Audit Report of SIMAT Particle Monitoring Network

Performed 2-4 October, 2013

Prepared for: Dirección de Monitoreo Atmosférico, Secretaría del Medio Ambiente del Distrito Federal

Prepared by: George Allen, Consultant

Submitted: October 22, 2013

Summary.

An audit of particle samplers at 8 sites in the Sistema de Monitoreo Atmosférico de la Ciudad de México (SIMAT) network was performed on 2-4 October, 2013. Both manual (FRM) and continuous samplers were audited. Audits consisted of flow and leak checks for each sampler as well as review of other relevant operating parameters. At most sites comparisons between audit and site flow standards were also made. Audits were performed on PM monitors at the following sites:

Tlalnepantla
Xalostoc
Pedregal
Merced
San Agustin
Hospital General de Mexico
Camarones

PM monitors audited included R&P (Thermo) and BGI manual FRM samplers (8), and Thermo TEOM (8) continuous samplers – 16 sampler audits total. The TEOM samplers were model 1405DF dichot FDMS for PM2.5 and PM-coarse and are approved as US EPA Federal Equivalent Monitors (FEM) when operated in accordance with the instrument manual.

Audit results are based on the sample flows reported by the sampler, not the flow measured by the site manual flow check, since data are reduced by the data reported by the sampler.

A summary of audit results follows; only samplers with audit flow errors > 4% or other instrument parameters that exceeded acceptable limits are listed here. Audit flow criteria used were 4% for warning, and 7% for fail. For TEOMs, where the sample inlet flow is not the sample sensor flow, a criteria of 10% is used for inlet flow. All audit flows were measured at local temperature and pressure using a BGI tetraCal flowmeter, s/n 304, factory calibrated 9 August 2013.

1405 TEOM:

XAL	1405DF PM-coarse	-6.2%*
SAG	1405DF PM-coarse	-6.2 %*

* coarse channel flow error in a dichot sampler does not directly reflect measurement error.

In summary, all TEOM and FRM samplers passed the flow audits, and all but 2 sampler flows were within 4% of the audit flow standard.

During the audit, other aspects of the network operation were informally reviewed, both at field sites and at the SIMAT laboratory. Overall, the operation of the network is very robust, with strong QA/QC systems in place. Interactions with SIMAT staff indicated a high level of skill and understanding of the network's systems.

Introduction.

Sistema de Monitoreo Atmosférico de la Ciudad de México (SIMAT) requested an external audit of network PM samplers to be performed in the fall of 2013. An external audit is an on-site, independent measurement of sampler flows and related instrument parameters on instruments "as found" – no adjustments. SIMAT supplied a list of sites and samplers to audit over a three-day period; audits were performed 2-4 October 2013, using an audit flowmeter, BGI tetraCal s/n 304, factory calibrated on 9 August 2013.

Unlike audits for gas samplers such as ozone or sulfur dioxide, PM samplers can not be "challenged" with a known standard of the pollutant being measured; it is not practical to generate an aerosol of known concentration at a field site. Thus, only indicators of performance such as flows and leak checks can be audited, and a successful audit does not by itself guarantee that the sampler is producing data of known quality. Ongoing co-location with other samplers is an essential component of a quality program for PM samplers.

The SIMAT staff were present for the audits, and performed parallel sampler flow checks on most of the audited samplers. Those measurements are not part of the audit, but can be used as diagnostics when audit results indicate possible problems.

SIMAT staff present for all audits:
Juan Manuel Campos Díaz
Jesusyael Jímenez Valdez
Armando Retama Hernandez

PM sampler flows are nominally controlled at the inlet flow setpoint of 16.67 lpm, and all audit results for FRM and TEOM sampler inlet flows are calculated relative to this flow. Sensor flows for TEOM samplers are 3 lpm for the PM2.5 channel and 1.67 lpm for the coarse PM channel. These flows are controlled to their respective design setpoints.

Audit result flow errors are calculated as: (sampler flow minus audit flow)/audit flow
and expressed as percent difference (%diff). Flow error limits used in this report are as follows:

Pass:	No more than 4%
Warning:	greater than 4 and no more than 7% (underlined in tables)
Fail:	greater than 7% (bold in tables)

There are two exceptions to these audit criteria:

1. Inlet flows for TEOMs. The TEOM sensor flow is a small portion of the inlet flow; the inlet flow only determines the particle size cut; thus inlet flow errors do not directly impact data quality. An audit limit of 10% is used for TEOM inlet flows.

2. TEOM dichotomous (dichot) coarse channel flows. In theory, all the coarse PM in the sample inlet flow is present in the coarse channel (along with 10% of the PM2.5). The dichot "virtual impactor" performance is a function of the ratio of total to minor flows; in this case that

is the inlet and coarse channel flow. The design value ratio for the TEOM-DF virtual impactor is 10. To assess performance of a dichot sampler's coarse channel, the total flow should be within 10% of the design value (16.7 lpm), and the total to minor flow ratio should be within 7% of the design value (10). The flow error of the coarse channel should also be within 10% of the design value (1.67).

Finally, the TEOM samplers have an internal calibration value for the mass detector, K_0. This value was also audited, with a tolerance of 2% for warning and 2.5% for failure.

Results.

Detailed audit results for each sampler are given in table 1 for FRM samplers, and table 2 for TEOM samplers. Sampler flows were also measured with the site flowmeter; these readings are included in the audit tables.

FRM (manual) samplers: all FRM samplers passed the audit. Audit flow errors were less than 3% for all samplers. In the context of system QC, it is very important that the FRM samplers be operating properly, since the performance of the automated (FEM) samplers is in part determined by comparison to the FRM sampler data.

TEOM (FEM automated) samplers: Two of the seven TEOM samplers showed audit flows outside of in the normal range for PM-coarse:
XAL 1405DF PM-coarse -6.2%
SAG 1405DF PM-coarse -6.2%

All audited TEOM samplers had virtual impactor ratios within the 7% tolerance, although XAL was close to the limit, at 6.8%.

TEOM K_0 values were all within the 2% limit except for the MER coarse channel, which was -2.3% different than the audit standard. This test was repeated with a different audit K_0 filter with similar results (-2.1%). These results are consistent with the 2012 audits.

One TEOM (CAM) failed the bypass flow leak check by a small amount. While it is unlikely that this failure would effect the data, it does indicate the need for maintenance.

Half (4 of 8) FDMS TEOMs audited did not have the FEM sticker on the instrument; these were older instruments. While it is likely that these TEOMs meet the FEM requirements, this needs confirmation by the manufacturer, and stickers should be requested and applied to these instruments.

Table 1: FRM PM2.5 Manual Sampler Audit Results.

Bold indicates out of audit limits (7%) All flows LPM as Qa

Underline means corrective action is needed (4%)

Site	Date	Mfg	Model	Serial #	Audit Flow	Sampler Flow	**Audit % Diff**	Site Flow	Site - Audit Flow	% Diff *	Leak Test** Pass/Fail	
XAL	2-Oct-13	BGI	PQ-200	988	16.75	16.7	0.30	16.7	-0.01	-0.06	N/A - old method used	
TLA	2-Oct-13	R&P	Partisol 2000-H	200FB205360112	16.23	16.7	-2.90	16.9	0.63	3.88	Pass	
SAG	2-Oct-13	BGI	PQ-200	615	16.55	16.7	-0.91	16.59	0.04	0.24	Pass	
MER	3-Oct-13	BGI	PQ-200	608	16.83	16.7	0.77	16.70	-0.13	-0.77	Pass	
PED	3-Oct-13	R&P	Partisol 2000-H	200FB205310111	16.73	16.7	0.18	16.63	-0.10	-0.60	Pass	Primary
PED	3-Oct-13	R&P	Partisol 2000-H	200FB206820505	16.67	16.67	0.00	16.71	0.04	0.24	Pass	Collo
PED	3-Oct-13	R&P	Partisol 2000-H	200FB205350112	16.67	16.6	0.42	16.66	-0.01	-0.06	Pass	
CAM	4-Oct-13	R&P	Partisol 2000-H	200FB205290111	16.86	16.6	1.54	16.88	0.02	0.12	Pass	

Site flowmeter:
BGI deltaCal sn 980 for all sites

Notes:
* not used for audit results
** based on mfg. criteria

Notes:

1. The Leak Test for the Xalostoc FRM was not performed using the new procedures necessary for PQ-200 samplers with serial numbers 906 and higher. Thus the leak test results are not valid.
2. The CAM FRM inlet and PM2.5 WINS impactor cleaning dates reported by SIMAT during the audit were 25 Sept. 13 for both the inlet and WINS impactor. However, observations by Armando Retama (SIMAT staff) showed that both the inlet and the WINS and down tube were not clean. In addition, the WINS impactor did not have the required oil; only the fiber filter was inside the WINS. Although these issues are unlikely to significantly affect data quality, these are substantial variations from required operating practice and should be investigated.

Table 2: Thermo FDMS-TEOM Continuous Sampler Audit Results.

All flows LPM as Qa

Site	Date	Thermo Model	Serial #	PM size	Audit Inlet flow	Sampler Inlet	**Inlet Audit % diff**	Audit Fine sensor	Sampler Fine sensor	**Fine Audit % diff**	Audit Coarse Channel	Sampler Coarse Channel	** **Coarse Audit % diff**	Audit inlet to coarse ratio	*** **Audit ratio % diff**
XAL	2-Oct-13	1405DF	211841011	Dichot	16.59	16.67	0.48	2.99	3	0.33	1.78	1.67	-6.18	9.32	-6.80
TLA	2-Oct-13	1405DF *	204730904	Dichot	16.30	16.67	2.27	2.94	3	2.04	1.66	1.67	0.60	9.82	-1.81
SAG	2-Oct-13	1405DF	211341010	Dichot	16.80	16.67	-0.77	3.02	3	-0.66	1.78	1.67	-6.18	9.44	-5.62
HGM	3-Oct-13	1405DF	211191009	Dichot	16.90	16.67	-1.36	3.07	3	-2.28	1.71	1.67	-2.34	9.88	-1.17
PED	3-Oct-13	1405DF *	204770905	Dichot	16.66	16.67	0.06	3.02	3	-0.66	1.65	1.67	1.21	10.10	0.97
MER	3-Oct-13	1405DF *	204390903	Dichot	16.52	16.67	0.91	3.03	3	-0.99	1.7	1.67	-1.76	9.72	-2.82
CAM	4-Oct-13	1405DF	211331010	Dichot	16.60	16.67	0.42	3.05	3	-1.64	1.67	1.67	0.00	9.94	-0.60
SFE	4-Oct-13	1405DF *	204740904	Dichot	16.33	16.67	2.08	3.05	3	-1.64	1.67	1.67	0.00	9.78	-2.22

* no FEM sticker on instrument.

Bold indicates out of audit flow limits (7%) for dichot fine channel

underline means corrective action may be needed (4% for flow; 2% for K0)

** For Dichot Coarse Mass Flow Audit Results, the CM flow error is not a direct indicator of CM concentration error; that is a function of total flow and total to coarse flow ratios and PM concentrations.

*** The inlet to coarse flow ratio limit is 10%.

Inlet flow TEOM audit results have a minimal effect on measurement error; an inlet flow tolerance of 10% is acceptable.

Additional audit checks:

Leak Check		**Result**
XAL	2-Oct-13	Pass
TLA	2-Oct-13	Pass
SAG	2-Oct-13	Pass
HGM	3-Oct-13	Pass
PED	3-Oct-13	Pass
MER	3-Oct-13	Pass
CAM	4-Oct-13	**Fail Bypass (0.62, 0.61)** Bypass leak limit = 0.60
SFE	4-Oct-13	Pass

K0 Checks with filter #01: Audit K0 limit = 2% warning; 2.5% fail (based on mfg limits)

	Fine Channel			Coarse Channel			
	Audit	Site	**%Diff.**	Audit	Site	**%Diff.**	
XAL	15148.0	15064	0.56	15148.0	15962	0.79	
TLA	15740.0	15476	1.71	14515.9	14369	1.02	
SAG	15048.0	15061	0.09	16859.7	17022	0.95	
HGM	14870.7	14782	0.60	16495.0	16447	0.29	
PED	15885.0	15614	1.74	14535.3	14320	1.50	
MER	16017.8	15789	1.45	14572.0	14249	2.27	audit K0 filter #02 result was 2.10%
CAM	15500.5	15366	0.88	16136.9	15976	1.01	
SFE	15790.7	15418	2.42	14277.2	14029	1.77	

Table 3: Comparison of Audit and Site Flowmeter Audit Readings

TEOM 1400DF Audit and Site flowmeter radings
All flows Qa, lpm

Site Flowmeter:
sn682*

		Inlet			Fine channel			Coarse channel		
Site	Date	Audit	Site	% diff	Audit	Site	% diff	Audit	Site	% diff
XAL	2-Oct-13	16.59	16.67	0.5	2.99	3.16	5.7	1.78	1.96	10.1
TLA	2-Oct-13	16.30	16.39	0.6	2.94	3.01	2.4	1.66	1.54	-7.2
SAG	2-Oct-13	16.80	16.86	0.4	3.02	3.05	1.0	1.78	1.8	1.1
HGM	3-Oct-13	16.90	16.85	-0.3	3.07	2.99	-2.6	1.71	1.69	-1.2
PED	3-Oct-13	16.66	16.62	-0.2	3.02	2.94	-2.6	1.65	1.62	-1.8
MER	3-Oct-13	16.52	16.51	-0.1	3.03	2.93	-3.3	1.7	1.66	-2.4
CAM	4-Oct-13	16.60	16.51	-0.5	3.05	2.96	-3.0	1.67	1.65	-1.2
SFE	4-Oct-13	16.33	16.18	-0.9	3.05	2.96	-3.0	1.67	1.63	-2.4

* deltaCal sn980 site flowmeter used for 2 Oct TEOM audits

Note: Differences greater than 4% between audit and site flow standards are considered larger than normal, and are shown underlined

These results are NOT sampler audit results.

The CAM bypass flow leak test failed with a value of 0.62 and 0.61 for base and reference channels respectively. The tolerance is 0.60, based on the manufacturer's limit. While this test was out of normal limits, it does not mean that data quality for this instrument is compromised. First, the test result is just slightly out of tolerance. Second, these results are for the bypass flow channel, and not either the PM2.5 or PM-coarse measurement channels. This leak test result should be followed up with preventative maintenance however, since it is an indication of a minor problem.

Other audit observations and recommendations.

While not technically part of the audit, the following are observations made during the audit that may be useful to SIMAT staff.

Site temperature:
The temperature inside some of the site shelters was 16 to 17 degrees C, too cold for proper operation of instruments, and potentially outside of the typical 20 - 30 C range required for FEM/FRM operation of some analyzers. The shelter temperature during the warmer seasons should be higher than the highest expected seasonal hourly dew point temperature, to avoid condensation in sample lines and inside analyzers. For the rainy season, a shelter setpoint of 23 to 25 degrees C is preferable. The shelter temperature at sites with FDMS or SES-TEOMs should not exceed 25 C because the TEOM filter temperature is 30 C and could become unstable if shelter temperature became too high.

Flow Standards:
Site flow standards are now either the BGI tetraCal or deltaCal. The BGI triCal (which does not have an external temperature sensor) is no longer being used for field site slow measurements, per recommendations of the 2012 audit.

Even with the external temperature sensor, it is important to keep the flowmeter out of direct sun as much as possible, since that can still cause short-term temperature fluctuations. Care must be taken when working on a roof in mid-day sun – the flowmeter must be left [out of its case] in the shade prior to use long enough to be sure that its temperature is stable. 3 degrees C is 1% flow error, so this is an important factor.

The SIMAT flow meter issues experienced during the 2012 audit have been resolved. The two field flow standards used appear to be in reasonably good agreement with the audit flow standard.

tetraCal 682 = August 15, 2012 / by Brian DeVoe Jr, BGI
deltaCal 980 = August 15, 2012 / by Brian DeVoe Jr, BGI

The BGI calibration certificates for these calibrations and a summary of changes to the internal

SIMAT flowmeter QC procedures implemented after the 2012 audit are included in Appendix B.

The older TEOMs may benefit from updates to the instrument's software. Many FDMS TEOMs have software version 1.51; 1.57 is the current revision.

The Camarone site has a large tree close to the sampler inlets, and the tree is much taller than the inlets. While the tree is not likely to affect PM2.5 data, SIMAT staff report that there are plans to remove the tree since it could affect ozone and PM10 data and does not meet normal distance and height requirements for inlet siting.

During the audit, other aspects of the network operation were informally reviewed, both at field sites and at the SIMAT laboratory. Overall, the operation of the network is very robust, with strong QA/QC systems in place. Interactions with SIMAT staff indicated a high level of skill and understanding of the network's systems. The successful audit results reported here are a direct result of the efforts and skills of SIMAT staff.

Appendix A: Audit flow standards

Audit Flow and TEOM K0 standards:

Flowmeter BGI tetraCal, sn304
Last calibration: 9 Aug 2013 (BGI)

Site Flow Standards

BGI tetraCal, sn 682	"tetraCal"	external temp sensor
BGI DeltaCal, sn980	"triCal"	internal temp sensor

Audit K0 Teom filters:

#	Date	Mass [g]
01	Sept. 2013	0.097569
02	Sept. 2013	0.097751

TEOM K0 audit filters were weighed at two different laboratories: Maine Dept. of Environmental Protection and the Harvard School of Public Health (Boston). The two laboratory values (Maine-DEP, HSPH) for audit filter # 01 are: 0.097569 and 0.097569. Values for # 02 are: 0.097753 and 0.097749; the mean of these 2 values was used.

Note: site flow standard readings are not used for audit results but are useful for understanding the source of audit flow error

The factory flow certification for the audit flowmeter (BGI tetraCal s/n 304) on 9August 2013 is included below.

BGI INCORPORATED 58 GUINAN STREET WALTHAM, MA 02451
NIST Traceable Calibration Facility, ISO 9001:2008 Registered

tetraCal

CERTIFICATE OF CALIBRATION - NIST TRACEABILITY

(Refer to instruction manual for further details of calibration)

tetraCal Serial Number: **304** DATE: 9-Aug-13

Calibration Operator: Sean Crossman

Critical Venturi Flow Meter: Max Uncertainity = 0.346%
Serial Number: 1 *CEESI NVLAP NIST Data File 04BGI151*
Serial Number: 2 *CEESI NVLAP NIST Data File 04BGI152*
Serial Number: 3 *CEESI NVLAP NIST Data File 04BGI153*

Room Temperature: Uncertainity=0.071% Room Temperature: 22.3 C
Brand: Ever-Safe Serial Number: 016076
NIST Traceability No. 516837
tetraCal:
Ambient Temperature (set): 22.3 C
Aux (filter) Temperature (set): C

Barometric Pressure and Absolute Pressure
Vaisala Model PTB330(50-1100) Digital Accuracy: 0.03371%
S/N D4310002
NIST Traceable (Princo Primary Standard Model 453 S/N W12537) Certificate No. P-7485
tetraCal:
Barometric pressure (set): 756 mm of Hg

Results of Venturi Calibration
Flow Rate (Q) vs. Pressure Drop (ΔP). Where: Q=Lpm, ΔP= Cm of H2O

No. 1 Q = 5.33163 ΔP ^ 0.51645
No. 2 Q = 1.16173 ΔP ^ 0.52404
No. 3 Q = 0.21437 ΔP ^ 0.54280

Overall Uncertainty: 0.35%

Date Placed In Service_____
(To be filled in by operator upon receipt)

Recommended Recalibration Date _____
(12 months from date placed in service)

Revised: July 2012

To Check a Tetra Cal 9-Aug-13 Sean Crossman
6 - 30.00 Lpm BP= 756 mm of Hg
VER. 3.41P Room Temp= 22.3 C

Maximum allowable error at any flow rate is .75%.
Serial No. 304

Reading Abs. P Crit. Vent. mm of Hg	Crit. Vent. TEMP	Q 760/20 Flow Lpm	QA Flow Lpm	QA TriCal Indicated	% Error	
214.65	21.2	8.34	8.45	8.48	**0.30**	
414.88	21.2	16.31	16.53	16.46	**-0.41**	**Average %**
693.2	21.2	27.39	27.75	27.81	**0.22**	**0.04**

To Check a Tetra Cal BP= 755.5 mm of Hg
1.20 - 6.00 Lpm Room Temp= 22.3 C

Reading Abs. P Crit. Vent. mm of Hg	Crit. Vent. TEMP	Q 760/20 Flow Lpm	QA Flow Lpm	QA TriCal Indicated	% Error	
153.8	21.2	1.70	1.72	1.718	**-0.26**	
331.6	21.2	3.72	3.77	3.75	**-0.51**	**Average %**
484.0	21.2	5.45	5.52	5.53	**0.11**	**-0.22**

To Check a Tetra Cal BP= 755.5 mm of Hg
0.10 - 1.20 Lpm Room Temp= 22.3 C

Reading Abs. P Crit. Vent. mm of Hg	Crit. Vent. TEMP	Q 760/20 Flow Lpm	QA Flow Lpm	QA TriCal Indicated	% Error	
173.54	21.2	0.305	0.309	0.31	**0.39**	
368.25	21.2	0.679	0.689	0.684	**-0.71**	**Average %**
579.03	21.2	1.085	1.100	1.105	**0.42**	**0.03**

Appendix B: Summary of changes to the internal SIMAT flowmeter QC procedures implemented after the 2012 audit, and site flowmeter factory calibrations.

As a result of the audit conducted in August 2012, important differences in flow readings were found for the various reference calibrators used in the flow calibration of the continuous and manual samplers. After identifying the origin of these deviations, the auditor recommended actions for the immediate calibration of the reference equipment. As a result, the Dirección de Monitoreo Atmosférico sent to the factory the following equipment for calibration in August 2012: deltaCal s/n 980, deltaCal s/n 984, TetraCal s/n 682.

The calibrated equipment was received back in the Laboratory in November of 2012 and a comparison was conducted for the different instruments that were in use against the equipment just received. Since January 2013 the QA/QC staff has been reviewing flows for the automatic monitors using the tetraCal s/n 682 as a reference, making the necessary flow adjustments in the field PM continuous monitors. For FRM samplers, corrective action was not performed, because there were no significant differences with the field equipment.

During February 2013 an internal audit was performed on the flow of FRM samplers, and the results of the audit showed a deviation of -0.3 lpm, which was within the tolerance range of the audit. In September 2013, a second internal flow audit was performed and it was observed that the difference was still -0.3 lpm, and even though this difference was within the tolerance range, an adjustment in the flow for all the samplers was recommended.

In September 2013 the QA/QC staff conducted a comparison for the different flow calibrators used in the field and in the laboratory, and the results indicate a good agreement in all the instruments, with a difference of ± 0.1 lpm, except for the deltaCal s/n 360, used for verification of the FRM samplers, which showed a difference of -0.3 lpm. As a corrective action the QA/QC staff recommended the immediate replace of the deltaCal.

In summary, the actions that were implemented derived from the audit of 2012 were:

- the use of the old triCal calibrator for field checking and calibration was discontinued,
- bimonthly flow verifications for continuous field monitors ,
- quarterly flow verifications for FRM samplers,
- annual factory calibration of one tetraCal, which will be used as reference,
- annual comparison of flow measurement calibrators against the reference equipment.

The factory flow certification for the two site flowmeters used during the 2013 audits reported here are included below.

BGI INCORPORATED 58 GUINAN STREET WALTHAM, MA 02451
NIST Traceable Calibration Facility, ISO 9001:2008 Registered

tetraCal

CERTIFICATE OF CALIBRATION - NIST TRACABILITY

(Refer to instruction manual for further details of calibration)

tetraCal Serial Number: 000682 DATE 15-Aug-12
Calibration Operator: Brian DeVoe Jr.

Critical Venturi Flow Meter: Max Uncertainty = 0.346%
Serial Number: 1 *CEESI NVLAP NIST Data File 04BGI151*
Serial Number: 2 *CEESI NVLAP NIST Data File 04BGI152*
Serial Number: 3 *CEESI NVLAP NIST Data File 04BGI153*

Room Temperature : Uncertainty = 0.071% Room Temperature: 21.7 C
Brand: *Ever-Safe* Serial Number: 016076
NIST Traceability No. 516837
tetraCal:
Ambient Temperature (set): 21.7 C
Aux (filter) Temperature (set): C

Barometric Pressure and Absolute Pressure
Vaisala Model PTB330(50-1100) Digital Accuracy: 0.03371%
S/N D4310002
NIST Traceable (Princo Primary Standard Model 453 S/N W12537) Certificate No. P-7485
tetraCal:
Barometric Pressure (set): **755** mm of Hg

Results of Venturi Calibration

Flow Rate (Q) vs. Pressure Drop (ΔP). Where: Q=Lpm, ΔP= Cm of H_2O

No. 1 Q= 5.37644 ΔP ^ 0.52107
No. 2 Q= 1.14001 ΔP ^ 0.52616
No. 3 Q= 0.21175 ΔP ^ 0.54239

Overall Uncertainty: 0.35%

Date Placed In Service_____
(To be filled in by operator upon receipt)

Recommended Recalibration Date _____
(12 months from date placed in service)

Revised: March 2012

To Check a Tetra Cal
6 - 30.00 Lpm
VER. 3.37P

15-Aug-12 Brian DeVoe Jr.

BP= 755 mm of Hg
Room Temp= 21.7 C

Maximum allowable error at any flow rate is .75%.
Serial No. 682

Reading Abs. P Crit. Vent. mm of Hg	Crit. Vent. TEMP	Q 760/20 Flow Lpm	QA Flow Lpm	QA TriCal Indicated	% Error
189.56	21.2	7.36	7.45	7.48	**0.43**
418.2	21.2	16.47	16.67	16.58	**-0.55**
696.15	21.2	27.54	27.89	27.96	**0.27**

Average %
0.05

To Check a Tetra Cal
1.20 - 6.00 Lpm

BP= 755 mm of Hg
Room Temp= 21.2 C

Reading Abs. P Crit. Vent. mm of Hg	Crit. Vent. TEMP	Q 760/20 Flow Lpm	QA Flow Lpm	QA TriCal Indicated	% Error
166.5	21.1	1.84	1.86	1.86	**-0.21**
331.2	21.1	3.71	3.75	3.73	**-0.64**
491.6	21.1	5.54	5.60	5.61	**0.26**

Average %
-0.20

To Check a Tetra Cal
0.10 - 1.20 Lpm

BP= 755 mm of Hg
Room Temp= 21.2 C

Reading Abs. P Crit. Vent. mm of Hg	Crit. Vent. TEMP	Q 760/20 Flow Lpm	QA Flow Lpm	QA TriCal Indicated	% Error
193.37	21.0	0.343	0.346	0.346	**-0.12**
378.88	21.0	0.700	0.707	0.703	**-0.63**
576.28	21.0	1.080	1.092	1.095	**0.31**

Average %
-0.15

Unit BP = 766 mm

To Check a Tetra Cal 15-Aug-12 BD
6 - 30.00 Lpm
VER. 2.47

BP= 756 mm of Hg
Room Temp= 21.6 C

Maximum allowable error at any flow rate is .75%.
Serial No. 682

Reading Abs. P Crit. Vent. mm of Hg	Crit. Vent. TEMP	Q 760/20 Flow Lpm	QA Flow Lpm	QA TriCal Indicated	% Error	
211.5	20.9	8.21	8.30	7.93	**-4.45**	
416.5	20.9	16.36	16.54	16.17	**-2.22**	**Average %**
696	20.9	27.47	27.77	27.48	**-1.04**	**-2.57**

To Check a Tetra Cal
1.20 - 6.00 Lpm

BP= 756 mm of Hg
Room Temp= 21.6 C

Reading Abs. P Crit. Vent. mm of Hg	Crit. Vent. TEMP	Q 760/20 Flow Lpm	QA Flow Lpm	QA TriCal Indicated	% Error	
155.0	21.0	1.71	1.73	1.702	**-1.55**	
336.5	21.0	3.77	3.81	3.74	**-1.81**	**Average %**
501.0	21.0	5.63	5.69	5.63	**-1.13**	**-1.50**

To Check a Tetra Cal
0.10 - 1.20 Lpm

BP= 756 mm of Hg
Room Temp= 21.2 C

Reading Abs. P Crit. Vent. mm of Hg	Crit. Vent. TEMP	Q 760/20 Flow Lpm	QA Flow Lpm	QA TriCal Indicated	% Error	
172	21.0	0.301	0.304	0.295	**-2.97**	
369	21.0	0.680	0.686	0.66	**-3.85**	**Average %**
576	21.0	1.078	1.088	1.058	**-2.78**	**-3.20**

BGI INCORPORATED 58 GUINAN STREET WALTHAM, MA 02451
NIST Traceable Calibration Facility, ISO 9001:2008 Registered

deltaCal

CERTIFICATE OF CALIBRATION - NIST TRACEABILITY

(Refer to instruction manual for further details of calibration)

deltaCal Serial Number: **980** DATE: 15-Aug-12

Calibration Operator: Brian DeVoe Jr.

Critical Venturi Flow Meter: Max Uncertainity = 0.346%
Serial Number: 1 *CEESI NVLAP NIST Data File 04BGI151*
Serial Number: 2 *CEESI NVLAP NIST Data File 04BGI152*
Serial Number: 3 *CEESI NVLAP NIST Data File 04BGI153*
Serial Number: 4 *CEESI NVLAP NIST Data File 02BGI004*

Room Temperature: Uncertainity=0.071% Room Temperature: 22 C
Brand: Ever-Safe Serial Number: 016076
NIST Traceability No. 516837
deltaCal:
Ambient Temperature (set): 22 C
Aux (filter) Temperature (set): 22 C

Barometric Pressure ans Absolute Pressure
Vaisala Model PTB330(50-1100) Digital Accuracy: 0.03371%
S/N D4310002
NIST Traceable (Princo Primary Standard Model 453 S/N W12537) Certificate No. P-7485
deltaCal:
Barometric pressure (set): 755 mm of Hg

Results of Venturi Calibration
Flow Rate (Q) vs. Pressure Drop (ΔP). Where: Q=Lpm, ΔP= Cm of H2O

Q= 3.84531 ΔP ^ 0.52771 Overall Uncertainty: 0.35%

Date Placed In Service_____
(To be filled in by operator upon receipt)

Recommended Recalibration Date _____
(12 months from date placed in service)

Revised: July 2012

To Check a deltaCal 15-Aug-12 Brian DeVoe Jr.

1.5-19.5 VER 3.37P

BP= 755 mm of Hg

Maximum allowable error at any flow rate is .75%. Room Temp= 22 C

Serial No. 980

	Reading Abs. P Crit. Vent. mm of Hg	Crit. Vent. Temp	Q 760/20 Flow Lpm	QA Flow Lpm	QA deltaCal Indicated	% Error
# 2	245.11	21.00	2.74	2.77	2.78	**0.26**
	478.09	21.00	5.38	5.45	5.43	**-0.44**
# 1	242.79	21.00	9.47	9.60	9.55	**-0.51**
	412.28	21.00	16.22	16.44	16.43	**-0.05**
	482.23	21.00	19.01	19.26	19.36	**0.51**
					Average %	**-0.04**

To Check a deltaCal 15-Aug-12 BD

1.5-19.5 VER 2.56

BP= 755.5 mm of Hg

Maximum allowable error at any flow rate is .75%. Room Temp= 21.7 C

Serial No. 980

	Reading Abs. P Crit. Vent. mm of Hg	Crit. Vent. Temp	Q 760/20 Flow Lpm	QA Flow Lpm	QA deltaCal Indicated	% Error
# 2	193	21.00	2.14	2.17	2.15	**-0.83**
	486	21.00	5.47	5.53	5.51	**-0.39**
# 1	251.5	21.00	9.81	9.93	9.82	**-1.08**
	419.8	21.00	16.51	16.70	16.46	**-1.46**
	488.2	21.00	19.23	19.46	19.49	**0.17**
					Average %	**-0.72**

Appendix C: PM instrument audit logs.

1405DF TEOM Audit form Date: 2 OCT 13 Auditor: C. Allen

Site: XAL Site Operator: MANUEL CAMPOS Shelter T (C): 16.5 (logger)

Instrument Model: 1405DF Serial #: 211841011 Firmware: 1.51 FEM sticker? ✓

Instrument Time: 12:04 (CST) Site Datalogger time: 12:02 Pump vac: 0.29 atm

Instrument ambient readings: T: 24.2 C Dewpoint: 3.2 C BP: 0.750 atm RH: 26 %

Instrument temperatures (C). Cap: 30.00 Case: 30.00 PM2.5 air: 30.00 PM-C air: 30.00

Instrument flows (display). PM2.5: 3.00 PM-C: 1.67 Bypass: 12.00 Total: 16.67 lpm, Qa

Flow Control. (confirm settings) Active (25 C, 1 atm): ✓ Actual conditions: ✓

K0 Audit. Audit filter ID: #01 Mass: 0.097569 g Cal. Date: SEPT 2013 MAINE DEP & HSPH

Instrument K0: PM2.5 15064 PM-C 15962

Audit K0: PM2.5 15148 ; % diff= 0.56 PM-C 16087.5 ; % diff= 0.79

Flow Audit. (lpm)
Audit Flowmeter Model: ~~Gilian~~ BGI S/N: 304 T-amb: 24.6 C BP: 580.5 mm Hg

Site Flowmeter Model: ~~Gilian~~ BGI S/N: 980 T-amb: 24.0 C BP: 580.5 mm Hg

Inlet (total) flow.	Audit: 16.59 Qa, 12.68 Qs	Site: 16.67 Qa, 12.77 Qs
PM2.5 (bypass and CM capped). T=25.1	Audit: ~~1.667~~ 2.199 Qa, ~~2.277~~ 2.228 Qs	Site: 3.16 Qa, 2.38 Qs T=24.5
PM-C (bypass & PM2.5 capped). T=26.0	Audit: 1.78 Qa, 1.36 Qs	Site: 1.96 Qa, 1.50 Qs T=23.7

FDMS Module.

Dryer T (fine):	20.27	Dryer T (coarse):	20.41 C.
Dryer DP (fine):	-9.76	Dryer DP (coarse):	-20.34 C.
PM cooler (fine):	3.96	PM cooler (coarse):	4.02 C.

PREO Noise
PM2.5 257,384 .004
PM-C 268,842 .004

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.01	0.21	0.00	0.21	(Limit: 0.15)
PM coarse:	0.00	0.61	0.00	0.61	(Limit: 0.15)
Bypass:	0.04	0.26	0.03	0.26	(Limit: 0.6)

Inlet Cleaning Dates. PM10: 27 SEPT 13 Virtual Impactor: 27 SEPT 13

1405DF TEOM Audit form Date: 20 OCT 13 Auditor: G. Allen

Site: TCA Site Operator: MANUEL CAMPOS Shelter T (C): 9

Instrument Model: 1405DF Serial #: 204730904 Firmware: 1.51 FEM sticker? NO

Instrument Time: 1533 (CST) Site Datalogger time: 1534 Pump vac: 0.27 atm

Instrument ambient readings: T: 25.5 C Dewpoint: 3.3 C BP: 0.735 atm RH: 24 %

Instrument temperatures (C). Cap: 30.00 Case: 30.00 PM2.5 air: 30.00 PM-C air: 30.00

Instrument flows (display). PM2.5: 3.00 PM-C: 1.67 Bypass: 12.00 Total: 16.68 lpm, Qa

Flow Control. (confirm settings) Active (25 C, 1 atm): ✓ Actual conditions: ✓

K0 Audit. Audit filter ID: #01 Mass: 0.097569 g Cal. Date: SEPT '13 MAINE DEP & HS PH

Instrument K0: PM2.5 15476 PM-C 14369

Audit K0: PM2.5 15740 ; % diff= 1.71 PM-C 14515.9 ; % diff= 1.02

Flow Audit. (lpm)
Audit Flowmeter Model: BGI DeltaCal S/N: 304 T-amb: 25.7 C BP: 578 mm Hg

Site Flowmeter Model: BGI DeltaCal S/N: 980 T-amb: 25.3 C BP: 578 mm Hg

Inlet (total) flow. Audit: 16.30 Qa, 12.38 Qs Site: 16.39 Qa, 12.45 Qs

PM2.5 (bypass and CM capped). T=26.2 Audit: 2.94 Qa, 2.23 Qs Site: 3.01 Qa, 2.27 Qs

PM-C (bypass & PM2.5 capped). Audit: 1.66 Qa, 1.26 Qs Site: 1.54 Qa, — Qs T=26.3

FDMS Module.
Dryer T (fine): 12.2 Dryer T (coarse): 12.7 C.
Dryer DP (fine): -8.6 Dryer DP (coarse): -11.4 C.
PM cooler (fine): 10.0 PM cooler (coarse): 10.0 C.

	mg NOISE	FREQ
PM2.5	.005	267.632
PM-C	.0013	253.149

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.00	0.18	0.00	0.18	(Limit: 0.15)
PM coarse:	0.00	-0.17	0.00	-0.17	(Limit: 0.15)
Bypass:	0.37	0.41	0.28	0.41	(Limit: 0.6)

Inlet Cleaning Dates. PM10: 20 SEPT 13 Virtual Impactor: 20 SEPT 13

SAG AGUSTIN

1405DF TEOM Audit form Date: 2 OCT 13 Auditor: Geo, A Ol

Site: ~~SAN AUGUSTIN~~ SAN AGUSTIN Site Operator: MANUEL CAMPOS Shelter T (C): ~~22~~ 17 GM

Instrument Model: 1405DF Serial #: 211341010 Firmware: 1.51 FEM sticker? ✓

Instrument Time: 0912 (CST) Site Datalogger time: 0910 Pump vac: 0,31 atm

Instrument ambient readings: T: 15,1 C Dewpoint: 11,7 C BP: 0,761 atm RH: 79 %

Instrument temperatures (C). Cap: 30,00 Case: 30,00 PM2.5 air: 30,00 PM-C air: 30,00

Instrument flows (display). PM2.5: 3,00 PM-C: 1,67 Bypass: 12,0 Total: 16,67 lpm, Qa

Flow Control. (confirm settings) Active (25 C, 1 atm): ✓ Actual conditions: ✓

K0 Audit. Audit filter ID: #01 Mass: 97.569 g M Cal. Date: SEPT 2013 MAINE DEP & HSPH

Instrument K0: PM2.5 15861 PM-C 17022

Audit K0: PM2.5 15048; % diff= 0,09 PM-C 16859.7; % diff= 0,95

Flow Audit. (lpm)

Audit Flowmeter Model: BGI tCAL S/N: 304 T-amb: 17,8 C BP: 584,5 mm Hg

Site Flowmeter Model: BGI DELTA CAL S/N: 980 T-amb: ~~14,5~~ 18.1 C GM BP: ~~584,5~~ mm Hg

Inlet (total) flow. Audit: 16,80 Qa, 13,20 Qs Site: 16,86 Qa, 13,31 Qs

PM2.5 (bypass and CM capped). TA = 19.8 Audit: 3.02 Qa, 2,37 Qs Site: 3,05 Qa, 2,40 Qs

PM-C (bypass & PM2.5 capped). TA = 20.7 Audit: 1,78 Qa, 1,40 Qs Site: 1,80 Qa, — Qs UNDER RANGE

* SITE FLOWMETER NOT WORKING - TCAL SN 682

FDMS Module. Dryer T (fine): 23,63 Dryer T (coarse): 23,91 C.

Dryer DP (fine): 1,55 Dryer DP (coarse): 3,94 C.

PM cooler (fine): 10,0 PM cooler (coarse): 10,0 C.

	FREQ	NOISE
PM2.5	N/A	—
PM-C	NOT YET STABILIZED.	

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0,04	0,25	0,05	0.24	(Limit: 0.15)
PM coarse:	0.00	0,16	0,00	0.16	(Limit: 0.15)
Bypass:	0.00	0,24	0,00	0,24	(Limit: 0.6)

Inlet Cleaning Dates. PM10: 11 SEP 13 Virtual Impactor: 11 SEP 13

* LOGGER TEMP (22 IS T-STAT TEMP)

1405DF TEOM Audit form Date: 3 OCT 13 Auditor: G. Allen

Site: MER Site Operator: MANUEL CAMPOS Shelter T (C): 21.5

Instrument Model: 1405DF Serial #: 204390903 Firmware: 1.51 FEM sticker? NO

Instrument Time: 0904 (CST) Site Datalogger time: 0902 Pump vac: 0.24 atm

Instrument ambient readings: T: 18.5 C Dewpoint: 11.8 C BP: 0.735 atm RH: 73 %

Instrument temperatures (C). Cap: 30.00 Case: 30.00 PM2.5 air: 30.00 PM-C air: 30.00

Instrument flows (display). PM2.5: 3.00 PM-C: 1.67 Bypass: 12.02 Total: 16.70 lpm, Qa

Flow Control. (confirm settings) Active (25 C, 1 atm): ✓ Actual conditions: ✓

K0 Audit. Audit filter ID: #01 Mass: 0.097569 g Cal. Date: SEPT 13 - MAINE DEP & HSPH

SEE REVERSE SIDE FOR 2ND K0 TEST

Instrument K0: PM2.5 15789 PM-C 14249

Audit K0: PM2.5 16017.8 ; % diff= 1.45 PM-C 14572 ; % diff= 2.27

Flow Audit. (lpm)

Audit Flowmeter Model: BGI DeltaCal S/N: 304 T-amb: 20.0 C BP: 583.5 mm Hg

Site Flowmeter Model: BGI DELTA CAL S/N: 980 T-amb: 20.7 C BP: 583.5 mm Hg

Inlet (total) flow. Audit: 16.52 Qa, 12.92 Qs Site: 16.51 Qa, 12.87 Qs

PM2.5 (bypass and CM capped). T=20.6 Audit: ~~16.51~~ 3.03 Qa, ~~12.87~~ 2.36 Qs GMA Site: 2.93 Qa, 2.29 Qs T=20.6

PM-C (bypass & PM2.5 capped). T=21.1 Audit: 1.70 Qa, 1.32 Qs Site: 1.66 Qa, 1.30 Qs T=20.7

FDMS Module.

Dryer T (fine): 20.9 Dryer T (coarse): 21.0 C.

Dryer DP (fine): -5.3 Dryer DP (coarse): -4.4 C.

PM cooler (fine): 4.01 PM cooler (coarse): 4.03 C.

	NOISE	FREQ
PM2.5	.005	268.825
PM_{10}	.043	256,094

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.00	0.17	0.00	0.17	(Limit: 0.15)
PM coarse:	0.00	-0.17	0.06	-0.17	(Limit: 0.15)
Bypass:	0.05	0.39	0.01	0.39	(Limit: 0.6)

Inlet Cleaning Dates. PM10: 23 SEPT 13 Virtual Impactor: 23 SEPT 13

OVER

REPEAT K_d W/ AUDIT FILTER #02 SEPT '13
MAINE DEP & HSPH

0.097751 g.

INSTRUMENT K_0: $PM_{2.5}$ 15789 PM-C 14249

AUDIT K_0: $PM_{2.5}$ 15959.8 PM-C 14548.2

$PM_{2.5}$ %D = 1.08

PM-C %D = 2.10

1405DF TEOM Audit form Date: 3 OCT 13 Auditor: G Allen

Site: ~~1405DF~~ HGM* GW Site Operator: MANUEL CAMPOS Shelter T (C): 13 to 28** LOGGER T.

Instrument Model: 1405DF Serial #: 211191009 Firmware: 1.55 FEM sticker? Yes

Instrument Time: 1131 (CST) Site Datalogger time: 1130 Pump vac: 0.27 atm

Instrument ambient readings: T: 21.6 C Dewpoint: 11.1 C BP: 0.736 atm RH: 51 %

Instrument temperatures (C). Cap: 30.00 Case: 30.00 PM2.5 air: 30.00 PM-C air: 30.00

Instrument flows (display). PM2.5: 3.00 PM-C: 1.67 Bypass: 12.00 Total: 16.69 lpm, Qa

Flow Control. (confirm settings) Active (25 C, 1 atm): ✓ Actual conditions: ✓

K0 Audit. Audit filter ID: #01 Mass: 0.097569 g Cal. Date: SEPT 13 - MAINE DEP & HSPH

Instrument K0: PM2.5 14782 PM-C 16447

Audit K0: PM2.5 14870.7; % diff= 0.60 PM-C 16495; % diff= 0.29

Flow Audit. (lpm)
Audit Flowmeter Model: BGI tetraCal S/N: 304 T-amb: 24.2 C BP: 581.5 mm Hg

Site Flowmeter Model: ~~tetraCal~~ BGI S/N: 682 T-amb: 24.2 C BP: 582 mm Hg

Inlet (total) flow. Audit: 16.90 Qa, 12.96 Qs Site: 16.85 Qa, 12.93 Qs

PM2.5 (bypass and CM capped). T_A = 25.2 Audit: ~~16.85~~ 3.07 Qa, ~~12.93~~ 2.134 Qs Site: 2.99 Qa, 2.29 Qs T= 25.1

PM-C (bypass & PM2.5 capped). T= 25.6 Audit: 1.71 Qa, 1.31 Qs Site: 1.69 Qa, 1.29 Qs

FDMS Module. Dryer T (fine): 15.9 Dryer T (coarse): 15.8 C.

Dryer DP (fine): -6.7 Dryer DP (coarse): 17.5 C.

PM cooler (fine): 4.05 PM cooler (coarse): 4.05 C.

	NOISE	FREQ
PM2.5	.006	260.715
PM-C	.008	272.912

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.04	0.22	0.02	0.23	(Limit: 0.15)
PM coarse:	0.05	0.25	0.03	0.26	(Limit: 0.15)
Bypass:	0.00	0.32	0.00	0.32	(Limit: 0.6)

Inlet Cleaning Dates. PM10: 23 SEPT 13 Virtual Impactor: 23 SEPT 13

* HOSPITAL GENERAL de Mexico.

** SITE AIR CONDX SETTING CHANGED. NOW 23C.

1405DF TEOM Audit form Date: 3 OCT 13 Auditor: G. Allen

Site: PED Site Operator: MANUEL CAMPOS Shelter T (C): 21

Instrument Model: 1405DF Serial #: 20477 0905 Firmware: 1.51 FEM sticker? NO

Instrument Time: 1441 (CST) Site Datalogger time: 1440 Pump vac: 0.35 atm

Instrument ambient readings: T: 25.1 C Dewpoint: 5.6 C BP 0.747 atm RH: 29 %

Instrument temperatures (C). Cap: 30.00 Case: 30.00 PM2.5 air: 30.00 PM-C air: 30.00

Instrument flows (display). PM2.5: 3.00 PM-C: 1.67 Bypass: 12.00 Total: 16.68 lpm, Qa

Flow Control. (confirm settings) Active (25 C, 1 atm): ✓ Actual conditions: ✓

K0 Audit. Audit filter ID: #01 Mass: 0.097569 g Cal. Date: SEPT. 13 MANG DEP & HSPH

Instrument K0: PM2.5 15614 PM-C 14320

Audit K0: PM2.5 15885 ; % diff= 1.74 PM-C 14535.3; % diff= 1.50

Flow Audit. (lpm)
Audit Flowmeter Model: BGI Ectra Cal S/N: 304 T-amb: 27.6 C BP: 573 mm Hg

Site Flowmeter Model: Ectra Cal S/N: 682 T-amb: 28.0 C BP: 573 mm Hg

Inlet (total) flow. Audit: 16.66 Qa, 12.44 Qs Site: 16.62 Qa, 12.40 Qs

PM2.5 (bypass and CM capped). Audit: 3.02 Qa, 2.25 Qs Site: 2.94 Qa, 2.20 Qs TA = 27.2

PM-C (bypass & PM2.5 capped). Audit: 1.65 Qa, 1.24 Qs TA = 25.7 Site: 1.62 Qa, 1.22 Qs TA = 26.5

FDMS Module. Dryer T (fine): 22.3 Dryer T (coarse): 22.1 C.

Dryer DP (fine): -6.8 Dryer DP (coarse): -6.4 C.

PM cooler (fine): 4.01 PM cooler (coarse): 4.03 C.

	NOISE	FREQ
PM2.5	.007	268.442
PM-C	.011	255.679

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	-0.01	0.16	-.02	00.17	(Limit: 0.15)
PM coarse:	-.02	0.28	-.03	0.28	(Limit: 0.15)
Bypass:	0.07	0.24	0.05	0.24	(Limit: 0.6)

Inlet Cleaning Dates. PM10: 24 SEPT 13 Virtual Impactor: 24 SEPT 13

1405DF TEOM Audit form Date: 4 OCT 13 Auditor: G. Allen

Site: CAM (CAMARONES) Site Operator: MANUEL CAMPOS Shelter T (C): 16.3 (logger T, N)

Instrument Model: 1405DF Serial #: 211331010 Firmware: 1.55 FEM sticker? ✓

Instrument Time: 0856 (CST) Site Datalogger time: 0855 Pump vac: 0.24 atm

Instrument ambient readings: T: 15.7 C Dewpoint: 10.6 C BP: 0.757 atm RH: 69 %

Instrument temperatures (C). Cap: 30.00 Case: 30.00 PM2.5 air: 30.00 PM-C air: 30.00

Instrument flows (display). PM2.5: 3.00 PM-C: 1.67 Bypass: 11.99 Total: 16.71 lpm, Qa

Flow Control. (confirm settings) Active (25 C, 1 atm): ✓ Actual conditions: ✓

K0 Audit. Audit filter ID: #01 Mass 0.097569 g Cal. Date: SEPT '13 - MAINE DEP & HSPH

Instrument K0: PM2.5 15366 PM-C 15976

Audit K0: PM2.5 15500.5 ; % diff= 0.88 PM-C 16136.9 ; % diff= 1.01

Flow Audit. (lpm)
Audit Flowmeter Model: BGI tetra Cor S/N: 304 T-amb: 18.0 C BP: 584 mm Hg

Site Flowmeter Model: BGI tetraCor S/N: 682 T-amb: 17.5 C BP: 584 mm Hg

Inlet (total) flow. Audit: 16.60 Qa, 13.07 Qs Site: 16.51 Qa, 13.01 Qs

PM2.5 (bypass and CM capped). T=18.8 Audit: 3.05 Qa, 2.40 Qs Site: 2.96 Qa, 2.33 Qs T=17.8

PM-C (bypass & PM2.5 capped) T=19.2 Audit: 1.67 Qa, 1.31 Qs Site: 1.65 Qa, 1.29 Qs T=18.2

FDMS Module.

Dryer T (fine): 21.6	Dryer T (coarse): 21.7 C.		NOISE FREQ
Dryer DP (fine): -3.27	Dryer DP (coarse): -14.99 C.		PM2.5 .006 262.774
PM cooler (fine): 4.05	PM cooler (coarse): 3.96 C.		PM-C .016 269.869

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.08	0.18	0.07	0.18	(Limit: 0.15)
PM coarse:	0.07	0.22	0.06	0.22	(Limit: 0.15)
(Bypass:)	0.62	0.28	0.61	0.28	(Limit: 0.6)

Inlet Cleaning Dates. PM10: ~~25~~ 27 SEPT 13 (27 BKA) Virtual Impactor: 27 SEPT 13

1405DF TEOM Audit form Date: 4 Oct 13 Auditor: G. Allen

Site: SFE (Santa Fe) Site Operator: Manuel Compos Shelter T (C): 20.4

Instrument Model: 1405DF Serial #: 2047 40904 Firmware: 1.51 FEM sticker? NO

Instrument Time: 11:10 (CST) Site Datalogger time: 11:12 Pump vac: 0.21 atm

Instrument ambient readings: T: 19.1 C Dewpoint: 9.0 C BP: 0.727 atm RH: 53.5 %

Instrument temperatures (C). Cap: 30.00 Case: 30.00 PM2.5 air: 30.00 PM-C air: 30.00

Instrument flows (display). PM2.5: 3.00 PM-C: 1.67 Bypass: 12.02 Total: 16.70 lpm, Qa

Flow Control. (confirm settings) Active (25 C, 1 atm): ✓ Actual conditions: ✓

K0 Audit. Audit filter ID: # 01 Mass: 0.097569 g Cal. Date: SEPT. 13 MAINE DEP + HSPH.

Instrument K0: PM2.5 15418 PM-C 14029

Audit K0: PM2.5 15790.7; % diff= 2.42 PM-C 14277.2; % diff= 1.77

↳ this is normal for this instrument

Flow Audit. (lpm)

Audit Flowmeter Model: BGI TetraCal S/N: 304 T-amb: 21.7 C BP: 559.5 mm Hg

Site Flowmeter Model: BGI TetraCal S/N: 682 T-amb: 20.0 C BP: 559.5 mm Hg

Inlet (total) flow. Audit: 16.33 Qa, 12.16 Qs Site: 16.18 Qa, 12.12 Qs

PM2.5 (bypass and CM capped). T=21.3 Audit: 3.05 Qa, 2.28 Qs Site: 2.96 Qa, 2.20 Qs

PM-C (bypass & PM2.5 capped). T=22.1 Audit: 1.67 Qa, 1.24 Qs Site: 1.63 Qa, 1.212 Qs T=22.2

FDMS Module.

Dryer T (fine): 18.3 Dryer T (coarse): 18.3 C.

Dryer DP (fine): -19.0 Dryer DP (coarse): -14.6 C.

PM cooler (fine): 3.96 PM cooler (coarse): 3.90 C.

	NOISE	FREQ
PM2.5	.008	267.067
PM-C	.011	251.624

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.10	0.15	0.10	0.15	(Limit: 0.15)
PM coarse:	0.00	0.27	0.00	0.27	(Limit: 0.15)
Bypass:	0.07	0.20	0.15	0.11	(Limit: 0.6)

Inlet Cleaning Dates. PM10: 10 SEPT 13 Virtual Impactor: 10 SEPT 13

Manual FRM Audit form Date: 2 OCT 13 Auditor: G. Allen

Site: XAL Site Operator: ADRIANA PEREZ - NOT PRESENT

PM size: 2.5 (Primary) or Collo Run Day? NO

Instrument Mfg/Model: BGI PQ200 Serial #: 988 Firmware: 5.62

Instrument Time: 13:01 Actual time: 13:01 (CST)

Instrument readings. Flow: 16.70 lpm T(AMB): 25.4 C BP: 584 mm Hg
FILT: 29.0

Flow Audit.

Audit Flowmeter Model: BGI TETRACAL S/N: 304 T-amb: 26.7 C BP: 580.5 mm Hg

Site Flowmeter Model: BGI DELTACAL S/N: 980 T-amb: 26.0 C BP: 580.5 mm Hg

Inlet flow (lpm). Audit: 16.75 Qa, 12.73 Qs Site flowmeter: 16.74 Qa, 12.74 Qs

BGI Leak Test. Initial vac: 98 Final vac: 93 cm ; 95/90 ~~FAIL~~ GAA N/A *

~~Partisol Leak Test.~~ Initial vac: _____ In. Hg Result: _____ mm Hg/min.

PM10 Inlet Cleaning Date: 23 SEPT 13 PM2.5 VSCC Cleaning Date: 23 Sept 13

* GAA FOUND "NOT TIGHT" VSCC Cyclone thread - Tightened.

3RD test 95/90 - FAIL.

SIMAT STAFF PRESENT:
ARMANDO RETAMA
MANUEL CAMPOS
JESUS

THIS IS A REVISED HARDWARE VERSION WITH A MANUAL leak test valve - STARTING W/ PQ-200 SN 906 -

THE PROPER LEAK CHECK PROCEDURE FOR THIS VERSION OF THE PQ-200 WAS NOT FOLLOWED, RESULTING IN THE LEAK-CHECK FAILURE.

Manual FRM Audit form Date: 2 OCT 13 Auditor: G. Allen

Site: TLA Site Operator: ADRIAN PEREZ (NOT Present)

PM size: PM2.5 WINS Primary or Collo Run Day? NO

Instrument Mfg/Model: R+P PARTISOL Serial #: 200FB205360112 Firmware: 1.202

Instrument Time: 16:30 Actual time: 16:32 (CST)

Instrument readings. Flow: ~~16.83~~ 16.70 lpm (GAA) T: 25.1 C (FILTER) BP: 580 mm Hg

T_A = 25.0

Flow Audit.

Audit Flowmeter Model: BGI DeltaCal S/N: 304 T-amb: 25.7 C BP: 578 mm Hg

Site Flowmeter Model: BGI DeltaCal S/N: 980 T-amb: 25.2 C BP: 577.5 mm Hg

Inlet flow (lpm). Audit: 16.83 Qa, 12.76 Qs Site flowmeter: 16.86 Qa, 12.81 Qs

~~BGI Leak Test.~~ Initial vac: _____ Final vac: _____ cm

Partisol Leak Test. Initial vac: 12.5 In. Hg Result: 28 mm Hg/min. PASS

PM10 Inlet Cleaning Date: ~~23 SEP 13~~ 4 July 13 GAA

PM2.5 ~~VSSC~~ WINS Cleaning Date: ~~23 SEP 13~~ 4 July 13 GAA

Manual FRM Audit form Date: 2 OCT 13 Auditor: Geo A Clem

Site: SAG / SAN AGUSTIN Site Operator: ~~MANUEL CAMPOS~~ GAA ADRIAN PEREZ NOT PRESENT

PM size: 2.5 (Primary) or Collo Run Day? NO

Instrument Mfg/Model: BGI PQ200 Serial #: 615 Firmware: N/A

Instrument Time: 10:55 Actual time: 10:54 (CST)

Instrument readings. Flow: 16.7 lpm T: 22.4 C (FILTER) BP: 587 mm Hg

TAMB = 19.8

Flow Audit.

Audit Flowmeter Model: BGI tetra S/N: 304 T-amb: ~~20.7~~ 21.8 C BP: 584.5 mm Hg

* Site Flowmeter Model: BGI DeltaCal S/N: 980 T-amb: 21.1 C BP: 584.5 mm Hg

Inlet flow (lpm). Audit: ~~16.65~~ GAA 16.55 Qa, 12.97 Qs Site flowmeter: 16.59 Qa, 12.93 Qs

BGI Leak Test. Initial vac: 105 Final vac: 101 cm PASS

~~Partisol Leak Test.~~ Initial vac: _____ In. Hg Result: _____ mm Hg/min.

PM10 Inlet Cleaning Date: 10 July 13 PM2.5 VSSC Cleaning Date: 10 July 13

* SITE tetraCAL SN 682 WAS NOT WORKING. DeltaCal USED FOR ALL SITE FLOW CHECKS DURING AUDIT. GAA

INSPECTION of VENTURIS SHOWED Grease over pressure ports - cleaning of ports Appears to have fixed the problem. GAA

Manual FRM Audit form Date: 3 OCT 13 Auditor: G. Allen

Site: MER Site Operator: ADRIAN PEREZ (NOT PRESENT)

PM size: 2.5 WINS Primary or Collo Run Day? NO

Instrument Mfg/Model: BGI PQ-200 Serial #: 608 Firmware: 5.62

Instrument Time: 10:27 Actual time: 10:26 (CST)

Instrument readings. Flow: 16.70 lpm T: 24.3 C BP: 586 mm Hg

TA=20.1

Flow Audit.

Audit Flowmeter Model: BGI tetra-CAL S/N: 304 T-amb: 21.8 C BP: 583.5 mm Hg

Site Flowmeter Model: BGI DELTA-CAL S/N: 980 T-amb: 19.2 C BP: 583.5 mm Hg

Inlet flow (lpm). Audit: 16.83 Qa, 13.05 Qs Site flowmeter: 16.70 Qa, 13.08 Qs

BGI Leak Test. Initial vac: 97 Final vac: 96 cm PASS

~~Partisol Leak Test.~~ Initial vac: _____ In. Hg Result: _____ mm Hg/min.

PM10 Inlet Cleaning Date: ~~20 SEPT 13 GAA~~ 18 July 13 PM2.5 ~~VSSC~~ WINS Cleaning Date: ~~20 SEPT 13 GAA~~ 18 July 13

Manual FRM Audit form Date: 3 OCT 13 Auditor: G. Allen

Site: PED Site Operator: ADRIAN PEREZ (NOT PRESENT)

PM size: 2.5 WINS (Primary) or Collo Run Day? NO

Instrument Mfg/Model: R+P PARTISOL 2000 Serial #: 20531011 Firmware: L202

Instrument Time: 15:19 Actual time: 1518 (CST)

Instrument readings. Flow: ~~16.9~~ GAA 16.7 lpm T: F 27.6 C TA 25.9 BP: 576 mm Hg

Flow Audit.

Audit Flowmeter Model: BGI Tetra Cal S/N: 304 T-amb: 27.1 C BP: 573 mm Hg

Site Flowmeter Model: BGI DELTA CAL S/N: 980 T-amb: 26.2 C BP: 573 mm Hg

Inlet flow (lpm). Audit: 16.73 Qa, 12.51 Qs Site flowmeter: 16.63 Qa, 12.48 Qs

~~BGI Leak Test.~~ Initial vac: _____ Final vac: _____ cm

Partisol Leak Test. Initial vac: 12.5 In. Hg Result: 48 mm Hg/min. PASS

PM10 Inlet Cleaning Date: ~~24 SEPT 13~~ GAA 8 July 13 PM2.5 ~~VSSC~~ WINS Cleaning Date: ~~24 SEPT 13~~ GAA 8 July 13

Manual FRM Audit form Date: 3 OCT 13 Auditor: G. Allen

Site: PED Site Operator: ADRIAN PEREZ (NOT PRESENT)

PM size: 2.5 (WINS) Primary or Collo Run Day? NO

Instrument Mfg/Model: R+P PARTISOL 2000 Serial #: 20682050 5 Firmware: 1.263

Instrument Time: 15:30 Actual time: 15:29 (CST)

Instrument readings. Flow: 16.67 lpm T: F 27.9 C BP: 576 mm Hg

TA 25.5

Flow Audit.

Audit Flowmeter Model: BGI tetra CAL S/N: 304 T-amb: 27.6 C BP: 573 mm Hg

Site Flowmeter Model: ~~BGI DELTACAL PARTISOL 2000~~ GMW S/N: 980 T-amb: 26.3 C BP: 573 mm Hg

Inlet flow (lpm). Audit: 16.67 Qa, 12.47 Qs Site flowmeter: ~~16.67~~ GMW 16.71 Qa, ~~12.50~~ GMW 12.54 Qs

~~BGI Leak Test.~~ Initial vac: _____ Final vac: _____ cm

Partisol Leak Test. Initial vac: 13 In. Hg Result: 28 mm Hg/min. PASS

PM10 Inlet Cleaning Date: ~~24 SEPT~~ GMW 8 July 13 PM2.5 ~~VSSC~~ WINS Cleaning Date: ~~24 SEPT~~ GMW 8 July 13

Manual FRM Audit form Date: 3 OCT 13 Auditor: G. Allen

Site: RED Site Operator: ADRIAN PEREZ (NOT PRESENT)

PM size: PM10 (Primary) or Collo Run Day? NO

Instrument Mfg/Model: ~~R&P~~ PARTISOL 2000 Serial #: 20535014 2 Firmware: 1.202

Instrument Time: 1539 Actual time: 1538 (CST)

Instrument readings. Flow: 16.6 lpm T: 26.3 C BP: 576 mm Hg

TA 25.4

Flow Audit.

Audit Flowmeter Model: BGI ~~tetra Cal~~ S/N: 304 T-amb: 27.2 C BP: 573 mm Hg

Site Flowmeter Model: BGI DELTA CAL S/N: 980 T-amb: ~~16.66~~ 25.8 C BP: ~~12.50~~ 573 mm Hg

GAA GAA

Inlet flow (lpm). Audit: 16.67 Qa, 12.47 Qs Site flowmeter: 16.66 Qa, 12.50 Qs

~~BGI Leak Test.~~ Initial vac: _____ Final vac: _____ cm

Partisol Leak Test. Initial vac: 15 In. Hg Result: 47 mm Hg/min. PASS

PM10 Inlet Cleaning Date: ~~24 SEPT 13~~ GAA 8 July 13

PM2.5 ~~VSSC~~ WINS Cleaning Date: ~~24 SEPT~~ 13 GAA 8 July 13

Manual FRM Audit form Date: 4 OCT 13 Auditor: C. Allen

Site: CAM Site Operator: ADRIAN PEREZ (NOT PRESENT)

PM size: 2.5 WINS Primary or Collo Run Day? NO

Instrument Mfg/Model: PARTISOL 2000 Serial #: 2052901111 Firmware: 1.202

Instrument Time: 0946 Actual time: 0945 (CST)

Instrument readings. Flow: 16.6 lpm T: 20.8 F C BP: 587 mm Hg

T_A 20.1

Flow Audit.

Audit Flowmeter Model: BGI Petra Cal S/N: 304 T-amb: 19.8 C BP: 584 mm Hg

Site Flowmeter Model: BGI Delta Cal S/N: 980 T-amb: 19.5 C BP: 583.5 mm Hg

Inlet flow (lpm). Audit: 16.86 Qa, 13.18 Qs Site flowmeter: 16.88 Qa, 13.20 Qs

~~BGI Leak Test.~~ Initial vac: _____ Final vac: _____ cm

Partisol Leak Test. Initial vac: 15 In. Hg Result: 54 mm Hg/min.

* PM10 Inlet Cleaning Date: 25 SEPT 13 * PM2.5 ~~VSSC~~ WINS Cleaning Date: 25 SEPT 13 *

* VISUAL INSPECTION by ARMANDO RETAMA SHOWED DIRTY PM10 INLET, NO OIL IN THE WINS PM2.5 IMPACTOR, AND DIRT/SOOT IN THE DOWN TUBING.

CLEANING DATES ARE FROM SITE TECHNICIAN LOG, NOT SITE LOGBOOK.