OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NC 27711

NATTS/PAMS Carbonyl Flow Check Technical Note
August 22, 2024

Summary

The purpose of this technical note is to describe best practice for performing flow check audits, providing the most accurate determination of flow rate for the carbonyls sampler. Based on the results of an abbreviated investigation, the EPA is preliminarily recommending that air agencies perform carbonyl sampler flow checks with the flow transfer standard upstream of the DNPH cartridge, with the DNPH cartridge installed during the flow check. This technical note is intended to relate the EPA's determined best practice for performing flow check audits, providing the most accurate determination of flow rate for the carbonyls sampler. The procedure described in this note details how the EPA plans to conduct future carbonyl flow check audits for carbonyl samplers for both the PAMS and NATTS program technical system audits. The EPA encourages air agencies which have been using other flow check configurations to adopt this procedure for accurate and comparable flow check results. The EPA anticipates addressing these clarifications on the carbonyl sampler flow check configurations in future revisions of the PAMS and NATTS quality assurance documents.

Background

While conducting technical assistance audits (TAAs) and technical system audits (TSAs) for the Photochemical Assessment Monitoring Stations (PAMS) and National Air Toxic Trends Stations (NATTS) networks throughout 2022 and 2023, auditors observed inconsistencies amongst air agencies in the placement of the flow transfer standard (FTS) with relation to the sample path during routine carbonyl sampler flow checks/audits performed by air agencies. Based on these audit observations, EPA conducted an abbreviated investigation to evaluate the different sample path audit locations (see Appendix 1) with two common FTSs.[1]

[1] This limited investigation was not intended to evaluate all commercially available FTS devices.

According to both program's Technical Assistance Documents (TADs), the indicated flow rate for carbonyls must be <±10.1% of the certified flow transfer standard. Inability to meet these criteria must result in corrective action of both the sampler as well as the sample data collected. [2,3]

The EPA preliminarily recommends that the carbonyl sampler flow checks be performed in the front of the sampler with the FTS located upstream of a DNPH cartridge and connected to the tubing upstream of the mass flow controllers and the pump (see Figure 1). If the FTS has both "in" and "out" ports (e.g., a Mesa Labs DryCal - Bios Defender, Alicat M Series), the FTS should be connected to the rest of the sample stream leading to the roof inlet. If it does not have both "in" and "out" ports (e.g., a BGI tetraCal), no other connection is needed.

Consistent with the NATTS and PAMS TADs, these recommended configurations provide the most accurate determination of flow rate for the carbonyls sampler, as they include as much of the sample path as possible with relation to the type of FTS. See Figure 1 for a graphical representation of this recommendation for each type of FTS.

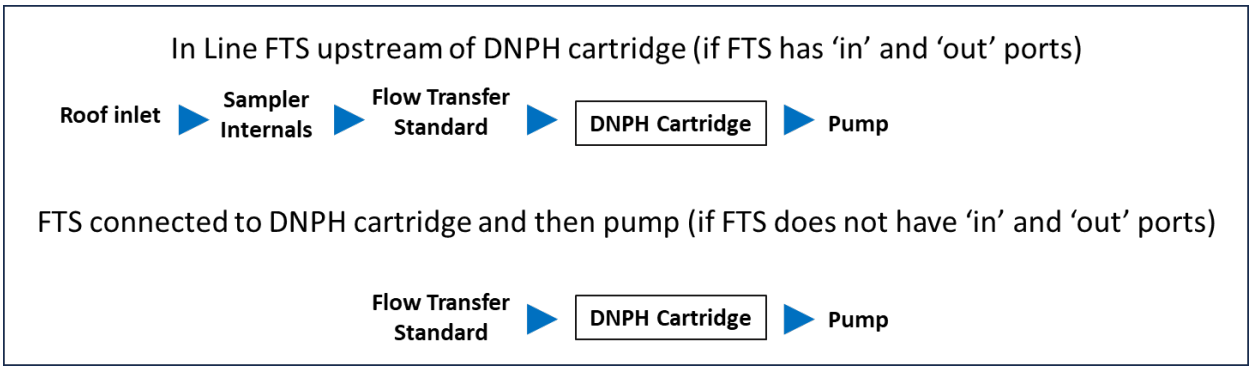


Figure 1. Graphical representation of the recommendation for NATTS/PAMS carbonyl sampler flow check position for audits, with arrows indicating air flow. Top represents the configuration if the FTS has both 'in' and 'out' ports (e.g., a Mesa Labs DryCal), where the bottom portion represents the configuration if the FTS does not have 'in and 'out' ports (e.g., a BGI tetraCal).

Air agencies which have been using other flow check configurations are not required to take any remedial action but are encouraged to adopt this process for flow check results to be comparable between the air agency and the methods that the EPA is recommending, particularly in the case of a flow check failure during a TSA. Auditors have noted percent differences of more than 20% between varying air agency procedures; early adoption is recommended. The EPA plans to conduct future flow check audits for carbonyls samplers for both the PAMS and NATTS programs by the procedure described in this technical note. The EPA anticipates more formally addressing these clarifications on the carbonyl sampler flow check configurations in future revisions of the PAMS and NATTS technical assistance

[2] NATTS TAD Revision 4: https://www.epa.gov/system/files/documents/2022-08/NATTS-TAD-Revision-4-Final-July-2022-508.pdf
[3] PAMS TAD Revision 3: https://www.epa.gov/system/files/documents/2023-05/TAD%20R3%20May%202023.pdf

documents (TADs), QAPPs, and/or SOPs, so air agencies are encouraged to implement this recommendation as soon as it is practical.

For questions, you may contact Greg Noah at Noah.Greg@epa.gov.

Appendix 1:
Summary of Investigation

The following is a brief summary of the flow check investigation; for further experimental details, see Appendix 2. All experimental data is included in Appendix 3.

- The flow rate was checked with two FTSs (both with 'in' and 'out' ports): (1) Alicat M series and (2) a Bios Defender 530 (DryCal) in several configuration scenarios using an ATEC 8000 sampler. Flow rate set points were 0.500, 0.750, 1.000, 1.250, and 1.500 L/min under standard conditions of 760 mmHg and 25°C. Some scenarios only included use of the 'out' port of the FTS.
- Configuration scenarios for carbonyl sampler flow check audits included the following locations:
    - Roof inlet with one port connection (simulated)
    - Rear of sampler with one port connection
    - Front of the sampler with FTS upstream of DNPH cartridge
    - Front of the sampler with the FTS downstream of DNPH cartridge
    - Front of the sampler with one port connection with the DNPH cartridge
    - Front of the sampler with one port connection without the DNPH cartridge
- The single substantial difference between the flow check set point and the measured flow was for the one of the in and out port FTS located downstream of the DNPH cartridge (see Appendix 3, Table 1 for experimental data).
- All other carbonyl sampler flow check configurations for both the 'in and out' as well as single port connection scenarios measured flow rates less than 3% different from the sampler set point.
- The average flow rate percent difference with error bars representing standard deviations are shown in Figure 2.

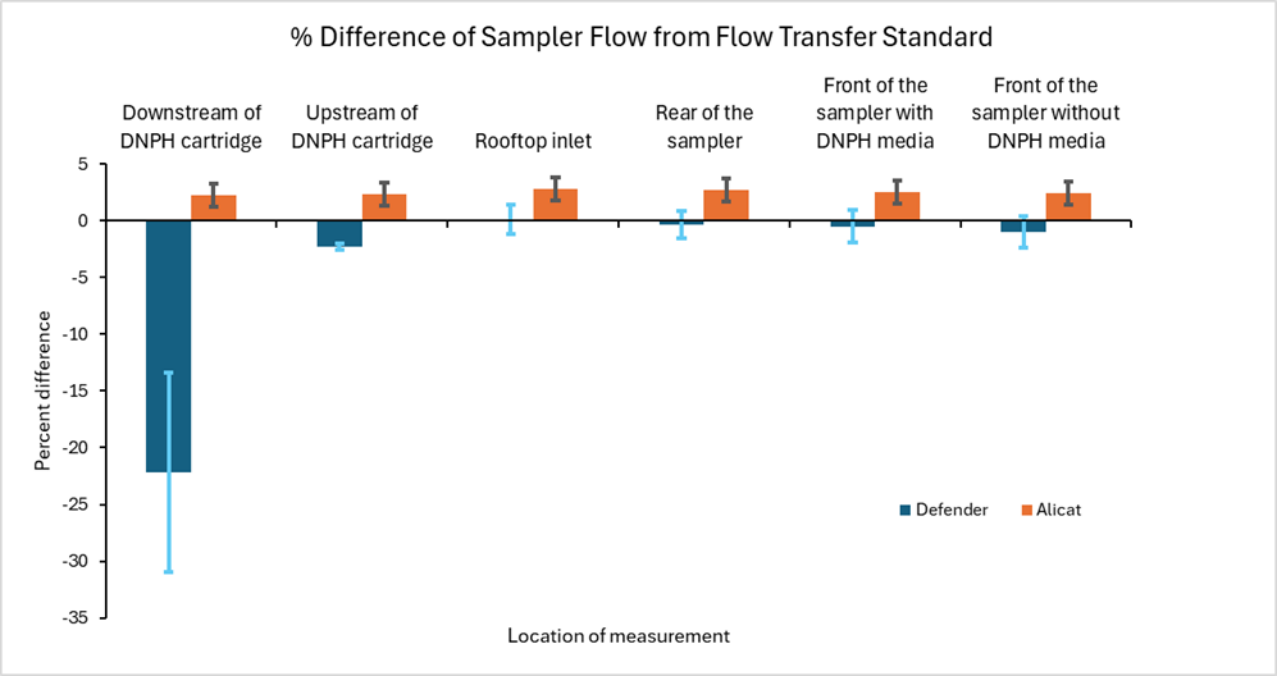


Figure 2. A bar graph showing the average percent differences of all measured flow rates with the FTS in different locations along the carbonyl sampler flow path. The Defender 530 results are shown in blue bars, and the Alicat Series M in orange bars, with error bars representing the standard deviation. All experimental data is shown in Appendix 3.

Appendix 2

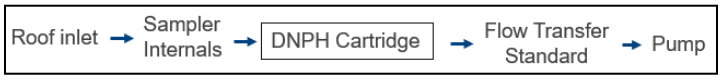
Carbonyl Flow-check Location Investigation Details

Objective: Determine how carbonyl sampler flow check audit location along the sample flow system impacts the measured flow rate.

Approach: The experimental design included measuring the flow of an ATEC 8000 carbonyl sampler by placing either the Alicat M Series or the Bios Defender 530 FTS along the sampler flow system. Replicate measurements for each flow check device were taken at flow rates of 0.500, 0.750, 1.000, 1.250, and 1.500 L/min under standard conditions of 760 mmHg and 25°C. Results were reported as percent difference ($\frac{sampler\ flow - FTS\ flow}{FTS\ flow}$) between the flow rate measured by the sampler and the FTS at the different locations. The measurement location and corresponding results are described below as the position of the FTS relative to the sampler flow system (path). All experimental data is tabulated in Appendix 3 of this technical note.

Results:

Downstream of DNPH cartridge:



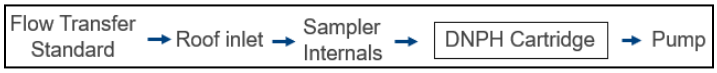
The DNPH cartridge was connected to the 'inlet' of the carbonyl sampler followed by the FTS connected to the 'outlet' of the carbonyl sampler (pump). The FTS was downstream relative to the DNPH cartridge. This approach considers the entire sample path while measuring/verifying the flow rate of the carbonyl sampler. Under these conditions, the average flow rate percent difference across all measured flow rates with the Bios Defender 530 at different flow levels was significantly biased at -22.2% ± 8.8%. The average flow rate percent difference across all measured flow rates with the Alicat M Series was 2.1% ±1.3%. See Appendix 3 Table 1 for the corresponding raw data. This was the most significantly deviating configuration scenario, where the measured flow was more than 20% different than the sampling set point.

Upstream of DNPH cartridge:

The FTS was connected to the 'inlet' in front of the carbonyl sampler followed by DNPH cartridge which was connected to the 'outlet' of the carbonyl sampler (pump). The FTS was upstream relative to the

DNPH cartridge. This configuration considers the entire sample path while measuring and verifying the flow of the carbonyl sampler. Under these conditions, the average flow rate percent difference across all measured flow rates with the Bios Defender 530 was -2.3% ± 0.3%. The average flow rate percent difference measured using Alicat M Series at different flow levels was 2.3% ± 1.2%. See Appendix 3 Table 2 for the corresponding raw data.

Rooftop inlet:

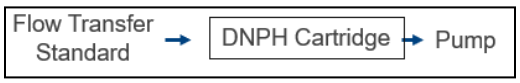


The FTS was connected with a single port to the simulated roof top sampling inlet (made by adding a 15 ft Teflon line to the sampler) of the carbonyl sampler with the DNPH media inline. Under these conditions, the average flow %D measured using the Bios Defender at different flow levels was 0.1% ±1.3%. In this configuration, it was also observed that the percent difference using the Bios Defender was negatively biased at the 2 lower flow rates (≤0.750 L/min) and positively biased at higher flow rates (≥1.000 L/min). The average flow rate percent difference measured using Alicat M Series at different flow levels was 2.8% ±1.2%. See Appendix 3 Table 3 for the corresponding raw data.

Rear of the sampler:

The FTS was connected to the rear of the carbonyl sampler (single port connection) with the DNPH media inline. This approach does not consider the entire sample flow path. Under these conditions, the average flow %D measured using the Bios Defender 530 at different flow levels was -0.4% ±1.2%. In this configuration it was also observed that, the flow rate percent difference was negatively biased at the 3 lower flow rates (≤1.000 L/min) and positively biased at higher flow rates (≥1.250 L/min). The average flow rate percent difference measured using the Alicat M Series was 2.7% ±1.2%. See Appendix 3 Table 4 for the corresponding raw data.

Front of the sampler with DNPH media:



The FTS was connected to the DNPH cartridge (single port connection), which was connected to the outlet (in the front) of the carbonyl sampler. This approach does not consider the entire sample flow path. Under these conditions, the average flow rate percent difference across all measured flow rates with the Bios Defender 530 was -0.5% ± 1.4%. In this scenario, it was observed that this percent difference was negatively biased at the 3 lower flow rates (≤1.000 L/min) and became positively biased

at higher flow rates (≥1.250 L/min). The average flow rate percent difference for the Alicat M Series was 2.3% ± 1.4%. See Appendix 3 Table 5 for the corresponding raw data.

Front of the sampler without DNPH media:

The FTS was connected to the outlet of the carbonyl sampler (single port connection). This configuration does not consider the entire sample path and does not include any DNPH media. Under these conditions, the average flow rate percent difference measured using the Bios Defender 530 at different flow levels was -1.0% ± 1.1%. In this scenario, it was observed that this percent difference was negatively biased at the 4 lower flow rates (≤1.250 L/min) but positively biased at the highest flow rate (1.500 L/min). The average flow rate percent difference across all measured flow rates with the Alicat M Series was 2.4% ± 1.2%. See Appendix 3 Table 6 for the corresponding raw data.

Note: An earlier version of this technical note (dated August 1, 2024) incorrectly identified the FTS for the series of experiments at the front of the sampler without DNPH media. This error has been corrected in this version (August 22, 2024) of the note.

Appendix 3.

Experimental data

All experimental data is tabulated in this Appendix.

Table 1. Downstream of DNPH cartridge (2 port connection):

Alicat

Set point (L/min)	Sampler flow (L/min)	FTS Flow (L/min)	%D	Avg %D
0.500	0.495	0.493	0.4%	**0.2%**
	0.494	0.493	0.2%	
	0.493	0.493	0.0%	
0.750	0.751	0.740	1.5%	**1.5%**
	0.750	0.740	1.4%	
	0.751	0.740	1.5%	
1.000	1.009	0.985	2.4%	**2.6%**
	1.011	0.985	2.6%	
	1.011	0.985	2.6%	
1.250	1.267	1.227	3.3%	**3.1%**
	1.263	1.228	2.9%	
	1.264	1.228	2.9%	
	1.267	1.228	3.2%	
1.500	1.392	1.350	3.1%	**3.2%**
1.400	1.421	1.377	3.2%	
1.350	1.368	1.324	3.3%	
1.300	1.318	1.276	3.3%	
			Average:	**2.1%**
			St Dev:	**1.3%**

Defender

Set point (L/min)	Sampler flow (L/min)	FTS Flow (L/min)	%D	Avg %D
0.500	0.494	0.556	-11.2%	**-11.3%**
	0.493	0.556	-11.3%	
	0.495	0.558	-11.4%	
0.750	0.752	0.889	-15.4%	**-15.5%**
	0.751	0.890	-15.6%	
	0.752	0.890	-15.5%	
1.000	1.010	1.281	-21.1%	**-21.1%**
	1.010	1.281	-21.1%	
	1.010	1.280	-21.1%	
1.250	1.267	1.757	-27.9%	**-29.7%**
	1.265	1.758	-28.1%	
	1.267	1.759	-28.0%	
1.500	1.482	2.280	-35.0%	**-35.0%**

	1.482	2.280	-35.0%	
	1.481	2.280	-35.0%	
			Average:	**-22.2%**
			Std Dev:	**8.8%**

Table 2. Upstream of DNPH cartridge (2 port connection):

Alicat

Set point (L/min)	Sampler flow (L/min)	FTS Flow (L/min)	%D	Avg %D
0.500	0.492	0.490	0.4%	**0.4%**
	0.493	0.492	0.2%	
	0.492	0.490	0.4%	
	0.494	0.491	0.6%	
	0.493	0.492	0.2%	
0.750	0.752	0.738	1.9%	**1.7%**
	0.753	0.740	1.8%	
	0.754	0.741	1.8%	
	0.750	0.739	1.5%	
	0.751	0.738	1.8%	
1.000	1.008	0.983	2.5%	**2.5%**
	1.010	0.985	2.5%	
	1.009	0.986	2.3%	
	1.008	0.984	2.4%	
	1.009	0.983	2.6%	
1.250	1.266	1.226	3.3%	**3.2%**
	1.267	1.230	3.0%	
	1.268	1.228	3.3%	
	1.267	1.226	3.3%	
	1.266	1.226	3.3%	
1.500	1.499	1.446	3.7%	**3.7%**
	1.501	1.448	3.7%	
	1.502	1.450	3.6%	
	1.500	1.445	3.8%	
	1.497	1.444	3.7%	
			Average:	**2.3%**
			Std Dev:	**1.2%**

Defender

Set point (L/min)	Sampler flow (L/min)	FTS Flow (L/min)	%D	Avg %D
0.500	0.493	0.506	-2.5%	**-2.6%**
	0.494	0.508	-2.8%	
	0.495	0.507	-2.4%	
	0.492	0.506	-2.7%	
	0.494	0.506	-2.4%	

0.750	0.750	0.766	-2.1%	**-2.1%**
	0.752	0.770	-2.3%	
	0.754	0.768	-1.8%	
	0.751	0.767	-2.1%	
	0.750	0.767	-2.3%	
1.000	1.011	1.031	-1.9%	**-2.0%**
	1.012	1.033	-2.0%	
	1.014	1.034	-1.9%	
	1.008	1.031	-2.2%	
	1.011	1.031	-1.9%	
1.250	1.266	1.296	-2.3%	**-2.4%**
	1.268	1.298	-2.3%	
	1.267	1.298	-2.4%	
	1.265	1.296	-2.4%	
	1.266	1.297	-2.4%	
1.500	1.522	1.564	-2.7%	**-2.7%**
	1.523	1.568	-2.9%	
	1.524	1.565	-2.6%	
	1.523	1.564	-2.6%	
	1.522	1.565	-2.7%	
			Average:	**-2.3%**
			Std Dev:	**0.3%**

Table 3. Rooftop inlet (single port connection):

Alicat

Set point (L/min)	Sampler flow (L/min)	FTS Flow (L/min)	%D	Avg %D
0.500	0.495	0.491	0.9%	**0.9%**
	0.496	0.492	0.8%	
	0.497	0.493	0.8%	
	0.495	0.490	1.0%	
	0.494	0.490	0.9%	
0.750	0.752	0.736	2.1%	**2.1%**
	0.755	0.738	2.3%	
	0.754	0.739	2.0%	
	0.751	0.736	2.0%	
	0.752	0.736	2.2%	
1.000	1.009	0.980	2.9%	**3.0%**
	1.011	0.982	3.0%	
	1.012	0.984	2.8%	
	1.010	0.980	3.1%	
	1.010	0.980	3.1%	
1.250	1.268	1.222	3.8%	**3.7%**
	1.270	1.224	3.8%	
	1.271	1.225	3.8%	
	1.266	1.222	3.6%	
	1.267	1.220	3.8%	
1.500	1.507	1.447	4.1%	**4.2%**
	1.510	1.448	4.3%	
	1.511	1.450	4.2%	
	1.509	1.447	4.3%	
	1.508	1.447	4.2%	
			Average:	**2.8%**
			Std Dev:	**1.2%**

Defender

Set point (L/min)	Sampler flow (L/min)	FTS Flow (L/min)	%D	Avg %D
0.500	0.492	0.501	-1.8%	**-2.0%**
	0.493	0.504	-2.2%	
	0.495	0.505	-2.0%	
	0.492	0.502	-2.0%	
	0.492	0.503	-2.1%	
0.750	0.751	0.754	-0.4%	**-0.4%**
	0.754	0.756	-0.3%	
	0.755	0.758	-0.4%	
	0.750	0.755	-0.7%	

	0.752	0.755	-0.5%	
1.000	1.010	1.006	0.4%	**0.3%**
	1.008	1.007	0.1%	
	1.008	1.005	0.3%	
	1.010	1.004	0.6%	
	1.010	1.008	0.2%	
1.250	1.267	1.255	1.0%	**0.9%**
	1.268	1.258	0.8%	
	1.266	1.257	0.7%	
	1.265	1.255	0.8%	
	1.266	1.252	1.1%	
1.500	1.521	1.495	1.7%	**1.7%**
	1.522	1.497	1.7%	
	1.524	1.498	1.7%	
	1.522	1.496	1.7%	
	1.522	1.496	1.7%	
			Average:	**0.1%**
			Std Dev:	**1.3%**

Table 4. Rear of the sampler (inlet-single port connection):

Alicat

Set point (L/min)	**Sampler flow (L/min)**	**FTS Flow (L/min)**	**%D**	**Avg %D**
0.500	0.495	0.490	1.0%	**0.8%**
	0.495	0.491	0.8%	
	0.496	0.491	1.0%	
	0.493	0.490	0.5%	
	0.494	0.491	0.7%	
0.750	0.752	0.736	2.2%	**2.1%**
	0.753	0.738	2.0%	
	0.752	0.737	2.0%	
	0.751	0.736	2.1%	
	0.750	0.736	1.9%	
1.000	1.011	0.981	3.0%	**2.9%**
	1.012	0.985	2.7%	
	1.011	0.984	2.7%	
	1.010	0.982	2.9%	
	1.011	0.981	3.1%	
1.250	1.267	1.223	3.6%	**3.6%**
	1.268	1.222	3.8%	
	1.267	1.224	3.5%	
	1.266	1.223	3.5%	
	1.265	1.223	3.4%	
1.500	1.478	1.422	3.9%	**4.1%**
	1.480	1.424	3.9%	
	1.479	1.422	4.0%	

	1.477	1.422	3.9%	
	1.477	1.412	4.6%	
			Average:	**2.7%**
			Std Dev:	**1.2%**

Defender

Set point (L/min)	Sampler flow (L/min)	FTS Flow (L/min)	%D	Avg %D
0.500	0.494	0.505	-2.2%	**-2.3%**
	0.495	0.508	-2.6%	
	0.496	0.507	-2.2%	
	0.494	0.505	-2.2%	
	0.495	0.506	-2.1%	
0.750	0.751	0.759	-1.0%	**-1.0%**
	0.751	0.759	-1.0%	
	0.752	0.759	-1.0%	
	0.751	0.759	-1.1%	
	0.752	0.760	-1.0%	
	0.751	0.760	-1.2%	
	0.752	0.760	-1.0%	
1.000	1.011	1.012	-0.1%	**-0.1%**
	1.012	1.014	-0.2%	
	1.013	1.013	0.0%	
	1.011	1.012	-0.1%	
	1.011	1.012	-0.1%	
1.250	1.266	1.260	0.5%	**0.4%**
	1.265	1.260	0.4%	
	1.265	1.262	0.2%	
	1.264	1.260	0.4%	
	1.266	1.260	0.5%	
1.500	1.523	1.505	1.2%	**1.1%**
	1.525	1.508	1.1%	
	1.526	1.509	1.1%	
	1.522	1.505	1.1%	
	1.521	1.506	1.0%	
			Average:	**-0.4%**
			Std Dev:	**1.2%**

Table 5. Front of the sampler with DNPH media (single port connection)

Alicat

Set point (L/min)	Sampler flow (L/min)	FTS Flow (L/min)	%D	Avg %D
0.500	0.492	0.492	0.0%	**0.0%**
	0.493	0.494	-0.2%	
	0.494	0.493	0.2%	
	0.492	0.492	0.0%	
	0.494	0.493	0.3%	
0.750	0.752	0.739	1.8%	**1.6%**
	0.752	0.741	1.5%	
	0.751	0.740	1.5%	
	0.751	0.739	1.6%	
	0.752	0.739	1.7%	
1.000	1.010	0.983	2.7%	**2.6%**
	1.010	0.984	2.6%	
	1.010	0.985	2.5%	
	1.008	0.984	2.4%	
	1.010	0.985	2.6%	
1.250	1.266	1.226	3.2%	**3.2%**
	1.265	1.228	3.0%	
	1.267	1.228	3.2%	
	1.266	1.226	3.3%	
	1.265	1.226	3.2%	
1.500	1.522	1.465	3.9%	**3.8%**
	1.523	1.466	3.9%	
	1.522	1.467	3.7%	
	1.523	1.465	3.9%	
	1.521	1.466	3.7%	
			Average:	**2.3%**
			Std Dev:	**1.4%**

Defender

Set point (L/min)	Sampler flow (L/min)	FTS Flow (L/min)	%D	Avg %D
0.500	0.495	0.508	-2.6%	**-2.5%**
	0.496	0.506	-2.0%	
	0.492	0.508	-3.1%	
	0.495	0.507	-2.4%	
	0.494	0.507	-2.6%	
0.750	0.752	0.761	-1.2%	**-1.1%**
	0.753	0.760	-0.9%	
	0.753	0.761	-1.1%	
	0.752	0.761	-1.2%	

	0.752	0.762	-1.3%	
1.000	1.009	1.013	-0.4%	**-0.4%**
	1.010	1.014	-0.4%	
	1.010	1.013	-0.3%	
	1.011	1.014	-0.3%	
	1.009	1.014	-0.5%	
1.250	1.266	1.259	0.6%	**0.6%**
	1.267	1.260	0.6%	
	1.267	1.260	0.5%	
	1.268	1.261	0.6%	
	1.267	1.260	0.6%	
1.500	1.522	1.505	1.1%	**1.2%**
	1.522	1.505	1.1%	
	1.523	1.504	1.3%	
	1.523	1.504	1.3%	
	1.523	1.505	1.2%	
			Average:	**-0.5%**
			Std Dev:	**1.4%**

Table 6. Front of the sampler without DNPH media (single port connection)

Alicat

Set point (L/min)	Sampler flow (L/min)	FTS Flow (L/min)	%D	Avg %D
0.500	0.496	0.492	0.8%	**0.6%**
	0.496	0.493	0.7%	
	0.495	0.493	0.4%	
	0.496	0.493	0.6%	
	0.494	0.492	0.3%	
0.750	0.753	0.739	2.0%	**1.8%**
	0.752	0.739	1.7%	
	0.751	0.739	1.7%	
	0.752	0.740	1.6%	
	0.754	0.739	2.0%	
1.000	1.009	0.984	2.5%	**2.5%**
	1.009	0.985	2.4%	
	1.010	0.985	2.5%	
	1.009	0.984	2.5%	
	1.009	0.984	2.5%	
1.250	1.269	1.226	3.5%	**3.3%**
	1.267	1.226	3.3%	
	1.268	1.227	3.3%	
	1.266	1.226	3.3%	
	1.265	1.226	3.2%	
1.500	1.523	1.467	3.8%	**3.8%**
	1.524	1.468	3.8%	
	1.523	1.467	3.8%	
	1.522	1.467	3.7%	
	1.523	1.467	3.8%	
			Average:	**2.4%**
			Std Dev:	**1.2%**

Defender

Set point (L/min)	Sampler flow (L/min)	FTS Flow (L/min)	%D	Avg %D
0.500	0.494	0.508	-2.7%	**-2.7%**
	0.495	0.507	-2.4%	
	0.494	0.509	-2.9%	
	0.494	0.508	-2.8%	
	0.495	0.508	-2.6%	
0.750	0.750	0.764	-1.8%	**-1.7%**

	0.751	0.763	-1.6%	
	0.751	0.764	-1.7%	
	0.750	0.763	-1.7%	
	0.751	0.763	-1.5%	
1.000	1.009	1.017	-0.8%	**-0.7%**
	1.012	1.017	-0.5%	
	1.011	1.018	-0.7%	
	1.010	1.018	-0.8%	
	1.011	1.017	-0.6%	
1.250	1.266	1.267	-0.1%	**-0.1%**
	1.265	1.266	-0.1%	
	1.264	1.268	-0.3%	
	1.264	1.266	-0.2%	
	1.267	1.268	-0.1%	
1.500	1.522	1.517	0.4%	**0.4%**
	1.523	1.518	0.3%	
	1.523	1.518	0.3%	
	1.523	1.517	0.4%	
	1.523	1.517	0.4%	
			Average:	**-1.0%**
			Std Dev:	**1.1%**