTE)

In 2005, ETV initiated a new element of the program, Environmental and Sustainable Technology Evaluations (ESTE), which is designed to respond directly to high-priority EPA needs via an internal Agency competition. In 2006 to 2007, one of the ESTE projects is addressing technologies related to AFOs:

Innovative anaerobic digester: The project is evaluating an anaerobic digester for treatment of animal wastes at a large-scale farm, with energy production and phosphorus and pathogen reduction/removal. Methane generation, energy generation, reduction of organic solids, and reduction of potentially pathogenic microorganisms will be measured.

For more information on ESTE, please visit http://www.epa.gov/etv/este.html.

References

U.S. EPA, 2006. ETV Case Studies: Demonstrating Program Outcomes, Volume I. EPA/600/R-06/001. January. http://www.epa.gov/etv/pdfs publications/600r06001/600r06001pv.pdf.

U.S. EPA, 2006. ETV Case Studies: Demonstrating Program Outcomes, Volume II. EPA/600/R-06/082. September. http://www.epa.gov/etv/pdfs/publications/600r06082/600r06082pv.pdf.

U.S. EPA Animal Feeding Operations, www.epa.gov/oecaagct/anafoidx.html.

U.S. EPA, ETV, www.epa.gov/etv.

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