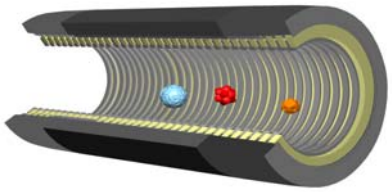
AMC Monitoring with IMS

Overview

- Ion Mobility Spectrometry Description
- Calibration
  - Factory
  - In the Field
- Future Directions in Monitoring

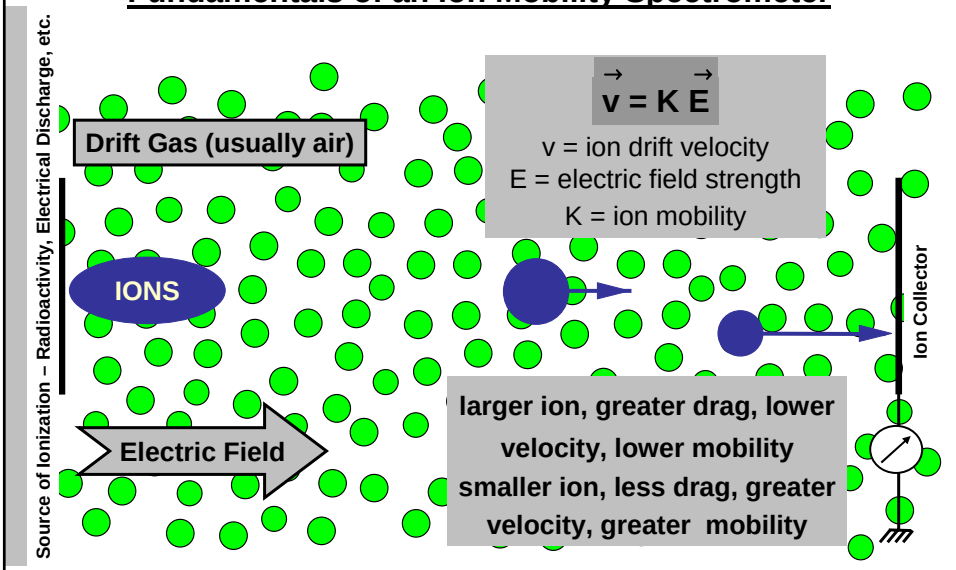
Ion Mobility:
Elementary Principles

- In the presence of a weak electric field, ions of different sizes separate based on the number of ion-neutral collisions.



PARTICLE MEASURING SYSTEMS

Fundamentals of an Ion Mobility Spectrometer



C. S. Harden

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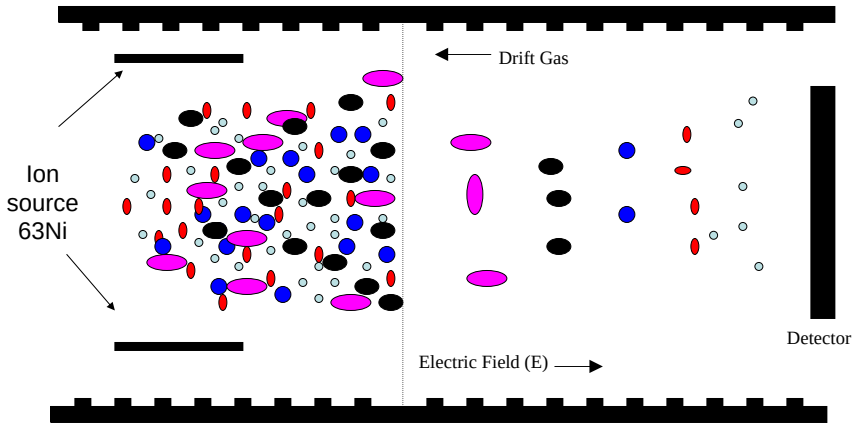
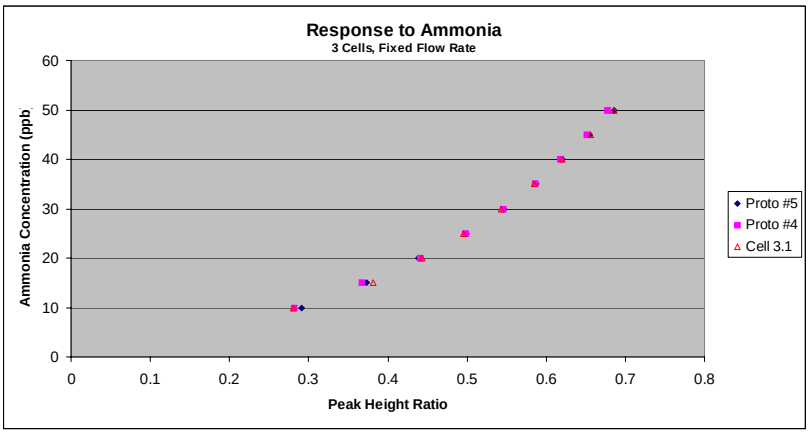
How Are Ions Separated?



Factory Calibration

- NIST Traceable Gas Standard
  - Permeation Tube
  - Temperature Controlled Oven
  - Mass Flow Controllers Generating Dilution Gas Flow
- Linearity Calibration
  - Create IMS Response vs. Gas Concentration Plot and Calibration Curve
  - Verifies Analyzer Accuracy across Dynamic Range

Example Calibration Curve



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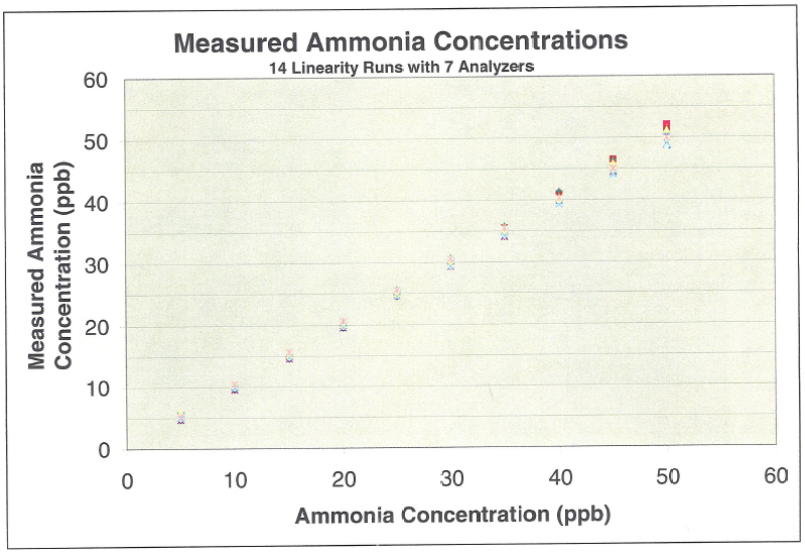
Linearity of Response



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IMS Calibration in the Field

- Zero Calibration
  - Calibrate response when no analyte is present
- Span Calibration
  - Calibrate response when known concentration is present
  - Usually concentration is 50 % of full scale

Future Direction for Molecular Contamination Monitoring

Build on lessons learned from particle counting

- Away from sequential to point-of-use
- Move from strictly environmental to include process monitoring
- Improve limits of detection
- Simplicity of design
- Maximize information delivered per unit time per $ invested

Performance Driven Design

Performance Driven Design

Meet application needs with specific products

- Move away from adapting existing products
- Creating new solutions for contamination monitoring

Centralized software for data acquisition and control

Design equipment for improved reliability and maximum sensitivity

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AirSentry II

Point of Use (POU)

- Continuous sampling
- Single calibration source guarantees matching
- Cost effective
- Simplified electronics and pneumatics for better reliability
- Software centralization

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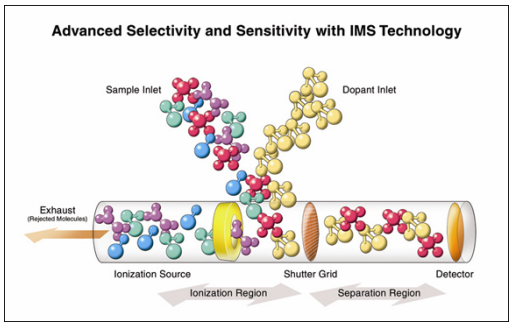
New Cell Design
Ion Mobility Spectrometry

- Simplicity of Design
- Better Repeatability
- Better Detection Limits
- Increased Selectivity



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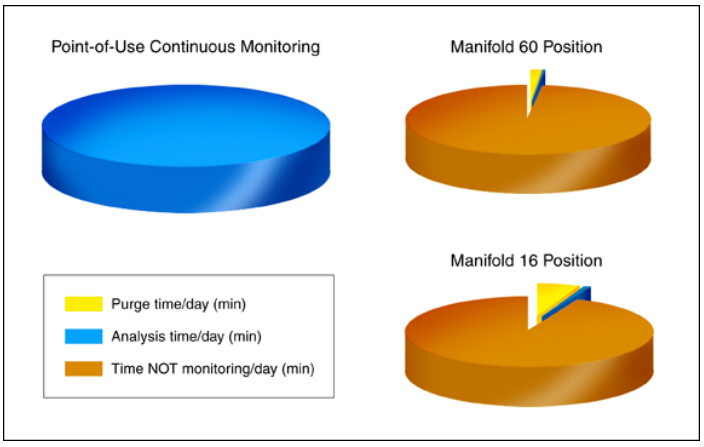
Point-of-Use Implementation



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Point-of-Use Benefits

	Technology	% Time Measuring Per Day	% Time NOT Measuring Per Day	Sample transport effects (typical tubing lengths)	Detection Limits
Conventional (60 Points)	Adaptation of complex laboratory instrumentation	0.17 % 2.4 Min.	99.83 % 1438 Min.	50 M. Significant	300 ppt
Conventional (16 Points)	Adaptation of complex laboratory instrumentation	0.62 % 9 Min.	99.38 % 1431 Min.	25 M. Significant	300 ppt
AirSentry-II (POU)	Simplicity of design	100.0 % 1440 Min.	0.0 % 0 Min.	2 M. Minimized	< 50 ppt (with sample averaging)
Benefits:	**Better Reliability**	**Continuous Data Obtained**	**No Missed Contamination Events**	**Better Response and Clear Down** **Better Accuracy**	**Better Detection Limits**

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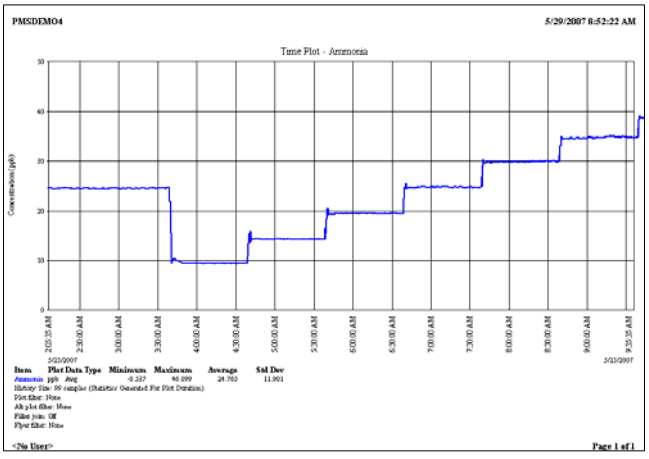
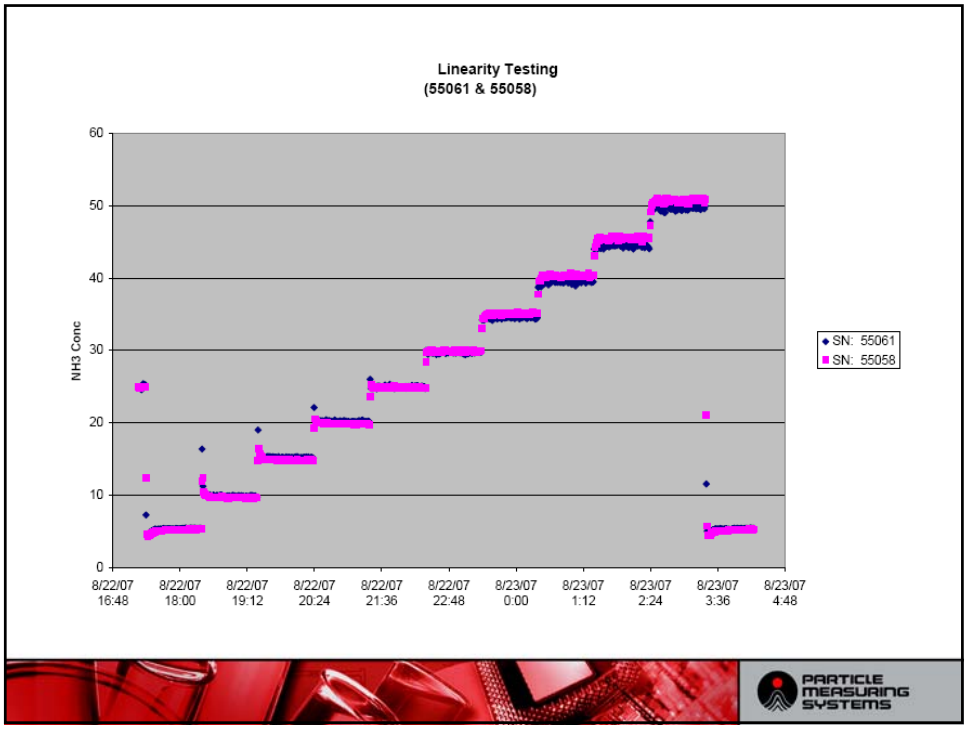
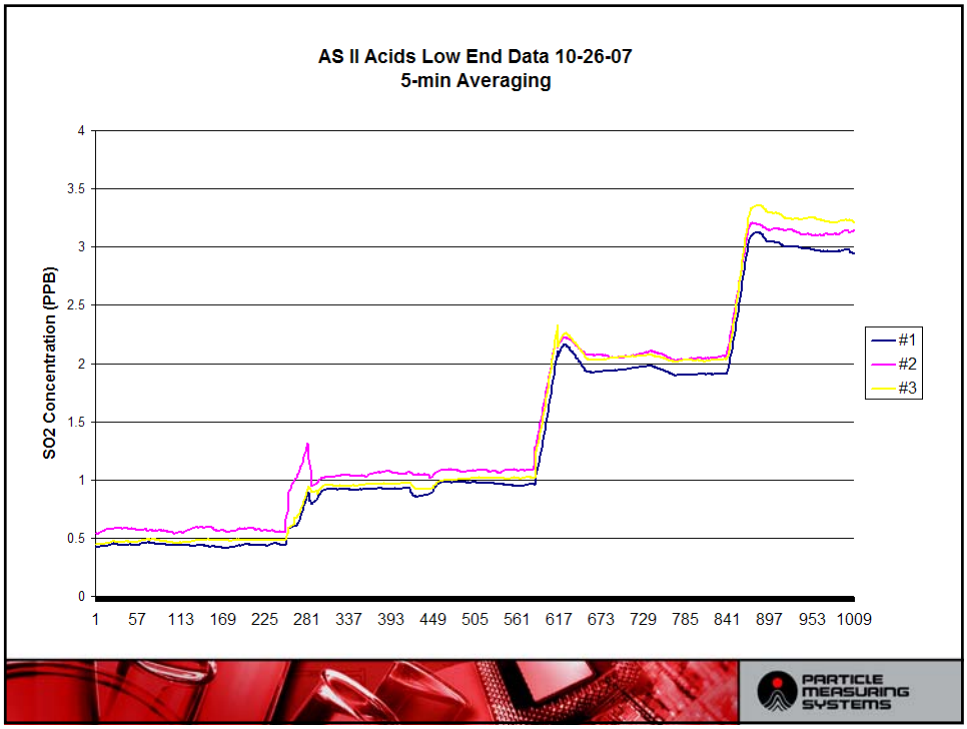
Concentration Steps



PARTICLE MEASURING SYSTEMS


Linearity Testing
(55061 & 55058)
NH3 Conc
60
50
40
30
20
10
0
8/22/07 16:48
8/22/07 18:00
8/22/07 19:12
8/22/07 20:24
8/22/07 21:36
8/22/07 22:48
8/23/07 0:00
8/23/07 1:12
8/23/07 2:24
8/23/07 3:36
8/23/07 4:48
SN: 55061
SN: 55058
PARTICLE MEASURING SYSTEMS


AS II Acids Low End Data 10-26-07
5-min Averaging
SO2 Concentration (PPB)
4
3.5
3
2.5
2
1.5
1
0.5
0
1 57 113 169 225 281 337 393 449 505 561 617 673 729 785 841 897 953 1009
#1
#2
#3
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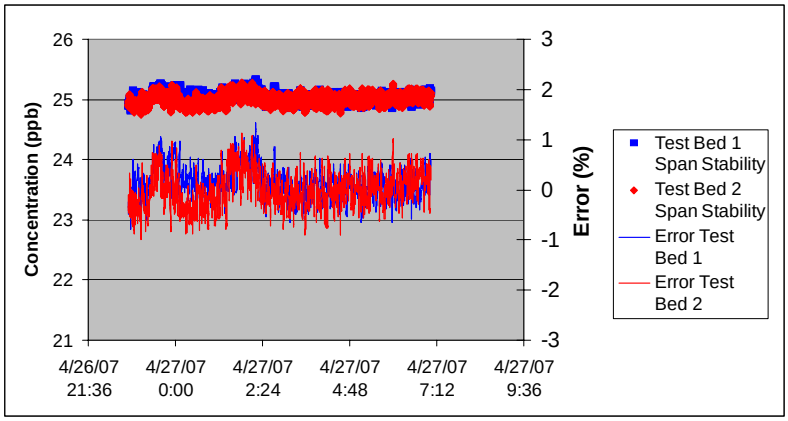
Span Calibration Stability

< 3 % of span value



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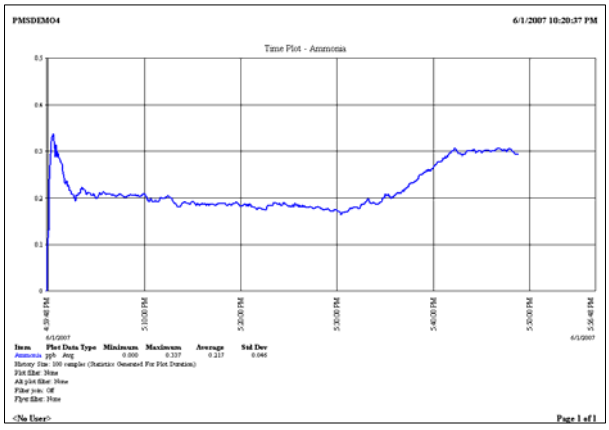
Sensitivity to Change

Intentional Injection of 100 ppt Ammonia



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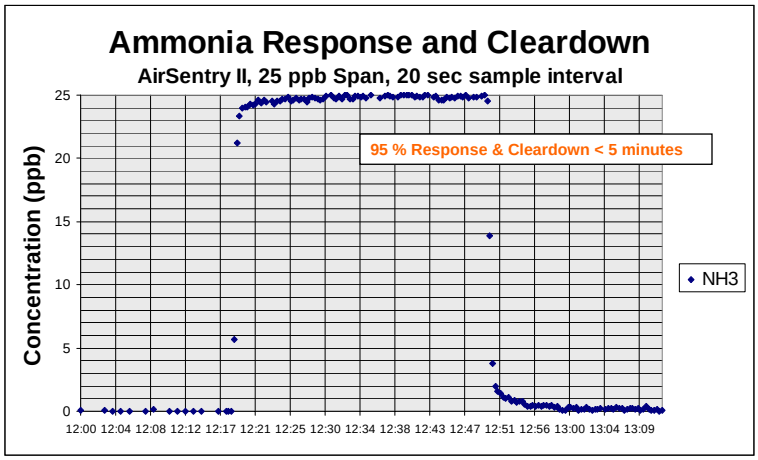
Ammonia Response-Cleardown



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Improved Limit of Detection
Reduction of Random Noise

If we can reduce the noise, we improve the limit of detection and our ability to detect small changes.

- Noise is the measurement variation for the same sample
- Limit of detection = 3 x standard deviation (noise at background)
- Standard deviation between samples decreases for longer measurement times

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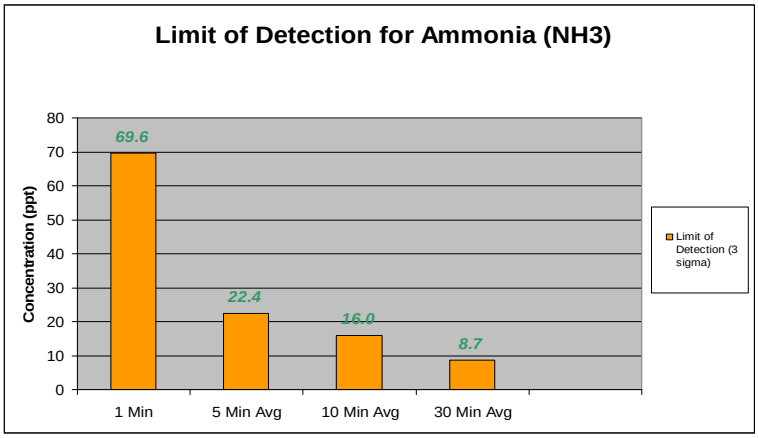
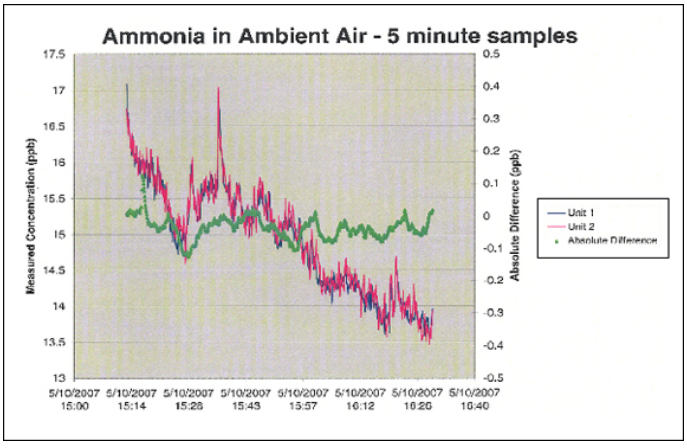
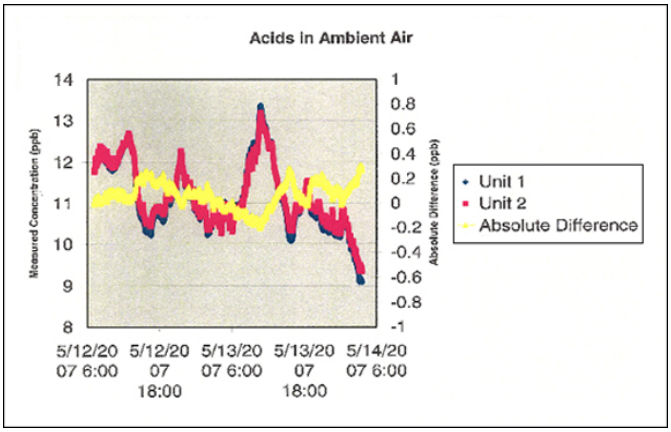
Sample Averaging



Unit to Unit Matching



Unit to Unit Matching



AirSentry II Specifications

- Contaminants Detected: Ammonia, Amines, or Acids
- Concentration Range: 0 – 50 ppb_v
- Limit of Detection (3σ): 70 ppt_v, 5 min. avg
- Sample Tubing:
  - 1/4 in. (or 6 mm) O.D. PFA
  - < 5 meters length
- Sample Flow: < 1000 cc/min
- Dimensions 12 x 9 x 4 in. (31 x 23 x 10 cm)
- Weight: 5 lbs. (2.3 kg)

AirSentry II Installation

- Power: 100 – 240 VAC (50/60 Hz), 60 W
- Clean Dry Air (CDA):
  - 1000 cc/min
  - -60 C dew point, no particles > 50 µm
  - 5 psig precision regulated
- Vacuum: 15 in. Hg (380 torr)
- Communications:
  - Ethernet (to Facility Net)
  - RS-232 (to HyperTerminal)
  - 4-20 mA

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Calibration Station with AirSentry II

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Cost of Ownership
Service Schedule

Ammonia & Amines Analyzer

- Wipe Test – every 6 months
- Dopant Replacement – Every 10 years
- Membrane Replacement – No membrane is used in AirSentry II
- Zero Calibration – Once every 6 months
- Span Calibration – Once every 6 months

Acids Analyzer

- Wipe Test – every 6 months
- Dopant Replacement – Every 4 years
- Membrane Replacement – No membrane is used in AirSentry II
- Zero Calibration – Once every 6 months
- Span Calibration – Once every 6 months

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Benefits of AirSentry II vs. AirSentry System

Continuous	Samples without interruption
Cost	Low cost of entry
Sensitivity	70 part-per-trillion detection limit
Accuracy	Pressure compensation and peak tracking
Simplicity	Increase reliability, decrease service needs
Sample	Minimize sample tubing
Size	Footprint allows placement in or near critical locations
Calibration	Single calibration source ensures matching

PARTICLE MEASURING SYSTEMS

Point-of-Use Benefits

- **Simplicity of design for better reliability**
- **Continuous 24/7 monitoring for no missed contamination events**
- **Better Accuracy - pressure compensation and peak tracking**
- **Better Response and Cleardown**
- **Better detection limits with sample averaging**