Production of Filters Quantitatively Loaded with Airborne Asbestos

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Background

- The ability to load filters with a known quantity of a contaminant (asbestos) has multiple uses.
  - Laboratory proficiency testing programs.
  - Collection method (filter media, pump flow) evaluations.
  - Analytical method comparisons.
  - Toxicology studies.
- Aqueous and airborne deposition are the two common procedures for loading filters.
  - RTI has performed aqueous deposition for many years.
- In 2010, RTI developed a method for uniformly loading filters using airborne deposition.
  - Mimics samples from typical field studies.
  - Reportedly keeps fibers closer to the surface of the MCE filter.

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Goal

- Develop a chamber and procedures to uniformly load filters with a known quantity of asbestos or other contaminant.
- Filter loading, filter handling, quality control assessment, and chamber cleaning procedures are needed.

Chamber Design Objectives

- Mimic sample collection characteristics (flows, filter media) of air samples from field studies.
- Generate a large number of samples for sufficient statistical power to address the study hypothesis and allow sample archival for future analyses.
- Known loading (str/mm^2).
- Multiple flows within the same batch.
- Intrinsically safe chamber design to avoid contamination of adjacent laboratory space.
- Easy to clean to minimize contamination between loadings.

Chamber Performance Objectives

- Minimize impact of known sources of error (Type II or Type B variability) on statistical analysis.
  - Flow rate variability between filters.
  - Asbestos loading (str/mm^2) heterogeneity between filters.
  - Intra-filter variability in loading.
- Maintain the fiber size (diameter, width, aspect ratio) characteristics of the bulk material.

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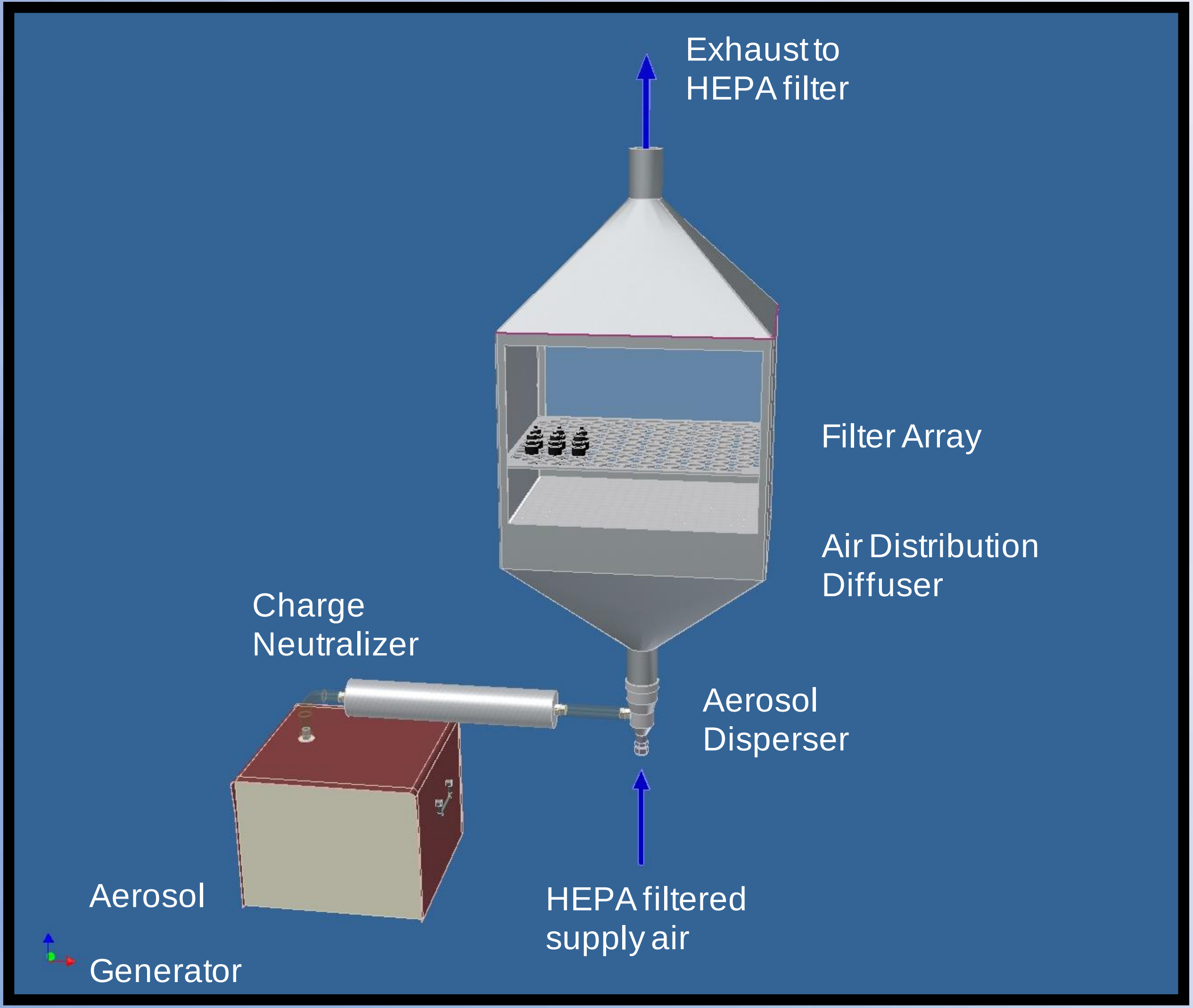
Conclusion

IT WORKS!!!!

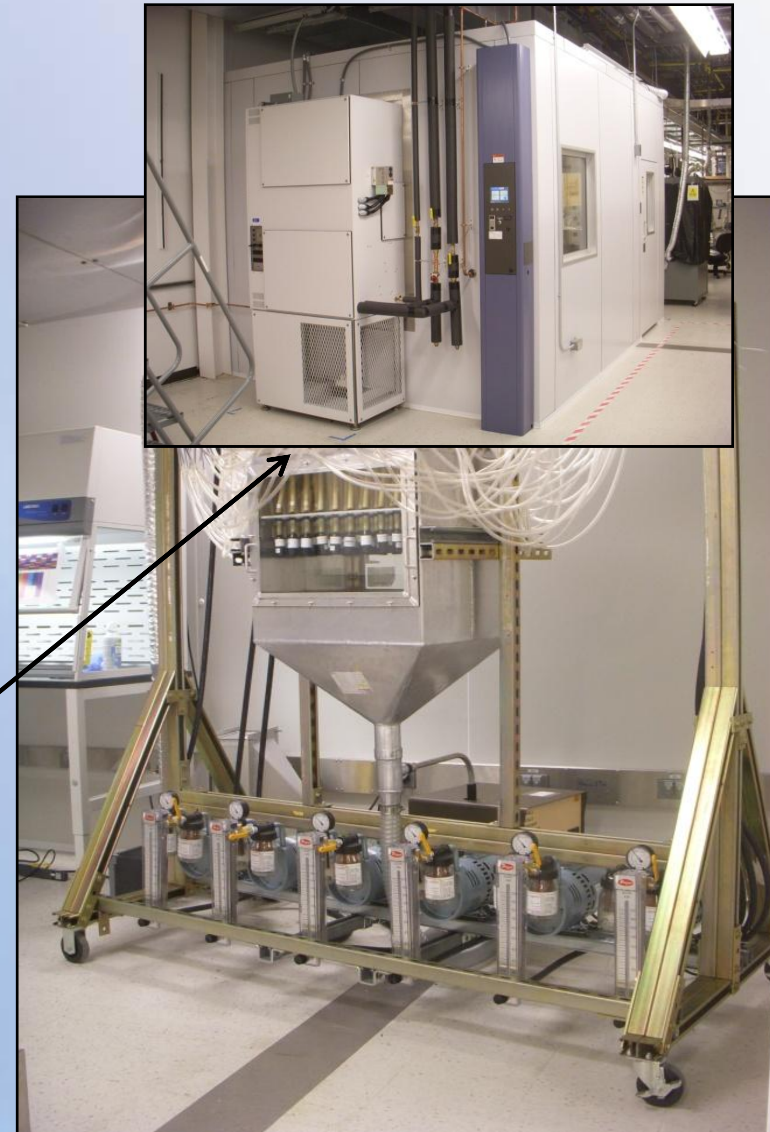
Let’s go get a frosty beverage!

Chamber Description



Chamber Design Details

- Filter array holds up to eighty 25 mm cassettes or forty 37 mm cassettes.
- Pumps provide sufficient vacuum to pull up to 8 in. H_2O per filter (10 Lpm thru a 0.45 μm MCE filter).
- Loading chamber fully isolated with HEPA filtered supply and exhaust air.
- Environmental chamber with HEPA filtered air recirculation provides secondary containment.



“Medusa”

Flow Variability

- Target flow ranges:
  - 10 Lpm = 9.6 to 10.4 Lpm
  - 3.5 Lpm = 3.35 to 3.65 Lpm
- CV < 3.7%
- Corresponds to Type II error of < 10%.

Cassettes at 3.5 Lpm and 10 Lpm

Manifold	3	2	1	4	5	6
Avg	3.54	9.79	9.64	9.98	10.02	3.59
Std	0.07	0.37	0.19	0.29	0.11	0.05
CV	0.02	0.04	0.02	0.03	0.01	0.01

Cassettes at 10 Lpm

Manifold	A	B	C	D	E	F	G	H
Avg	10.03	9.91	10.39	9.93	9.99	9.99	10.03	10.06
Std	0.29	0.32	0.16	0.21	0.17	0.24	0.13	0.12
CV	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01

Between Filter Loading Variability

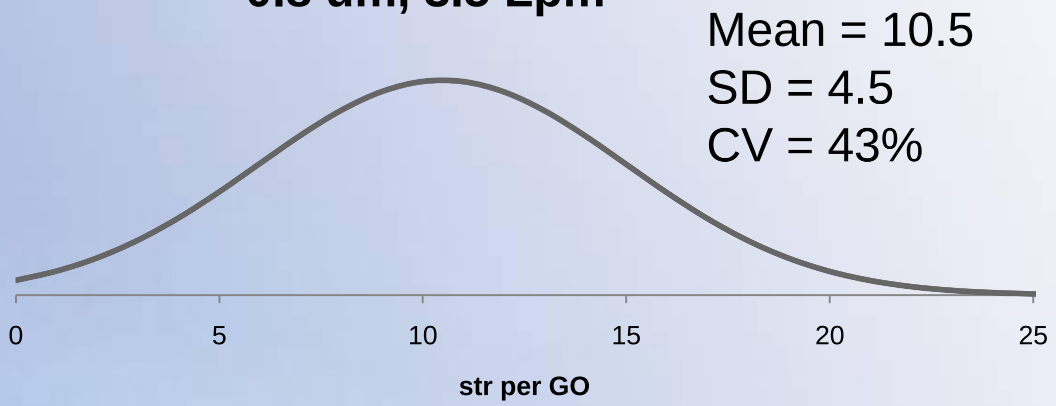
- Materials: Libby Amphibole, Amosite
- Loading target
  - High: >1000 str/mm^2 by TEM
  - Low: <400 str/mm^2 by TEM
- CV < 20% meets data quality indicator

	Libby, Low	Libby, High	Amosite, Low	Amosite, High
Filter 1	300	730	427	2518
Filter 2	350	790	382	2209
Filter 3	420	770	418	2082
Filter 4	318	741	345	2109
Avg	**357**	**763**	**393**	**2160**
SD	**60**	**31**	**37**	**233**
CV	**17%**	**4%**	**10%**	**11%**

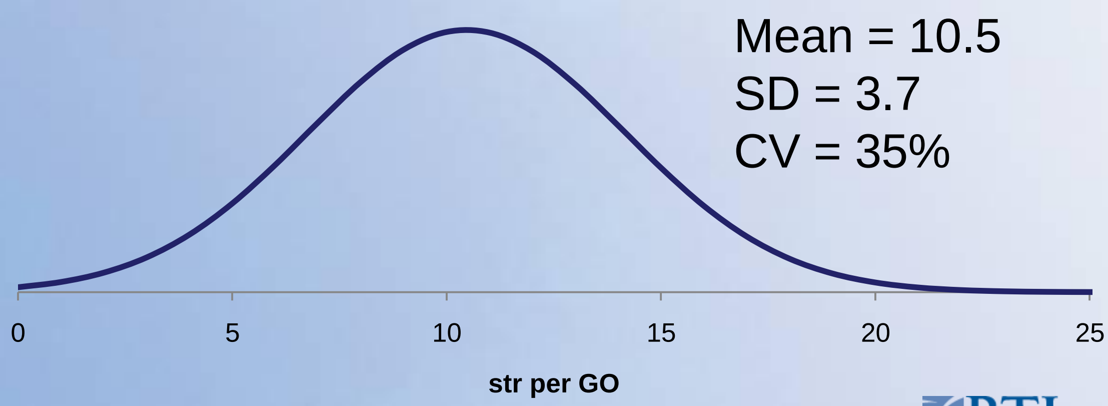
Within Filter Loading Variability

- 60 grid openings over 20 filters (3 GO/filter)
- 1000 str/mm^2
- Libby Amphibole
- Wide variability due counting statistics, even at 1000 str/mm^2

0.8 um, 3.5 Lpm



0.8 um, 10 Lpm



Size (Aspect Ratio) Characteristics

- Libby amphibole.
- Bulk material characterized by USGS.
- Chamber generated samples
  - 20 filters, 60 grid openings total.
  - 10 Lpm and 3.5 Lpm.
  - About 600 structures counted for each flow.
  - 90% structures were single fibers.

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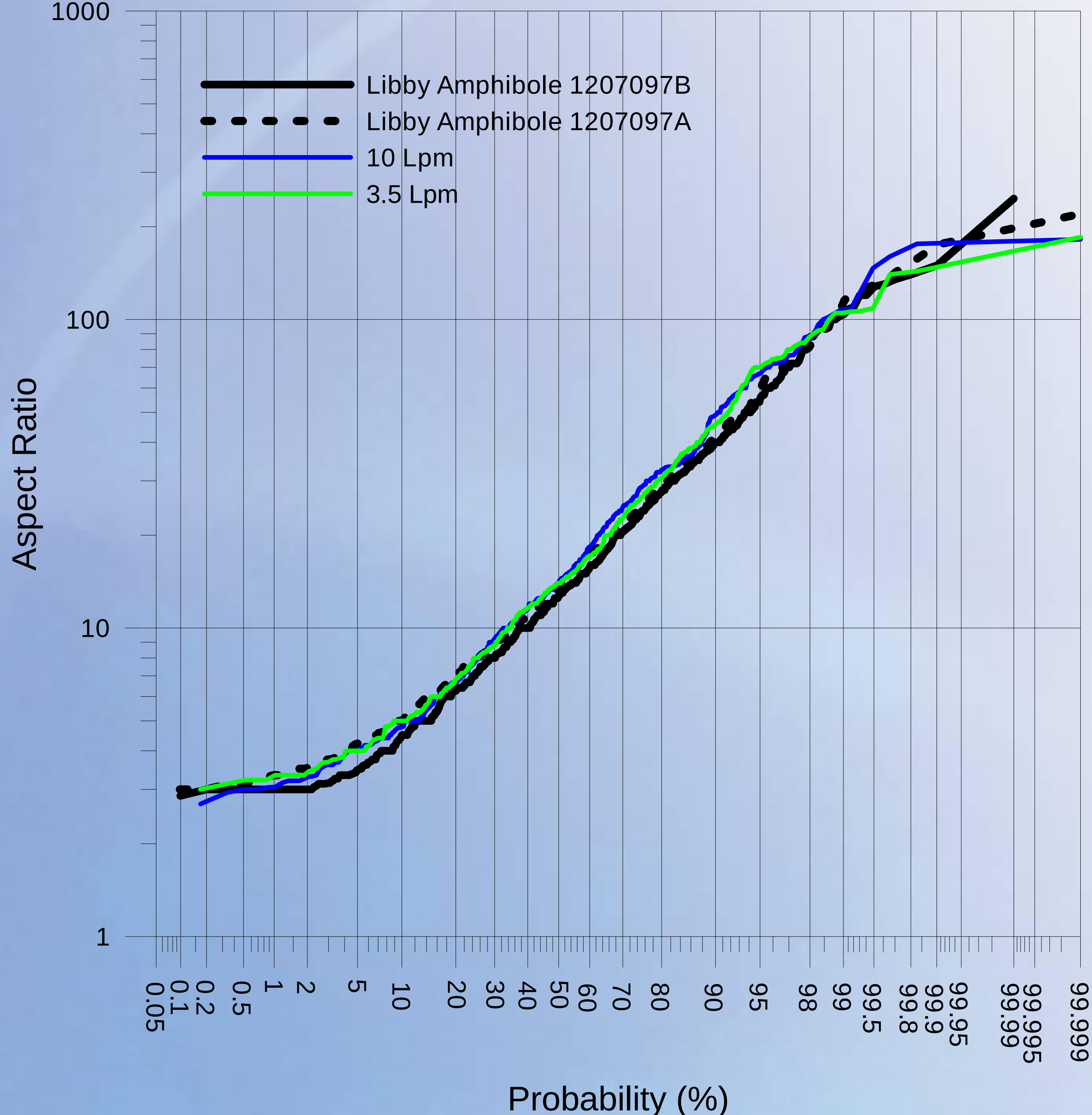

1000
100
10
1
Aspect Ratio
Libby Amphibole 1207097B
Libby Amphibole 1207097A
10 Lpm
3.5 Lpm
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
99.5
99.8
99.9
99.95
99.99
99.995
99.999
Probability (%)

Conclusions

- Chamber design safely and cost effectively produces up to 80 filters.
- Chamber performance objectives achieved.
  - Flow variability less than 3.7%.
    - Minimizes potential source of experimental error.
  - Between filter variability less than 10%.
    - No evidence of “hot” or “cool” spots within chamber.
  - Within filter variability is between 30% to 50% due to relatively low density of fibers on the filter.
    - An inherent error that may be difficult to address.
  - Size characteristics of deposited fibers match the bulk material.
    - Confidence filter samples are representative.

Other Uses

- Chamber can be used to load filters with other particles.
  - Non-asbestos fibers
  - Non-regulated fibers
  - Nanoparticles
  - Contaminated soil (lead, other metals)
  - Other standard particulate (e.g., Arizona Road Dust)

- Can make filters loaded with multiple particle types (e.g., fibers and non-fibers).

- Can use other filter types (e.g., Teflon).

Applications

- Analytical method evaluation (in progress).
  - High mag vs Low mag TEM, TEM methods, PCM vs PCMe, Direct vs. Indirect
- Filter media evaluation (in progress).
  - Flow-pore size effect on LA retention
- PE sample production.
- NVLAP, AIHA, PT filter production.
- Filters for toxicology studies.

Trivia Question: Where was the photo taken?

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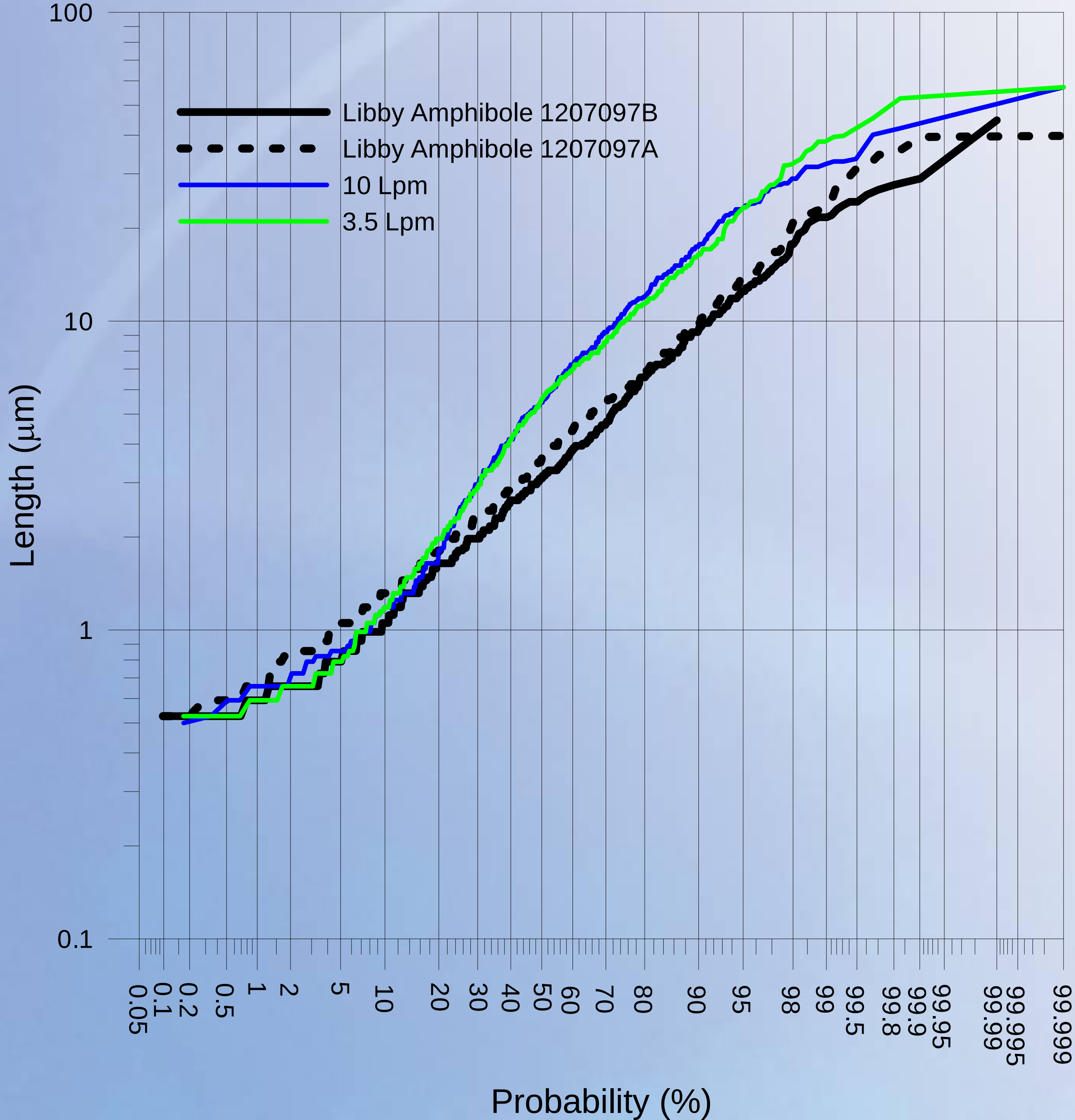
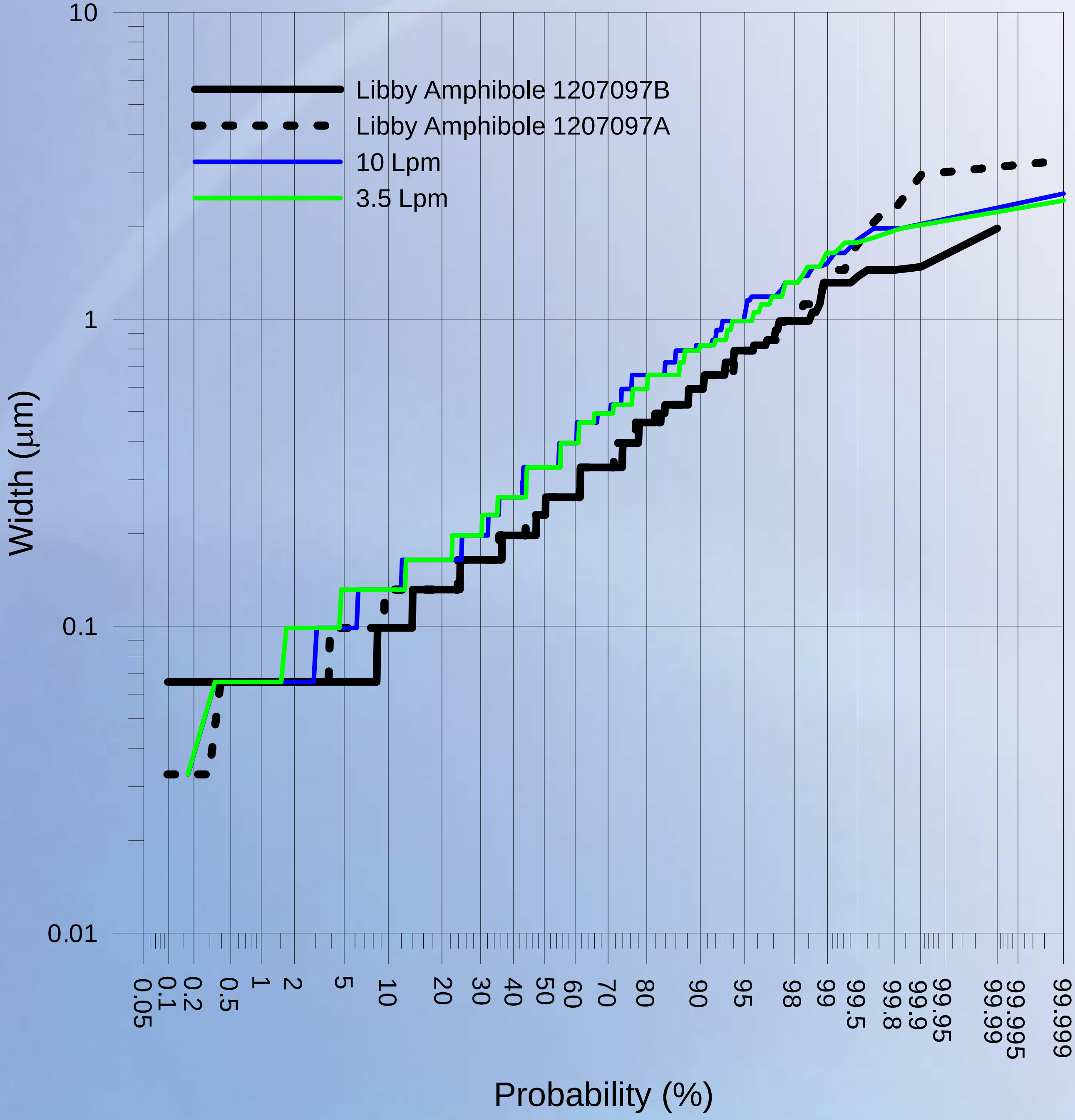
Kootenai Falls,
Between Libby and Troy, MT


Libby Amphibole 1207097B
Libby Amphibole 1207097A
10 Lpm
3.5 Lpm
100
10
1
0.1
Length (μm)
0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9 99.95 99.99 99.995 99.999
Probability (%)



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