Flow-Based Audit Method for the National Performance Audit Program

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National Performance Audit Program

- The National Performance Audit Program (NPAP) conducts audits for the criteria gaseous pollutants: SO2, NO/NOx/NO2, CO, and O3
  -Flow-based is specifically for non-O3 pollutants
- NPAP audits are required at all non-excluded regulatory sites and independent from PE audits per 40 CFR Part 58, Appendix A, Section 3.1.3
  -20% of each PQAO per year
  -100% of sites within 6 years
- EPA and contractors have been using a CO-based method based on what CARB had in place for auditing the non-ozone pollutants
- Many states already employ flow-based testing- how can this translate to EPA?

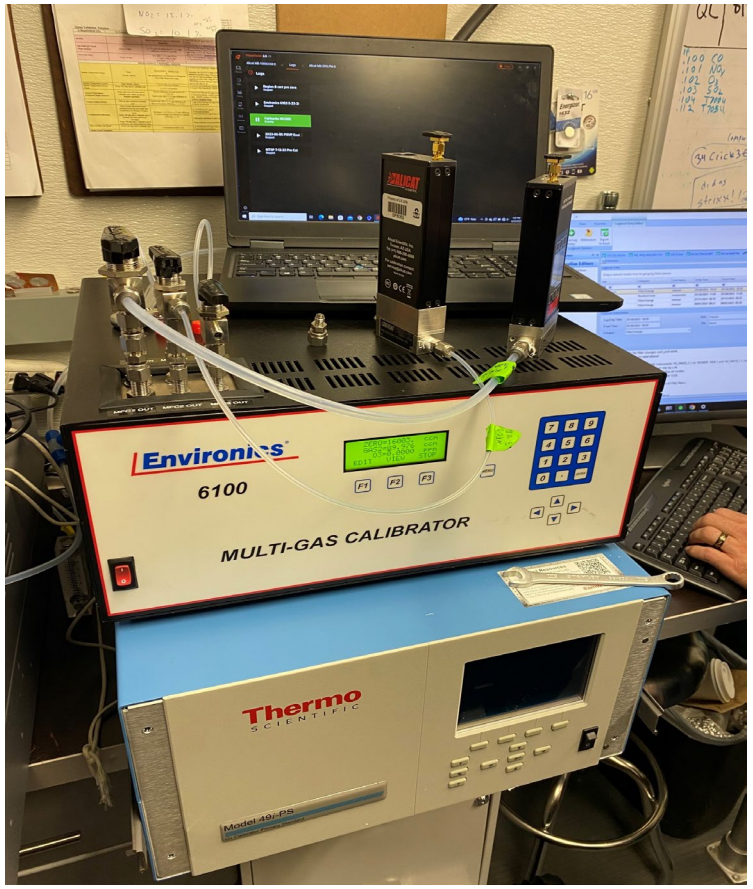
Reasons for Switching to Flow-Based

- Flow-based equipment requirements are much more mobile
- As the NPAP program moved to trace-levels of pollutants, CO drift and tighter audit levels have become more of an issue
  - -Audits fall into repeated levels after post audit calibration
  - -Instrument drift/stability is more problematic at lower levels
  - -Temperature instability is a larger issue
  - -Increased instrument warm-up period can be challenging

	ppm			
Audit Level	O_3	SO_2	NO_2	CO
1	0.0040 - 0.0059	0.0003 - 0.0029	0.0003 - 0.0029	0.020 - 0.059
2	0.0060 - 0.019	0.0030 - 0.0049	0.0030 - 0.0049	0.060 - 0.199
3	0.020 - 0.039	0.0050 - 0.0079	0.0050 - 0.0079	0.200 - 0.899
4	0.040 - 0.069	0.0080 - 0.0199	0.0080 - 0.0199	0.900 - 2.999
5	0.070 - 0.089	0.0200 - 0.0499	0.0200 - 0.0499	3.000 - 7.999
6	0.090 - 0.119	0.0500 - 0.0999	0.0500 - 0.0999	8.000 - 15.999
7	0.120 - 0.139	0.1000 - 0.1499	0.1000 - 0.2999	16.000 - 30.999
8	0.140 - 0.169	0.1500 - 0.2599	0.3000 - 0.4999	31.000 - 39.999
9	0.170 - 0.189	0.2600 - 0.7999	0.5000 - 0.7999	40.000 - 49.999
10	0.190 - 0.259	0.8000 - 1.000	0.8000 - 1.000	50.000 - 60.000

Required Equipment

- Mass Flow controller/dilution system (Environics 6100 or equivalent) with feedback loops
- Zero air generator
- Flow Check devices (Alicat or equivalent)
- Multi-blend tank
- Delivery line
- Flow based spreadsheet
- Plumbing
- Laptop/tablet with flow check logger
- AQS account
- Pelican cases if shipping, racks if in vehicle

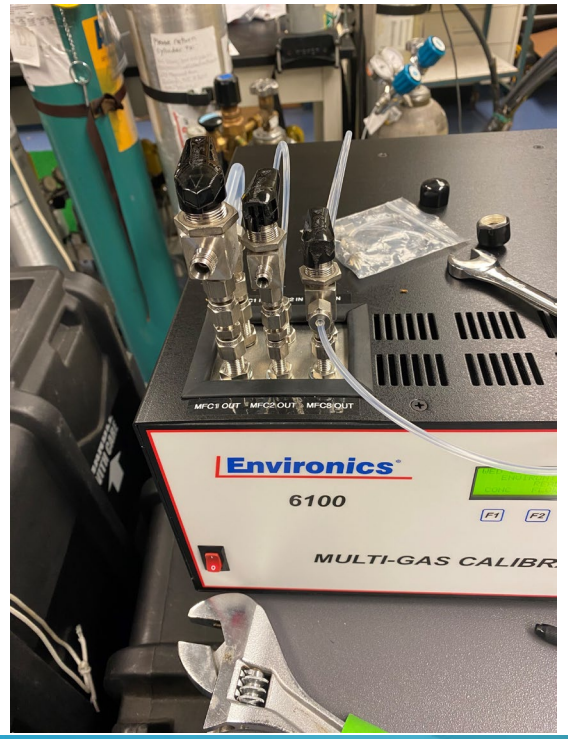


Differences from CO Method

- Flow-based does not require:
  - -High-level CO calibration gas
  - -Low-level CO calibration gas
  - -CO analyzer
- Flow-based additionally requires:
  - -2x flow check devices
  - -Feedback loops

Mobile lab with CO equipment

Feedback loops with 3-way adapter



Advantages of Flow-Based Method

- No instrument drift from audit equipment
- No drifting out of audit levels
- Quicker pre and post calibration
- Not as reliant on stable temperature
- Much less warm-up time
- Fewer tank gasses and analyzer
- More portable
- Large cost savings to the agency

Separate line for 0 air to mass flow controller with a split to 03 if needed


Environics
6100
MULTI-GAS CALIBRATOR
Thermo

General Procedure

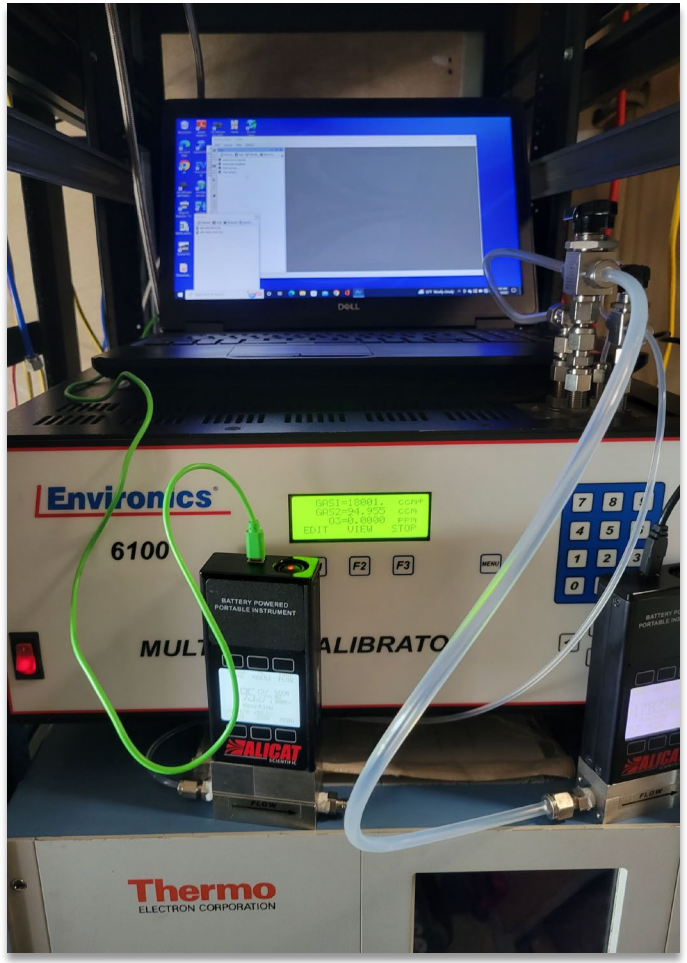
- Ship equipment in pelicans or case/rack system
- Assemble equipment at site or in vehicle
- Warm up equipment for at least 1.5 hours
- Connect via Teflon plumbing
- Turn on flow check device (Alicat) and software (FlowVision)
- Take down site channels
- Check site flow/pressure
- Connect delivery line to inlet
- Tare flow check device and connect to feedback loop

General Process Cont.

- Start recording software
- Punch in predetermined 0 air and tank gas concentrations from feedback loop to flow check device
- Recommended 5-second intervals in recording software
- After 1 minute, stop recording and check to make sure it’s working properly
- Start recording software and check 0-air and tank gas at predetermined levels for 15 minutes
- When 0 air is done, switch feedback loop to mass flow controller and check site pressure and flow
- Continue 0 air to site while finishing tank gas levels
- Check site pressure/flow

General Process Cont.

- After tank gas pre-calibration is complete, stop recording, record 0 value and enter 1st point into the Environics
- Wait for site stability before changing to the 2nd point
- While waiting for points to stabilize, take the final 5 minutes of data from the software logger and average the flow of the pre-calibration. Enter this information into pre-calibration on the spreadsheet and in the flow values of the audit
- Continue until all levels are complete
- Disconnect delivery line and begin post calibration of 0-air and tank gas flow. This can be done at 8 minutes each with a 5-minute average
- Record post calibration in spreadsheet
- Audit is complete!



Spreadsheet

TTP Audit Site Information

AUDIT AGENCY

Site Name:		AQS ID:	
Auditor:		Audit Date:	12/13/2023
Auditor Performing Agency:		Audit Type:	TTP
Station Manager:			

TTP PE Lab Instument and Standards

Instrument	Ozone	Flow Standards
Manufacturer		Alicat
Model		MB20LPM/MBS100CCM
Serial Number		
Calibration Date		8/24/2023
Slope		N/A
Intercept		N/A

GPS Readings

	Degrees	Minutes
Latitude		
Longitude		
Altitude (Ft.)		

Station Instrument Information

Instruments	Ozone	CO	SO2		NO/NOX
Manufacturer/Model #			Teledyne API	T100	
Property Number					
Calibration Date			08/05/23		
Slope/Intercept			1.01200	24.30000	
Indicated Flow					
In-Line Filter Change			N/A		
Local Primary Standard			EPA PROTOCOL GAS		
Manifold type			1/4" Teflon		
AQS Method Code / POC			100	1	

Station Pollutant Standards

Standards	Ozone	CO	SO2	NO/NOX
Type				
Manufacturer/serial #				
Concentration				
Cert. expiration date				

Station Gas calibrator(s)

Manufacturer	Model #	Serial #	Certification expiration	Notes

NPAP Cylinder Information

Cylinder	CO	SO2	NO	NOx	Serial #	CGA VALVE
Superblend #1		11.1			EB0093236	660

Superblend NO2 impurity (ppm)	0.0

Air Setting	Pre Cal Actual Flows	Gas Setting	Actual Flows	Post Cal Air	Gas	Air % Difference	Air CCM Difference	Gas %Difference	Gas CCM Difference
16	15804	95	95.28	15799	95.3	-0.03%	-5	0.02%	0.02
12	11839			11850		0.09%	11		
		25	25.62		25.67			0.20%	0.05
		10	10.74		10.785			0.42%	0.045

Spreadsheet Cont.

Audit Fill In Chart Step By Step

Audit Point #	Audit Point Description	Environics Zero Dilutant MFC (CCM)	Environics Gas MFC (CCM)	Environics Ozone Setting	Station Analyzer readings SO2	CO	NO	NO2	NOx
1	Pre Zero	11839	0.00		-0.0004				
2	CO, SO2, NO/Nox Point #1	11839	95.28		0.0882				
3	NO2 Point #1								
4	CO, SO2, NO/NOx Point #2	15804	95.28		0.0665				
5	NO2 Point #2								
6	CO, SO2, NO/NOx Point #3	15804	25.62		0.0177				
7	NO2 Point #3								
8	CO, SO2, NO/NOx Point #4	15804	10.74		0.0072				
9	NO2 Point #4								
10	CO, SO2, NO/NOx Point #5								
11	Post Zero	15804	0.00		-0.0007				

SO2 and CO Station Audit

Audit Point #	Audit Point Description	NPAP Trailer Readings: Environics Zero Dilutant MFC (CCM)	NPAP Trailer Readings: Environics Gas MFC (CCM)	Actual Concentration (ppm): SO2	Actual Concentration (ppm): CO	Station readings (ppm): SO2	Station readings (ppm): CO	% Difference: SO2	% Difference: CO
1	Pre Zero	11839	0.0	0.0000	0.0000	-0.0004			
2	CO & SO2 Point #1	11839	95.3	0.0886	0.0000	0.0882		-0.5	
4	CO & SO2 Point #2	15804	95.3	0.0665	0.0000	0.0665		0.0	
6	CO & SO2 Point #3	15804	25.6	0.0180	0.0000	0.0177		-1.7	
8	CO & SO2 Point #4	15804	10.7	0.0075	0.0000	0.0072		-4.0	
10	CO & SO2 Point #5								
11	Post Audit Zero	15804	0.0	0.0000	0.0000	-0.0007			

NPAP THROUGH-THE-PROBE AUDIT REPORT
AUDIT AGENCY
SULFUR DIOXIDE REPORT

Site Name:
Auditor:
Station Manager:
Airs ID:
Audit Date: 12/13/23

MOBILE LAB INSTRUMENTS

Instrument:	Ozone	Flow Standards
Manufacturer:	0	Alicat
Model:	0	MB20LPM/MBS100CCM
Serial Number:	0	0
Calibration Date:	01/00/00	8/24/2023
Slope	0	N/A
Intercept	0	N/A

STATION INSTRUMENT INFORMATION

Instrument:	SO2	
Manufacturer/Model #:	Teledyne API	T100
Property Number:	0	
Calibration Date:	08/05/23	
Slope/Intercept:	1.012	24.300
Indicated Flow:	0	
In-Line Filter Change:	N/A	
Manifold Type:	1/4" Teflon	

SULFUR DIOXIDE AUDIT RESULTS

NPAP SO2 Concentration (ppm)	Site Response (ppm)	ppb Difference	Percent Difference
0.0000	-0.0004	-0.0004	
0.0886	0.0882	-0.0004	-0.5
0.0665	0.0665	0.0000	0.0
0.0180	0.0177	-0.0003	-1.7
0.0075	0.0072	-0.0003	-4.0
0.0000	-0.0007	-0.0007	

Pass/Fail

SO_2 Audit Point #1	Pass
SO_2 Audit Point #2	Pass
SO_2 Audit Point #3	Pass
SO_2 Audit Point #4	Pass
SO_2 Audit Point #5	N/A

Auditor
Print
Signature
EPA person notified in case of audit failure

Audit Limits

Pass	Bias < ±15%. For level 1 and 2, ≤ 1.5 ppb difference
Fail	Bias > ±15%. For level 1 and 2, > 1.5 ppb difference

Future Changes

- The largest hurdle is not having access to PEAT for uploads
  - -This is being worked on by OAQPS
  - -The current spreadsheet has an AQS transaction generator
  - -The audits can be manually entered into AQS
- There is the possibility of leaving the flow standard in-line in the feedback loops
  - -This would take away the pre-calibration and post-calibration and save ~50% of the audit time
  - -This would allow for even greater accuracy
  - -This process is still being tested

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