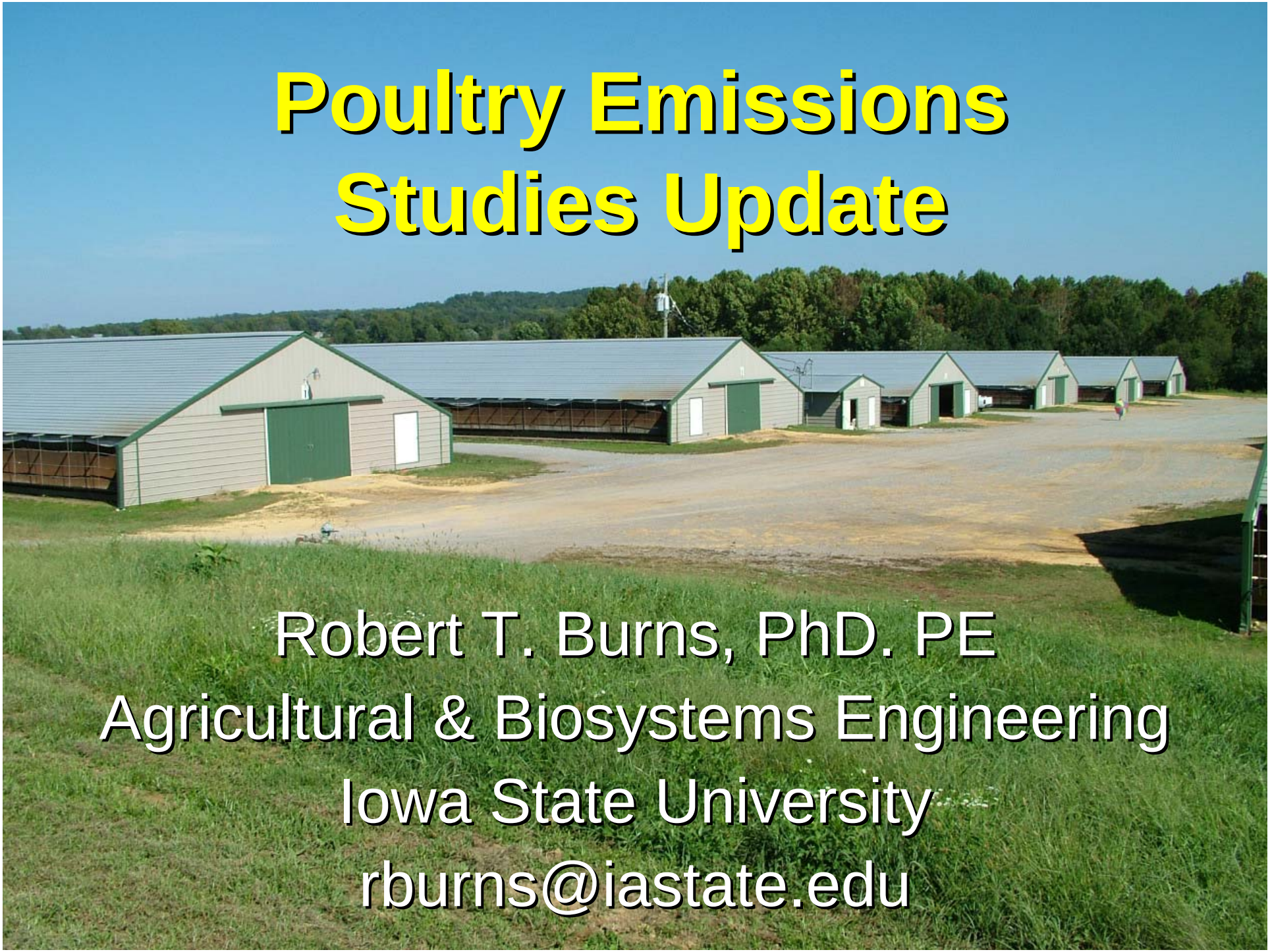
Poultry Emissions Studies Update



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Acknowledgments

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Presentation Outline

- Recently published studies
- Southeastern Broiler Air Emissions Study
- Layer NH_3 Mitigation Studies

Layer NH_3 Emissions

Liang, Y., H. Xin, E.F. Wheeler, R.S. Gates, H. Li, J.S. Zajaczkowski, P.A. Topper, K.D. Casey, B.R. Behrends, D.J. Burnham and F.J. Zajaczkowski. 2005. *Ammonia emissions from U.S. laying houses in Iowa and Pennsylvania.* Transactions of the ASAE 48(5): 1927-1941.


2
3

High-Rise House
(manure under birds)

Belt Battery House
Manure Storage

Comparison of Ammonia Emission Factors for Layer Houses (g NH_3 $AU^{-1}d^{-1}$)

Country	House Type (season)	Manure Removal	NH_3 ER	Reference
England	Deep pit (winter)	NA	192	Wathes et al. (1997)
England	Deep pit (summer)	NA	290	Wathes et al. (1997)
England	Deep pit (N/A)	NA	239	Nicholsen et al. (2004)
USA (OH)	High-rise (March)	Annual	523	Keener et al. (2002)
USA (OH)	High-rise (July)	Annual	417	Keener et al. (2002)
USA (IA)	High-rise (all year)	Annual	299	Yang et al. (2002)
USA (IA&PA)	High-rise (all year) – *standard diet*	Annual	298	Liang et al. (2005)
USA (IA)	High-rise (all year) – *1% lower CP diet*	Annual	268	Liang et al. (2005)
Netherlands	Belt (N/A)	Twice/wk w/o drying	31	Kroodsma et al. (1988)
Netherlands	Belt (N/A)	Weekly w/ drying	28	Kroodsma et al. (1988)
Denmark	Belt (all year)	NA	52	Koerkamp et al. (1998)
Germany	Belt (all year)	NA	14	Koerkamp et al. (1998)
Netherlands	Belt (all year)	NA	39	Koerkamp et al. (1998)
England	Belt (all year)	Weekly	96	Nicholsen et al. (2004)
England	Belt (all year)	Daily	38	Nicholsen et al. (2004)
USA (IA&PA)	Belt (all year)	Daily w/o drying	17.5	Liang et al. (2005)
USA (IA&PA)	Belt (all year)	Twice/wk w/ drying	30.8	Liang et al. (2005)

1 AU (animal unit) = 500 kg body weight

Table adapted from - Liang et al. (2005)

Broiler NH_3 Emissions

E.F. Wheeler, K.D. Casey, R.S. Gates, H.Xin, J.L. Zajaczkowski, P.A. Topper, Y. Liang, A. J. Pescatore. 2006. *Ammonia Emissions From Twelve U.S.A. Broiler Chicken Houses* Transactions of the ASAE – Accepted for Publication

Comparison of Ammonia Emission Factors for Broilers (g NH3 b-1d-1)

Reference (Year)	Flock Characteristics			Litter*	Emission Rate	Monitoring				
Study Location*	Market Age (Age during Measurement)	Final Wt.	Stocking Density			Number of...				
	(day)	(kg)	(b m^{-2})		g b^{-1} d^{-1}	Houses (Flocks)	Seasons*	Periods	Duration	Methods*
Wheeler (this study) USA, PA, KY	42 (1-45)	2.2	14.7	N	0.47	2 (5 each)	All	13	48 hr	C-EC
	42 (2-42)	2.2	14.7	B, T	0.65	2 (6 each)	All	13	48 hr	C-EC
	49 (1-53)	2.5	13.4	B, T	0.76	4 (6 each)	All	17	48 hr	C-EC
	63 (1-55)	3.3	10.8	B, T	0.98	4 (5 each)	All	20	48 hr	C-EC
Seifert (2004) USA, DE	42 (29-37)	n/a	20.0	B?	1.18	1 (1)	Sp, Su	7	6-12 hr	S-CM[1]
Müller (2003) German/Czech	32 (13-30)	1.6	n/a	N?	0.09	2 (1)	W	5	1hr	C-PS?
Lacey (2003) USA, TX	49	2.4	13.5	B	0.63	4 (3 each)	F, W	10	3 S/d	S-CM
Burns (2003) USA, TN	42 (1-42)	2.3	16.1	B	0.92	1 (9)	All	9	42 d	C-EC
Demmers (1999) UK	32 (1-32)	1.9	25	N	0.11	1 (1)	Su	1	32 d	C-CL
Wathes (1997) United Kingdom	32 (24-35)	1.1W 1.4 Su	9.3 W 9.4 Su	N?	0.26	4	Su, W	2	24 hr	C-CL
Groot Koercamp (1998)[2] UK				N?	0.48	4	Su, W	2	24 hr	C-CL
Netherlands				N?	0.27	4	Su, W	2	24 hr	C-CL
Denmark				N?	0.21	4	Su, W	2	24 hr	C-CL
Germany				N?	0.44	4	Su, W	2	24 hr	C-CL

Table adapted from - Wheeler et al. (2006)

Southeastern Broiler Air Emissions Study

(Burns, Xin, Gates & Hoff)

- Air emissions from two Tyson Foods broiler houses in Western Kentucky are being monitored
- Both broiler houses monitored continuously for a one year period
- Monitoring for all emissions began in January 2006, emissions calculation period 2/20/06 – 3/1/07

Study Purpose

Data from this project are proposed as representative air emissions from southeastern U.S. broiler houses for use in the Air Compliance Agreement (ACA)

Pollutants Measured

- Ammonia
- Carbon Dioxide
- Hydrogen Sulfide
- Non-Methane Hydrocarbons
- Methane
- Particulate Matter
  - Total Suspended Particulate
  - PM_{10}
  - $PM_{2.5}$

Monitoring Equipment Selection

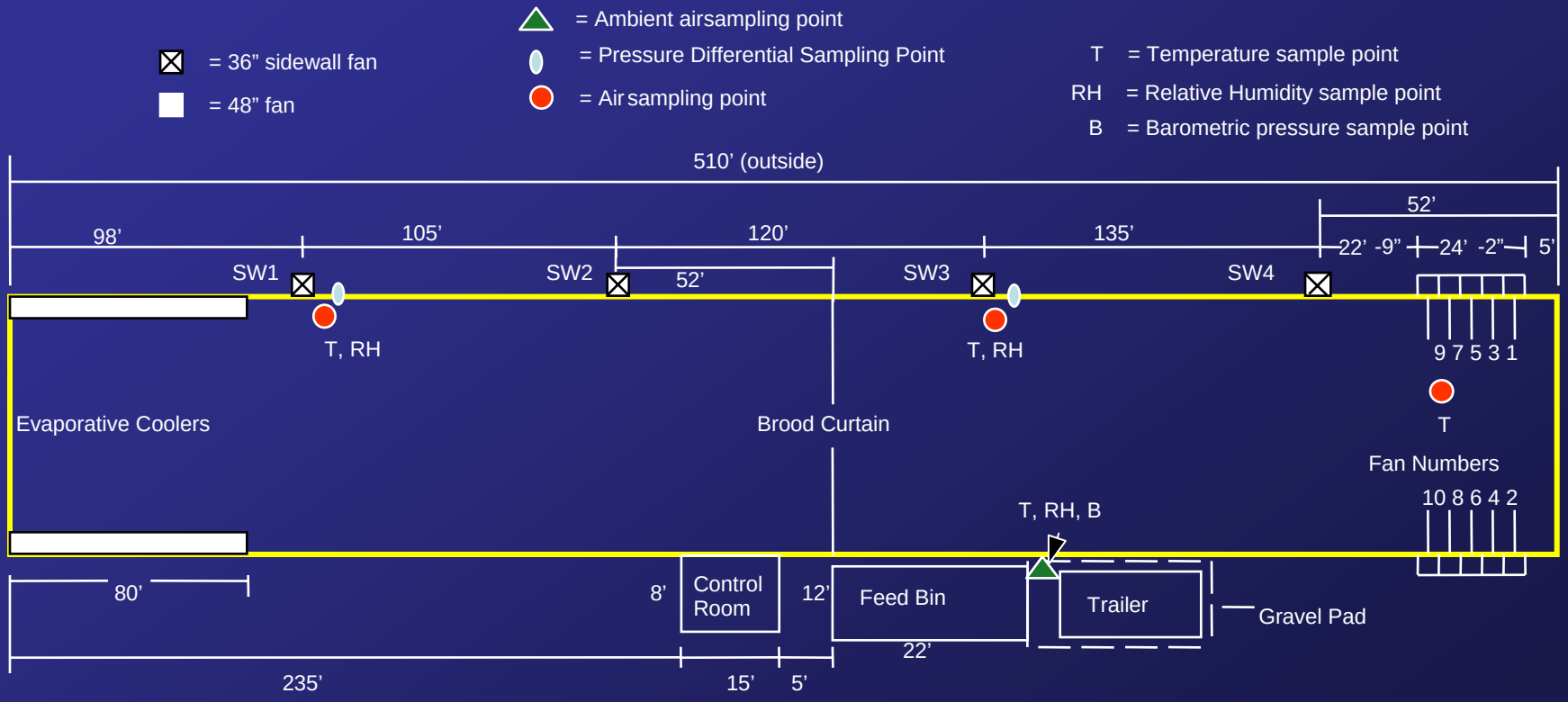
Pollutant	Monitoring Instrument
NH_3	Innova 1412, Innova AirTech Instruments A/S, Denmark
CO_2	Innova 1412, Innova AirTech Instruments A/S, Denmark
H_2S	UV Fluorescence Hydrogen Sulfide Analyzer Model 101E, Advance Pollution Instrumentation, San Diego, California
NMHC	Model 200 Heated Methane/Non-Methane/Total Hydrocarbon Analyzer, VIG Industries, Anaheim, California
THC	Model 200 Heated Methane/Non-Methane/Total Hydrocarbon Analyzer, VIG Industries, Anaheim, California & Innova 1412, Innova AirTech Instruments A/S, Denmark
CH_4	Model 200 Heated Methane/Non-Methane/Total Hydrocarbon Analyzer, VIG Industries, Anaheim, California & Innova 1412, Innova AirTech Instruments A/S, Denmark
TSP	Tapered Element Oscillating Microbalance (TEOM) Series 1400a with TSP inlet head, Thermo Electron Corporation, East Greenbush, New York
PM_{10}	PM_{10} - Tapered Element Oscillating Microbalance (TEOM) Series 1400a with PM_{10} inlet head, Thermo Electron Corporation, East Greenbush, New York
$PM_{2.5}$	$PM_{2.5}$ - Tapered Element Oscillating Microbalance (TEOM) Series 1400a with PM_{10} head and a 2.5 micron cut cyclone, Thermo Electron Corporation, East Greenbush, New York

Broiler Houses Monitored

- Two sites about 30 miles apart
- Mechanically ventilated houses– four 36” sidewall fans and ten 48” tunnel fans
- 43 x 510 ft, each housing 25,800 birds in winter & 24,400 birds in summer
- 50-53 d growth period (~6 lb. market wt)

Monitoring for NH_3 emissions began in Oct. 2005

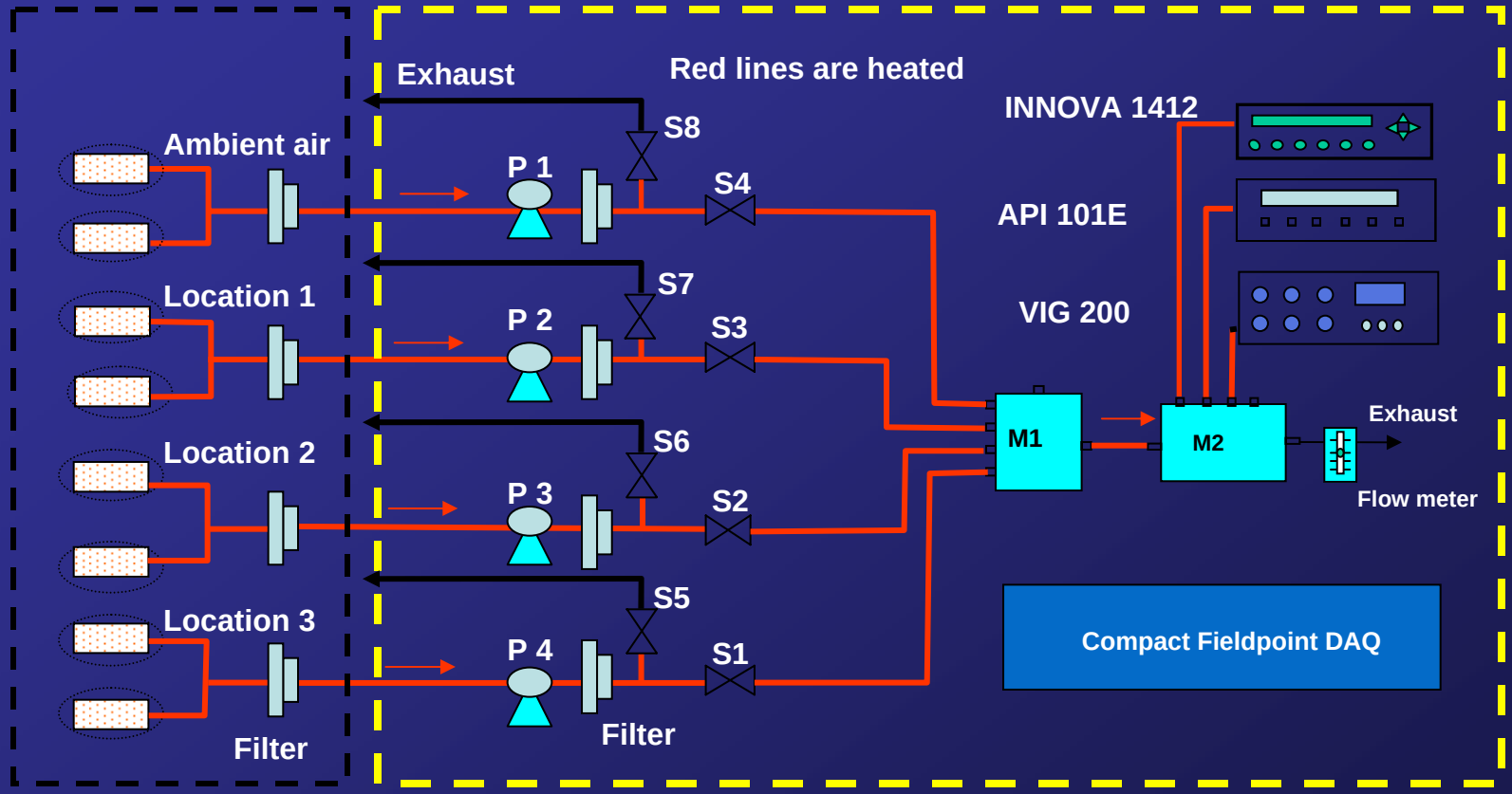
Schematic Layout of Broiler House & Monitoring Locations



Mobile Air Emissions Monitoring Unit (MAEMU)

In-house Air Sample Intake with In-line Filters

Schematic of Gas Sampling System

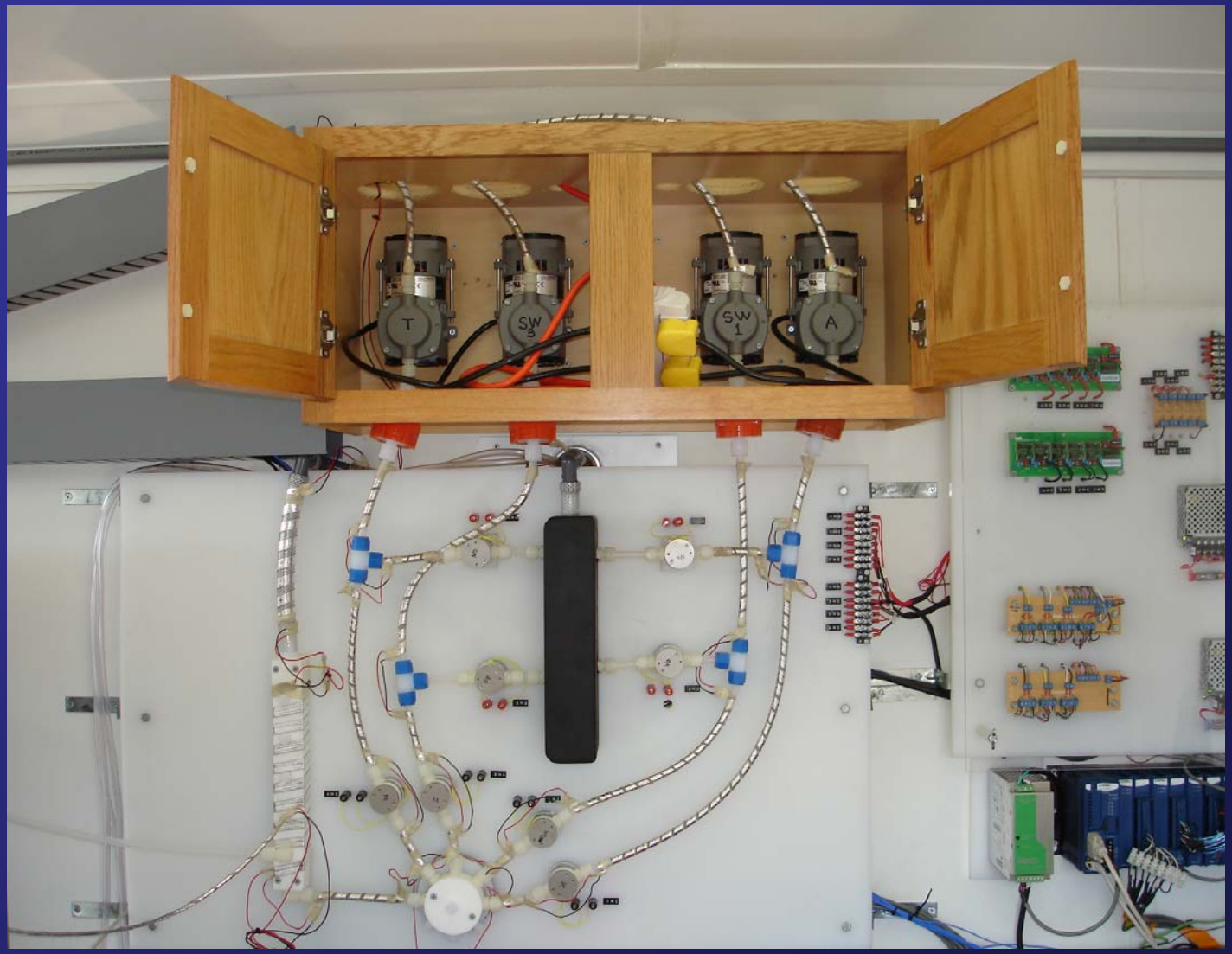


P: Pump, M: Manifold, S: Solenoid; S1- 4: Normal Closed; S5 - 8:Normally Open

Broiler House

MAEMU

Positive Pressure Gas Sampling System (GSS)



Gas Analyzers inside MAEMU

Particulate Matter measured using TEOMs

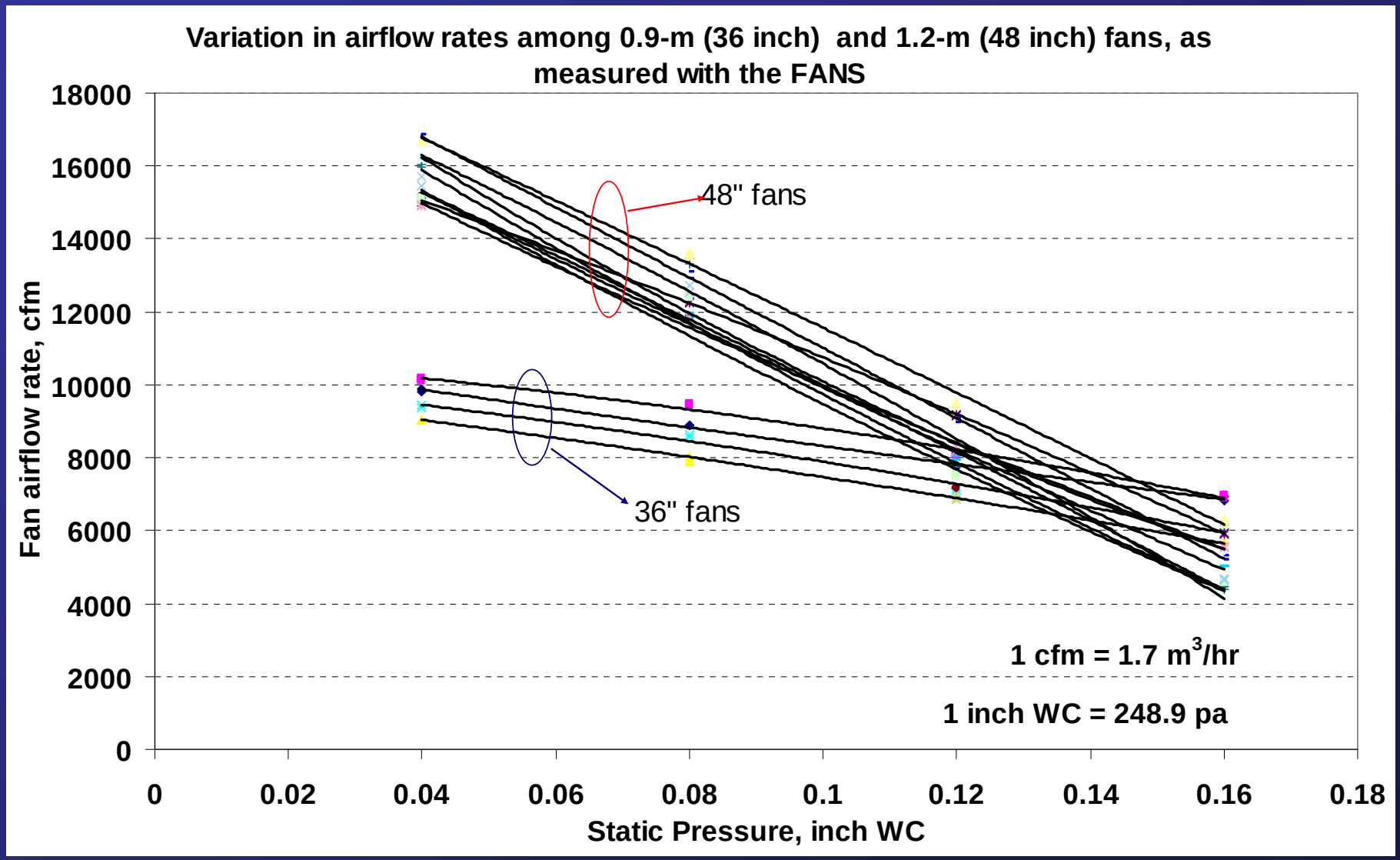
Determination of Building Ventilation Rate (Q_e)

- 14 ventilation fans per house
  - Four 36 inch sidewall fans
  - Ten 48 inch tunnel fans

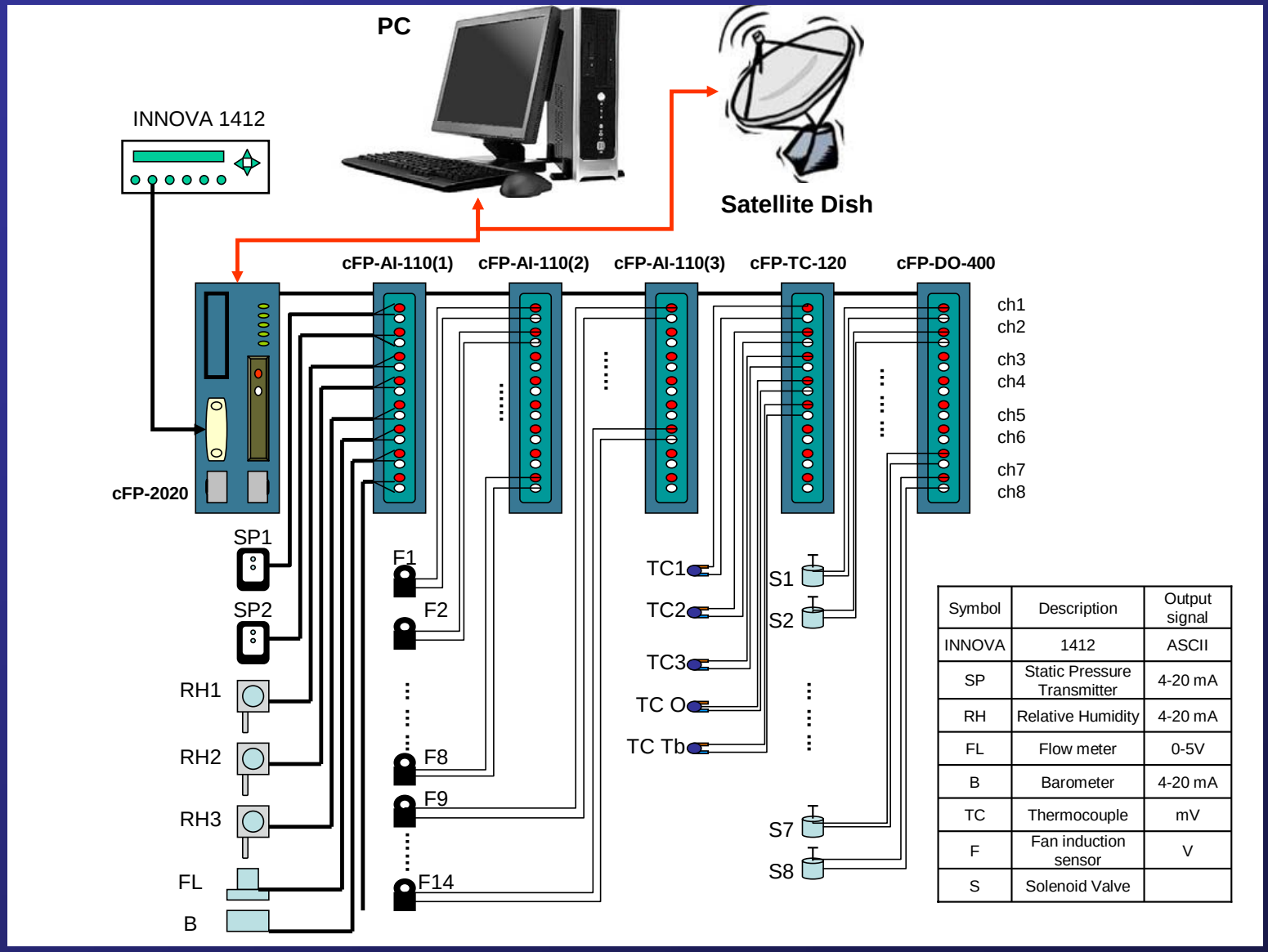
- Operational curve for each exhaust fan developed in-situ using FANS system

FANS Testing

Results of FANS Testing

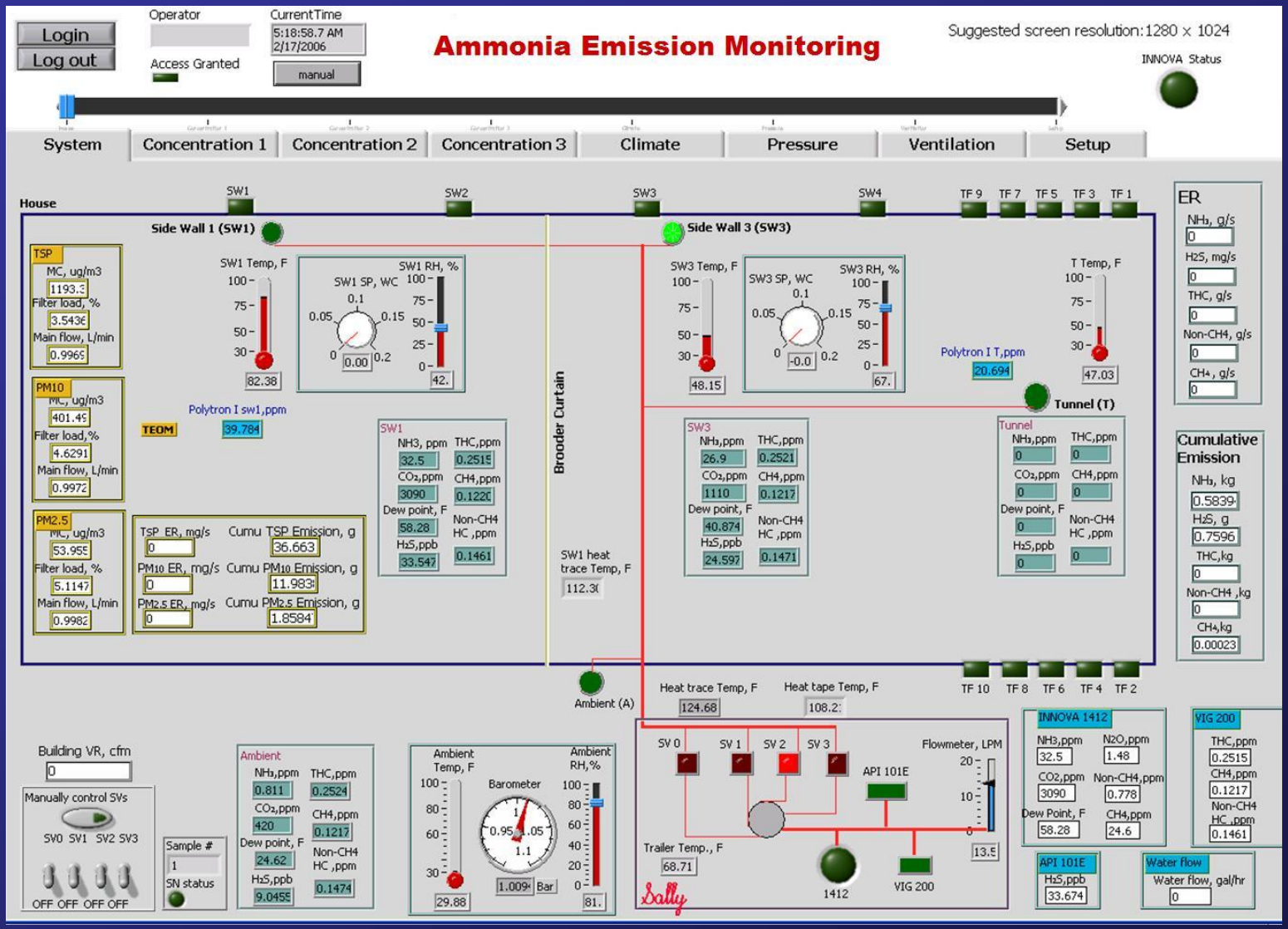


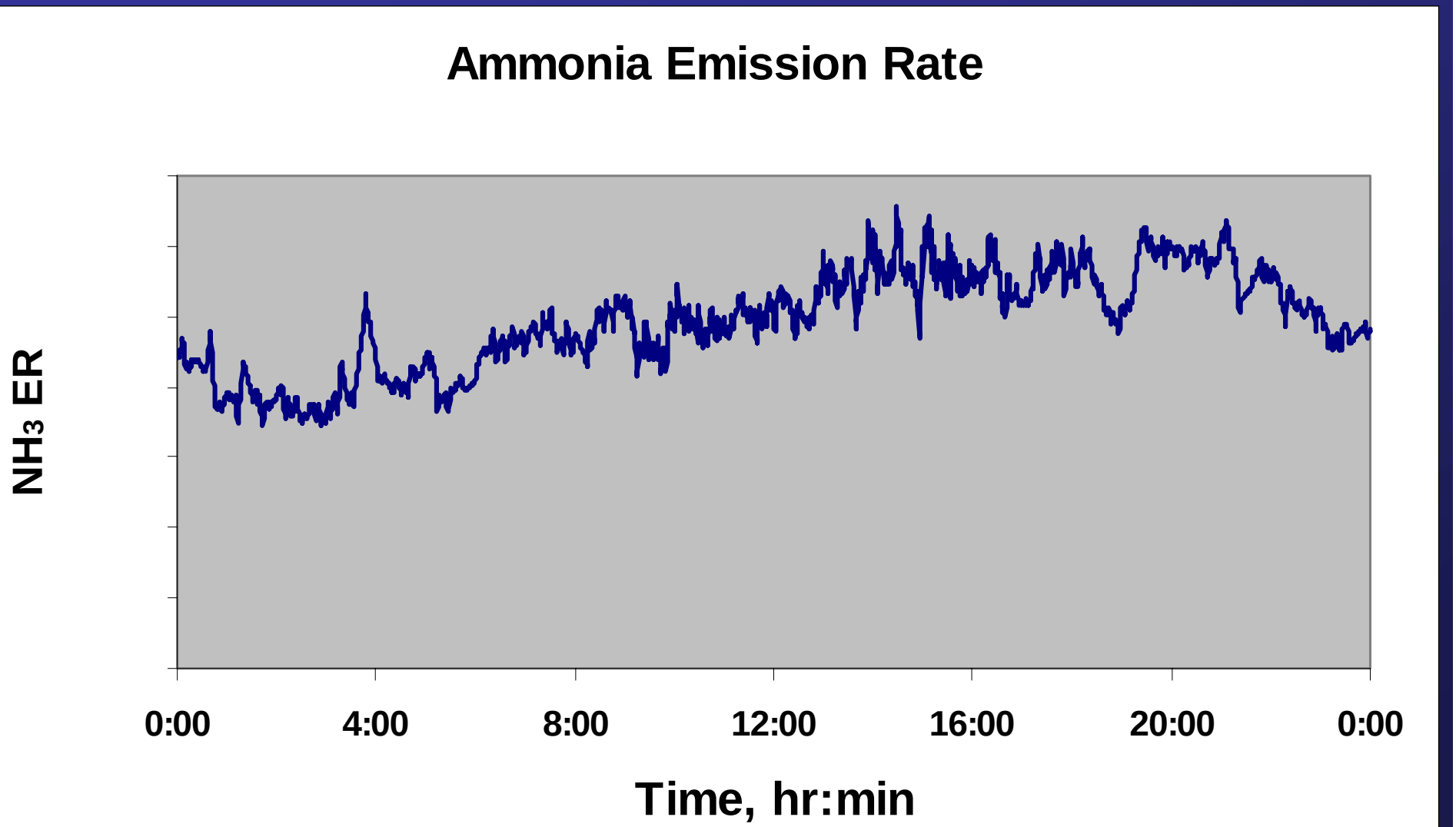
DAQ and Control System



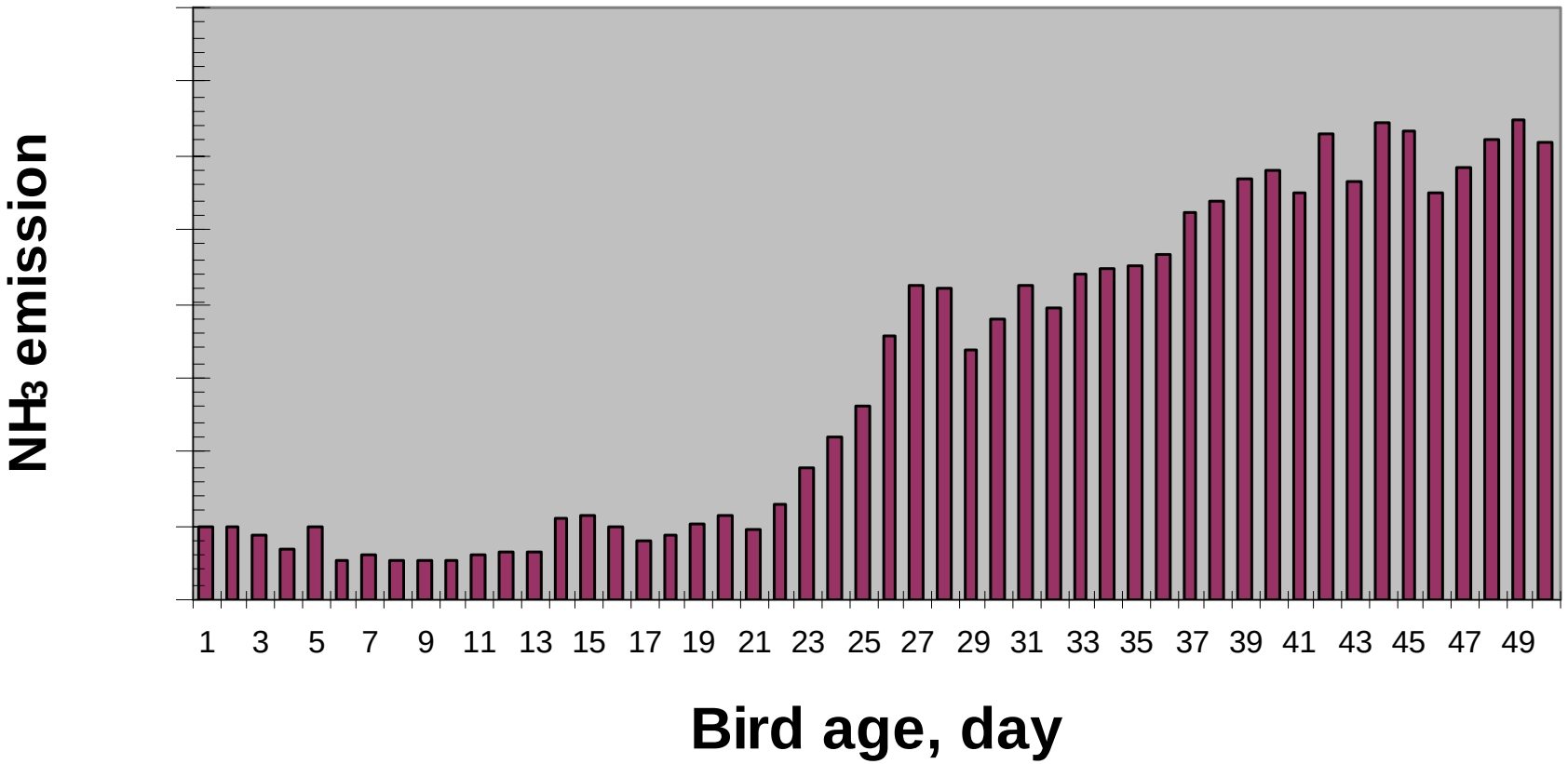
Symbol	Description	Output signal
INNOVA	1412	ASCII
SP	Static Pressure Transmitter	4-20 mA
RH	Relative Humidity	4-20 mA
FL	Flow meter	0-5V
B	Barometer	4-20 mA
TC	Thermocouple	mV
F	Fan induction sensor	V
S	Solenoid Valve	

Screen Display of Real-Time Air Emissions Monitoring

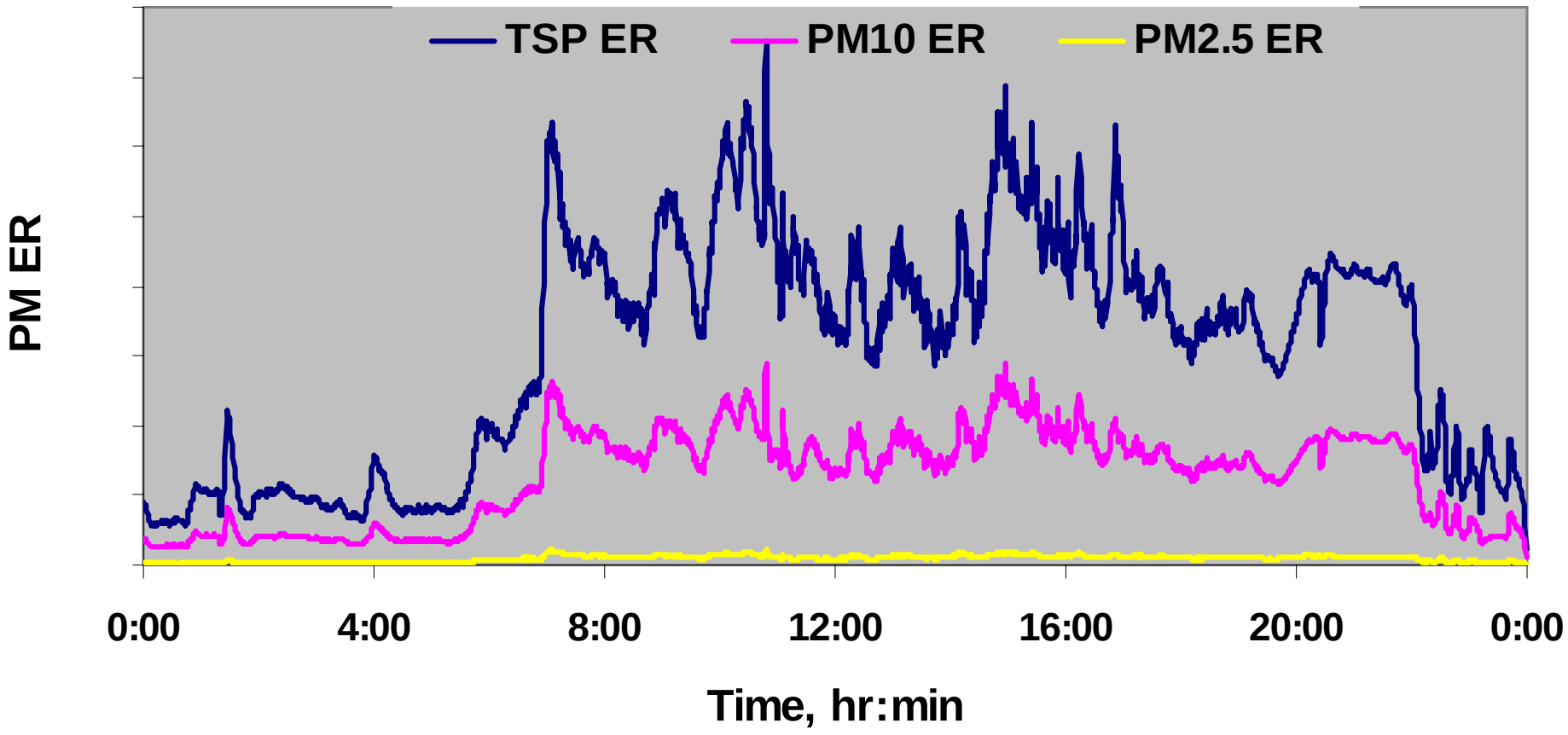



Ammonia Emission Rate
NH3 ER
0:00
4:00
8:00
12:00
16:00
20:00
0:00
Time, hr:min

Ammonia Emission (Flock Emission)



Particulate Matter Emission Rate



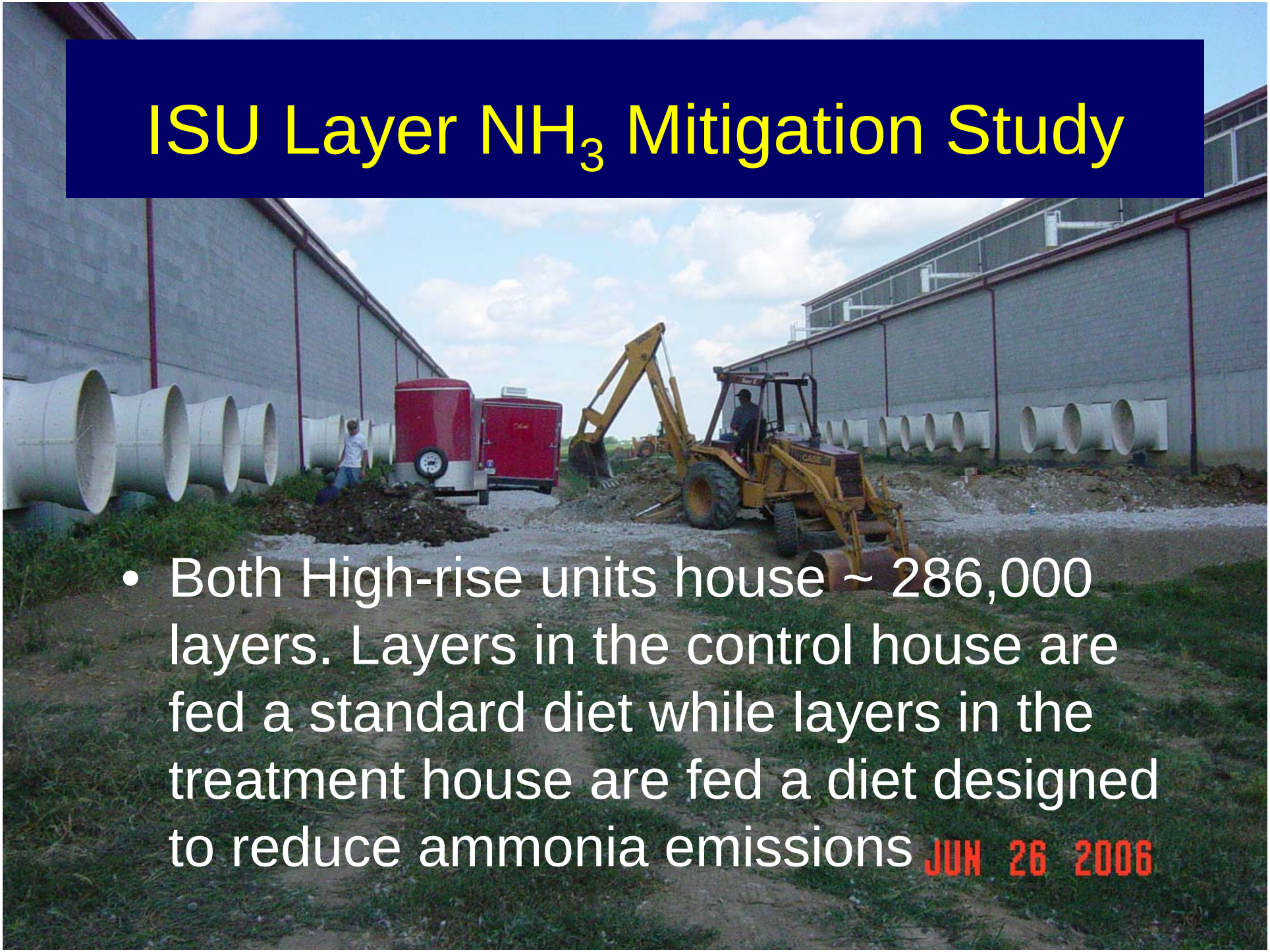
Southeastern Broiler Air Emissions Project Schedule

	2005	2006				2007		
	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.
Purchase Monitoring Equipment	X							
Prepare QAPP	X	X						
EPA Review of QAPP		X	X					
QAPP Revisions			X	X				
Prepare Monitoring Trailers	X	X						
On-site Equipment Installation	X	X						
Monitoring System Testing		X						
Collect Data		X	X	X	X	X		
Analyze Data			X	X	X	X	X	X
Progress Reports				X			X	
Final Emissions Report								X

ISU Layer NH_3 Mitigation Study
(Xin & Burns)

- NH3 emissions from two Rose Acre Farms High-Rise Layer houses in central Iowa are being monitored

ISU Layer NH_3 Mitigation Study



- Both High-rise units house ~ 286,000 layers. Layers in the control house are fed a standard diet while layers in the treatment house are fed a diet designed to reduce ammonia emissions


MAEMU placement so that two barns
(control & treatment) can be
measured using one unit

Layer NH_3 Mitigation Study

- NH_3 emissions monitoring system installation was recently completed
- NH_3 emissions as well as bird performance will be monitored for one year from the control and treatment high-rise houses

Layer NH_3 Emissions Study
(Xin, Burns & Arthur)

- NH_3 emissions are being calculated using a Nitrogen mass-balance approach for eight varieties of layers in conjunction with Hy-Line

- Project data collection is 2/3 complete

Recently Completed ISU Layer NH_3 Mitigation Studies

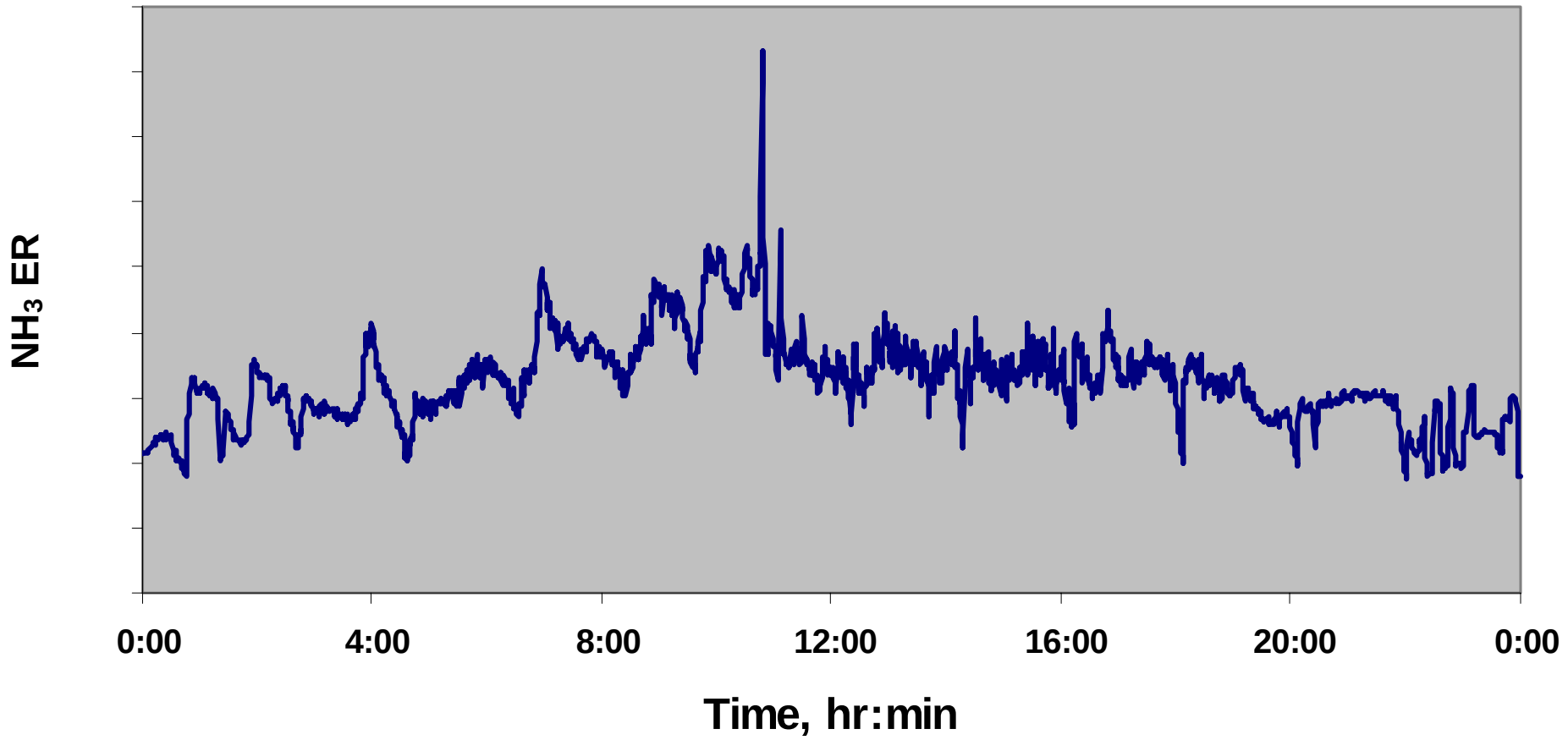
- *Reduction of Ammonia Emission from Stored Poultry Layer Manure Using Additives: Zeolite, Al+clear, Ferix-3 and PLT.* 2006 Li, Hong Li, H. Xin , R. T. Burns, and Y. Liang. Published in the proceedings of the 2006 ASABE Annual Meeting, Portland, Oregon.

- *Effects of Stack Surface to Volume Ratio and Air Exchange Rate on Ammonia Emission of Laying Hen Manure Storage.* 2005. Li, Hong and Y. Liang. Published in the proceedings of the 2005 AWMA Annual Meeting, Minneapolis, Minnesota.


Sally
IOWA STATE UNIVERSITY
Agricultural & Biosystems Engineering
Mobile Air Emissions Monitoring Unit

Questions ?

Ammonia Emission Rate



Positive Pressure Gas Sampling System

Initial “shake-down” data collection has begun

Cross-section View of Air Sampling Point Location