

# **QUALITY ASSURANCE AUDIT REPORT**

**Midlothian, Texas  
Ambient Air Collection and Chemical Analysis  
Midlothian, TX**

**Conducted:  
December 4, 2008**

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**January 6, 2009**

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## EXECUTIVE SUMMARY

On December 4, 2008, Darrin Barton of URS Corporation conducted performance and technical system audits of the Midlothian, Texas ambient air collection and chemical analysis monitoring program in Midlothian, Texas. The audits provided an independent assessment of the monitoring program.

There are five (5) monitoring locations involved in this program, identified as Sites 1, 2, 3a, 4, and 5. Each location contains specific monitoring equipment and measurement systems as part of a network designed to document air quality. All monitoring equipment and measurement systems associated with the network were found to be in operation at the time of the audit and were subsequently audited. Performance audit results indicate acceptable responses for measurement systems and monitoring equipment.

Performance audit results are presented in this report. Any identified concerns or observations, were reported to the URS project team via a corrective action report (CAR) at the conclusion of the audit. For each issued CAR, the project team will initiate measures to resolve the identified area in a timely manner and a follow up concerning any CAR's will be conducted during the next audit.

## 1.0 Introduction

On December 4, 2008, Darrin Barton of URS Corporation conducted performance and audits of the Midlothian, Texas ambient air collection and chemical analysis monitoring program in Midlothian, Texas. This report, along with the attached appendices, documents the audit procedures, performance audit results, and identified concerns and observations. Where applicable, recommendations are offered to improve overall operations and quality control. At the conclusion of the audit, the auditor met with the project staff to discuss all results, identified concerns and observations.

### 1.1 Purpose

This audit was conducted as part of an independent URS quality assurance program for the Midlothian Ambient Air Collection and Chemical Analysis monitoring project. The objectives of the audit were to provide an assessment of the performance for air quality and meteorological monitoring equipment and to evaluate the technical systems employed.

### 1.2 Scope

The monitoring program for the Midlothian Ambient Air Collection and Chemical Analysis monitoring project consists of a network of five (5) monitoring locations with the following monitoring measurement systems:

- Sites 1, 2, 3c, 4, and 5.
  - Meteorological monitoring systems measuring wind direction, wind speed, temperature, barometric pressure and precipitation;
- Sites 1, 2, 3c, 4, and 5.
  - High-volume time-integrated PM<sub>10</sub> air monitors to collect particulate samples for the determination of metals other than Cr<sup>6+</sup>. Low-volume time-integrated air monitors to collect particulate samples for Cr<sup>6+</sup>.

### **1.3 Audit Procedures**

Performance audits were conducted by comparing field measurements to an audit standard of known quality or through artificial field tests in which the instrument response is predicted. In each case, results were obtained and compared to the audit criteria for accuracy. Audit criteria used to assess each measured parameter are derived from the following:

- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Specific Methods, Section 2.11, EPA/600/R-94/038b, revised April 1994;
- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, EPA/600/R-94/038d, revised April 1994; and
- Quality Assurance Project Plan (QAPP) for Midlothian, Texas Ambient Air Collection and Chemical Analysis.

Performance audit results for each measurement are summarized in this report, with detailed documentation provided in the appendix. Specific procedures and methods employed for the audit are described in the subsections below.

#### **1.3.1 High-Volume PM<sub>10</sub> Sampler**

Each PM<sub>10</sub> sampler was audited using a certified Volumetric Flow Control (VFC) orifice comparing the calculated audit flow rate to the sampler calibration flow rate and the designed (ideal) flow rate.

#### **1.3.2 Cr<sup>6+</sup> Sampler**

The TEOM unit was audited for flow rate accuracy for the main flow. Flow rate accuracy was tested using a NIST-traceable volumetric flow meter for each portion of the flow system.

#### **1.3.3 Wind Direction**

Wind direction was audited for two independent characteristics: alignment of the sensor with respect to true north and output linearity. Alignment was tested using a certified compass transit by comparing the response of the sensor to the known magnetic declination. Output linearity was tested in 30-degree increments using a linearity device in both the clockwise and counterclockwise directions. These results were used to determine the maximum total error over the range of the sensor. Additionally, the condition of each sensor's bearings was inspected.

#### **1.3.4 Horizontal Wind Speed**

Wind speed was audited using a constant velocity motor drive unit for which several specific rates of revolution correspond to known wind speeds. In addition, the condition of each sensor's bearings was checked to ensure that the starting threshold (i.e., lowest detectable wind speed) was within manufacturer's specification.

#### **1.3.5 Temperature**

Temperature was audited by comparing the measured response against a collocated NIST-traceable digital thermometer over several time intervals.

#### **1.3.6 Barometric Pressure**

Barometric pressure was audited by comparing the measured response against a collocated NIST-traceable barometer over several time intervals.

#### **1.3.7 Precipitation**

Precipitation was audited by introducing a known amount of water into the gauge bucket and testing against the predicted response.

## 2.0 Audit Results

The following tables contain a summary of the performance audit results by measurement parameter. Detailed performance audit data are contained in the field audit data sheets section (Appendix A).

**Table 2-1. PM<sub>10</sub> Audit Results**

Site Number	Sampler Serial Number	Calculated Audit Flow (m <sup>3</sup> /min)	Sampler Flow (m <sup>3</sup> /min)	Audit Flow Rate Difference (%) (Criteria ± 7%)	Design Flow Rate Difference (%) (Criteria ± 10%)	Pass / Fail
1	580	1.085	1.096	1.0	-4.0	Pass
	675	1.085	1.073	-1.1	-4.0	Pass
2	641	1.080	1.045	-3.2	-4.4	Pass
	585	1.098	1.1	0.3	-2.9	Pass
	726	1.098	1.054	-3.9	-2.9	Pass
3c	6673	1.085	1.063	-2.1	-4.0	Pass
	6671	1.102	1.076	-2.4	-2.4	Pass
4	6670	1.096	1.079	-1.5	-3.0	Pass
	6672	1.114	1.086	-2.5	-1.4	Pass
5	583	1.086	1.095	0.9	-3.9	Pass
	584	1.103	1.1	-0.3	-2.4	Pass

**Table 2-2. Cr<sup>6+</sup> Flow Rate Audit Results**

Site Number	Channel	Expected Flow Rate (LPM)	Measured Flow Rate (LPM)	Measurement Error (%) (Criteria ± 10%)	Pass / Fail
1	1	15.0	15.62	4.1	Pass
	2	15.0	15.47	3.1	Pass
2	1	15.0	16.06	7.1	Pass
	2	15.0	14.86	-0.9	Pass
	1d	15.0	15.89	5.9	Pass
3c	1	15.0	16.24	8.3	Pass
	2	15.0	16.15	7.7	Pass
4	1	15.0	15.51	3.4	Pass
	2	15.0	15.24	1.6	Pass
5	1	15.0	15.04	0.3	Pass
	2	15.0	14.92	-0.5	Pass

**Table 2-3. Wind Direction Audit Results**

Site Number	Sensor Height (meters)	Alignment Error (°) (Criteria ± 2°)	Max Linearity Error (°) (Criteria ± 3°)	Max Total Error (°) (Criteria ± 5°)	Pass / Fail
1	10	-1.4	1.68	-3.07	Pass
2	10	-0.4	-1.25	-1.65	Pass
3c	10	1.6	-2.58	4.02	Pass
4	10	1.6	2.82	4.12	Pass
5	10	-1.4	-2.62	-2.52	Pass

**Table 2-4. Horizontal Wind Speed Audit Results**

Site Number	Sensor Height (Meters)	Audit Input Value (mph)	Sensor Measurement (mph)	Measurement Error (mph) (Criteria $\pm 0.4$ mph)	Pass / Fail
1	10	0.6	0.6	0.0	Pass
		4.2	4.2	0.0	Pass
		10.1	10.1	0.0	Pass
		18.5	18.5	0.0	Pass
		36.4	36.4	0.0	Pass
		54.3	54.3	0.0	Pass
2	10	0.6	0.6	0.0	Pass
		4.2	4.2	0.0	Pass
		10.1	10.1	0.0	Pass
		18.5	18.5	0.0	Pass
		36.4	36.4	0.0	Pass
		54.3	54.3	0.0	Pass
3c	10	0.6	0.6	0.0	Pass
		4.2	4.2	0.0	Pass
		10.1	10.1	0.0	Pass
		18.5	18.5	0.0	Pass
		36.4	36.4	0.0	Pass
		54.3	54.3	0.0	Pass
4	10	0.6	0.6	0.0	Pass
		4.2	4.2	0.0	Pass
		10.1	10.1	0.0	Pass
		18.5	18.5	0.0	Pass
		36.4	36.4	0.0	Pass
		54.3	54.3	0.0	Pass
5	10	0.6	0.6	0.0	Pass
		4.2	4.2	0.0	Pass
		10.1	10.1	0.0	Pass
		18.5	18.5	0.0	Pass
		36.4	36.4	0.0	Pass
		54.3	54.3	0.0	Pass

**Table 2-6. Temperature Audit Results**

Site Number	Sensor Height (Meters)	Reference Temperature (°C)	Sensor Reading (°C)	Measurement Error (°C) (Criteria ± 1.0° C)	Pass / Fail
1	1.1	1.8	2.1	0.4	Pass
		3.1	3.1	0.0	Pass
2	1.1	9.7	9.5	-0.2	Pass
		9.7	9.6	-0.1	Pass
3c	1.1	9.2	9.0	-0.2	Pass
4	1.1	5.2	5.7	0.5	Pass
5	1.1	8.7	8.6	-0.1	Pass

**Table 2-7. Barometric Pressure Audit Results**

Site Number	Sensor Height (Meters)	Reference Pressure (mm/Hg)	Sensor Reading (mm/Hg)	Measurement Error (mm/Hg) (Criteria ± 7.6 mm/Hg)	Pass / Fail
1	1.1	756.6	754.7	-1.9	Pass
		757.4	755.4	-2.0	Pass
2	1.1	756.7	754.0	-2.7	Pass
		756.7	754.2	-2.5	Pass
3c	1.1	752.7	750.9	-1.8	Pass
4	1.1	753.5	751.1	-2.5	Pass
5	1.1	751.6	749.9	-1.7	Pass

**Table 2-8. Precipitation Audit Results**

Site Number	Sensor Height (Meters)	Input Volume (Inches)	Sensor Reading (Inches)	Measurement Error (%) (Criteria ± 10%)	Pass / Fail
1	0.6	.10	.09	-10.0	Pass
2	0.6	.10	.09	-10.0	Pass
3c	0.6	.10	.09	-10.0	Pass
4	0.6	.10	.09	-10.0	Pass
5	0.6	.10	.10	0.0	Pass

## **3.0 Discussions and Recommendations**

This section focuses on concerns identified during the audit. An audit concern can be a performance audit results that does not meet the criteria, or a technical systems audit result of any condition that may adversely affect quality. Three categories are used to rank the audit concerns critical, major and minor. Each level of concern is defined in the following paragraphs, along with an explanation of any audit issues that are so categorized. General recommendations for corrective actions are listed at the end of the section, where applicable. Appended to this report are the field data worksheets (Appendix A), audit equipment traceability (Appendix B) and corrective action reports (Appendix C).

### **3.1 Critical Concerns**

Critical concerns are situations that will adversely impact data quality and have a significant effect on successful project operations. Nonconforming audit results that indicate measurements out of quality control requirements are classified as critical concerns. These concerns require immediate action to ensure that the measurement quality will return to in-control conditions. Critical concerns must be addressed and corrective action documented and reported to the project team. Based on the results of this audit, no critical concerns were identified.

### **3.2 Major Concerns**

Major concerns may not immediately affect successful project operations, but may potentially impact data quality and could lead to data invalidation. Measurement systems outside the audit objective are classified as major concerns. A written response normally is required for major concerns so that acknowledgment of the problem and a corrective action plan can be communicated and implemented effectively. Based on the results of this audit, no major concerns were identified.

### **3.3 Minor Concerns**

Minor concerns are typically based on observed inconsistencies in implementation of procedures, or performance audit results that indicate potential for future problems. Data validity is not compromised, but a degree of inefficiency or the beginning of a larger problem could result from these situations. Based on the results of this audit, no minor concerns were identified.

### **3.4 General Recommendations**

There were no concerns identified during the QA audit. The monitoring equipment responses were all acceptable and the technical system audit found no deficiencies.

## **4.0 Response Requirements**

The current Quality Assurance database used for corrective action reports requires input from field operations staff, data editors, QA staff and project management prior to closure. No concerns were noted during this audit, and consequently no response is required.

## **APPENDIX A**

### **Field Data Worksheets**

### Wind Direction Audit Data Sheet (360 Sensor)

Site ID: Midlothian CAMS 52(Site 1)  
 Date: December 4, 2008  
 Time: 950-1120 CST  
 Sensor ID: Met One 020 C  
 Serial #: Y2145

Tower Height: 10 Meters  
 Sensor Level: yes  
 Vane Condition: good  
 Bearing Condition: good  
 Last Field Calibration: n/a

Audit Device: Compass Transit  
 Model: Lietz 115  
 Serial #: 32100  
 Cert. Expiration: November 18, 2009  
 Linearity Device: Met One Degree Wheel  
 Serial #: 1

Reference Angle (deg)	Sensor Rotation	Sensor Response (deg)	Measurement Error (deg)	Hysteresis Error (deg)	Normalized Linearity Error (deg)	Average Error (deg)	Total Error (deg)
0	cw	2.52	2.52		1.68		
30	cw	29.16	-0.84		-1.68		
60	cw	59.50	-0.50		-1.34		
90	cw	89.94	-0.06		-0.90		
120	cw	120.02	0.02		-0.82		
150	cw	150.21	0.21		-0.63		
180	cw	180.36	0.36		-0.48		
210	cw	210.79	0.79		-0.05		
240	cw	241.32	1.32		0.48		
270	cw	271.66	1.66		0.82		
300	cw	302.09	2.09		1.25		
330	cw	332.52	2.52		1.68		
360	ccw	362.47	2.47	0.05	1.63	1.66	0.26
330	ccw	332.52	2.52	0.00	1.68	1.68	0.28
300	ccw	302.09	2.09	0.00	1.25	1.25	-0.15
270	ccw	271.66	1.66	0.00	0.82	0.82	-0.58
240	ccw	241.32	1.32	0.00	0.48	0.48	-0.92
210	ccw	210.79	0.79	0.00	-0.05	-0.05	-1.45
180	ccw	180.36	0.36	0.00	-0.48	-0.48	-1.88
150	ccw	150.21	0.21	0.00	-0.63	-0.63	-2.03
120	ccw	119.98	-0.02	0.00	-0.86	-0.84	-2.24
90	ccw	89.93	-0.07	0.01	-0.91	-0.90	-2.30
60	ccw	59.50	-0.50	0.00	-1.34	-1.34	-2.74
30	ccw	29.17	-0.83	0.01	-1.67	-1.67	-3.07
<b>Mean:</b>			<b>0.84</b>	<b>0.01</b>			
<b>Maximum Hysteresis Error :</b>				<b>0.05</b>			
<b>Maximum Normalized Linearity Error :</b>					<b>1.68</b>		
		<i>Specification : +/- 3 degrees</i>					
<b>Maximum Total Error :</b>							<b>-3.07</b>
		<i>Specification : +/- 5 degrees</i>					

True North Alignment	
Known Declination:	4.4 EMD
Expected Magnetic Compass Reading for True North:	355.6 Degrees
Actual Magnetic Compass Reading w/ Vane Aligned to 180/360:	357 Degrees
Alignment Error:	-1.40 Degrees
Data Correction:	None
Alignment Correction:	None
Action Taken	
Alignment meets specification. No action required.	

*Specification : +/- 2 degrees*

Auditor : Darrin Barton

Notes :

## Horizontal Wind Speed Audit Data Sheet

**Site ID:** Midlothian CAMS 52(Site 1)  
**Date:** December 4, 2008  
**Time:** 950-1120 CST  
**Sensor ID:** Met One 010 C  
**Serial #:** A1796

**Tower Height:** 10 Meters  
**Sensor Level:** yes  
**Cup Condition:** good  
**Bearing Check:** 0.2 g-cm CCW  
 0.2 g-cm CW

**Last Field Calibration:** n/a

**Audit Device:** Anemometer Drive  
**Model:** RM Young 18811  
**Serial #:** 10501  
**Cert. Expiration:** June 18, 2009  
**Torque Device:** RM Young Torque Disc  
**Serial #:** 1

Audit Input CCW (rpm)	Known Input Value (m/h)	Sensor Response (m/h)	Measurement Error (m/h)	Audit Input CW (rpm)	Known Input Value (m/h)	Sensor Response (m/h)	Measurement Error (m/h)
0	0.6	0.6	0.0	0	0.6	0.6	0.0
60	4.2	4.2	0.0	60	4.2	4.2	0.0
160	10.1	10.1	0.0	160	10.1	10.1	0.0
300	18.5	18.5	0.0	300	18.5	18.5	0.0
600	36.4	36.4	0.0	600	36.4	36.4	0.0
900	54.3	54.3	0.0	900	54.3	54.3	0.0

*Specification: +/- 0.4*

*Specification: +/- 0.4*

**Auditor:** Darrin Barton

**Notes:**

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## Temperature Audit Data Sheet

Site ID: Midlothian CAMS 52(Site 1)  
Date: December 4, 2008  
Time: 905-955 CST  
Sensor ID: Met One 060A-2  
Serial #: G3468

Sensor Height: 3.5'  
Sensor Condition: good  
Sensor Level: yes  
Aspirator Condition: working  
Last Field Calibration: n/a

Audit Device: Digital Thermometer  
Model: VWR  
Serial #: 230058352  
Cert. Expiration: July 29, 2009

Time of the Audit	Type of Comparison	Audit Reference Temperature (deg C)	Station Probe Temperature (deg C)	Measurement Error (deg C)
905	Collocated Measurement	1.75	2.1	0.4
955	Collocated Measurement	3.1	3.15	0.0

Specification: +/- 1.0

Auditor: Darrin Barton

Notes:

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## Precipitation Audit Data Sheet

Site ID: Midlothian CAMS 52(Site 1)  
Date: December 4, 2008  
Time: 1055 CST  
Sensor ID: Met One  
Serial #: X6391

Sensor Height: 2 inches  
Sensor Condition: good  
Sensor Level: yes  
Sensor Clean: yes  
Last Field Calibration: n/a

Audit Device: Acrylic Buret  
Model: Cole Parmer  
Serial #: 2  
Cert. Expiration: none

Time of the Audit	Input Volume (mL)	Gauge Input (inches)	Response (inches)	Measurement Error (%)
1055	80.0	0.10	0.09	-10.0%

Specification: +/- 10.0

Auditor : Darrin Barton

Notes:

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### Barometric Pressure Audit Data Sheet

Site ID: Midlothian CAMS 52(Site 1)  
Date: December 4, 2008  
Time: 905- CST  
Sensor ID: Vaisala  
Serial #: unknown

Sensor Height: 3.5'  
Sensor Condition: good  
Sensor Level: yes  
Last Field Calibration: n/a

Audit Device: Barometer/Altimeter  
Model: Airs-Vaisala  
Serial #: OF1475  
Cert. Expiration: May 1, 2009

Time of the Audit	Type of Comparison	Audit Reference Barometric Pressure (mmHg)	Site Sensor Barometric Pressure (mmHg)	Measurement Error (mmHg)
905	Collocated Measurement	756.6	754.7	-1.9
955	Collocated Measurement	757.4	755.4	-2.0

Specification: +/- 7.6

Auditor: Darrin Barton

Notes:

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**PM<sub>10</sub> / VOLUMETRIC FLOW CONTROL (VFC)  
PERFORMANCE AUDIT DATA**

Site ID: Midlothian CAMS 52(Site 1)  
 Date: December 4, 2008  
 Time: 830-900 . CST  
 Pressure (P<sub>a</sub>) (mm Hg): 756.6  
 Temperature (T<sub>a</sub>) (F): 35.0  
 Temperature (T<sub>a</sub>) (C): 1.7

Audit Device: Variable Orifice  
 Serial #: R53  
 Slope: 0.98474  
 Intercept: -0.00778  
 Correlation: 0.99995  
 Cert. Exp. Date: September 30, 2009

PM <sub>10</sub> AUDIT DATA						
Sampler ID#	Audit Pressure Drop (ΔH) ("H <sub>2</sub> O)	Stagnation Pressure (ΔP <sub>STG</sub> ) ("H <sub>2</sub> O)	Audit Flow (Q <sub>a</sub> ) (m <sup>3</sup> /min)	Sampler Flow <sup>1</sup> (Q <sub>s</sub> ) (m <sup>3</sup> /min)	Percent Difference <sup>2</sup> (Sampler vs. Audit)	Percent Difference <sup>3</sup> (Audit vs. Design)
580	3.10	19.3	1.085	1.096	1.0%	-4.0%
675	3.10	20.2	1.085	1.073	-1.1%	-4.0%

1. From Sampler Look-Up Table or Calibration Data
2. Acceptance Criteria: ±7%
3. Acceptance Criteria: ±10%

SAMPLER CALIBRATION DATA					
Sampler ID#	Pressure Ratio (P <sub>1</sub> /P <sub>a</sub> ) (mm Hg)	Calibration Date	Sampler Slope	Sampler Intercept	Sampler Correlation
580	0.9524	11/19/08	12.2996	0.1387	1.0000
675	0.9501	11/19/08	12.0731	0.1683	1.0000

AUDITOR: Darrin Barton

Notes:

## Cr<sup>6+</sup> Sampler PERFORMANCE AUDIT DATA

**Site ID:** Midlothian CAMS 52(Site 1)  
**Date:** December 4, 2008  
**Time:** 1000-1015 CST  
**ANALYZER ID:** ERG CR6-15  
**Serial #:** 15.0

**Audit Flow Meter :** BIOS Cry Cal  
**Model No :** DC Lite  
**Serial No :** 4989  
**Cert. Exp. Date :**

Sample Inlet Flow Audit Data		
Designed Flow Rate (LPM)	Measured Flow Rate (LPM)	Percent Difference <sub>2</sub>
15	15.62	4.13%
15	15.47	3.13%

*2. Acceptance Criteria: ± 10%*

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**Notes:**

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### Wind Direction Audit Data Sheet (360 Sensor)

Site ID: Midlothian Old CAMS 302(Site 2)  
 Date: December 4, 2008  
 Time: 1300-1430 CST  
 Sensor ID: Met One 020 B  
 Serial #: J3045

Tower Height: 10 Meters  
 Sensor Level: yes  
 Vane Condition: good  
 Bearing Condition: good  
 Last Field Calibration: n/a

Audit Device: Compass Transit  
 Model: Lietz 115  
 Serial #: 32100  
 Cert. Expiration: November 18, 2009  
 Linearity Device: Met One Degree Wheel  
 Serial #: 1

Reference Angle (deg)	Sensor Rotation	Sensor Response (deg)	Measurement Error (deg)	Hysteresis Error (deg)	Normalized Linearity Error (deg)	Average Error (deg)	Total Error (deg)
0	cw	0.50	0.50		0.25		
30	cw	31.20	1.20		0.95		
60	cw	61.00	1.00		0.75		
90	cw	91.00	1.00		0.75		
120	cw	120.30	0.30		0.05		
150	cw	150.50	0.50		0.25		
180	cw	179.90	-0.10		-0.35		
210	cw	210.00	0.00		-0.25		
240	cw	240.00	0.00		-0.25		
270	cw	270.00	0.00		-0.25		
300	cw	300.00	0.00		-0.25		
330	cw	329.00	-1.00		-1.25		
360	ccw	0.60	0.60	0.10	0.35	0.30	-0.10
330	ccw	329.00	-1.00	0.00	-1.25	-1.25	-1.65
300	ccw	300.00	0.00	0.00	-0.25	-0.25	-0.65
270	ccw	270.00	0.00	0.00	-0.25	-0.25	-0.65
240	ccw	240.00	0.00	0.00	-0.25	-0.25	-0.65
210	ccw	210.00	0.00	0.00	-0.25	-0.25	-0.65
180	ccw	180.00	0.00	0.10	-0.25	-0.30	-0.70
150	ccw	150.00	0.00	0.50	-0.25	0.00	-0.40
120	ccw	120.00	0.00	0.30	-0.25	-0.10	-0.50
90	ccw	91.00	1.00	0.00	0.75	0.75	0.35
60	ccw	61.00	1.00	0.00	0.75	0.75	0.35
30	ccw	31.00	1.00	0.20	0.75	0.85	0.45
<b>Mean:</b>			<b>0.25</b>	<b>0.10</b>			
<b>Maximum Hysteresis Error :</b>				<b>0.50</b>			
<b>Maximum Normalized Linearity Error :</b>					<b>-1.25</b>		
<i>Specification : +/- 3 degrees</i>							
<b>Maximum Total Error :</b>							<b>-1.65</b>
<i>Specification : +/- 5 degrees</i>							

True North Alignment	
Known Declination:	4.4 EMD
Expected Magnetic Compass Reading for True North:	355.6 Degrees
Actual Magnetic Compass Reading w/ Vane Aligned to 180/360:	356 Degrees
Alignment Error:	-0.40 Degrees
Data Correction:	None
Alignment Correction:	None
Action Taken	
Alignment meets specification. No action required.	
<i>Specification : +/- 2 degrees</i>	

Auditor : Darrin Barton

Notes :



Rev. 8.7 (3/08)

## Horizontal Wind Speed Audit Data Sheet

**Site ID:** Midlothian Old CAMS 302(Site 2)  
**Date:** December 4, 2008  
**Time:** 1300-1430 CST  
**Sensor ID:** Met One 010 B  
**Serial #:** H1095

**Tower Height:** 10 Meters  
**Sensor Level:** yes  
**Cup Condition:** good  
**Bearing Check:**  
 0.2 g-cm CCW  
 0.2 g-cm CW  
**Last Field Calibration:** n/a

**Audit Device:** Anemometer Drive  
**Model:** RM Young 18811  
**Serial #:** 10501  
**Cert. Expiration:** June 18, 2009  
**Torque Device:** RM Young Torque Disc  
**Serial #:** 1

Audit Input CCW (rpm)	Known Input Value (m/h)	Sensor Response (m/h)	Measurement Error (m/h)	Audit Input CW (rpm)	Known Input Value (m/h)	Sensor Response (m/h)	Measurement Error (m/h)
0	0.6	0.6	0.0	0	0.6	0.6	0.0
60	4.2	4.2	0.0	60	4.2	4.2	0.0
160	10.1	10.1	0.0	160	10.1	10.1	0.0
300	18.5	18.5	0.0	300	18.5	18.5	0.0
600	36.4	36.4	0.0	600	36.4	36.4	0.0
900	54.3	54.3	0.0	900	54.3	54.3	0.0

*Specification: +/- 0.4*

*Specification: +/- 0.4*

**Auditor:** Darrin Barton

**Notes:**

**URS**  
 Rev. 8.7 (3/08)

## Temperature Audit Data Sheet

Site ID: Midlothian Old CAMS 302(Site 2)  
Date: December 4, 2008  
Time: 1320-1330 CST  
Sensor ID: Met One 060A-2  
Serial #: unknown

Sensor Height: 3.5'  
Sensor Condition: good  
Sensor Level: yes  
Aspirator Condition: working  
Last Field Calibration: n/a

Audit Device: Digital Thermometer  
Model: VWR  
Serial #: 230058352  
Cert. Expiration: July 29, 2009

Time of the Audit	Type of Comparison	Audit Reference Temperature (deg C)	Station Probe Temperature (deg C)	Measurement Error (deg C)
1320	Collocated Measurement	9.7	9.5	-0.2
1330	Collocated Measurement	9.7	9.6	-0.1

Specification: +/- 1.0

Auditor: Darrin Barton

Notes:

**URS**

Rev. 8.7 (3/08)

## Precipitation Audit Data Sheet

Site ID: Midlothian Old CAMS 302(Site 2)

Date: December 4, 2008

Time: 1320 CST

Sensor ID: Met One

Serial #: unknown

Sensor Height: 2 inches

Sensor Condition: good

Sensor Level: yes

Sensor Clean: yes

Last Field Calibration: n/a

Audit Device: Acrylic Buret

Model: Cole Parmer

Serial #: 2

Cert. Expiration: none

Time of the Audit	Input Volume (mL)	Gauge Input (inches)	Response (inches)	Measurement Error (%)
1320	80.0	0.10	0.09	-10.0%

Specification: +/- 10.0

Auditor : Darrin Barton

**URS**

Rev. 8.7 (3/08)

Notes:

## Barometric Pressure Audit Data Sheet

Site ID: Midlothian Old CAMS 302(Site 2)  
Date: December 4, 2008  
Time: 1320-1330 CST  
Sensor ID: Vaisala  
Serial #: unknown

Sensor Height: 3.5'  
Sensor Condition: good  
Sensor Level: yes  
Last Field Calibration: n/a

Audit Device: Barometer/Altimeter  
Model: Airs-Vaisala  
Serial #: OF1475  
Cert. Expiration: May 1, 2009

Time of the Audit	Type of Comparison	Audit Reference Barometric Pressure (mmHg)	Site Sensor Barometric Pressure (mmHg)	Measurement Error (mmHg)
1320	Collocated Measurement	756.7	754.0	-2.7
1330	Collocated Measurement	756.7	754.2	-2.5

Specification: +/- 7.6

Auditor: Darrin Barton

Notes:

**URS**

Rev. 8.7 (3/08)

**PM<sub>10</sub> / VOLUMETRIC FLOW CONTROL (VFC)  
PERFORMANCE AUDIT DATA**

Site ID: Midlothian Old CAMS 302(Site 2)  
 Date: December 4, 2008  
 Time: 1140-1150 CST  
 Pressure (P<sub>a</sub>) (mm Hg): 757.5  
 Temperature (T<sub>a</sub>) (F): 47.0  
 Temperature (T<sub>a</sub>) (C): 8.3

Audit Device: Variable Orifice  
 Serial #: R53  
 Slope: 0.98474  
 Intercept: -0.00778  
 Correlation: 0.99995  
 Cert. Exp. Date: September 30, 2009

PM <sub>10</sub> AUDIT DATA						
Sampler ID#	Audit Pressure Drop (ΔH) ("H <sub>2</sub> O)	Stagnation Pressure (ΔP <sub>STG</sub> ) ("H <sub>2</sub> O)	Audit Flow (Q <sub>a</sub> ) (m <sup>3</sup> /min)	Sampler Flow <sup>1</sup> (Q <sub>s</sub> ) (m <sup>3</sup> /min)	Percent Difference <sup>2</sup> (Sampler vs. Audit)	Percent Difference <sup>3</sup> (Audit vs. Design)
641	3.00	23.0	1.080	1.045	-3.2%	-4.4%
585	3.10	19.8	1.098	1.100	0.3%	-2.9%

1. From Sampler Look-Up Table or Calibration Data
2. Acceptance Criteria: ±7%
3. Acceptance Criteria: ±10%

SAMPLER CALIBRATION DATA					
Sampler ID#	Pressure Ratio (P <sub>i</sub> /P <sub>a</sub> ) (mm Hg)	Calibration Date	Sampler Slope	Sampler Intercept	Sampler Correlation
641	0.9433	02/04/08	11.4853	0.2279	1.0000
585	0.9512	11/20/08	12.2142	0.1499	1.0000

AUDITOR: Darrin Barton

Notes:

**PM<sub>10</sub> / VOLUMETRIC FLOW CONTROL (VFC)  
PERFORMANCE AUDIT DATA**

Site ID: Midlothian Old CAMS 302(Site 2)  
 Date: December 4, 2008  
 Time: 1140-1150 CST  
 Pressure (P<sub>a</sub>) (mm Hg): 757.5  
 Temperature (T<sub>a</sub>) (F): 47.0  
 Temperature (T<sub>a</sub>) (C): 8.3

Audit Device: Variable Orifice  
 Serial #: R53  
 Slope: 0.98474  
 Intercept: -0.00778  
 Correlation: 0.99995  
 Cert. Exp. Date: September 30, 2009

PM <sub>10</sub> AUDIT DATA						
Sampler ID#	Audit Pressure Drop (ΔH) ("H <sub>2</sub> O)	Stagnation Pressure (ΔP <sub>STG</sub> ) ("H <sub>2</sub> O)	Audit Flow (Q <sub>a</sub> ) (m <sup>3</sup> /min)	Sampler Flow <sup>1</sup> (Q <sub>a</sub> ) (m <sup>3</sup> /min)	Percent Difference <sup>2</sup> (Sampler vs. Audit)	Percent Difference <sup>3</sup> (Audit vs. Design)
726	3.10	20.3	1.098	1.054	-3.9%	-2.9%

1. From Sampler Look-Up Table or Calibration Data
2. Acceptance Criteria: ±7%
3. Acceptance Criteria: ±10%

SAMPLER CALIBRATION DATA					
Sampler ID#	Pressure Ratio (P <sub>v</sub> /P <sub>a</sub> ) (mm Hg)	Calibration Date	Sampler Slope	Sampler Intercept	Sampler Correlation
726	0.9499	02/04/08	11.4853	0.2279	1.0000

AUDITOR: Darrin Barton

Notes:

## Cr<sup>6+</sup> Sampler PERFORMANCE AUDIT DATA

**Site ID:** Midlothian Old CAMS 302(Site 2)  
**Date:** December 4, 2008  
**Time:** 1200-1210 CST  
**ANALYZER ID:** ERG CR6  
**Serial #:** s/n 1 and s/n 24

**Audit Flow Meter :** BIOS Cry Cal  
**Model No :** DC Lite  
**Serial No :** 4989  
**Cert. Exp. Date :**

Sample Inlet Flow Audit Data		
Designed Flow Rate (LPM)	Measured Flow Rate (LPM)	Percent Difference <sub>2</sub>
15	16.06	7.07%
15	14.86	-0.93%
15	15.89	5.93%

*2. Acceptance Criteria: ±10%*

**AUDITOR:** Darrin Barton

**Notes:**

**URS**  
 Rev. 8.7 (3/08)

## Wind Direction Audit Data Sheet (360 Sensor)

Site ID: Midlothian Triangle Park(Site 3c)  
 Date: December 4, 2008  
 Time: 1520-1545 CST  
 Sensor ID: Met One 020 C  
 Serial #: F5701

Tower Height: 10 Meters  
 Sensor Level: yes  
 Vane Condition: good  
 Bearing Condition: good  
 Last Field Calibration: n/a

Audit Device: Compass Transit  
 Model: Lietz 115  
 Serial #: 32100  
 Cert. Expiration: November 18, 2009  
 Linearity Device: Met One Degree Wheel  
 Serial #: 1

Reference Angle (deg)	Sensor Rotation	Sensor Response (deg)	Measurement Error (deg)	Hysteresis Error (deg)	Normalized Linearity Error (deg)	Average Error (deg)	Total Error (deg)
0	cw	2.50	2.50		1.92		
30	cw	33.00	3.00		2.42		
60	cw	63.00	3.00		2.42		
90	cw	92.00	2.00		1.42		
120	cw	122.00	2.00		1.42		
150	cw	151.00	1.00		0.42		
180	cw	180.00	0.00		-0.58		
210	cw	209.00	-1.00		-1.58		
240	cw	238.00	-2.00		-2.58		
270	cw	268.00	-2.00		-2.58		
300	cw	298.00	-2.00		-2.58		
330	cw	328.00	-2.00		-2.58		
360	ccw	2.50	2.50	0.00	1.92	1.92	3.52
330	ccw	328.00	-2.00	0.00	-2.58	-2.58	-0.98
300	ccw	298.00	-2.00	0.00	-2.58	-2.58	-0.98
270	ccw	270.00	0.00	2.00	-0.58	-1.58	0.02
240	ccw	240.00	0.00	2.00	-0.58	-1.58	0.02
210	ccw	209.00	-1.00	0.00	-1.58	-1.58	0.02
180	ccw	180.00	0.00	0.00	-0.58	-0.58	1.02
150	ccw	151.00	1.00	0.00	0.42	0.42	2.02
120	ccw	122.00	2.00	0.00	1.42	1.42	3.02
90	ccw	93.00	3.00	1.00	2.42	1.92	3.52
60	ccw	63.00	3.00	0.00	2.42	2.42	4.02
30	ccw	33.00	3.00	0.00	2.42	2.42	4.02
<b>Mean:</b>			<b>0.58</b>	<b>0.42</b>			
<b>Maximum Hysteresis Error :</b>				<b>2.00</b>			
<b>Maximum Normalized Linearity Error :</b>					<b>-2.58</b>		
<i>Specification : +/- 3 degrees</i>							
<b>Maximum Total Error :</b>							<b>4.02</b>
<i>Specification : +/- 5 degrees</i>							

True North Alignment	
Known Declination:	4.4 EMD
Expected Magnetic Compass Reading for True North:	355.6 Degrees
Actual Magnetic Compass Reading w/ Vane Aligned to 180/360:	354 Degrees
Alignment Error:	1.60 Degrees
Data Correction:	None
Alignment Correction:	None
Action Taken	
Alignment meets specification. No action required.	

*Specification : +/- 2 degrees*

Auditor : Darrin Barton

Notes :

## Horizontal Wind Speed Audit Data Sheet

**Site ID:** Midlothian Triangle Park(Site 3c)  
**Date:** December 4, 2008  
**Time:** 1520-1545 CST  
**Sensor ID:** Met One 010 B  
**Serial #:** unknown

**Tower Height:** 10 Meters  
**Sensor Level:** yes  
**Cup Condition:** good  
**Bearing Check:**

0.2 g-cm CCW  
 0.2 g-cm CW

**Audit Device:** Anemometer Drive  
**Model:** RM Young 18811  
**Serial #:** 10501  
**Cert. Expiration:** June 18, 2009  
**Torque Device:** RM Young Torque Disc  
**Serial #:** 1

**Last Field Calibration:** n/a

Audit Input CCW (rpm)	Known Input Value (m/h)	Sensor Response (m/h)	Measurement Error (m/h)	Audit Input CW (rpm)	Known Input Value (m/h)	Sensor Response (m/h)	Measurement Error (m/h)
0	0.6	0.6	0.0	0	0.6	0.6	0.0
60	4.2	4.2	0.0	60	4.2	4.2	0.0
160	10.1	10.1	0.0	160	10.1	10.1	- 0.0
300	18.5	18.5	0.0	300	18.5	18.5	0.0
600	36.4	36.4	0.0	600	36.4	36.4	0.0
900	54.3	54.3	0.0	900	54.3	54.3	0.0

*Specification: +/- 0.4*

*Specification: +/- 0.4*

**Auditor:** Darrin Barton

**Notes:**

**URS**

Rev. 8.7 (3/08)

## Temperature Audit Data Sheet

Site ID: Midlothian Triangle Park(Site 3c)  
Date: December 4, 2008  
Time: 1455 CST  
Sensor ID: Met One 060A-2  
Serial #: G7946

Sensor Height: 3.5'  
Sensor Condition: good  
Sensor Level: yes  
Aspirator Condition: working  
Last Field Calibration: n/a

Audit Device: Digital Thermometer  
Model: VWR  
Serial #: 230058352  
Cert. Expiration: July 29, 2009

Time of the Audit	Type of Comparison	Audit Reference Temperature (deg C)	Station Probe Temperature (deg C)	Measurement Error (deg C)
1455	Collocated Measurement	9.14	9.0	-0.2

Specification: +/- 1.0

Auditor: Darrin Barton

Notes:

**URS**

Rev. 8.7 (3/08)

## Precipitation Audit Data Sheet

Site ID: Midlothian Triangle Park(Site 3c)  
Date: December 4, 2008  
Time: 1505 CST  
Sensor ID: Met One  
Serial #: B2029

Sensor Height: 2 inches  
Sensor Condition: good  
Sensor Level: yes  
Sensor Clean: yes  
Last Field Calibration: n/a

Audit Device: Acrylic Buret  
Model: Cole Parmer  
Serial #: 2  
Cert. Expiration: none

Time of the Audit	Input Volume (mL)	Gauge Input (inches)	Response (inches)	Measurement Error (%)
1505	80.0	0.10	0.09	-10.0%

Specification: +/- 10.0

Auditor : Darrin Barton

**URS**

Rev. 8.7 (3/08)

Notes:

## Barometric Pressure Audit Data Sheet

**Site ID:** Midlothian Triangle Park(Site 3c)  
**Date:** December 4, 2008  
**Time:** 1455 CST  
**Sensor ID:** Vaisala  
**Serial #:** unknown

**Sensor Height:** 3.5'  
**Sensor Condition:** good  
**Sensor Level:** yes  
**Last Field Calibration:** n/a

**Audit Device:** Barometer/Altimeter  
**Model:** Airt-Vaisala  
**Serial #:** OF1475  
**Cert. Expiration:** May 1, 2009

Time of the Audit	Type of Comparison	Audit Reference Barometric Pressure (mmHg)	Site Sensor Barometric Pressure (mmHg)	Measurement Error (mmHg)
1455	Collocated Measurement	752.7	750.9	-1.8

*Specification: +/- 7.6*

**Auditor:** Darrin Barton

**Notes:**

**URS**  
 Rev. 8.7 (3/08)

**PM<sub>10</sub> / VOLUMETRIC FLOW CONTROL (VFC)  
PERFORMANCE AUDIT DATA**

Site ID: Midlothian Triangle Park(Site 3c)  
 Date: December 4, 2008  
 Time: 1430-1445 CST  
 Pressure (P<sub>a</sub>) (mm Hg): 756.6  
 Temperature (T<sub>a</sub>) (F): 35.0  
 Temperature (T<sub>a</sub>) (C): 1.7

Audit Device: Variable Orifice  
 Serial #: R53  
 Slope: 0.98474  
 Intercept: -0.00778  
 Correlation: 0.99995  
 Cert. Exp. Date: September 30, 2009

PM <sub>10</sub> AUDIT DATA						
Sampler ID#	Audit Pressure Drop (ΔH) ("H <sub>2</sub> O)	Stagnation Pressure (ΔP <sub>STG</sub> ) ("H <sub>2</sub> O)	Audit Flow (Q <sub>a</sub> ) (m <sup>3</sup> /min)	Sampler Flow <sup>1</sup> (Q <sub>s</sub> ) (m <sup>3</sup> /min)	Percent Difference <sup>2</sup> (Sampler vs. Audit)	Percent Difference <sup>3</sup> (Audit vs. Design)
6673	3.10	19.1	1.085	1.063	-2.1%	-4.0%
6671	3.20	19.2	1.102	1.076	-2.4%	-2.4%

1. From Sampler Look-Up Table or Calibration Data
2. Acceptance Criteria: ±7%
3. Acceptance Criteria: ±10%

SAMPLER CALIBRATION DATA					
Sampler ID#	Pressure Ratio (P <sub>v</sub> /P <sub>a</sub> ) (mm Hg)	Calibration Date	Sampler Slope	Sampler Intercept	Sampler Correlation
6673	0.9529	11/20/08	11.9097	0.1892	1.0000
6671	0.9526	11/20/08	12.0629	0.1696	1.0000

AUDITOR: Darrin Barton

Notes:

## Cr<sup>6+</sup> Sampler PERFORMANCE AUDIT DATA

**Site ID:** Midlothian Triangle Park(Site 3c)  
**Date:** December 4, 2008  
**Time:** 1455-1515  
**ANALYZER ID:** ERG CR6  
**Serial #:** 9.0

**Audit Flow Meter :** BIOS Cry Cal  
**Model No :** DC Lite  
**Serial No :** 4989  
**Cert. Exp. Date :**

Sample Inlet Flow Audit Data		
Designed Flow Rate (LPM)	Measured Flow Rate (LPM)	Percent Difference <sub>2</sub>
15	16.24	8.27%
15	16.15	7.67%

*2. Acceptance Criteria: ±10%*

**AUDITOR:** Darrin Barton

**Notes:**

**URS**  
 Rev. 8.7 (3/08)

### Wind Direction Audit Data Sheet (360 Sensor)

Site ID: Midlothian Jaycee Park (Site 4)  
 Date: December 4, 2008  
 Time: 1725-1755 CST  
 Sensor ID: Met One 020 B  
 Serial #: unknown

Tower Height: 10 Meters  
 Sensor Level: yes  
 Vane Condition: good  
 Bearing Condition: good  
 Last Field Calibration: n/a

Audit Device: Compass Transit  
 Model: Lietz 115  
 Serial #: 32100  
 Cert. Expiration: November 18, 2009  
 Linearity Device: Met One Degree Wheel  
 Serial #: 1

Reference Angle (deg)	Sensor Rotation	Sensor Response (deg)	Measurement Error (deg)	Hysteresis Error (deg)	Normalized Linearity Error (deg)	Average Error (deg)	Total Error (deg)
0	cw	2.40	2.40		2.22		
30	cw	32.00	2.00		1.82		
60	cw	61.00	1.00		0.82		
90	cw	91.00	1.00		0.82		
120	cw	121.00	1.00		0.82		
150	cw	151.00	1.00		0.82		
180	cw	180.00	0.00		-0.18		
210	cw	209.00	-1.00		-1.18		
240	cw	238.00	-2.00		-2.18		
270	cw	268.00	-2.00		-2.18		
300	cw	298.00	-2.00		-2.18		
330	cw	329.00	-1.00		-1.18		
360	ccw	3.00	3.00	0.60	2.82	2.52	4.12
330	ccw	330.00	0.00	1.00	-0.18	-0.68	0.92
300	ccw	300.00	0.00	2.00	-0.18	-1.18	0.42
270	ccw	268.00	-2.00	0.00	-2.18	-2.18	-0.58
240	ccw	239.00	-1.00	1.00	-1.18	-1.68	-0.08
210	ccw	209.00	-1.00	0.00	-1.18	-1.18	0.42
180	ccw	180.00	0.00	0.00	-0.18	-0.18	1.42
150	ccw	151.00	1.00	0.00	0.82	0.82	2.42
120	ccw	121.00	1.00	0.00	0.82	0.82	2.42
90	ccw	91.00	1.00	0.00	0.82	0.82	2.42
60	ccw	61.00	1.00	0.00	0.82	0.82	2.42
30	ccw	31.00	1.00	1.00	0.82	1.32	2.92
<b>Mean:</b>			<b>0.18</b>	<b>0.47</b>			
<b>Maximum Hysteresis Error :</b>				<b>2.00</b>			
<b>Maximum Normalized Linearity Error :</b>					<b>2.82</b>		
<i>Specification : +/- 3 degrees</i>							
<b>Maximum Total Error :</b>							<b>4.12</b>
<i>Specification : +/- 5 degrees</i>							

True North Alignment	
Known Declination:	4.4 EMD
Expected Magnetic Compass Reading for True North:	355.6 Degrees
Actual Magnetic Compass Reading w/ Vane Aligned to 180/360:	354 Degrees
Alignment Error:	1.60 Degrees
Data Correction:	None
Alignment Correction:	None
Action Taken	
Alignment meets specification. No action required.	

*Specification : +/- 2 degrees*

Auditor : Darrin Barton

Notes :

## Horizontal Wind Speed Audit Data Sheet

**Site ID:** Midlothian Jaycee Park (Site 4)  
**Date:** December 4, 2008  
**Time:** 1725-1755 CST  
**Sensor ID:** Met One 010 B  
**Serial #:** unknown

**Tower Height:** 10 Meters  
**Sensor Level:** yes  
**Cup Condition:** good  
**Bearing Check:**

0.2 g-cm CCW  
 0.2 g-cm CW

**Last Field Calibration:** n/a

**Audit Device:** Anemometer Drive  
**Model:** RM Young 18811  
**Serial #:** 10501  
**Cert. Expiration:** June 18, 2009  
**Torque Device:** RM Young Torque Disc  
**Serial #:** 1

Audit Input CCW (rpm)	Known Input Value (m/h)	Sensor Response (m/h)	Measurement Error (m/h)	Audit Input CW (rpm)	Known Input Value (m/h)	Sensor Response (m/h)	Measurement Error (m/h)
0	0.6	0.6	0.0	0	0.6	0.6	0.0
60	4.2	4.2	0.0	60	4.2	4.2	0.0
160	10.1	10.1	0.0	160	10.1	10.1	0.0
300	18.5	18.5	0.0	300	18.5	18.5	0.0
600	36.4	36.4	0.0	600	36.4	36.4	0.0
900	54.3	54.3	0.0	900	54.3	54.3	0.0

*Specification: +/- 0.4*

*Specification: +/- 0.4*

**Auditor:** Darrin Barton

**Notes:**

**URS**

Rev. 8.7 (3/08)

## Temperature Audit Data Sheet

Site ID: Midlothian Jaycee Park (Site 4)  
Date: December 4, 2008  
Time: 1805 CST  
Sensor ID: Met One 060A-2  
Serial #: unknown

Sensor Height: 3.5'  
Sensor Condition: good  
Sensor Level: yes  
Aspirator Condition: working  
Last Field Calibration: n/a

Audit Device: Digital Thermometer  
Model: VWR  
Serial #: 230058352  
Cert. Expiration: July 29, 2009

Time of the Audit	Type of Comparison	Audit Reference Temperature (deg C)	Station Probe Temperature (deg C)	Measurement Error (deg C)
1805	Collocated Measurement	5.23	5.7	0.5

Specification: +/- 1.0

Auditor: Darrin Barton

Notes:

**URS**  
Rev. 8.7 (3/08)

## Precipitation Audit Data Sheet

Site ID: Midlothian Jaycee Park (Site 4)  
Date: December 4, 2008  
Time: 1850 CST  
Sensor ID: Met One  
Serial #: unknown

Sensor Height: 2 inches  
Sensor Condition: good  
Sensor Level: yes  
Sensor Clean: yes  
Last Field Calibration: n/a

Audit Device: Acrylic Buret  
Model: Cole Parmer  
Serial #: 2  
Cert. Expiration: none

Time of the Audit	Input Volume (mL)	Gauge Input (inches)	Response (inches)	Measurement Error (%)
1850	80.0	0.10	0.09	-10.0%

Specification: +/- 10.0

Auditor : Darrin Barton

**URS**

Rev. 8.7 (3/08)

Notes:

## Barometric Pressure Audit Data Sheet

**Site ID:** Midlothian Jaycee Park (Site 4)  
**Date:** December 4, 2008  
**Time:** 1805 CST  
**Sensor ID:** Vaisala  
**Serial #:** unknown

**Sensor Height:** 3.5'  
**Sensor Condition:** good  
**Sensor Level:** yes  
**Last Field Calibration:** n/a

**Audit Device:** Barometer/Altimeter  
**Model:** Airs-Vaisala  
**Serial #:** OF1475  
**Cert. Expiration:** May 1, 2009

Time of the Audit	Type of Comparison	Audit Reference Barometric Pressure (mmHg)	Site Sensor Barometric Pressure (mmHg)	Measurement Error (mmHg)
1805	Collocated Measurement	753.5	751.1	-2.5

*Specification: +/- 7.6*

**Auditor:** Darrin Barton

**Notes:**

**URS**  
 Rev. 8.7 (3/08)

**PM<sub>10</sub> / VOLUMETRIC FLOW CONTROL (VFC)  
PERFORMANCE AUDIT DATA**

Site ID: Midlothian Jaycee Park (Site 4)  
 Date: December 4, 2008  
 Time: 1755-1805 CST  
 Pressure (P<sub>a</sub>) (mm Hg): 751.1  
 Temperature (T<sub>a</sub>) (F): 41.5  
 Temperature (T<sub>a</sub>) (C): 5.3

Audit Device: Variable Orifice  
 Serial #: R53  
 Slope: 0.98474  
 Intercept: -0.00778  
 Correlation: 0.99995  
 Cert. Exp. Date: September 30, 2009

PM <sub>10</sub> AUDIT DATA						
Sampler ID#	Audit Pressure Drop (ΔH) ("H <sub>2</sub> O)	Stagnation Pressure (ΔP <sub>STG</sub> ) ("H <sub>2</sub> O)	Audit Flow (Q <sub>a</sub> ) (m <sup>3</sup> /min)	Sampler Flow <sup>1</sup> (Q <sub>s</sub> ) (m <sup>3</sup> /min)	Percent Difference <sup>2</sup> (Sampler vs. Audit)	Percent Difference <sup>3</sup> (Audit vs. Design)
6670	3.10	20.1	1.096	1.079	-1.5%	-3.0%
6672	3.20	20.2	1.114	1.086	-2.5%	-1.4%

1. From Sampler Look-Up Table or Calibration Data
2. Acceptance Criteria: ±7%
3. Acceptance Criteria: ±10%

SAMPLER CALIBRATION DATA					
Sampler ID#	Pressure Ratio (P <sub>1</sub> /P <sub>a</sub> ) (mm Hg)	Calibration Date	Sampler Slope	Sampler Intercept	Sampler Correlation
6670	0.9500	11/20/08	12.0629	0.1696	1.0000
6672	0.9498	11/20/08	12.1388	0.1598	1.0000

AUDITOR: Darrin Barton

Notes:

## Cr<sup>6+</sup> Sampler PERFORMANCE AUDIT DATA

**Site ID:** Midlothian Jaycee Park (Site 4)  
**Date:** December 4, 2008  
**Time:** 1810-1815 CST  
**ANALYZER ID:** ERG CR6  
**Serial #:** 16.0

**Audit Flow Meter :** BIOS Cry Cal  
**Model No :** DC Lite  
**Serial No :** 4989  
**Cert. Exp. Date :**

Sample Inlet Flow Audit Data		
Designed Flow Rate (LPM)	Measured Flow Rate (LPM)	Percent Difference <sub>2</sub>
15	15.51	3.40%
15	15.24	1.60%

*2. Acceptance Criteria: ±10%*

**AUDITOR:** Darrin Barton

**Notes:**

**URS**  
 Rev. 8.7 (3/08)

## Wind Direction Audit Data Sheet (360 Sensor)

Site ID: Midlothian Water Treatment Plant(Site 5)  
 Date: December 4, 2008  
 Time: 1600-1700 CST  
 Sensor ID: Met One 020 B  
 Serial #: K3069

Tower Height: 10 Meters  
 Sensor Level: yes  
 Vane Condition: good  
 Bearing Condition: good  
 Last Field Calibration: n/a

Audit Device: Compass Transit  
 Model: Lietz 115  
 Serial #: 32100  
 Cert. Expiration: November 18, 2009  
 Linearity Device: Met One Degree Wheel  
 Serial #: 1

Reference Angle (deg)	Sensor Rotation	Sensor Response (deg)	Measurement Error (deg)	Hysteresis Error (deg)	Normalized Linearity Error (deg)	Average Error (deg)	Total Error (deg)
0	cw	2.70	2.70		1.08		
30	cw	31.70	1.70		0.08		
60	cw	61.90	1.90		0.28		
90	cw	91.70	1.70		0.08		
120	cw	121.30	1.30		-0.32		
150	cw	150.50	0.50		-1.12		
180	cw	180.00	0.00		-1.62		
210	cw	210.00	0.00		-1.62		
240	cw	240.00	0.00		-1.62		
270	cw	269.00	-1.00		-2.62		
300	cw	300.00	0.00		-1.62		
330	cw	330.00	0.00		-1.62		
360	ccw	1.15	1.15	1.55	-0.47	0.30	-1.10
330	ccw	332.00	2.00	2.00	0.38	-0.62	-2.02
300	ccw	302.00	2.00	2.00	0.38	-0.62	-2.02
270	ccw	272.00	2.00	1.00	0.38	-1.12	-2.52
240	ccw	242.00	2.00	2.00	0.38	-0.62	-2.02
210	ccw	212.00	2.00	2.00	0.38	-0.62	-2.02
180	ccw	183.00	3.00	3.00	1.38	-0.12	-1.52
150	ccw	153.00	3.00	2.50	1.38	0.13	-1.27
120	ccw	124.00	4.00	2.70	2.38	1.03	-0.37
90	ccw	93.00	3.00	1.30	1.38	0.73	-0.67
60	ccw	63.00	3.00	1.10	1.38	0.83	-0.57
30	ccw	33.00	3.00	1.30	1.38	0.73	-0.67
<b>Mean:</b>			1.62	1.87			
<b>Maximum Hysteresis Error :</b>				3.00			
<b>Maximum Normalized Linearity Error :</b>					-2.62		
			<i>Specification : +/- 3 degrees</i>				
<b>Maximum Total Error :</b>							-2.52
			<i>Specification : +/- 5 degrees</i>				

True North Alignment	
Known Declination:	4.4 EMD
Expected Magnetic Compass Reading for True North:	355.6 Degrees
Actual Magnetic Compass Reading w/ Vane Aligned to 180/360:	357 Degrees
Alignment Error:	-1.40 Degrees
Data Correction:	None
Alignment Correction:	None
Action Taken	
Alignment meets specification. No action required.	

*Specification : +/- 2 degrees*

Auditor : Darrin Barton

Notes :

## Horizontal Wind Speed Audit Data Sheet

**Site ID:** Midlothian Water Treatment Plant(Site 5)  
**Date:** December 4, 2008  
**Time:** 1600-1700 CST  
**Sensor ID:** Met One 010 B  
**Serial #:** G1380

**Tower Height:** 10 Meters  
**Sensor Level:** yes  
**Cup Condition:** good  
**Bearing Check:**

0.2 g-cm CCW  
 0.2 g-cm CW

Last Field Calibration: n/a

**Audit Device:** Anemometer Drive  
**Model:** RM Young 18811  
**Serial #:** 10501  
**Cert. Expiration:** June 18, 2009  
**Torque Device:** RM Young Torque Disc  
**Serial #:** 1

Audit Input CCW (rpm)	Known Input Value (m/h)	Sensor Response (m/h)	Measurement Error (m/h)	Audit Input CW (rpm)	Known Input Value (m/h)	Sensor Response (m/h)	Measurement Error (m/h)
0	0.6	0.6	0.0	0	0.6	0.6	0.0
60	4.2	4.2	0.0	60	4.2	4.2	0.0
160	10.1	10.1	0.0	160	10.1	10.1	0.0
300	18.5	18.5	0.0	300	18.5	18.5	0.0
600	36.4	36.4	0.0	600	36.4	36.4	0.0
900	54.3	54.3	0.0	900	54.3	54.3	0.0

Specification: +/- 0.4

Specification: +/- 0.4

**Auditor:** Darrin Barton

**Notes:**

**URS**  
 Rev. 8.7 (3/08)

## Temperature Audit Data Sheet

**Site ID:** Midlothian Water Treatment Plant(Site 5)  
**Date:** December 4, 2008  
**Time:** 1645 CST  
**Sensor ID:** Met One 060A-2  
**Serial #:** unknown

**Sensor Height:** 3.5'  
**Sensor Condition:** good  
**Sensor Level:** yes  
**Aspirator Condition:** working  
**Last Field Calibration:** n/a

**Audit Device:** Digital Thermometer  
**Model:** VWR  
**Serial #:** 230058352  
**Cert. Expiration:** July 29, 2009

Time of the Audit	Type of Comparison	Audit Reference Temperature (deg C)	Station Probe Temperature (deg C)	Measurement Error (deg C)
1645	Collocated Measurement	8.7	8.6	-0.1

*Specification: +/- 1.0*

**Auditor:** Darrin Barton

**Notes:**

**URS**

Rev. 8.7 (3/08)

## Precipitation Audit Data Sheet

Site ID: Midlothian Water Treatment Plant(Site 5)  
Date: December 4, 2008  
Time: 1640 CST  
Sensor ID: Met One  
Serial #: unknown

Sensor Height: 2 inches  
Sensor Condition: good  
Sensor Level: yes  
Sensor Clean: yes  
Last Field Calibration: n/a

Audit Device: Acrylic Buret  
Model: Cole Parmer  
Serial #: 2  
Cert. Expiration: none

Time of the Audit	Input Volume (mL)	Gauge Input (inches)	Response (inches)	Measurement Error (%)
1640	80.0	0.10	0.10	0.0%

Specification: +/- 10.0

Auditor : Darrin Barton

**URS**

Rev. 8.7 (3/08)

Notes:

## Barometric Pressure Audit Data Sheet

**Site ID:** Midlothian Water Treatment Plant(Site 5)      **Sensor Height:** 3.5'  
**Date:** December 4, 2008      **Sensor Condition:** good  
**Time:** 1645      CST      **Sensor Level:** yes  
**Sensor ID:** Vaisala      **Last Field Calibration:** n/a  
**Serial #:** unknown

**Audit Device:** Barometer/Altimeter  
**Model:** Airs-Vaisala  
**Serial #:** OF1475  
**Cert. Expiration:** May 1, 2009

Time of the Audit	Type of Comparison	Audit Reference Barometric Pressure (mmHg)	Site Sensor Barometric Pressure (mmHg)	Measurement Error (mmHg)
1645	Collocated Measurement	751.6	749.9	-1.7

*Specification: +/- 7.6*

**Auditor:** Darrin Barton

**Notes:**

**URS**  
 Rev. 8.7 (3/08)

**PM<sub>10</sub> / VOLUMETRIC FLOW CONTROL (VFC)  
PERFORMANCE AUDIT DATA**

Site ID: Midlothian Water Treatment Plant(Site 5)  
 Date: December 4, 2008  
 Time: 1610-1620 CST  
 Pressure (P<sub>a</sub>) (mm Hg): 751.6  
 Temperature (T<sub>a</sub>) (F): 48.5  
 Temperature (T<sub>a</sub>) (C): 9.2

Audit Device: Variable Orifice  
 Serial #: R53  
 Slope: 0.98474  
 Intercept: -0.00778  
 Correlation: 0.99995  
 Cert. Exp. Date: September 30, 2009

PM <sub>10</sub> AUDIT DATA						
Sampler ID#	Audit Pressure Drop (ΔH) ("H <sub>2</sub> O)	Stagnation Pressure (ΔP <sub>STG</sub> ) ("H <sub>2</sub> O)	Audit Flow (Q <sub>a</sub> ) (m <sup>3</sup> /min)	Sampler Flow <sup>1</sup> (Q <sub>s</sub> ) (m <sup>3</sup> /min)	Percent Difference <sup>2</sup> (Sampler vs. Audit)	Percent Difference <sup>3</sup> (Audit vs. Design)
583	3.00	19.6	1.086	1.095	0.9%	-3.9%
584	3.10	20.5	1.103	1.100	-0.3%	-2.4%

1. From Sampler Look-Up Table or Calibration Data
2. Acceptance Criteria: ±7%
3. Acceptance Criteria: ±10%

SAMPLER CALIBRATION DATA					
Sampler ID#	Pressure Ratio (P <sub>s</sub> /P <sub>a</sub> ) (mm Hg)	Calibration Date	Sampler Slope	Sampler Intercept	Sampler Correlation
583	0.9513	11/02/08	12.2892	0.1501	1.0000
584	0.9491	11/20/08	12.2246	0.1485	1.0000

AUDITOR: Darrin Barton

Notes:

## Cr<sup>6+</sup> Sampler PERFORMANCE AUDIT DATA

**Site ID:** Midlothian Water Treatment Plant(Site 5)  
**Date:** December 4, 2008  
**Time:** 1620-1630 CST  
**ANALYZER ID:** ERG CR6  
**Serial #:** 14.0

**Audit Flow Meter :** BIOS Cry Cal  
**Model No :** DC Lite  
**Serial No :** 4989  
**Cert. Exp. Date :**

Sample Inlet Flow Audit Data		
Designed Flow Rate (LPM)	Measured Flow Rate (LPM)	Percent Difference <sub>2</sub>
15	15.04	0.27%
15	14.92	-0.53%

*2. Acceptance Criteria: ± 10%*

**AUDITOR:** Darrin Barton

**Notes:**

**URS**  
 Rev. 8.7 (3/08)

## **APPENDIX B**

### **Audit Standards Traceability Documentation**



501 W. 6<sup>th</sup> St.  
Austin, TX 78701  
512/478-8793

10713 Metric Blvd.  
Austin, TX 78758  
512/837-8991

106 W. Nakoma St.  
San Antonio, TX 78216  
210/681-4280

G4 SPATIAL TECHNOLOGIES

November 18, 2008

Mr. Darrin Barton  
URS, Inc.  
9400 Amberglenn  
Austin, TX 78729

Dear Mr. Barton,

This letter certifies that your Lietz Sokkisha Model 115 transit, serial number 32100, has been examined and found to be operating within normal parameters. Inasmuch as this is a manual instrument using vernier scales, accuracy is highly dependent on the care and skill of the operator. However, when used properly, the instrument will generate one minute precision in both vertical and horizontal readings. A complete calibration of the instrument was preformed and all features are functioning to within factory specifications.

Please let me know if I can be of further assistance.

Thank you,  
Neal Hagood

A handwritten signature in black ink that reads "Neal Hagood". The signature is written in a cursive style with a large, sweeping flourish at the end.



**CALIBRATION PROCEDURE  
18801/18810 ANEMOMETER DRIVE**

**DWG: CP18801(A)**

REV: C101107 PAGE: 3 of 3  
BY: TJT DATE: 10/11/07  
CHK: JC W.C. GAS-12

CERTIFICATE OF CALIBRATION AND TESTING

MODEL: **18810** (Comprised of Models 18820 Control Unit & 18831 Motor Assembly)  
SERIAL NUMBER: 10501

R. M. Young Company certifies that the above equipment was inspected and calibrated prior to shipment in accordance with established manufacturing and testing procedures. Standards established by R.M. Young Company for calibrating the measuring and test equipment used in controlling product quality are traceable to the National Institute of Standards and Technology.

Nominal Motor Rpm	Output Frequency Hz (1)	Calculated Rpm (2)	Indicated Rpm (3)
60	320	60	60
120	640	120	120
240	1280	240	240
420	2240	420	420
600	3200	600	600
810	4320	810	810
990	5280	990	990
<input checked="" type="checkbox"/> Clockwise and Counterclockwise rotation verified			

- (1) Measured at the optical encoder output.
- (2) Frequency output produces 320 pulses per revolution of motor shaft.
- (3) Indicated on the Control Unit LCD display. Note: Divide indicated rpm by 10 to calculate actual motor rpm.

\* Indicates out of tolerance

No Calibration Adjustments Required       As Found       As Left

Traceable frequency meter used in calibration Model: DPS740 SN: 4863

Date of inspection 6/18/08  
Inspection Interval One Year

Tested By RP



Calibration  
Certificate No. 1750.01

**Calibration complies with ISO 9001  
ISO/IEC 17025 AND ANSI/NCSL Z540-1**



**Cert. No.: 4000-1939847**

**Traceable® Certificate of Calibration for Digital Thermometer**

**Instrument Identification:**

URS Corp., 9400 Amberglen Blvd., Attn: James Clarke, Austin, TX 78729 U.S.A. (RMA:944141)

Model: 61220-601      S/N: 230058352      Manufacturer : Control Company

Model: 61220-604      S/N: 230058318

**Standards/Equipment:**

Description	Serial Number	Due Date	NIST Traceable Reference
Temperature Calibration Bath TC191	A79341		
Thermistor Module	A27129	10/17/08	1000228256
Temperature Probe	3039	10/26/08	A7710039-4
Temperature Probe	149	3/06/09	A82225037-3
Thermistor Module	A17118	8/30/08	A7831032
Temperature Calibration Bath TC218	A73332		

**Certificate Information:**

Technician: 68      Procedure: CAL-06      Cal Date: 7/29/08      Cal Due: 7/29/09  
Test Conditions: 23.0°C      49.0 %RH      1014 mBar

**Calibration Data:**

Unit(s)	Nominal	As Found	In Tol	Nominal	As Left	In Tol	Min	Max	±uc	TUR
°C	0.001	-0.003	Y	0.001	-0.003	Y	-0.049	0.051	0.013	3.8:1
°C	25.001	24.998	Y	25.001	24.998	Y	24.951	25.051	0.013	3.8:1
°C	60.001	59.995	Y	60.001	59.995	Y	59.951	60.051	0.018	2.8:1
°C	100.001	100.008	Y	100.001	100.008	Y	99.951	100.051	0.013	3.8:1

**This Instrument was calibrated using instruments Traceable to National Institute of Standards and Technology.**

A Test Uncertainty Ratio of at least 4:1 is maintained unless otherwise stated and is calculated using the expanded measurement uncertainty. Uncertainty evaluation includes the instrument under test and is calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement" (GUM). The uncertainty represents an expanded uncertainty using a coverage factor k=2 to approximate a 95% confidence level. In tolerance conditions are based on test results falling within specified limits with no reduction by the uncertainty of the measurement. The results contained herein relate only to the item calibrated. This certificate shall not be reproduced except in full, without written approval of Control Company.

Nominal=Standard's Reading; As Left=Instrument's Reading; In Tol=In Tolerance; Min/Max=Acceptance Range; ±uc=Measurement Uncertainty; TUR=Test Uncertainty Ratio; Accuracy=±(Max-Min)/2; Date=MM/DD/YY

*Wallace Barry*  
Wallace Barry, Technical Manager

**Maintaining Accuracy:**

In our opinion once calibrated your Digital Thermometer should maintain its accuracy. There is no exact way to determine how long calibration will be maintained. Digital Thermometers change little, if any at all, but can be affected by aging, temperature, shock, and contamination.

**Recalibration:**

For factory calibration and re-certification traceable to National Institute of Standards and Technology contact Control Company.

**CONTROL COMPANY 4455 Rex Road Friendswood, TX 77546 USA**  
Phone 281 482-1714 Fax 281 482-9448 service@control3.com www.control3.com

Control Company is an ISO 17025:2005 Calibration Laboratory Accredited by (A2LA) American Association for Laboratory Accreditation, Certificate No. 1750.01.  
Control Company is ISO 9001:2000 Quality Certified by (DNV) Det Norske Veritas, Certificate No. CERT-01805-AQ-HOU.  
International Laboratory Accreditation Cooperation (ILAC) - Multilateral Recognition Arrangement (MRA).

625 East Bunker Court  
 Vernon Hills, Illinois  
 TOLL FREE: 1-866-466-6225  
 FAX: 847-247-2984  
 www.InnoCalSolutions.com

*NIST Traceable*  
**Calibration Report**



Reference Number: **15405**  
 PO Number: **94684**

**URS Corp**  
 9400 Amberglenn Blvd  
 Austin, TX 78729



**Manufacturer:** AIR Inc.  
**Model Number:** AIR-HB-1A  
**Description:** Pressure, Barometer, Digital  
**Asset Number:** 17414-12  
**Serial Number:** OF1475

**Calibration Date:** 05/01/2008  
**Calibration Due Date:** 05/01/2009  
**Calibration Interval:** 12 Months  
**Condition As Found:** Out of Tolerance  
**Condition As Left:** In Tolerance, No adjustment  
**Procedure:** NAVAIR 17-20MP-216

**Remarks:**

Performed calibration traceable to NIST. The barometer was outside of the manufacturer's accuracy "As Found" for barometric pressure. Applied -0.97 mBar correction prior to performing "As Left" data. Performed "As Left" documentation. Barometer is now within manufacturer's accuracy and in good working order. The calibration was performed at Latitude 42.233603 Longitude -87.948128 at an elevation of 737' above sea level. Received State-Meter was returned with a dead battery. "As Found" data was performed with zero correction applied as when the battery is replaced the correction needs to be manually re-entered via holding down the Set/Zero Key along with the Mode key, arrow down or up to the correction desired, release key's. The "As Left" data was collected after inputting the -0.97 mBar correction which was noted on the previous NIST certificate # 19600.

**Standards Utilized**

Asset No	Manufacturer	Model No	Description	Cal Date	Due Date
CP05020	DH INSTRUMENTS INC	RPM4 BA100KS	Calibrator, Reference Pressure Monitor	12/03/2007	12/03/2008

**Calibration Data**

FUNCTION TESTED	Nominal Value	As Found	As Left	Out of Tol.	CALIBRATION TOLERANCE
Ambient Pressure	990.0 mbar	991.53	990.06	X	989.5 to 990.5 mbar [TUR 4.0:1] [EMU 0.12 mbar]
Decreasing Barometric Pressure Test	1030.0 mbar	1031.5	1030.1	X	1029.5 to 1030.5 mbar [TUR 3.9:1] [EMU 0.13 mbar]
	950.0 mbar	951.6	950.0	X	949.5 to 950.5 mbar [TUR 4.2:1] [EMU 0.12 mbar]
	805.0 mbar	806.3	804.8	X	804.5 to 805.5 mbar [TUR 4.7:1] [EMU 0.11 mbar]
	610.0 mbar	611.3	609.9	X	609.5 to 610.5 mbar [TUR 5.6:1] [EMU 0.089 mbar]
Increasing Barometric Pressure Test	805.0 mbar	806.3	804.8	X	804.5 to 805.5 mbar [TUR 4.7:1] [EMU 0.11 mbar]
	950.0 mbar	951.6	950.0	X	949.5 to 950.5 mbar [TUR 4.2:1] [EMU 0.12 mbar]
	1030.0 mbar	1031.5	1030.1	X	1029.5 to 1030.5 mbar [TUR 3.9:1] [EMU 0.13 mbar]

**Temperature:** 22° C  
**Humidity:** 50% RH  
**Test No.:** 27567

Calibration Performed By:			Quality Reviewer:	
Ziegler, Jeff	Metrologist	847-327-5335	Collins, Bob	5/1/2008
Name	Title	Phone	Name	Date

*This report may not be reproduced, except in full, without written permission of Innocal. The results stated in this report relate only to the items tested or calibrated. Measurements reported herein are traceable to SI units via national standards maintained by NIST and were performed in compliance with MIL-STD-45662A, ANSI/NCSL Z540-1-1994, 10CFR50, Appendix B, ISO 9002-94, and ISO 17025:2005. The estimated measurement uncertainty (EMU) reported on this certificate is being reported at a confidence level of 95% or K=2 unless otherwise noted in the remarks section.*



TISCH ENVIRONMENTAL, INC.  
 145 SOUTH MIAMI AVE.  
 VILLAGE OF CLEVELAND, OH 45002  
 513.467.9000  
 877.263.7610 TOLL FREE  
 513.467.9009 FAX  
 WWW.TISCH-ENV.COM

AIR POLLUTION MONITORING EQUIPMENT

ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET TE-5028A

Date - Sep 30, 2008 Roots-meter S/N 9833620 Ta (K) - 295  
 Operator Tisch Orifice I.D. - R53 Pa (mm) - 749.3

PLATE OR VDC #	VOLUME START (m3)	VOLUME STOP (m3)	DIFF VOLUME (m3)	DIFF TIME (min)	METER DIFF Hg (mm)	ORFICE DIFF H2O (in.)
1	NA	NA	1.00	1.2600	4.5	1.50
2	NA	NA	1.00	0.9730	7.4	2.50
3	NA	NA	1.00	0.8910	8.9	3.00
4	NA	NA	1.00	0.8230	10.3	3.50
5	NA	NA	1.00	0.6220	17.6	6.00

DATA TABULATION

Vstd	(x axis) Qstd	(y axis)	Va	(x axis) Qa	(y axis)
0.9899	0.7857	1.2223	0.9940	0.7889	0.7685
0.9861	1.0135	1.5779	0.9901	1.0176	0.9921
0.9841	1.1045	1.7285	0.9881	1.1090	1.0868
0.9822	1.1935	1.8670	0.9862	1.1984	1.1739
0.9724	1.5634	2.4445	0.9764	1.5698	1.5369
Qstd slope (m) = 1.57260			Qa slope (m) = 0.98474		
intercept (b) = -0.01238			intercept (b) = -0.00778		
coefficient (r) = 0.99995			coefficient (r) = 0.99995		
y axis = SQRT[H2O(Pa/760)(298/Ta)]			y axis = SQRT[H2O(Ta/Pa)]		

CALCULATIONS

Vstd = Diff. Vol [(Pa-Diff. Hg)/760] (298/Ta)  
 Qstd = Vstd/Time

Va = Diff Vol [(Pa-Diff Hg)/Pa]  
 Qa = Va/Time

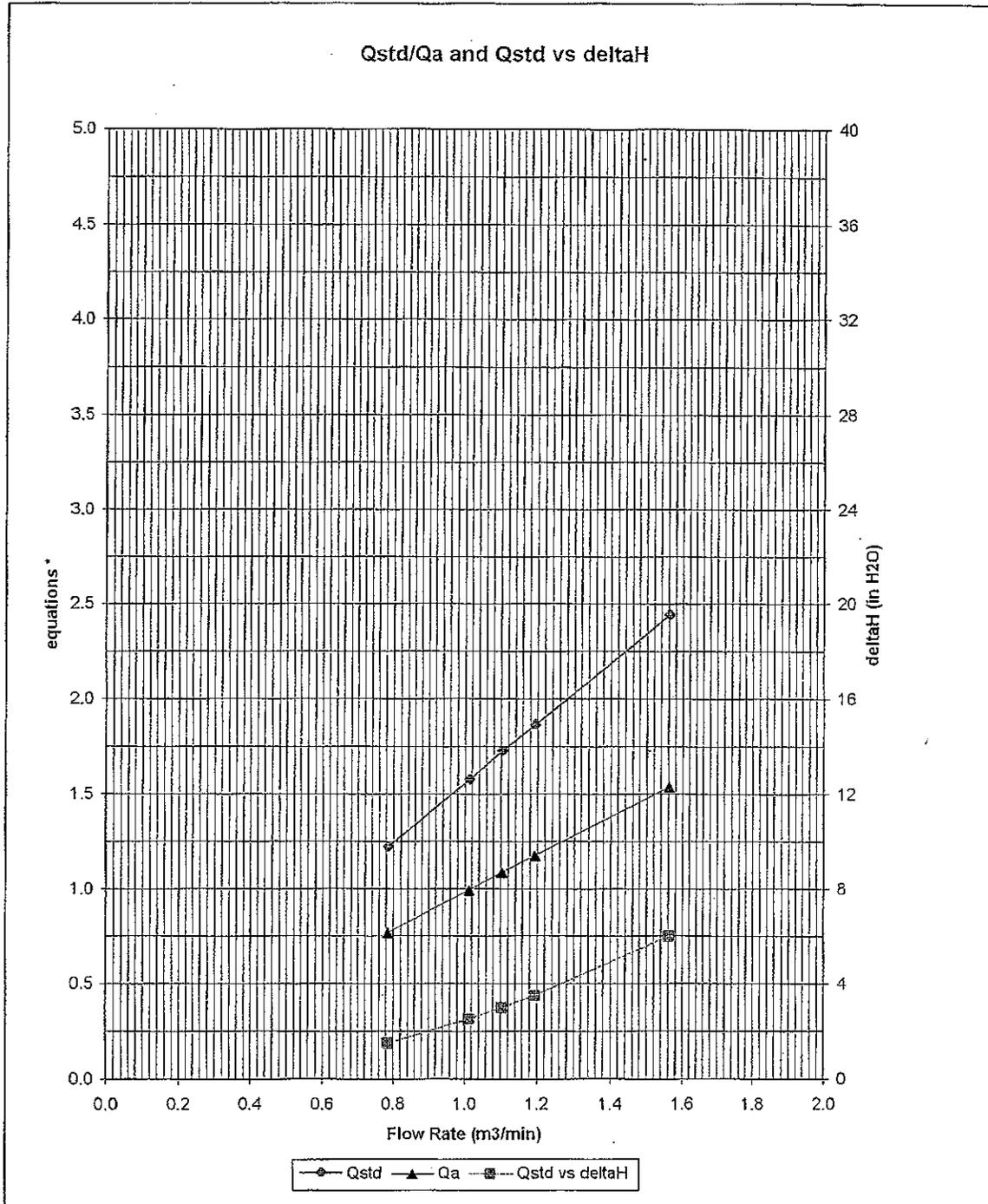
For subsequent flow rate calculations:

Qstd = 1/m{ [SQRT(H2O(Pa/760)(298/Ta))] - b}  
 Qa = 1/m{ [SQRT H2O(Ta/Pa)] - b}



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AIR POLLUTION MONITORING EQUIPMENT



\* y-axis equations:

Qstd series: 
$$\sqrt{\Delta H \left( \frac{P_a}{P_{std}} \right) \left( \frac{T_{std}}{T_a} \right)}$$

Qa series: 
$$\sqrt{(\Delta H (T_a / P_a))}$$

# R53

# Bios International Calibration Certificate

Report No. 65305  
 Product DCL-MH  
 Serial No. 4989  
 Cal. Date 22 January 2008  
 Annual Maint. Recommended

URS Corporation  
 9400 Amberglen Blvd.  
 Austin TX 78729  
 Acct. No. URSAUS  
 PO No.



## As Received Test Data

### Calibration Standards Used

All units tested in accordance with Bios International Corporation test number PR05-2 Rev B or PR01-10 Rev D using high-purity bottled nitrogen.

Asset Number	Description	Cal Date	Due Date
ML-500-10 100427	ML-500 Low Flow Cell	5/4/2007	5/4/2008
ML-500-44 102677	ML-500 High Flow Cell	10/22/2007	10/22/2008

Technician Sonia Otero                      Lab. Pressure 748.2 mmHg  
 Lab. Temperature 22.6 °C

Instrument Reading (ml/min)	Lab Standard Reading (ml/min)	Lab Standard Unit No.	Deviation	Allowable Deviation	Condition Shipped
200	200.455	100427	-0.23%	1.00%	in tolerance
5003	5009.25	102677	-0.12%	1.00%	in tolerance
16990	17018	102677	-0.16%	1.00%	in tolerance

The allowable deviation consists of the RSS of the expanded uncertainties of the working standards (0.25%), experimental errors (0.25%), and the error of the device under test (DUT), which is the remainder of the allowable deviation.

## As Shipped Test Data

### Calibration Standards Used

All units tested in accordance with Bios International Corporation test number PR05-2 Rev B or PR01-10 Rev D using high-purity bottled nitrogen.

Asset Number	Description	Cal Date	Due Date
ML-500-10 102174	ML-500 Low Flow Cell	5/24/2007	5/24/2008
ML-500-44 102677	ML-500 High Flow Cell	10/22/2007	10/22/2008

Technician Zenalda Ortiz                      Lab. Pressure 747.01 mmHg  
 Lab. Temperature 22.2 °C

Instrument Reading (ml/min)	Lab Standard Reading (ml/min)	Lab Standard Unit No.	Deviation	Allowable Deviation	Condition Shipped
199.9	200.045	102174	-0.07%	1.00%	in tolerance
4984	5005.65	102677	-0.43%	1.00%	in tolerance
16970	17026.5	102677	-0.33%	1.00%	in tolerance

The allowable deviation consists of the RSS of the expanded uncertainties of the working standards (0.25%), experimental errors (0.25%), and the error of the device under test (DUT), which is the remainder of the allowable deviation.

Each DryCal flow calibrator is dynamically tested by comparing it to a laboratory standard primary piston prover of much higher accuracy ( $\pm 0.25\%$  or better) but of similar operating principles. Flow generators of  $\pm 0.03\%$  stability are used for the comparison. Use of provers of similar construction to the device under test assures the validity of the flow generator as a transfer standard. The primary laboratory standards are qualified by direct measurement of their dimensions (diameter, length of measured path, time base) against NIST traceable gauges and instruments (NIST numbers available upon request). A rigorous analysis of their accuracy in accordance with the International Guide to Uncertainty in Measurements has been performed, assuring their traceable accuracy. Test procedures ensure temperature matching of the laboratory standards and the device under test.

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 www.biosint.com

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# Bios International Calibration Certificate

Report No. 65305  
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A handwritten signature in cursive script, which appears to read 'Harvey F. Padden', is written over a horizontal line.

Harvey Padden, President

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