Carbonyls sampler flow checks

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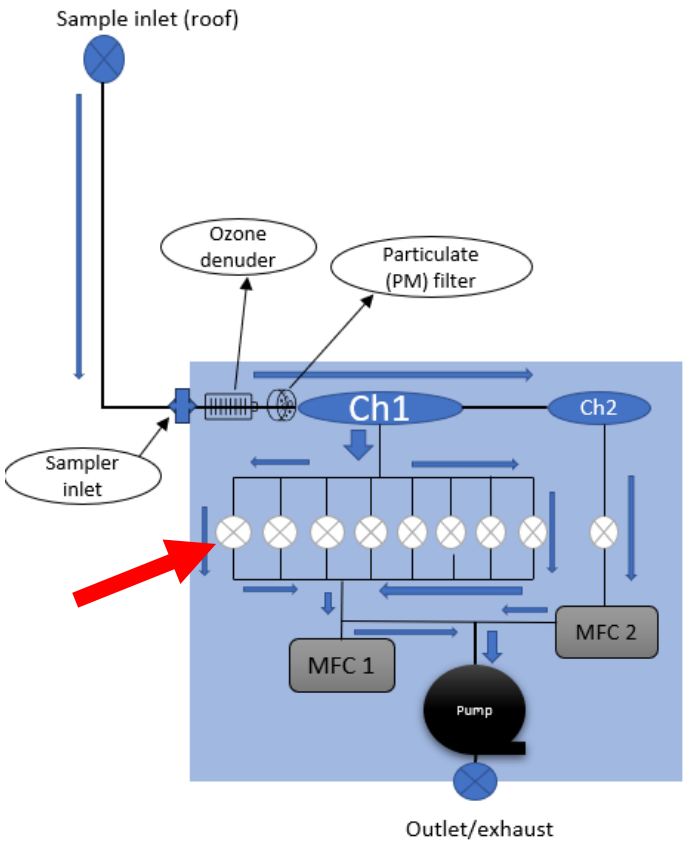
Background

- PAMS TAD requires monthly flow checks and report the results to AQS (NATTS TAD requires quarterly and recommends monthly checks)
- Instrument performance audits (flow checks) are performed as part of TSAs
- During recent TSAs, auditors noticed variation in the locations of these flow checks
- Audits suggested wide variation in flow check results depending on location
- Objective: Conduct controlled experiments that indicate the importance of flow check location



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EPA Flow Verification Procedures

PAMS TAD Revision 3, Section 5.7.1.2 (Page 103)

standard conditions. A suitable calibration procedure for MFCs is as follows. The sampling unit pump(s) and MFC should be warmed up and run for approximately five minutes to ensure the MFC is stable. A blank DNPH cartridge should be installed into the air sampler to provide a pressure drop to the pump, and airflow through the cartridge commenced. The calibrated flow transfer standard should be connected at the upstream end of the sampling unit so as much of the flow path is included as possible in order to identify potential leaks in the flow path that may not otherwise be evident. MFC calibration should be performed at minimally three flow rates: the

NATTS TAD Version 4, Section 4.3.7.1.2 (Page 164)

To perform a flow calibration verification on the sampling unit flow, the sampling unit pump(s) should be warmed up and run for approximately five minutes to ensure flows are stable. A blank DNPH cartridge should be installed into the air sampler to provide a pressure drop to the pump, and airflow through the cartridge commenced. The calibrated flow transfer standard should be connected at the upstream end of the sampling unit so as much of the flow path is included as possible in order to identify potential leaks in the flow path that may not otherwise be evident. The sample flow is then set to the flow setting of typical sample collection and the flow compared to the transfer standard. Ensure that both the sampling unit and flow transfer standard

TAD Priorities

- Blank DNPH cartridge installed during flow checks
- Calibrated flow transfer standard (FTS) connected at the upstream end of the sample path so as much as the sample path can be included as possible (this can also be accomplished by connecting FTS inline)

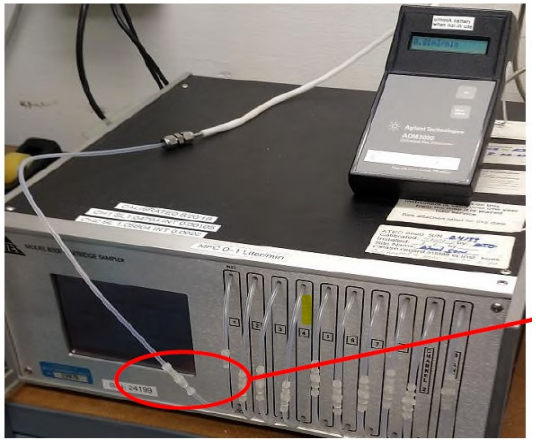
TSA Observations

- Variation in placement of FTS during flow checks (including downstream placement)
- Flow checks with no use of sample media
- Variation in flow check accuracy seemingly dependent on location

TSA observed flow check locations

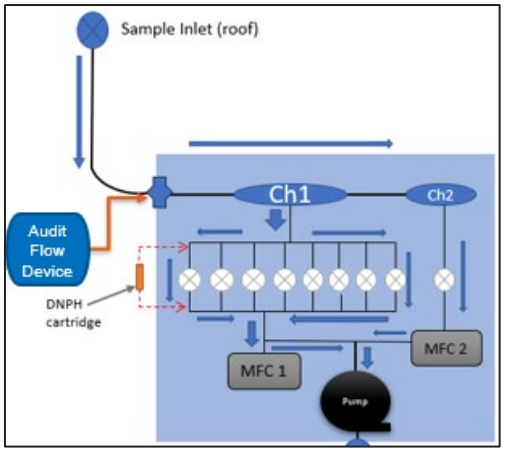
Roof Inlet

Front with no DNPH

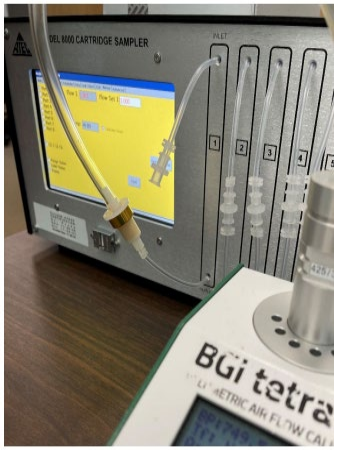


Inline with DNPH

Rear of Sampler



Front with DNPH



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Experimental Design

- Placement
  - Sample inlet (simulated-1 port)
  - Rear of sampler (sampler inlet-1 port)
  - Connected inline with the DNPH cartridge using 2 ports of a flow transfer standard
  - Connected to DNPH cartridge and then pump (1 port)
  - Connected only to pump with no DNPH cartridge (1 port)
- Flow rates of 500, 750, 1000, 1250, and 1500 mL/min
- 5 replicate measurements
- Experiments done with Alicat and Defender 530 FTSs

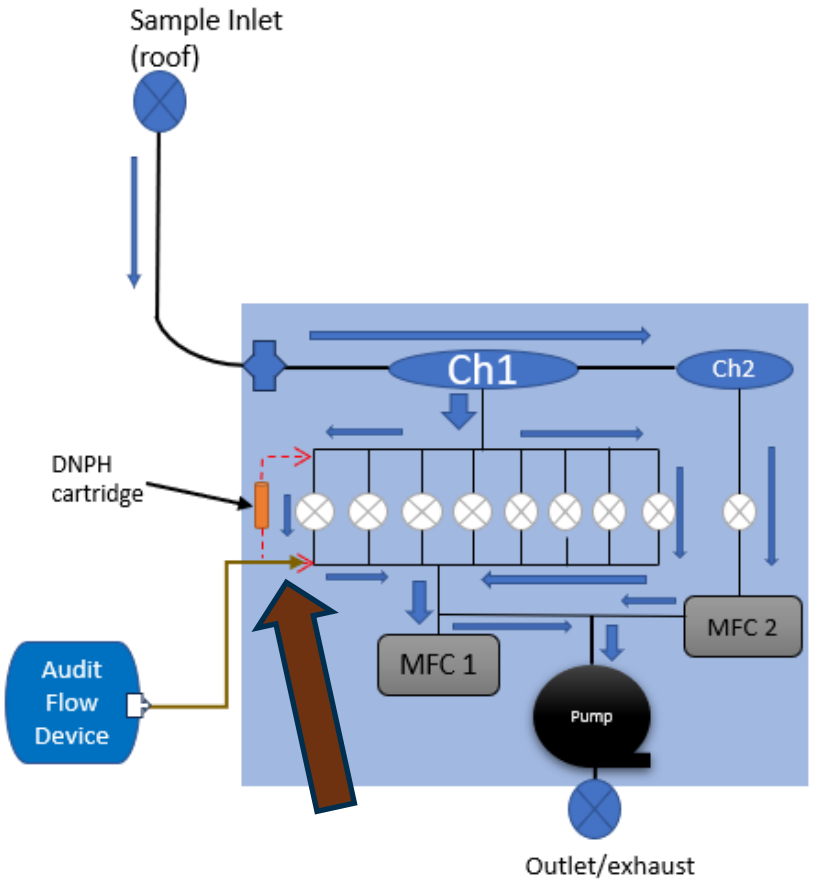
Relative Position of Flow Transfer Standard

FTS Downstream:	Roof inlet	→	Sampler Internals	→	DNPH Cartridge	→	Flow Transfer Standard	→ Pump
FTS Upstream:	Roof inlet	→	Sampler Internals	→	Flow Transfer Standard	→	DNPH Cartridge	→ Pump
FTS at roof inlet:	Flow Transfer Standard	→	Roof inlet	→	Sampler Internals	→	DNPH Cartridge	→ Pump
FTS at rear sampler inlet:	Roof inlet	→	Flow Transfer Standard	→	Sampler Internals	→	DNPH Cartridge	→ Pump
FTS to DNPH:					Flow Transfer Standard	→	DNPH Cartridge	→ Pump
FTS to pump :							Flow Transfer Standard	→ Pump

Experimental Results

FTS Downstream of DNPH Cartridge (inline)

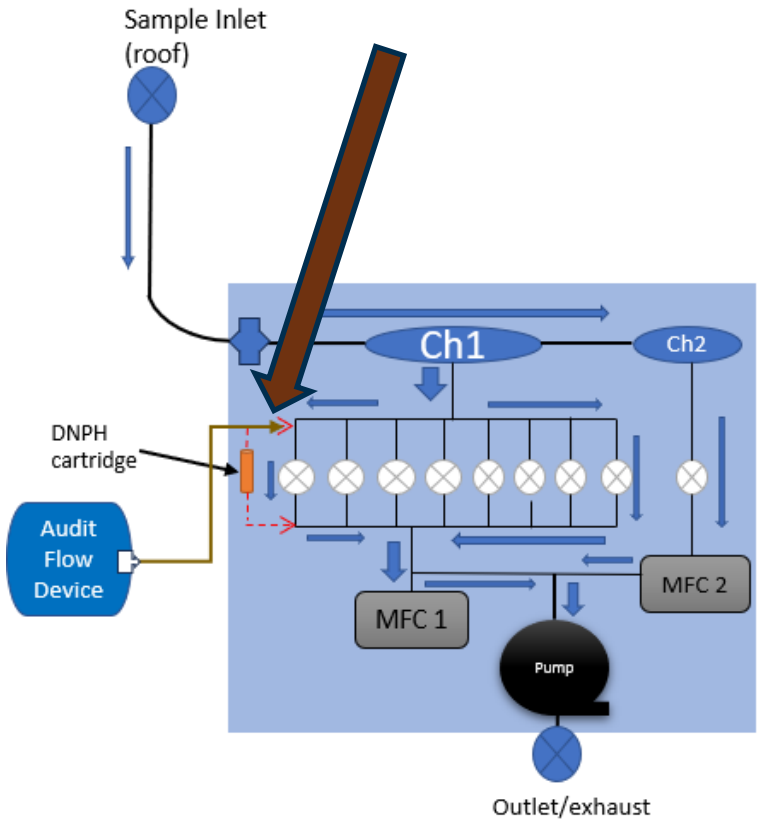
FTS	%D
Alicat	2.1 ± 1.3
Defender	-22.2 ± 8.8



Experimental Results

FTS upstream of DNPH (inline)

FTS	%D
Alicat	2.3 ± 1.2
Defender	-2.3 ± 0.3



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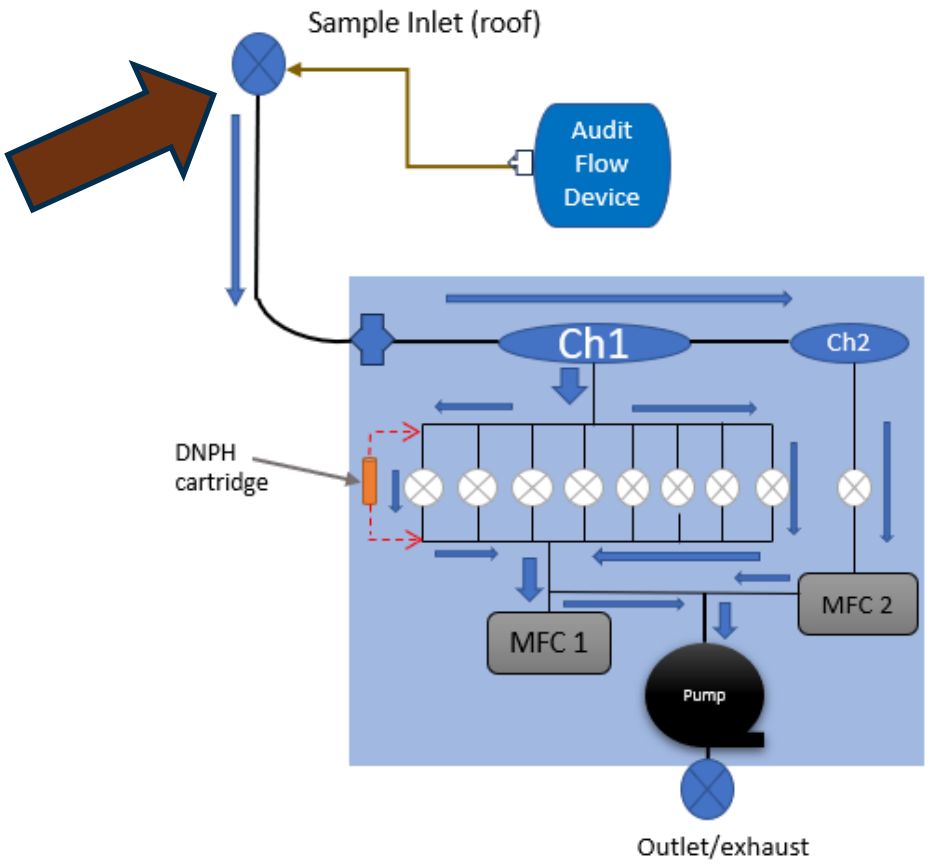
Experimental Results

Roof inlet (single port)

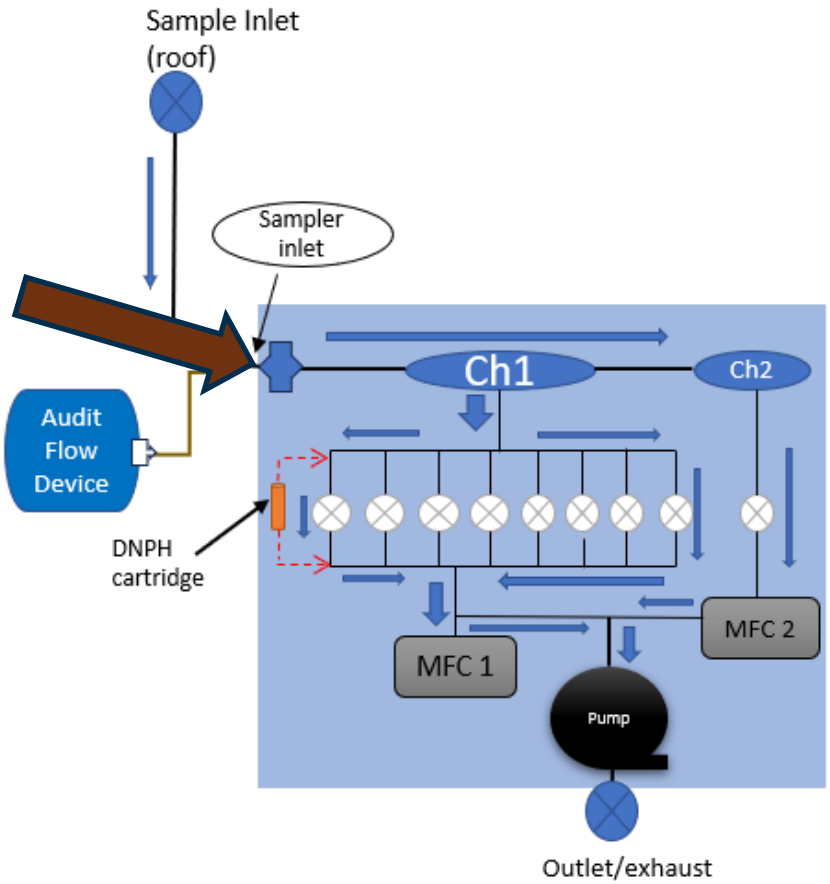
FTS	%D
Alicat	2.8 ± 1.2
Defender	0.1 ± 1.3



Experimental Results

Rear of sampler (inlet-single port)

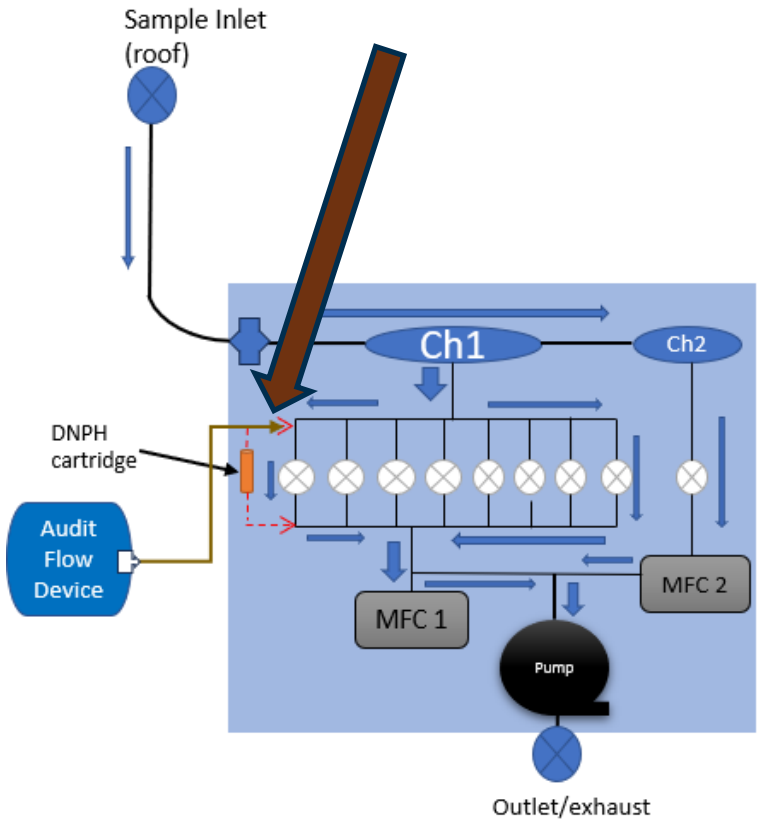
FTS	%D
Alicat	2.7 ± 1.2
Defender	-0.4 ± 1.2



Experimental Results

Front with DNPH (single port)

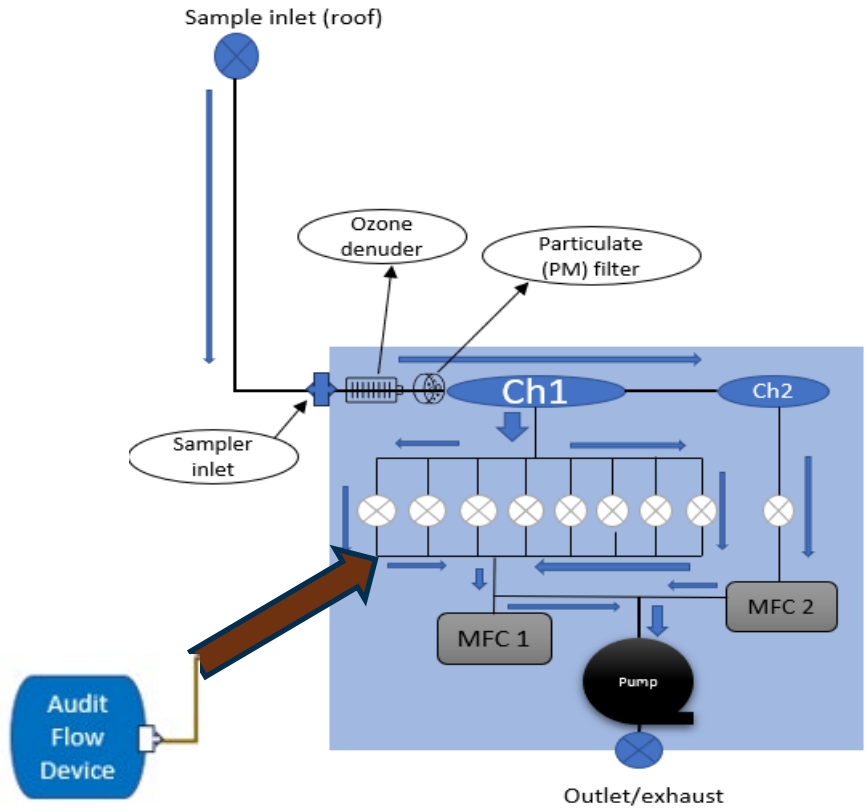
FTS	%D
Alicat	2.3 ± 1.4
Defender	-0.5 ± 1.4



Experimental Results

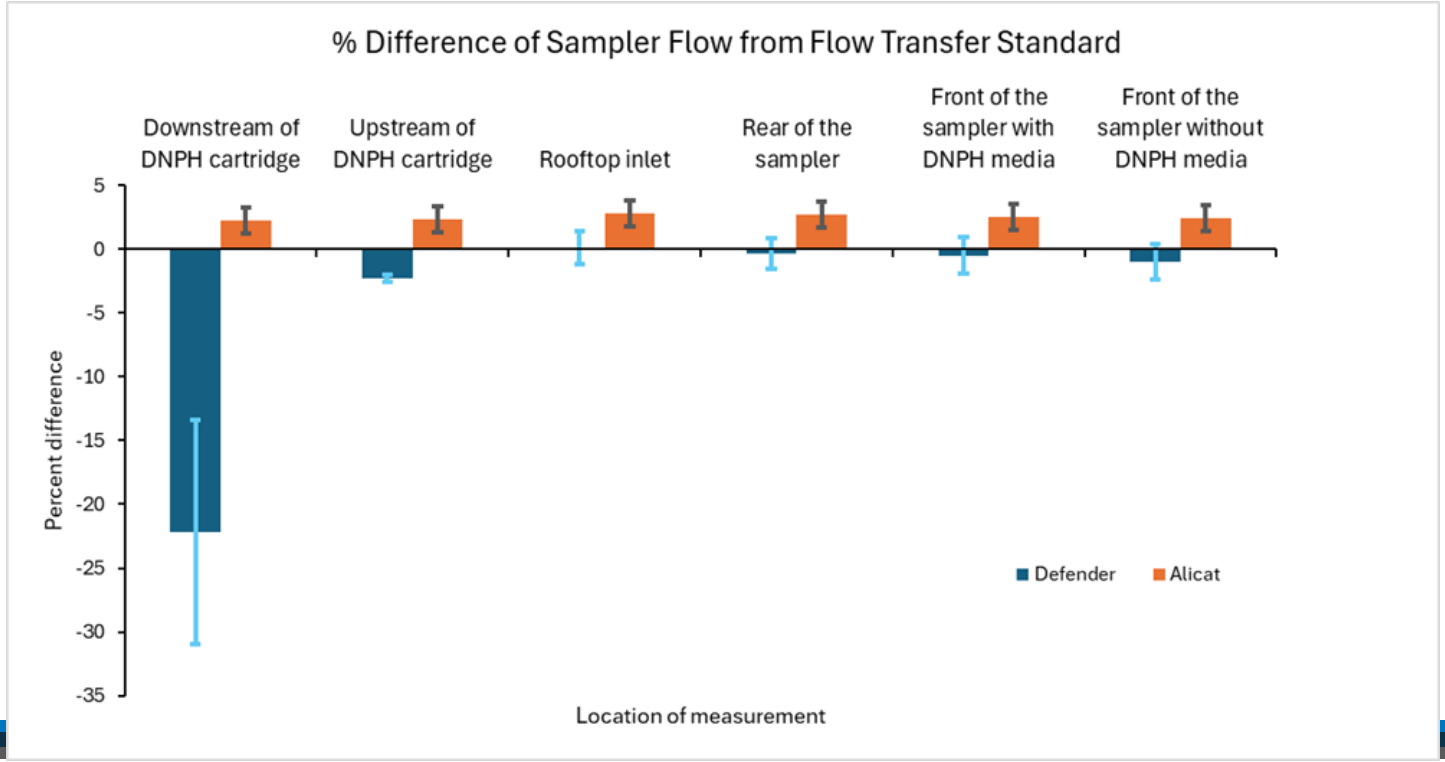
Front with no DNPH (single port)

FTS	%D
Alicat	2.4 ± 1.2
Defender	-1.0 ± 1.1



Summary of Results (%D)

Flow transfer standard	Downstream of DNPH Cartridge	Upstream of DNPH Cartridge	Roof	Rear of sampler	Front with DNPH	Front w/o DNPH
	Percent Difference					
Alicat	2.1 ± 1.3	2.3 ± 1.2	2.8 ± 1.2	2.7 ± 1.2	2.3 ± 1.4	2.4 ± 1.2
Defender	-22.2 ± 8.8	-2.3 ± 0.3	0.1 ± 1.3	-0.4 ± 1.2	-0.5 ± 1.4	-1.0 ± 1.1



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Discussion

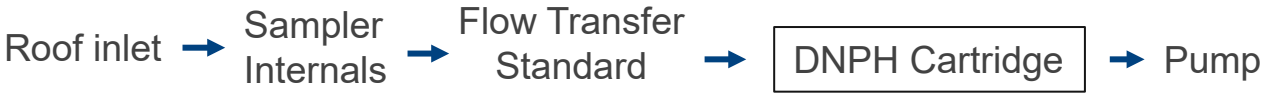
- %Ds of Alicat measurements compared to ATEC 8000 carbonyl sampler were consistent (Avg %Ds <3%) irrespective of the location of the measurement.
- When Defender was positioned downstream of the DNPH cartridge the %Ds were >20%
- All other positions of Defender and Alicat demonstrated Avg %Ds <3%

- Experimental Considerations:
  - Only used Waters cartridges
  - One carbonyl Sampler

Recommendations

- **Recommendations for NATTS/PAMS flow check position:**

1. Inline FTS upstream of DNPH cartridge (if FTS has ‘in’ and ‘out’ ports)



2. FTS connected to DNPH and then pump (at front of ATEC sampler)

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It can be done

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