Audit Report of SIMAT Particle Monitoring Network

Performed 10-12 November, 2014

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

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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 10-12 November, 2014. 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. Comparisons between audit and site flow standards were also made at each site.

Audits were performed on PM monitors at the following sites (three letter site code in parenthesis):
Tlalnepantla (TLA)
Xalostoc (XAL)
Pedregal (PED)
Laboratory "Supersite" (LAB)
San Agustin (SAG)
Hospital General de Mexico (HGM)
Camarones (CAM)
Hospital Ajusco Medio (AJM)

PM monitors audited included nine R&P or BGI manual FRM samplers, and nine Thermo TEOM continuous samplers – 18 sampler audits total. All but one of the audited TEOM samplers were model 1405DF dichot FDMS for PM2.5 and PM-coarse (and thus also PM10) and are approved as U.S. EPA Federal Equivalent Monitors (FEM) for PM2.5 when operated in accordance with the instrument manual. These TEOMS are also approved as PM-coarse and PM10 FEMs, but only with a newer software version than was in use at the time of the audit.

The LAB PM-1.0 TEOM is a model 1400AB with FDMS model 8500, revision C. This instrument is approved as an EPA FEM for PM2.5 but only with a newer software version than was in use at the time of the audit.

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 are 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 18 September 2014.

TEOMs:

Site	Parameter	Audit Flow Result
CAM	1405DF PM-fine	-4.2%
CAM	1405DF PM-coarse	-5.0%*
TLA	1405DF PM-coarse	-4.1%*
LAB	14000AB PM-1.0	-4.5

LAB	1405DF	all three leak checks failed
XAL	1405DF PM-fine	-4.2%
PED	1405DF PM-fine	-4.5 %*
PED	1405DF PM-coarse	-4.2 %*

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

All nine FRM PM sampler audit flows were within 4% of the audit flow standard.

In summary, all TEOM and FRM samplers passed the flow audits. Seven sampler flows were different from the audit flow standard by more than 4 %, indicating that corrective action may be needed; three of these were the coarse channel where flow errors do not directly indicate the error in the coarse PM data. One TEOM sampler (LAB 1405DF) failed the leak checks, indicating that corrective action is necessary.

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 2014. 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 10-12 November 2014 using an audit flowmeter: BGI tetraCal s/n 304, factory calibrated on 18 September 2014.

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.

SIMAT staff were present for the audits, and performed parallel sampler flow checks on 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 (SIMAT QA)
Jesusyael Jímenez Valdez (TEOM samplers)
Adrian Perez Narvaez (FRM samplers)

Armando Retama Hernandez was present on November 10, and for the LAB audits on November 12.

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. For proper 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). Taken together, these operational specifications should limit uncertainty in the coarse channel PM to less than approximately 7%.

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 (the manufacturer's specifications).

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. For TEOMs, the site and audit flowmeter comparisons are presented in Table 3.

FRM (manual) samplers: all FRM samplers passed the audit. Audit flow errors were less than 2% for all samplers; these excellent results are due in part to SIMAT field staff now using only the deltaCal flowmeter, and no longer using the triCal flowmeters, as field-site flow standards. All FRM samplers passed the leak check test. 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 (automated) PM samplers: all samplers passed the flow audit. One recently installed sampler (LAB 1405DF) failed the leak-check audit. Of the nine TEOM samplers, five had audit flows outside of the normal range:

Site	Parameter	Flow Audit Result, %
CAM	1405DF PM-fine	-4.2
CAM	1405DF PM-coarse	-5.0*
TLA	1405DF PM-coarse	-4.1*
LAB	14000AB PM-1.0	-4.5
XAL	1405DF PM-fine	-4.2
PED	1405DF PM-fine	-4.5*
PED	1405DF PM-coarse	-4.2*

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

The relative consistency of these audit flow errors (all between -4 and -5%) may indicate a modest bias in the accuracy of the field tetraCal flowmeter.

All audited TEOM samplers had virtual impactor flow ratios within the 7% tolerance.

All TEOM samplers passed the K_0 audits. Values were all within the 2% normal limit except for the PED fine channel, which was -2.3% different than the audit standard. The coarse channel K0 audit error on this instrument was also unusually high, at -1.90%. It is recommended that both K0 values of the PED TEOM be re-calibrated.

One TEOM 1405DF sampler (LAB) failed the bypass flow leak check by a substantial amount. This new sampler was deployed the week before the audit, and post-installation leak tests had not yet been performed.

Two of the 1405DF FDMS TEOMs audited did not have the PM2.5 FEM sticker on the instrument; these were older instruments. While it is likely that these TEOMs meet the PM2.5 FEM requirements, this needs confirmation by the manufacturer, and stickers should be requested and applied to these instruments. None of the 1405DF TEOMs had PM-coarse or PM-10 FEM stickers, since they did not meet the FEM requirements with the older firmware versions in use. It is recommended that all 1405DF TEOMS be upgraded to firmware version 1.70 (released earlier this year) and that PM-coarse and PM-10 FEM stickers be applied to the instruments after that upgrade has been performed.

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

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

Underline means corrective action is needed (>4%)

Site	Date	Mfg	Model	Serial #	PM Size	Audit Flow	Sampler Flow	**Audit % Diff**	Site Flow	Site - Audit Flow	% Diff *	Leak Test** Pass/Fail	Comments
CAM	10-Nov-14	R&P	Partisol 2000-H	200FB205340111	2.5	16.77	16.7	0.42	17.08	0.31	1.85	Pass	
TLA	10-Nov-14	R&P	Partisol 2000-H	200FB205360112	2.5	16.70	16.7	0.00	16.70	0.00	0.00	Pass	Primary Sampler
TLA	10-Nov-14	R&P	Partisol 2000-H	200FB206820505	2.5	16.54	16.7	-0.97	16.78	0.24	1.45	Pass	Collo Sampler
PED	11-Nov-14	R&P	Partisol 2000-H	200FB205350112	10	16.55	16.7	-0.91	16.73	0.18	1.09	Pass	
PED	11-Nov-14	R&P	Partisol 2000-H	200FB205310111	2.5	16.40	16.7	-1.83	16.68	0.28	1.71	Pass	
XAL	12-Nov-14	BGI	PQ-200	988	2.5	16.42	16.7	-1.71	16.56	0.14	0.85	Pass	
SAG	12-Nov-14	BGI	PQ-200	615	2.5	16.25	16.7	-2.77	16.42	0.17	1.05	Pass	
LAB	12-Nov-14	BGI	PQ-200	606	2.5	16.52	16.7	-1.09	16.82	0.30	1.82	Pass	
LAB	12-Nov-14	R&P	Partisol 2000-H	200FB205290111	10	16.37	16.7	-2.016	16.63	0.26	1.59	Pass	

Site flowmeter: BGI deltaCal sn 351 for all FRM sites

Notes:

* not used for audit results

** based on mfg. criteria

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

All TEOM 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**
CAM	10-Nov-14	1405DF	226221310	Dichot	16.78	16.67	-0.7	3.13	3.00	-4.2	1.758	1.67	-5.0	9.5	-4.6
TLA	10-Nov-14	1405DF *	204750905	Dichot	16.82	16.67	-0.9	3.10	3.00	-3.2	1.741	1.67	-4.1	9.7	-3.4
LAB	10-Nov-14	1405DF	226241310	Dichot	16.82	16.67	-0.9	3.06	3.00	-2.0	1.702	1.67	-1.9	9.9	-1.2
LAB	10-Nov-14	1400AB-FDMS	26336	PM-1.0	16.90	16.67	-1.4	3.14	3.00	-4.5	n/a	n/a	n/a	n/a	n/a
AJM	11-Nov-14	1405DF	226131310	Dichot	16.51	16.67	1.0	3.00	3.00	0.0	1.677	1.67	-0.4	9.8	-1.6
HGM	11-Nov-14	1405DF	211191009	Dichot	16.73	16.67	-0.4	3.02	3.00	-0.7	1.735	1.67	-3.7	9.6	-3.6
PED	11-Nov-14	1405DF *	204770905	Dichot	16.81	16.67	-0.8	3.14	3.00	-4.5	1.743	1.67	-4.2	9.6	-3.6
XAL	12-Nov-14	1405DF	211841011	Dichot	16.79	16.67	-0.7	3.13	3.00	-4.2	1.705	1.67	-2.1	9.8	-1.5
SAG	12-Nov-14	1405DF	211341010	Dichot	16.87	16.67	-1.2	3.12	3.00	-3.8	1.758	1.67	-5.0	9.6	-4.0

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)
* No FEM sticker on instrument.
Notes:
1. Inlet flow TEOM audit results have a minimal effect on measurement error; an inlet flow tolerance of 10% is acceptable.
2. The audit flowmeter calibration error at 1.7 lpm is + 0.77%; the coarse channel audit flows are not corrected for this error.
3. 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.
4. The inlet to coarse flow ratio audit limit is 7%.
5. The last 4 digits of the 1405 serial number indicate the year and month of manufacturer (YYMM).

Additional audit checks:

Audit K0 limit = 2% warning; 2.5% fail (based on mfg limits)

Leak Check		**LkChk Result**	Audit Filter ID	Fine Channel K0 Checks: Audit	Site	**%Diff.**	Coarse Channel K0 Checks: Audit	Site	**%Diff.**
CAM	10-Nov-14	Pass	#01	13690.7	13753	0.46	15882.2	15984	0.64
TLA	10-Nov-14	Pass	#01	15543.5	15550.3	0.04	14928.9	14881	-0.32
LAB	10-Nov-14	**Fail***	#01	15826.7	15615	-1.34	16690.4	16586	-0.63
LAB	10-Nov-14	Pass	#01	15076.0	15194	0.78	n/a	n/a	n/a
AJM	11-Nov-14	Pass	#01	13403.0	13424	0.16	13400.7	13434	0.25
HGM	11-Nov-14	Pass	#01	14868.7	14782	-0.58	16567.0	16447	-0.72
PED	11-Nov-14	Pass	#01	15984.8	15614	-2.32 **	14597.6	14320	-1.90 **
XAL	12-Nov-14	Pass	#02	15189.7	15064	-0.83	16082.5	15962	-0.75
SAG	12-Nov-14	Pass	#02	15028.8	15061	0.21	16898.4	17022	0.73

* recently deployed instrument, site leak test not yet performed.
** PED 1405: fine and coarse channel K0s both pass, but errors are larger than normal; recommend recalibration of both.

Table 3: Comparison of TEOM Audit and Site Flowmeter Audit Readings

TEOM Audit and Site flowmeter readings
All flows Qa, LPM

Site Flowmeter: tetraCal s/n 682 for all TEOM sites

		Inlet			Fine channel			Coarse channel		
Site	Date	Audit	Site	% diff	Audit	Site	% diff	Audit	Site	% diff
CAM	10-Nov-14	16.78	16.97	1.1	3.13	3.07	-1.9	1.734	1.758	1.4
TLA	10-Nov-14	16.82	16.92	0.6	3.10	3.03	-2.3	1.719	1.741	1.3
LAB	10-Nov-14	16.82	16.88	0.4	3.06	2.99	-2.3	1.633	1.702	4.2
LAB PM-1	10-Nov-14	16.90	16.96	0.4	3.14	3.07	-2.2	n/a	n/a	n/a
AJM	11-Nov-14	16.51	16.72	1.3	3.00	2.94	-2.0	1.639	1.677	2.3
HGM	11-Nov-14	16.73	16.88	0.9	3.02	3.06	1.3	1.715	1.735	1.2
PED	11-Nov-14	16.81	17.03	1.3	3.14	3.08	-1.9	1.707	1.743	2.1
XAL	12-Nov-14	16.79	16.92	0.8	3.13	3.06	-2.2	1.656	1.705	3.0
SAG	12-Nov-14	16.87	17.19	1.9	3.12	3.08	-1.3	1.740	1.758	1.0

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.

Other audit observations and recommendations.

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

Site temperature:
The site shelter temperatures were between 20 and 24 degrees C, not as cold as observed during the 2013 audits. 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 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 sensor 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.

TEOM Firmware Updates:
All TEOMs would benefit from updates to the instrument firmware. The 1405DF TEOMs require version 1.70 to be FEM-compliant for PM-coarse and PM10. The 1400AB/8500 FDMS PM-1.0 TEOM at the LAB site should be updated to firmware version 3.5, the version that is required to be FEM compliant for PM2.5.

PM-1.0 measurements:
Robust measurement of PM-1.0 to PM2.5 µm at the LAB site requires that both the PM-1.0 and PM2.5 TEOM measurements be carefully matched. In addition to the firmware updates for both the 1405DF PM2.5 and 1400AB/FDMS PM-1.0 TEOMS, it is recommended that the PM-1.0 TEOM be run with a 2.5 µm size cut for at least several days every three months to allow any differences between the two instruments to be evaluated. The results of this comparison can be used to correct data to improve the accuracy of the PM-1.0 to PM2.5 measurement.

Deployment of second AE33 Aethalometer:
Current SIMAT plans are to put the second AE33 Aethalometer with CO2 measurements at the AJM site, to replace the AE42 Aethalometer presently in use there. The AE33 BC and CO2

measurements from this site, along with the Ajusco "Hazecam" pictures and aerosol mixing height data from the LAB site aerosol lidar instrument, could provide valuable information about BC emission factors during the winter season as the site goes from being in the free troposphere to within the mixing layer and back over the course of a day.

Roof Access Safety at Tlalnepantla:

The TEOM inlet at Tlalnepantla is on the roof of the shelter. Current roof access is by climbing the met tower next to the shelter. This is a potential safety hazard. It is recommended that a ladder be installed to allow safer access to the shelter roof.

Camarones Tree Removal:

The Camarones site had a large tree close to the sampler inlets on the shelter, and the tree was much taller than the inlets. While the tree is not likely to affect PM2.5 data, SIMAT staff report that the tree was been removed after the audit, since it could affect ozone and PM10 data and did not allow for normal distance and height requirements for inlet siting.

Recommendations regarding other particle samplers at the LAB supersite:

The data quality and capture from the MARGA analyzer for inorganic gases and particulate ions are much improved since the last audit. The ion-balance for sulfate, nitrate, and ammonium ions is excellent. The inlet line is a long non-conductive plastic tube; this will remove nearly all nitric acid and much of the ammonia and may remove some of the particles. A very short conductive inlet tube should be used to optimize the instrument performance, especially for ammonia and nitric acid. If possible, 3 to 6-hour denuder sampling for ammonia and nitric acid should be performed to allow assessment of data quality for these parameters. For nitric acid, denuder measurements should be performed during warm weather, when levels of nitric acid are likely to be highest. To assess basic instrument performance, MARGA SO2 and sulfate data should be compared to robust collocated measurements. The numerical agreement between methods for SO2 and sulfate should be comparable. If the sulfate method includes non-water soluble sulfate (such as XRF S), that sulfate is expected to be 5 to 10% higher than the MARGA water soluble sulfate.

NOy measurements:

A TAPI NOy instrument was recently deployed at the LAB site. A particle filter was used at the sample inlet, which prevents measurement of ammonium nitrate, a major component of NOy. Based on audit recommendations, the inlet filter was removed, and particle filters were placed on both the NO and NOy (after the converter) channel sample lines to keep them clean. The sampler inlet tubing length was reduced to minimize loss of nitric acid, another major component of NOy. If research-grade NOy measurements are needed, it is recommended to have the NOy channel inlet consist only of the tube coming from the converter, with a separate inlet for the NO channel. This eliminates the need for a tee fitting in the NOy channel path and provides a heated NOy channel inlet, minimizing loss of nitric acid.

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: 18 Sept 2014 (BGI)

Site Flow Standards

TEOMs:	BGI tetraCal, sn 682	"tetraCal" external temp sensor
FRMs:	BGI deltaCal, sn351	"deltaCal" external temp sensor

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

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.

The factory flow certification for the audit flowmeter (BGI tetraCal s/n 304) on 18 September 2014 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: 18-Sep-14

Calibration Operator: Brian DeVoe

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: 21 C
Brand: Ever-Safe Serial Number: 016076
NIST Traceability No. 516837
tetraCal:
Ambient Temperature (set): 21 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): 758 mm of Hg

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

No. 1 Q = 5.22031 ΔP ^ 0.52077
No. 2 Q = 1.15671 ΔP ^ 0.52191
No. 3 Q = 0.21181 ΔP ^ 0.54483

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 Date 18-Sep-14 Brian DeVoe
6 - 30.00 Lpm BP= 758 mm of Hg
VER. 3.41P

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

Reading Abs. P Crit. Vent. mm of Hg	Room TEMP	Crit. Vent. TEMP	CV Qa Flow Lpm	Qa TriCal Indicated	%Error	
203.28	21	20.9	7.87	7.91	**0.56**	
436.95	21	20.9	17.13	17.12	**-0.08**	**Average %**
700.93	21	20.9	27.60	27.81	**0.74**	**0.41**

To Check a Tetra Cal BP= 758 mm of Hg
1.20 - 6.00 Lpm

Reading Abs. P Crit. Vent. mm of Hg	Room TEMP	Crit. Vent. TEMP	CV Qa Flow Lpm	QA TriCal Indicated	% Error	
153.6	21.6	21.2	1.69	1.706	**0.77**	
336.0	21.6	21.2	3.76	3.76	**-0.03**	**Average %**
494.7	21.6	21.2	5.56	5.59	**0.56**	**0.43**

To Check a Tetra Cal BP= 758 mm of Hg
0.10 - 1.20 Lpm

Reading Abs. P Crit. Vent. mm of Hg	Room TEMP	Crit. Vent. TEMP	CV Qa Flow Lpm	QA TriCal Indicated	% Error	
216.46	21.8	21.1	0.387	0.388	**0.33**	
384.26	21.8	21.1	0.709	0.707	**-0.34**	**Average %**
568.39	21.8	21.1	1.064	1.070	**0.61**	**0.20**

Appendix B: PM instrument audit logs.

Manual FRM Audit form Date: 10 NOV 14 Auditor: G. Allen

Site: CAM Site Operator: ADRIAN PEREZ NARANJEZ

PM size: 2.5 Primary or Collo Run Day? NO

Instrument Mfg/Model: R/P PARTISOL Serial #: 2005B20534011 Firmware: 1.300

Instrument Time: 12:06 Actual time: 12:07 (CST)

Instrument readings. Flow: 16.7 lpm Ta: 21.4 C Tf: 23.8 C BP: 585 mm Hg

Flow Audit.

Audit Flowmeter Model: ~~Delta Cal~~ Ecta S/N: 304 T-amb: 24.0 C BP: 582.5 mm Hg

Site Flowmeter Model: ~~Delta Cal~~ S/N: 351 T-amb: 23.7 C BP: 585 mm Hg

Inlet flow (lpm). Audit: 16.77 Qa, 12.91 Qs Site flowmeter: 17.08 Qa, _____ Qs

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

Partisol Leak Test. Initial vac: 246 ~~in~~ mm Hg Result: 12 mm Hg/min. PASS

PM10 Inlet Cleaning Date: 1 OCT 14 PM2.5 VSSC/WINS Cleaning Date: 1 OCT 14

Large Tree near shelter roof

OK FOR FRM PM2.5

RECOMMEND LARGER LADDER FOR SAFE ROOF ACCESS

Manual FRM Audit form Date: 10 NOV 14 Auditor: G. ALLEN

Site: TLA Site Operator: ADRIAN PEREZ NARVAEZ

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

Instrument Mfg/Model: R&P PARTISOL Serial #: 200 FB 20J360 112 Firmware: 1.202

Instrument Time: 0928 Actual time: 0928 (CST)

Instrument readings. Flow: 16.7 lpm Ta: 17.1 C Tf: 16.7 C BP: 583 mm Hg

Flow Audit.

Audit Flowmeter Model: BGI tetraCal S/N: 304 T-amb: 19.2 C BP: 580.5 mm Hg

Site Flowmeter Model: DeltaCal S/N: 351 T-amb: 17.5 C BP: 583 mm Hg

Inlet flow (lpm). Audit: 16.7 Qa, 12.93 Qs Site flowmeter: 16.7 Qa, 12.9 Qs

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

(Partisol Leak Test.) Initial vac: 280 ~~In.~~ MM Hg Result: 18 mm Hg/min. PASS

PM10 Inlet Cleaning Date: 6 OCT 14 PM2.5 VSSC/WINS Cleaning Date: 6 OCT 14

Manual FRM Audit form Date: 10 NOV 14 Auditor: G. Arle

Site: TCA Site Operator: ADRIAN PEREZ NARVAEZ

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

Instrument Mfg/Model: PARTISOL Serial #: 200FB 20682055 Firmware: 1.203

Instrument Time: 0942 Actual time: 0943 (CST)

Instrument readings. Flow: 16.7 lpm Ta: 17.5 C Tf: 18.3 C BP: 584 mm Hg

Flow Audit.

Audit Flowmeter Model: tetra Cal S/N: 304 T-amb: 22.5 C BP: 580.5 mm Hg

Site Flowmeter Model: DeltaCal S/N: 351 T-amb: 19.7 C BP: 584 mm Hg

Inlet flow (lpm). Audit: 16.54 Qa, 12.75 Qs Site flowmeter: 16.78 Qa, ——— Qs

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

Partisol Leak Test. Initial vac: 581 ~~In.~~ mm Hg Result: 7 mm Hg/min. PASS

PM10 Inlet Cleaning Date: 6 OCT 14 PM2.5 VSSC/WINS Cleaning Date: 6 OCT 14

NOTE - SITE / INSTRUMENT "TAG" NOW INCLUDES DATES OF LAST CLEANINGS.

Manual FRM Audit form Date: 11 NOV 14 Auditor: G. Allen

Site: PEDREGAL Site Operator: ADRIAN PEREZ NARVAEZ

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

Instrument Mfg/Model: PARTISOL Serial #: 200FB205310111 Firmware: 1.202

Instrument Time: 11:41 Actual time: 11:42 (CST)

Instrument readings. Flow: 16.7 lpm Ta: 22.2 C Tf: 22.5 C BP: 578 mm Hg

Flow Audit.

Audit Flowmeter Model: tetra Cor S/N: 304 T-amb: 24.2 C BP: 575.0 mm Hg

Site Flowmeter Model: Delta Cor S/N: 351 T-amb: 23.4 C BP: 578 mm Hg

Inlet flow (lpm). Audit: 16.40 Qa, 12.45 Qs Site flowmeter: 16.68 Qa, ——— Qs

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

(Partisol Leak Test) Initial vac: 263 ~~In.~~ mm Hg Result: 5 mm Hg/min. PASS

PM10 Inlet Cleaning Date: 7 OCT 14 PM2.5 VSSC/WINS Cleaning Date: 7 OCT 14

Manual FRM Audit form Date: 11 NOV 14 Auditor: G. Allen

Site: PEDREGAL Site Operator: ADRIAN PEREZ NARVAEZ

PM size: 10 (Primary) or Collo Run Day? WO

Instrument Mfg/Model: PARTISOL Serial #: 200FB205350112 Firmware: 1.202

Instrument Time: 11:53 Actual time: 11:55 (CST)

Instrument readings. Flow: 16.7 lpm Ta: 20.6 C Tf: 23.5 C BP: 578 mm Hg

Flow Audit.

Audit Flowmeter Model: TetraCal S/N: 304 T-amb: 24.6 C BP: 575 mm Hg

Site Flowmeter Model: DELTACAL S/N: 351 T-amb: 23.7 C BP: 578 mm Hg

Inlet flow (lpm). Audit: 16.55 Qa, 12.54 Qs Site flowmeter: 16.73 Qa, ——— Qs

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

Partisol Leak Test. Initial vac: 254 ~~In.~~ mm Hg Result: 13 mm Hg/min. PASS

PM10 Inlet Cleaning Date: 7 OCT 14 PM2.5 VSSC/WINS Cleaning Date: 7 OCT 14

Manual FRM Audit form Date: 12 Nov 14 Auditor: G. Allen

Site: XAL Site Operator: ADRIAN PEREZ NARVAEZ

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

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

Instrument Time: 0954 Actual time: 0955 (CST)

Instrument readings. Flow: 16.70 lpm Ta: 18.1 C Tf: 19.1 C BP: 585 mm Hg

Flow Audit.

Audit Flowmeter Model: Delta Cal S/N: 304 T-amb: 21.3 C BP: 582.5 mm Hg

Site Flowmeter Model: delta Cal S/N: 351 T-amb: 19.5 C BP: 585 mm Hg

Inlet flow (lpm). Audit: 16.42 Qa, 12.73 Qs Site flowmeter: 16.56 Qa, — Qs

BGI Leak Test. Initial vac: 99 Final vac: 95 cm PASS

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

PM10 Inlet Cleaning Date: 16 OCT 14 PM2.5 VSSC/WINS Cleaning Date: 16 OCT 14

Manual FRM Audit form Date: 12 NOV 14 Auditor: G. Allen

Site: SAG Site Operator: ADRIAN PEREZ NARVAEZ

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

Instrument Mfg/Model: ~~BGI~~ PQ200 Serial #: 615 Firmware: 5.62

Instrument Time: 11:22 Actual time: 11:25 (CST)

Instrument readings. Flow: 16.7 lpm Ta: 21.5 C Tf: 25 C BP: 587 mm Hg

Flow Audit.

Audit Flowmeter Model: ~~Tetra Cal~~ S/N: 304 T-amb: 23.7 C BP: 584.5 mm Hg

Site Flowmeter Model: delta Cal S/N: 357 T-amb: 21.8 C BP: 587 mm Hg

Inlet flow (lpm). Audit: 16.25 Qa, 12.50 Qs Site flowmeter: 16.42 Qa, — Qs

BGI Leak Test. Initial vac: 103 Final vac: 99 cm PASS

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

PM10 Inlet Cleaning Date: 9 OCT 14 PM2.5 VSCC/WINS Cleaning Date: 9 OCT 14

Manual FRM Audit form Date: 12 NOV 14 Auditor: G. Allen

Site: LAB Site Operator: ADRIAN PEREZ NARVAEZ

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

Instrument Mfg/Model: BGI PQ-200 Serial #: 606 Firmware: 5.62

Instrument Time: 1504 Actual time: 1506 (CST)

Instrument readings. Flow: 16.7 lpm Ta: 23.9 C Tf: 26.0 C BP: 584 mm Hg

Flow Audit.

Audit Flowmeter Model: tetraCal S/N: 304 T-amb: 24.2 C BP: 581.0 mm Hg

Site Flowmeter Model deltaCal S/N: 351 T-amb: 23.6 C BP: 584 mm Hg

Inlet flow (lpm). Audit: 16.52 Qa, 12.67 Qs Site flowmeter: 16.82 Qa, — Qs

BGI Leak Test. Initial vac: 100 Final vac: 100 cm ✓PASS

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

PM10 Inlet Cleaning Date: 20 OCT 14 PM2.5 VSCC/WINS Cleaning Date: 20 Oct 14

COAT =

Manual FRM Audit form Date: 12 NOV 14 Auditor: G. Allen

Site: LAB Site Operator: ADRIAN PEREZ NARVAEZ

PM size: PM10 Primary or Collo Run Day? NO

Instrument Mfg/Model: PARTISOL Serial #: 200FB205290111 Firmware: 1.202

Instrument Time: 1455 Actual time: 1456 (CST)

Instrument readings. Flow: 16.7 lpm Ta: 22.3 C Tf: 24.4 C BP: 585 mm Hg

Flow Audit.

Audit Flowmeter Model: tetra Gas S/N: 304 T-amb: 25.3 C BP: 581.5 mm Hg

Site Flowmeter Model: delta Gas S/N: 351 T-amb: 24.6 C BP: 584 mm Hg

Inlet flow (lpm). Audit: 16.37 Qa, 12.48 Qs Site flowmeter: 16.63 Qa, ___ Qs

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

Partisol Leak Test. Initial vac: 222 ~~In.~~ mm Hg Result: 7 mm Hg/min. PASS

PM10 Inlet Cleaning Date: 20 OCT 14 PM2.5 VSCC/WINS Cleaning Date: N/A PM10

1405DF TEOM Audit form Date: 10 NOV 14 Auditor: G. Allen

Site: CAM Site Operator: Jesus Jimenez Shelter T (C): 24

Instrument Model: 1405DF Serial #: 1405A22622/310 Firmware: 1.57 FEM sticker? ✓

Instrument Time: 1242 (CST) Site Datalogger time: 1243 Pump vac: 0.18 atm

Instrument ambient readings: T: 23.0 C Dewpoint: 9.3 C BP: 0.767 atm RH: 41.5 %

Instrument temperatures (C). Cap: 30.00 Case: 30.01 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: 16.70 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: 9/13

Instrument K0: PM2.5 13753 PM-C 15984

Audit K0: PM2.5 13690.7 ; % diff= 0.45 PM-C 15882.2; % diff= 0.64

Flow Audit. (lpm)
Audit Flowmeter Model: tetraCal S/N: 304 T-amb: 23.7 C BP: 582.5 mm Hg

Site Flowmeter Model: tetraCal S/N: 682 T-amb: 24.5 C BP: 582.5 mm Hg

Inlet (total) flow.	Audit: 16.78 Qa, 12.90 Qs	Site: 16.97 Qa, 13.02 Qs
PM2.5 (bypass and CM capped).	Audit: 3.13 Qa, 2.41 Qs	Site: ~~1.734~~ 3.107 Qa, ~~1.334~~ 2.36 Qs GRY
PM-C (bypass & PM2.5 capped).	Audit: 1.758 Qa, 1.354 Qs	Site: 1.734 Qa, 1.334 Qs

FDMS Module. Dryer T (fine): 23.1 Dryer T (coarse): 23.3 C

Dryer DP (fine): 75.7 Dryer DP (coarse): 79.8 C

PM cooler (fine): 3.8 PM cooler (coarse): 3.9 C

	µg/m³ Noise	Freq. (Hz)
$PM_{2.5}$	N/A	247.742
PM-c	N/A	268.324

CHANGED SEASONALLY ← 10° RAINY 4° DRY

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.02	0.06	0.02	0.06	(Limit: 0.15)
PM coarse:	0.02	0.18	0.02	0.18	(Limit: 0.15)
Bypass:	0.05	-0.19	0.04	-0.19	(Limit: 0.6)

BASE + REF ONLY

Inlet Cleaning Dates. PM10: 29 SEPT 14 Virtual Impactor: 29 SEPT 14

1405DF TEOM Audit form Date: 10 NOV 14 Auditor: G. Alle

Site: TLA Site Operator: JESUS JIMENEZ Shelter T (C): 22

Instrument Model: 1405DF Serial #: 1405A2047 50905 Firmware: 1.51 FEM sticker? NO

Instrument Time: 10:10 (CST) Site Datalogger time: 10:11 Pump vac: 0.33 atm

Instrument ambient readings: T: 17.9 C Dewpoint: 9.8 C BP: 0.76 atm RH: 61 %

Instrument temperatures (C). Cap: 30.0 Case: 30.0 PM2.5 air: 30.0 PM-C air: 30.0

Instrument flows (display). PM2.5: 3.01 PM-C: 1.67 Bypass: 12.02 Total: 16.65 lpm, Qa

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

K0 Audit. Audit filter ID: #01 Mass: 97.569 Mg Cal. Date: 9/13

Instrument K0: PM2.5 15550.3 PM-C 14881.3

Audit K0: PM2.5 15543.5; % diff= 0.04 PM-C 14928.9; % diff= 0.32

Flow Audit. (lpm)
Audit Flowmeter Model: Tetra Cal S/N: 304 T-amb: 20.6 C BP: 580.5 mm Hg

Site Flowmeter Model Tetra Cal S/N: 682 T-amb: 20.6 C BP: 580 mm Hg

	Audit	Site
Inlet (total) flow.	16.82 Qa, 13.02 Qs	16.92 Qa, 13.14 Qs
PM2.5 (bypass and CM capped).	3.10 Qa, 2.40 Qs	3.03 Qa, 2.34 Qs
PM-C (bypass & PM2.5 capped).	1.741 Qa, 1.343 Qs T = 22.3	1.719 Qa, 1.328 Qs T = 21.6

FDMS Module.

Dryer T (fine): 21.9 Dryer T (coarse): 22.4 C

Dryer DP (fine): 2.8 Dryer DP (coarse): -0.2 C

PM cooler (fine): 10.0 PM cooler (coarse): 10.0 C

	µg/m³ Noise	Freq. (Hz)
$PM_{2.5}$	265.55	.004
PM-c	0.006	254.344

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	-0.03	0.15	-0.03	0.15	(Limit: 0.15)
PM coarse:	0.00	0.22	0.00	0.22	(Limit: 0.15)
Bypass:	0.06	0.41	0.06	0.41	(Limit: 0.6)

Base + Ref only ✓

Inlet Cleaning Dates. PM10: 22 Oct 14 Virtual Impactor: 22 Oct 14

1405DF TEOM Audit form Date: 10 NOV 14 Auditor: G. Allen

Site: LAB Site Operator: Jesus Jimenez Shelter T (C): 21

Instrument Model: 1405DF Serial #: 1405A226241310 Firmware: 1.57 FEM sticker? ✓

Instrument Time: 1550 (CST) Site Datalogger time: 1550 Pump vac: 0.27 atm

Instrument ambient readings: T: 22.8C Dewpoint: 8.1 C BP: 0.770 atm RH: 36 %

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: 9/13

Instrument K0: PM2.5 15615 PM-C 16586

Audit K0: PM2.5 15826.7; % diff= 1.36 PM-C 16690.4; % diff= 0.63

Flow Audit. (lpm)
Audit Flowmeter Model: tetraCal S/N: 304 T-amb: 26.7 C BP: 581 mm Hg

Site Flowmeter Model: tetraCal S/N: 682 T-amb: 29.6 C BP: 581 mm Hg

Inlet (total) flow. Audit: 16.82 Qa, 12.78 Qs Site: 16.88 Qa, 12.92 Qs

PM2.5 (bypass and CM capped). Audit: 3.06 Qa, 2.34 Qs 24.7 Site: 2.99 Qa, 2.29 Qs

PM-C (bypass & PM2.5 capped). Audit: 1.702 Qa, 1.305 Qs 24.5 Site: 1.633 Qa, 1.279 Qs 23.7

FDMS Module. Dryer T (fine): 21.7 Dryer T (coarse): 21.8 C

Dryer DP (fine): -15.8 Dryer DP (coarse): -21.8 C

PM cooler (fine): 3.9 PM cooler (coarse): 3.9 C

	µg/m³ Noise	Freq. (Hz)
$PM_{2.5}$	____	____
PM-c	____	____

FAIL

Leak Test. 2ND TIME:

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.72	0.15	0.53	0.15	(Limit: 0.15)
PM coarse:	0.75	0.12	0.97	0.12	(Limit: 0.15)
Bypass:	2.68	-0.21	2.28	-0.21	(Limit: 0.6)

NOTE! "NEW" INSTRUMENT INSTALLED 6 NOV 14; LK CHK NOT PERFORMED AT INSTALLATION

Inlet Cleaning Dates. PM10: 3 NOV 14 Virtual Impactor: 3 NOV 14

PM-1.0 FDMS

1400AB TEOM Audit form Date: 10 NOV 14 Auditor: G. Allen

Site: CAB Site Operator: JESUS JIMENEZ Shelter T (C): 23

Instrument Model: 1400 AB Serial #: 26336 *Firmware: 3.316 FEM sticker? ✓PM10 (NOT PM2.5)

Instrument Time: 1649 (CST) Site Datalogger time: 3 MIN FAST 1650 Pump vac: N/A atm

Instrument ambient readings: T: 20.4 C BP: 0.765 atm Confirm T/P A/S setting of 99/9: ✓

Instrument temperatures (C). Case: 30.00 Air: 29.99 Cap: 30.801

Instrument flows (display). F-Main: 3.01 F-Aux: 13.74 lpm, Qa

Flow Adjustment Factors. Main: 1.00 Aux: 1.00

Constant A: N/A Constant B: N/A Noise: .004 Frequency: 259.05404 Hz

*NOTE: FIRMWARE VER 3.5 IS REQUIRED FOR PM2.5 FEM.

K0 Audit. Audit filter ID: #01 Mass: .097569 g Cal. Date: 9/13

Sensor S/N: 1200C190690608 Sensor Label K0: 15194

K0 calc. (17, enter). F (no filter): 346.50195 Hz F (cal filter): 259.93035 Hz

Instrument K0 (cal constant): 15194 Audit K0: 15076 % diff= 0.78

NOISE = .004
FREQ = 259.05416

Flow Audit. (lpm)

Audit Flowmeter Model: tetra Cal S/N: 304 T-amb: 26.0 C BP: 581 mm Hg

Site Flowmeter Model: ~~DELTA~~ GAA tetra Cal S/N: 682 T-amb: 24.5 C BP: 581 mm Hg

Inlet (total) flow. Audit: 16.90 Qa, 12.88 Qs Site: 16.96 Qa, 13.01 Qs

Main flow (bypass capped). Audit: 3.14 Qa, 2.40 Qs 24.7 Site: 3.07 Qa, 2.36 Qs

FDMS Module. Rev: C S/N: 8500C208140611

Dryer T: 19.5 Dryer DP: -6.4 Purge filter: 4.00 C. (from datalogger)

AMB DP = 8.5 C
AMB T = 19.5
AMB RH = 50.4

Leak Test. MFM zeros: Main -0.04 Aux: -0.04 lpm

Pump on: Main -0.03 Aux: -0.02 lpm

Leak: Main 0.01 Aux: 0.02 lpm PASS

Inlet Cleaning Dates. PM10: 3 NOV 14 VSCC: 3 NOV 14 (if PM2.5)

BGI
PM1.0 SCC 2.229

1405DF TEOM Audit form Date: 11 Nov 14 Auditor: G. Allen

Site: Hospital AJM Ajusco Site Operator: Jesus Jimenez Shelter T (C): 22

Instrument Model: 1405DF Serial #: 1405A22613130 Firmware: 1.57 FEM sticker? ✓

Instrument Time: 1526 (CST) Site Datalogger time: 1527 Pump vac: 0.17 ~~Atm~~ atm

Instrument ambient readings: T: 23.2 C Dewpoint: 8.2 C BP 0.724 atm RH: 47 %

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: 9/13

Instrument K0: PM2.5 13424 PM-C 13434

Audit K0: PM2.5 13403.0; % diff= 0.16 PM-C 13408.7; % diff= 0.25

Flow Audit. (lpm)
Audit Flowmeter Model: tetra Cal S/N: 304 T-amb: 23.7 C BP: 555.8 mm Hg

Site Flowmeter Model: tetra Cal S/N: 682 T-amb: 23.7 C BP: 556.0 mm Hg

Inlet (total) flow.	Audit: 16.51 Qa, 12.13 Qs	Site: 16.72 Qa, 12.29 Qs
PM2.5 (bypass and CM capped).	Audit: 3.00 Qa, 2.21 Qs	Site: 2.94 Qa, 2.17 Qs
PM-C (bypass & PM2.5 capped).	Audit: 1.677 Qa, 1.233 Qs	Site: 1.639 Qa, 1.206 Qs

FDMS Module.

Dryer T (fine): 21.8 Dryer T (coarse): 22.0 C

Dryer DP (fine): -18.7 Dryer DP (coarse): -28.9 C

PM cooler (fine): 4.0 PM cooler (coarse): 4.0 C

	µg/m³ Noise	Freq. (Hz)
$PM_{2.5}$	.005	244.6685
PM-c	.003	249.8777

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.10	0.08	0.09	0.09	(Limit: 0.15)
PM coarse:	0.11	0.12	0.11	0.13	(Limit: 0.15)
Bypass:	0.07	-0.10	0.04	-0.07	(Limit: 0.6)

Inlet Cleaning Dates. PM10: 21 Oct 14 Virtual Impactor: 21 Oct 14

1405DF TEOM Audit form Date: 11 NOV 14 Auditor: G. Allen

Site: HOSPITAL GENERAL HGM Site Operator: Jesus Jimenez Shelter T (C): 21

Instrument Model: 1405DF Serial #: 1405A211191009 Firmware: 1.55 FEM sticker? ✓

Instrument Time: 10:18 (CST) Site Datalogger time: 10:19 Pump vac: 0.21 atm

Instrument ambient readings: T: 20.2 C Dewpoint: 10.0 C BP: 0.765 atm RH: 52 %

Instrument temperatures (C). Cap: 30.00 Case: 29.99 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: 9/13

Instrument K0: PM2.5 14782 PM-C 16447

Audit K0: PM2.5 14868.7; % diff= 0.59 PM-C 16567.0; % diff= 0.73

Flow Audit. (lpm)
Audit Flowmeter Model: tetraCal S/N: 304 T-amb: 21.5 C BP: 582.5 mm Hg

Site Flowmeter Model: ~~Delta Cal~~ tetra S/N: 682 T-amb: 22.2 C BP: 582.0 mm Hg

Inlet (total) flow.	Audit: 16.73 Qa, 12.98 Qs	Site: 16.88 Qa, 13.13 Qs	
PM2.5 (bypass and CM capped).	Audit: 3.02 Qa, 2.42 Qs 20.1	Site: 3.06 Qa, 2.38 Qs	
PM-C (bypass & PM2.5 capped).	Audit: 1.735 Qa, 1.348 Qs 20.7	Site: 1.715 Qa, 1.329 Qs	

FDMS Module.

			µg/m³ Noise	Freq. (Hz)
Dryer T (fine): 20.3	Dryer T (coarse): 20.4 C			
Dryer DP (fine): 2.0	Dryer DP (coarse): -9.0 C	$PM_{2.5}$	____	____
PM cooler (fine): 10.0	PM cooler (coarse): 16.0 C	PM-c	____	____

✱ Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.13	0.18	0.14	0.17	(Limit: 0.15) BASE + REF
PM coarse:	-0.52	0.89	0.15	0.22	(Limit: 0.15)
→ Bypass:	0.65	0.34	0.83	0.17	(Limit: 0.6)

Inlet Cleaning Dates. PM10: 5 NOV 14 Virtual Impactor: 5 NOV 14

1405DF TEOM Audit form Date: 11 NOV 14 Auditor: G. Allen

Site: PEDREGAL Site Operator: Jesus Jimenez Shelter T (C): 21

Instrument Model: ~~PM-7500~~ GM 1405DF Serial #: 1405A204770905 Firmware: 1.51 FEM sticker? NO

Instrument Time: 1222 (CST) Site Datalogger time: 1223 Pump vac: 0.24 atm

Instrument ambient readings: T: 22.9 C Dewpoint: 10.7 C BP 0.755 atm RH: 48 %

Instrument temperatures (C). Cap: 30.01 Case: 30.00 PM2.5 air: 29.99 PM-C air: 30.00

Instrument flows (display). PM2.5: 3.00 PM-C: 1.68 Bypass: 11.99 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: 9/13

Instrument K0: PM2.5 15614 PM-C 14320

→ Audit K0: PM2.5 15984.8; % diff= 2.37 PM-C 14597.6; % diff= 1.94

Flow Audit. (lpm)
Audit Flowmeter Model: tetra Cal S/N: 304 T-amb: 25.0 C BP: 574.5 mm Hg

Site Flowmeter Model: tetra Cal S/N: 682 T-amb: 25.2 C BP: 575.0 mm Hg

Inlet (total) flow. Audit: 16.81 Qa, 12.71 Qs Site: 17.03 Qa, 12.87 Qs

PM2.5 (bypass and CM capped). Audit: 3.14 Qa, 2.36 Qs (26.2) Site: 3.08 Qa, 2.33 Qs

PM-C (bypass & PM2.5 capped). Audit: GM ~~1.7~~ 1.743 Qa, 1.319 Qs (25.2) Site: 1.707 Qa, 1.293 Qs

FDMS Module. Dryer T (fine): 22.6 Dryer T (coarse): 22.5 C

Dryer DP (fine): -4.8 Dryer DP (coarse): -7.6 C

PM cooler (fine): 10.0 PM cooler (coarse): 10.0 C

	µg/m³ Noise	Freq. (Hz)
$PM_{2.5}$		
PM-c		

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	-0.01	0.17	-0.01	0.17	(Limit: 0.15) → BASE + REF
PM coarse:	-0.02	0.21	-0.02	0.21	(Limit: 0.15)
Bypass:	0.01	-0.08	0.00	-0.08	(Limit: 0.6)

Inlet Cleaning Dates. PM10: 21 OCT 14 Virtual Impactor: 21 OCT 14

1405DF TEOM Audit form Date: 12 NOV 14 Auditor: G. Allen

Site: XAL Site Operator: Jesus Jimenez Shelter T (C): 22

Instrument Model: 1405 DF Serial #: 1405A211841011 Firmware: 1.51 FEM sticker? Yes

Instrument Time: 1020 (CST) Site Datalogger time: 1021 Pump vac: 0.26 atm

Instrument ambient readings: T: 19.5 C Dewpoint: 13.9 C BP: 0.766 atm RH: 70 %

Instrument temperatures (C). Cap: 29.99 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: #02 Mass: 0.097751 g Cal. Date: 9/13

Instrument K0: PM2.5 15064 PM-C 15962

Audit K0: PM2.5 15189.7 ; % diff= 0.83 PM-C 16082.5 ; % diff= 0.75

Flow Audit. (lpm)
Audit Flowmeter Model: tetraCal S/N: 304 T-amb: 21.3 C BP: 582 mm Hg

Site Flowmeter Model: ~~DeltaCal~~ 6M tetra- S/N: 682 T-amb: 20.1 C BP: 582 mm Hg

Inlet (total) flow.	Audit: 16.79 Qa, 13.03 Qs	Site: 16.92 Qa, 13.18 Qs	
PM2.5 (bypass and CM capped).	Audit: 3.13 Qa, 2.43 Qs	Site: 3.06 Qa, 2.38 Qs	
PM-C (bypass & PM2.5 capped).	Audit: 1.705 Qa, 1.325 Qs	Site: 1.656 Qa, 1.290 Qs	

FDMS Module.

Dryer T (fine): 26.6 Dryer T (coarse): 26.6 C

Dryer DP (fine): 2.4 Dryer DP (coarse): 11.8 C

PM cooler (fine): 10.0 PM cooler (coarse): 10.0 C

	µg/m³ Noise	Freq. (Hz)
$PM_{2.5}$	0.010	
PM-c	0.009	

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.07	0.12	0.08	0.11	(Limit: 0.15)
PM coarse:	0.09	0.22	0.09	0.22	(Limit: 0.15)
Bypass:	0.42	-0.10	0.42	-0.10	(Limit: 0.6)

Base set REF only

Inlet Cleaning Dates. PM10: 22 Oct 14 Virtual Impactor: 22 Oct 14

1405DF TEOM Audit form Date: 12 Nov 14 Auditor: G. Allen

Site: SAG Site Operator: Jesus J. Menez Shelter T (C): 20

Instrument Model: 1405DF Serial #: 1405A21134101 0 Firmware: 1.51 FEM sticker? Yes

*Instrument Time: 1141 (CST) Site Datalogger time: 1150 Pump vac: 0.29 atm LOGGER TIME 6 MIN FAST

Instrument ambient readings: T: 20.9 C Dewpoint: 12.2 C BP: 0.766 atm RH: 55.3 %

Instrument temperatures (C). Cap: 29.99 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: # 0 2 Mass: 0.097751 g Cal. Date: 9/13

Instrument K0: PM2.5 15061 PM-C 17022

Audit K0: PM2.5 150288 ; % diff= 0.21 PM-C 16898.4; % diff= 0.73

Flow Audit. (lpm)
Audit Flowmeter Model: tetraCal S/N: 304 T-amb: 23.8 C BP: 584 mm Hg

Site Flowmeter Model: deltaCal (6M tetra-) S/N: ~~351~~ 682 (6M) T-amb: 25.7 C BP: 584 mm Hg

Inlet (total) flow. Audit: 16.87 Qa, 13.04 Qs Site: 17.19 Qa, 13.18 Qs

PM2.5 (bypass and CM capped). Audit: 3.12 Qa, 2.40 Qs (24.7) Site: 3.08 Qa, 2.36 Qs

PM-C (bypass & PM2.5 capped). Audit: (6M) ~~3~~ 1.758 Qa, 1.354 Qs (25.6) (T= 24.0) Site: 1.740 Qa, 1.334 Qs

FDMS Module. Dryer T (fine): 20.7 Dryer T (coarse): 20.4 C

Dryer DP (fine): 4.23 Dryer DP (coarse): 2.50 C

PM cooler (fine): 10.0 PM cooler (coarse): 10.0 C

	µg/m³ Noise	Freq. (Hz)
$PM_{2.5}$	.004	257.8323
PM-c	.063	269.9759

Leak Test.

Position:	Base	Zero	Ref.	Zero	
PM2.5:	0.05	0.20	0.06	0.19	(Limit: 0.15) – Base + REF only
PM coarse:	-0.01	0.18	-0.01	0.18	(Limit: 0.15)
Bypass:	0.02	-0.04	0.02	-0.04	(Limit: 0.6)

Inlet Cleaning Dates. PM10: 10 Oct 14 Virtual Impactor: 10 Oct 14