Effect on Aerosol Particle Size Distribution and Quantity When Using Injection and Sample Manifolds and Through a Type II Adsorber Bank

Presented at the 33rd
Nuclear Air Cleaning Conference 2014
St. Louis, MO

Joshua D. Lawson, Eric M. Banks, and Thomas P. Zimmerman
NUCON International, Inc.,
Columbus, OH USA

Introduction

- Properly designed manifolds have long been acknowledged within the nuclear industry as being essential to the testing of complex air cleaning system designs with multiple stages of filtration or systems with inadequate testing designs.

Introduction (Cont.)

- However, little to no data exists on how these manifolds, be they designed for sampling or injection of challenge aerosols, affect the characteristics of the aerosols as they interact with them.

Introduction (Cont.)

- ASME N510, N511 and AG-1 requires that the characteristics of a polydispersed in-place challenge aerosol, with respect to particle size, be as follows: 99% less than 3.0 µm, 50% less than 0.7 µm, and 10% less than 0.4µm.

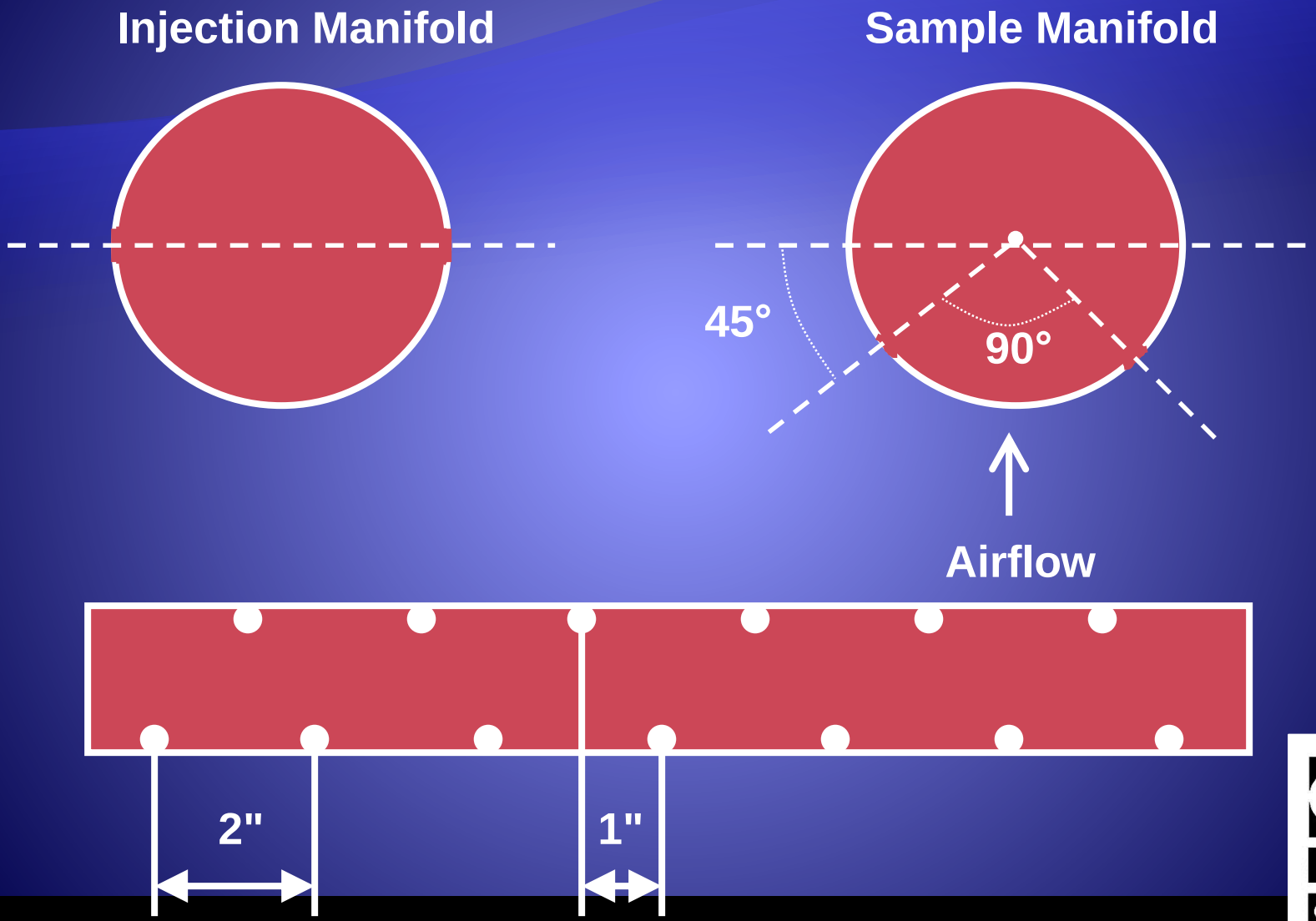
Introduction (Cont.)

- The following will show whether or not injection manifolds change the size of the challenge aerosol as they distribute it, and whether or not sample manifolds change the size of the challenge aerosol as they collect the representative sample, respectively. Also, particle size change will be investigated as to the effects of injecting through a two inch adsorber bed.

Manifold Review

- Injection Manifolds
  - Required when a suitable upstream single point location cannot be found.
  - Required to inject between a downstream and upstream bank of similar components.
- Sample Manifolds
  - Required when a suitable downstream single point location cannot be found.

Typical Manifold Design



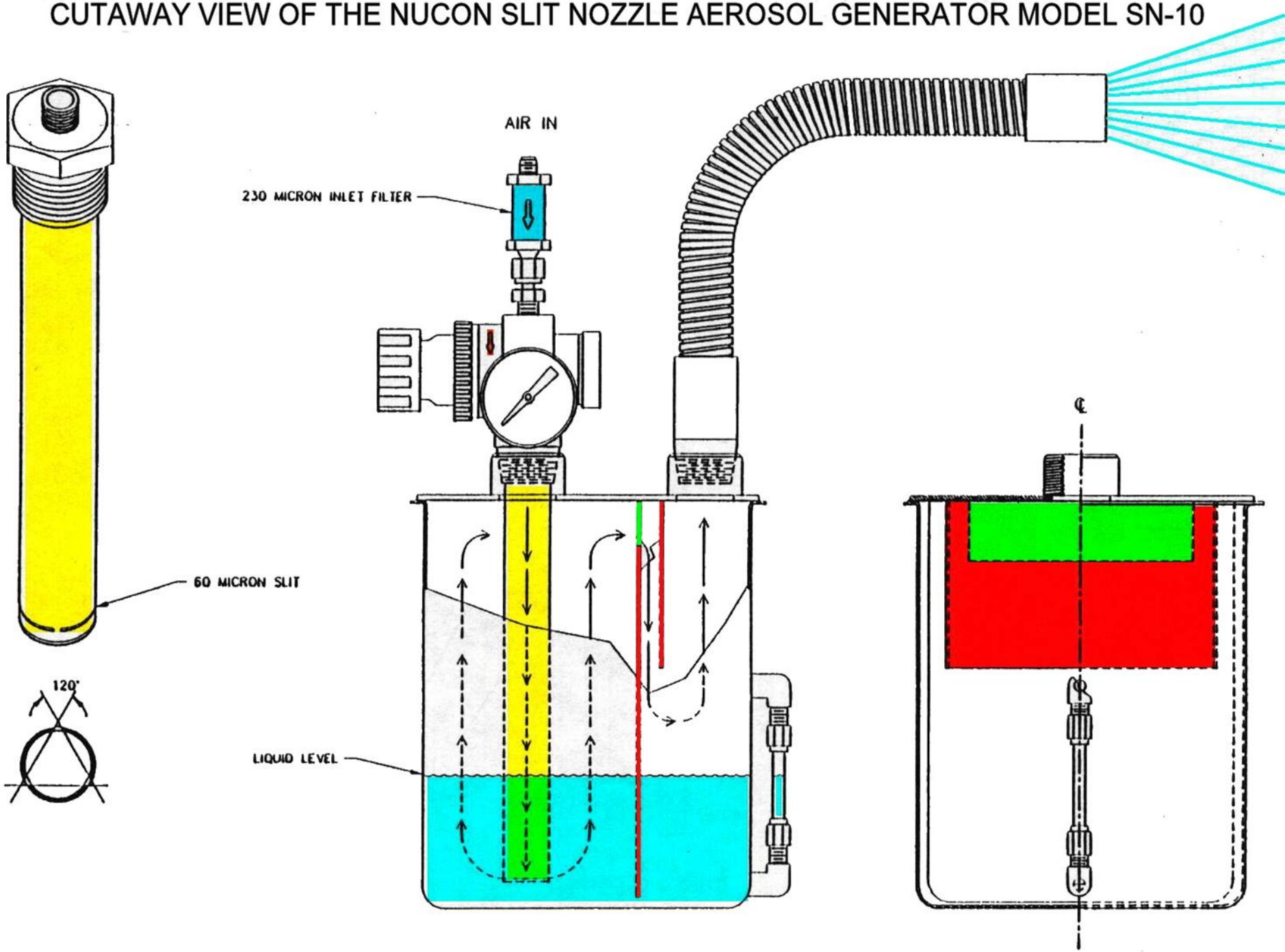
Test Equipment

- NUCON Model SN-10 used for Injection of Aerosol Dioctyl Phthalate (DOP)
- Solair Model S3100 used for Aerosol Particle Counting
- NUCON design copper Injection/Sample Manifold
- Cadillac Vacuum/Blower Model HP33P used for sampling through manifold

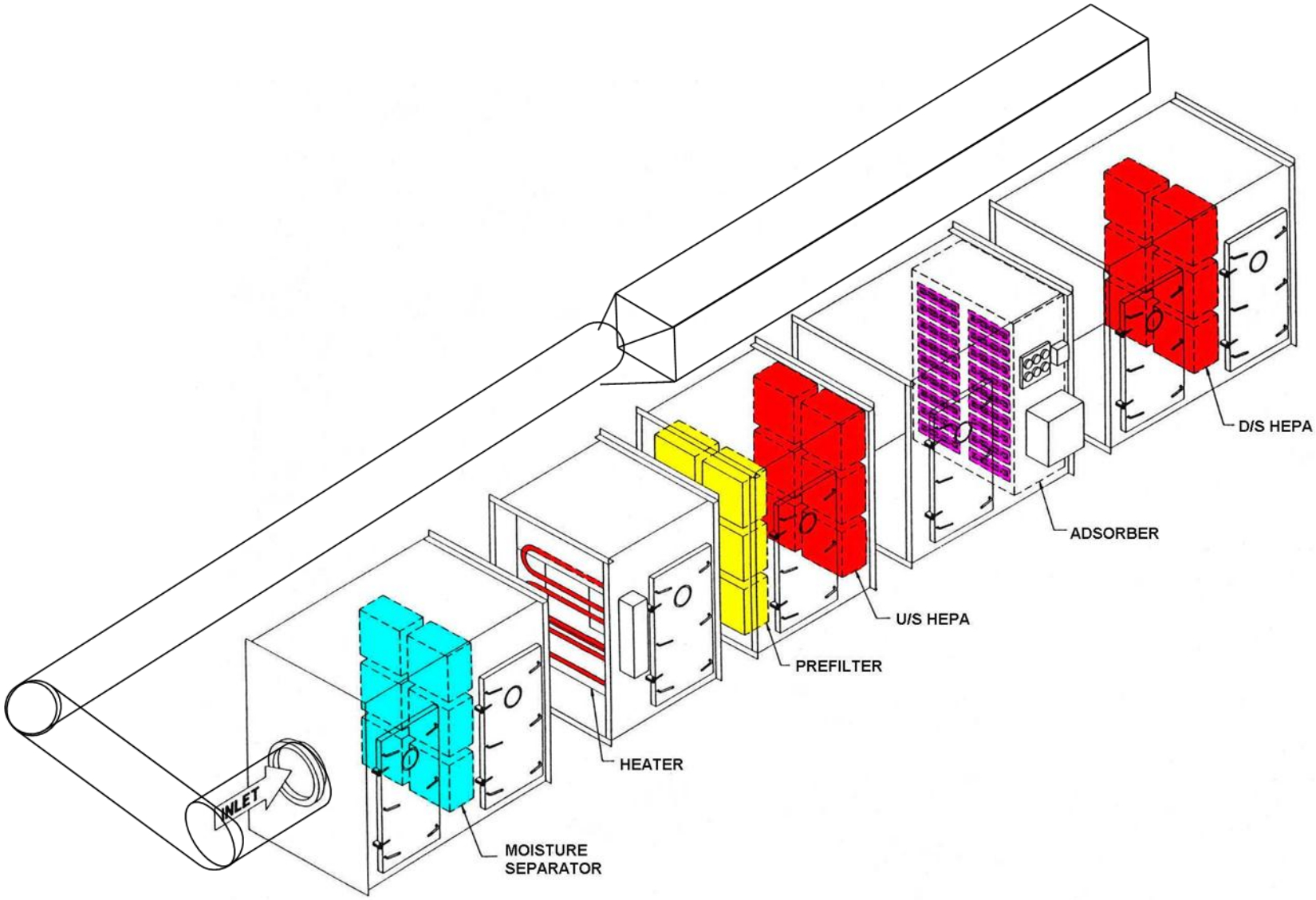
LIGHTHOUSE SOLAIR 3100

NUCON SN-10 Aerosol Generator

CUTAWAY VIEW OF THE NUCON SLIT NOZZLE AEROSOL GENERATOR MODEL SN-10



Filter Unit 6000 CFM

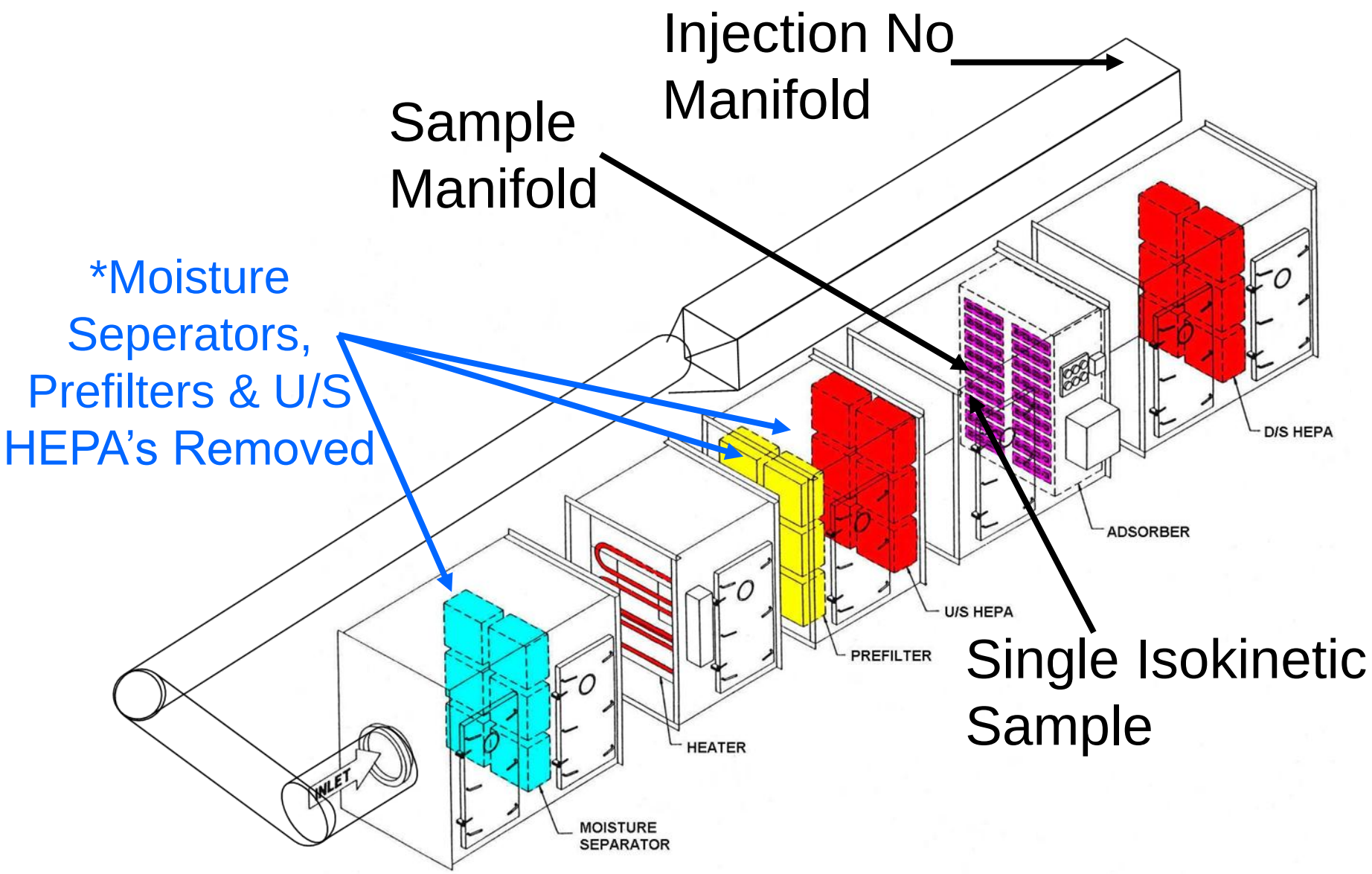


Injection Location

Test 1

- Comparing Manifold Sampling vs. Acceptable Single Point Sampling
- 4A (Single Point)
- 5A (Manifold)
- Results of both are comparable and acceptable

Filter Unit 6000 CFM



Sample Manifold U/S of all Filtration

Single Point Isokinetic Sample

Test 1 Results

		< 0.3 µ	0.3 µ-0.5 µ	< 0.7 µ	< 3.0 µ
Test 1	4A (Single Point)	34.05%*	26.70%	60.75%	99.43%
	5A (Sample Manifold)	35.83%	27.88%	63.70%	99.81%
	Difference	+1.78	+1.18	+2.95	+0.38
	% Difference	+5.23%	+4.42%	+4.86%	+0.38%

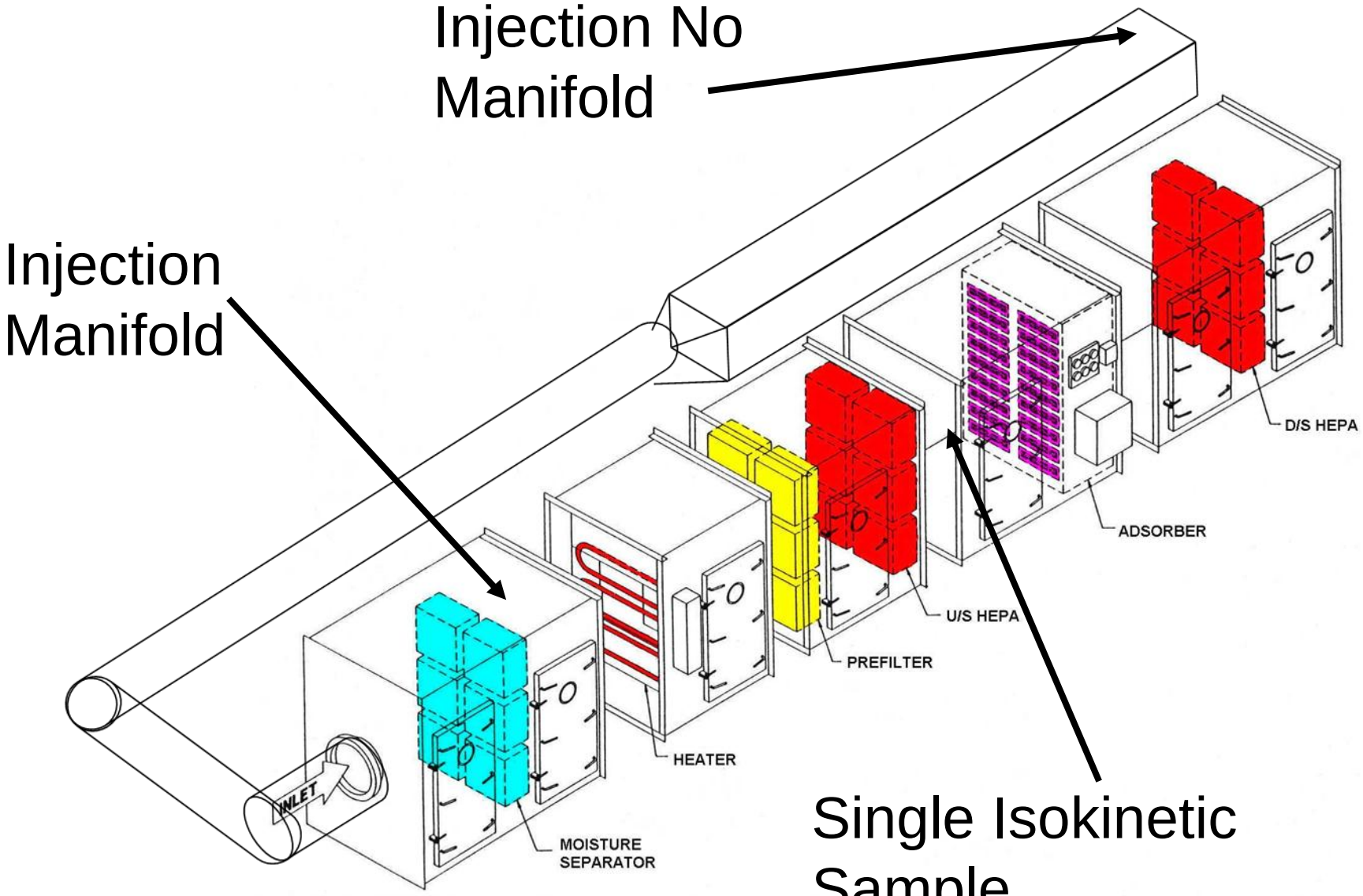
4A: Single Point Sample upstream of all filtration
5A: Sample via Manifold upstream of all filtration

*** Percentages are of the listed particle size.**
In this case 34.05% of the particles are < 0.3 µ.

Test 2

- Comparing Injection Manifold vs. Acceptable Single Point Injection
- 4A (Single Point)
- 6A (Manifold)
- Results of both are comparable and acceptable

Filter Unit 6000 CFM



Single Point Injection

View from Manifold Injection

Single Isokinetic Sample

Single Point Isokinetic Sample

Test 2 Results

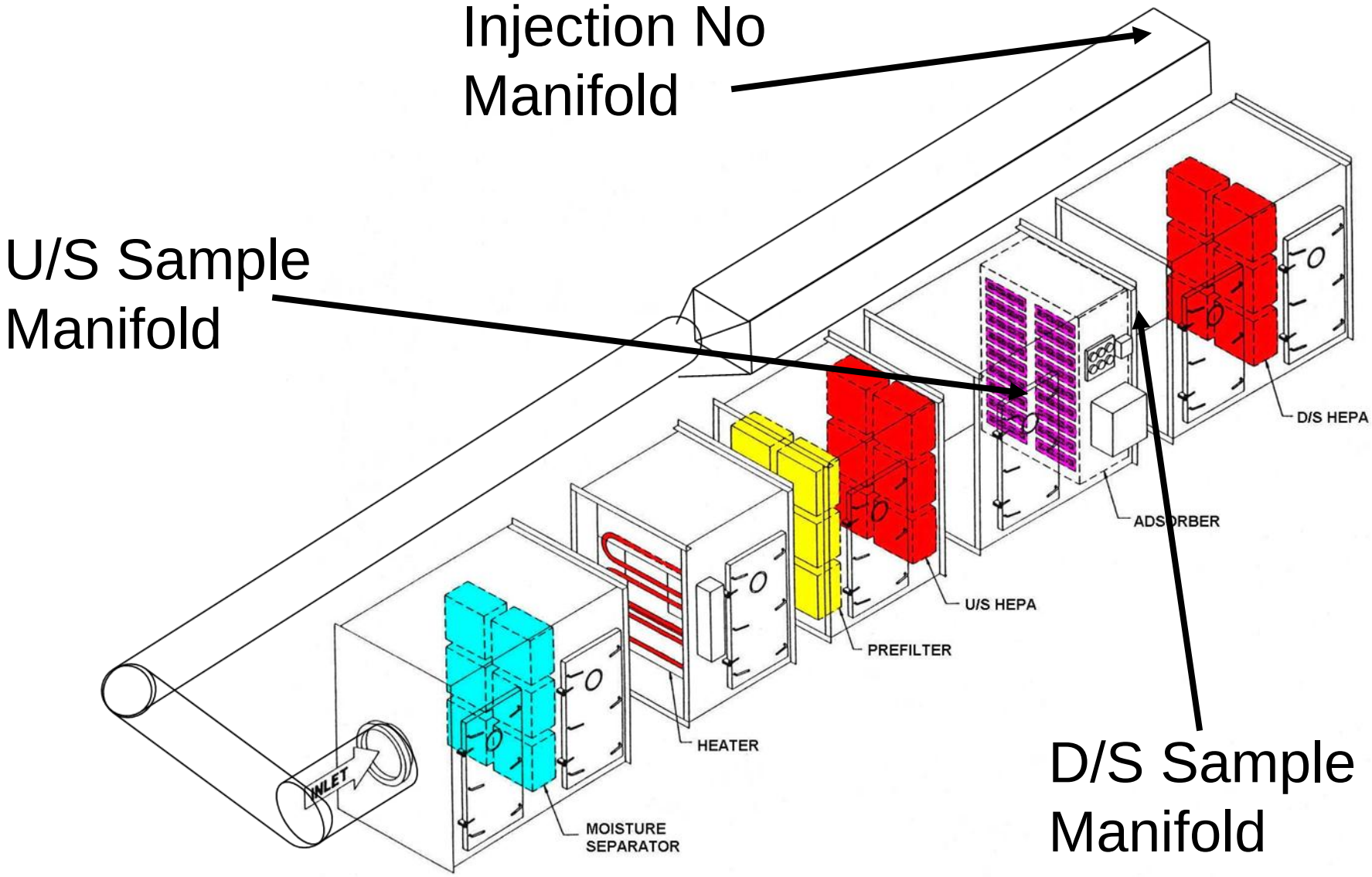
		< 0.3 µ	0.3 µ-0.5 µ	< 0.7 µ	< 3.0 µ
Test 2	4A (Injection No Manifold)	34.05%	26.70%	60.75%	99.43%
	6A (Injection Via Manifold)	31.26%	24.64%	55.89%	99.29%
	Difference	-2.79	-2.06	-4.86	-0.14
	% Difference	-8.19%	-7.72%	-8.00%	-0.14%

4A: Single Point Sample upstream of all filtration, no manifold
6A: Injection via Manifold, Single Point Sample U/S of all filtration

Test 3

- Compare Sampling Upstream and Downstream of Type II Adsorber Bank
- 5A (Upstream)
- 7A (Downstream)
- Results of both are comparable and acceptable

Filter Unit 6000 CFM



Injection Location

Manifold Sample U/S of Adsorber

Manifold Sample D/S of Adsorber

Test 3 Results

		< 0.3 µ	0.3 µ-0.5 µ	< 0.7 µ	< 3.0 µ
Test 3	5A (Upstream of Adsorber)	35.83%	27.88%	63.70%	99.81%
	7A (Downstream of Adsorber)	37.92%	29.76%	67.68%	99.89%
	Difference	+2.09	+1.88	+3.98	+0.08
	% Difference	+5.83%	+6.74%	+6.25%	+0.08%

5A: Sample via Manifold upstream of all filtration
7A: Sample via Manifold downstream of adsorber

Conclusion Test 1

- For test number 1 (single point sample verses sampling manifold) it appears that the manifold may cause a slight change in the particle size distribution to a slightly smaller size distribution. This may be attributed to the manifold acting as an impingement device and reducing some of the larger particles to smaller sizes. This effect is very minimal.

Conclusion Test 2

- For test number 2 (single point injection verses injection manifold). Injecting through a manifold produced a smaller percent of particles for all sizes. The particles may be agglomerating as they pass through the manifold resulting in the lower percentages. This effect is very minimal and the required particle size distribution is still met.

Conclusion Test 3

- For test number 3 (sampling via a manifold upstream and downstream of a two inch adsorber (charcoal) bed) it appears that the carbon bed may remove some of the larger particles and or reduce the size of some of the larger particles into smaller particles. This shows that injecting through or sampling through a two inch bed has little to no effect on test results. Further studies would need to be performed to confirm this for deeper beds.

Overall Conclusion

- Using a properly designed manifold for sampling and/or injecting of an aerosol and sampling through a type II adsorber bed does not adversely effect the sample to the point that it does not meet the relevant industry standards. However, there are some minor changes in the percentage of a given particle size between the various test conditions. All relevant sections of ASME N-510, 511 and AG-1 are met under all of the tested conditions.

End of Presentation

- Questions / Comments ?