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Performance of Particulate Matter Samplers When Exposed to Coarse Fraction Aerosol Particles

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PM NAAQS

- PM_{10} – 150 µg/m^3
- $PM_{2.5}$ – 65 µg/m^3
- PM_{CF} – Being developed to address confounding issues

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Concerns with PM NAAQS in Rural Environments

- FRM sampler overestimation
- Sampler performance in “real world”
- Basis for NAAQS development

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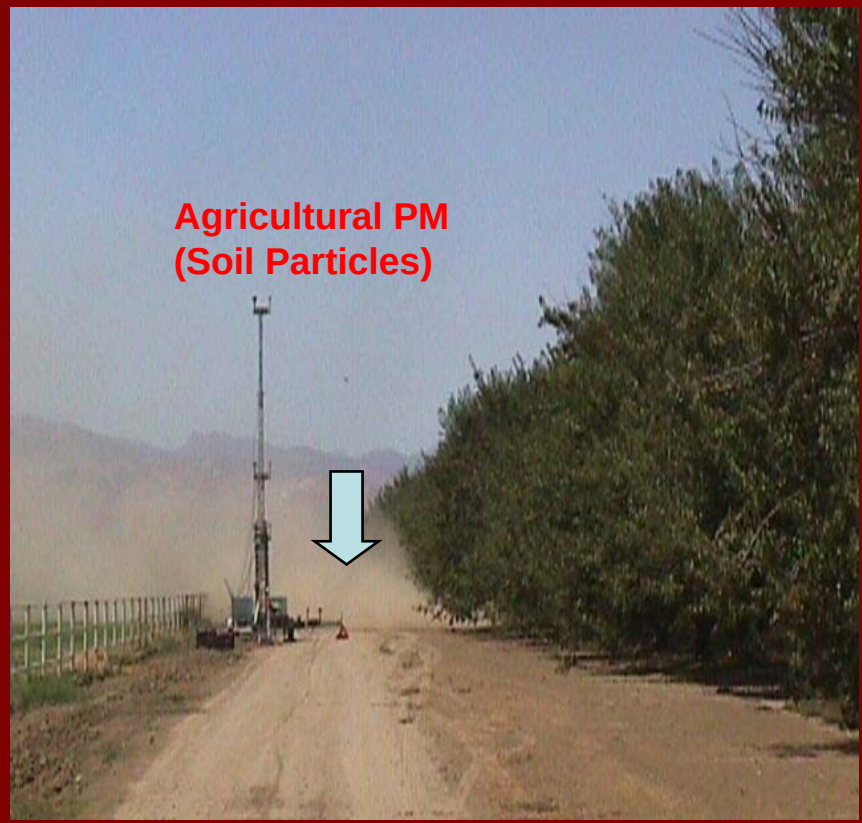
Urban Dust

Agricultural Dust



The PSD of PM emitted from agricultural operations is significantly larger than PM present in urban areas.

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Physical Differences

	Urban Dust	Rural Dust
Sources	Combustion Boilers Stack Gases	Soil Dried Manure Pollens
Typical Size	< 10 micron	> 10 micron
(MMD & GSD)	MMD < 10 μm GSD = 1.5	MMD > 10 μm GSD = 2

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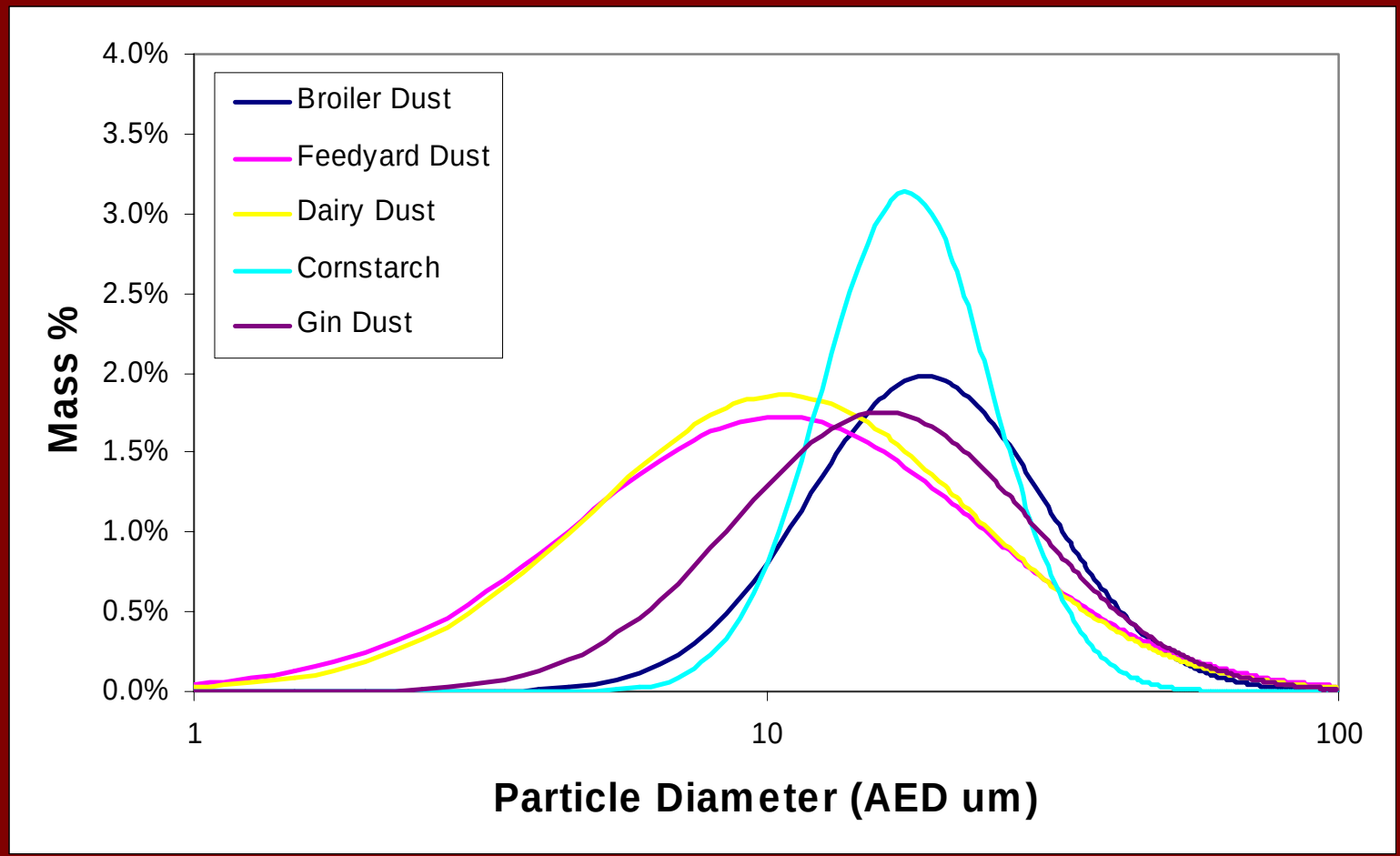
PSD of Agricultural Dusts



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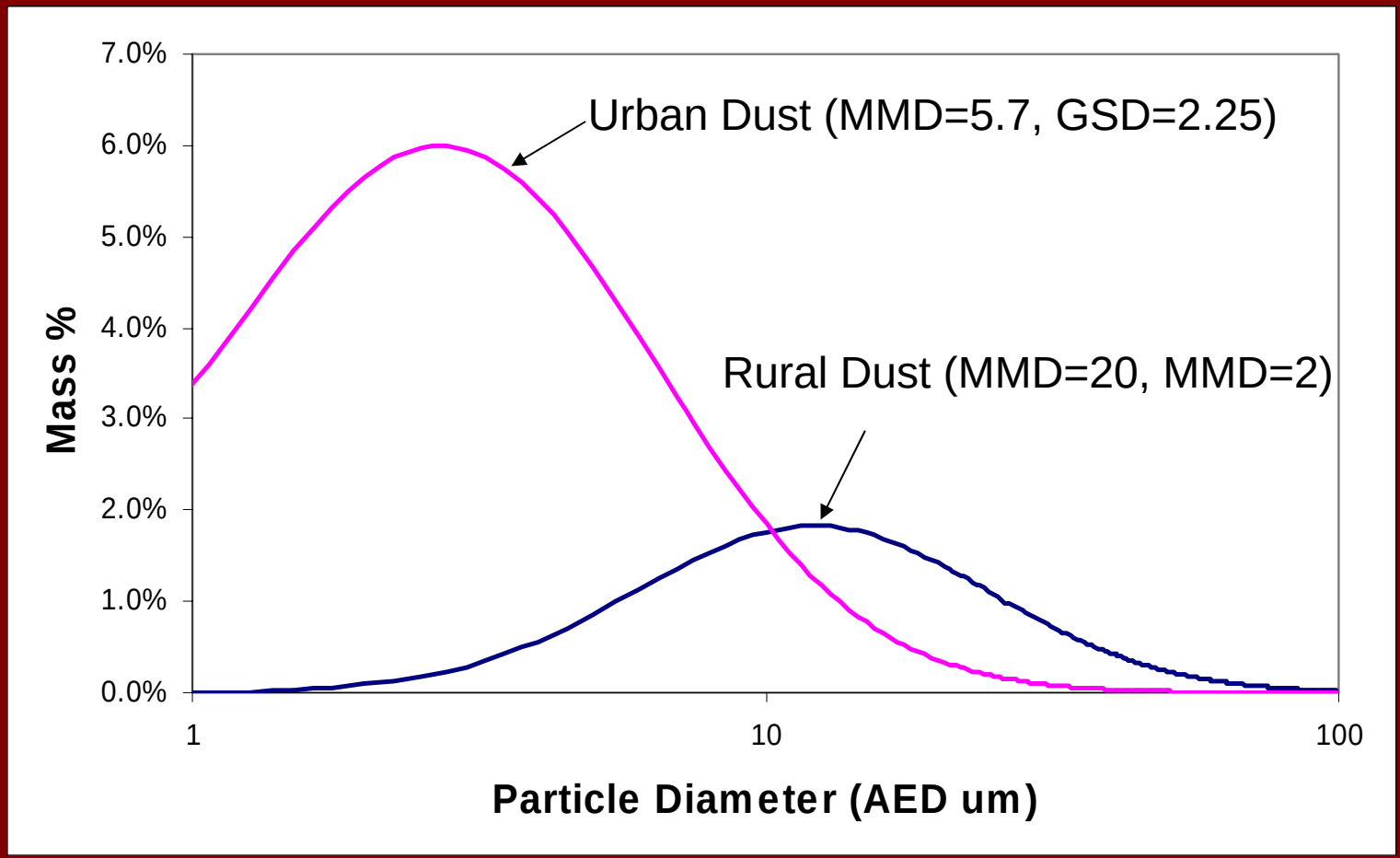
Idealized Urban vs Rural Dust



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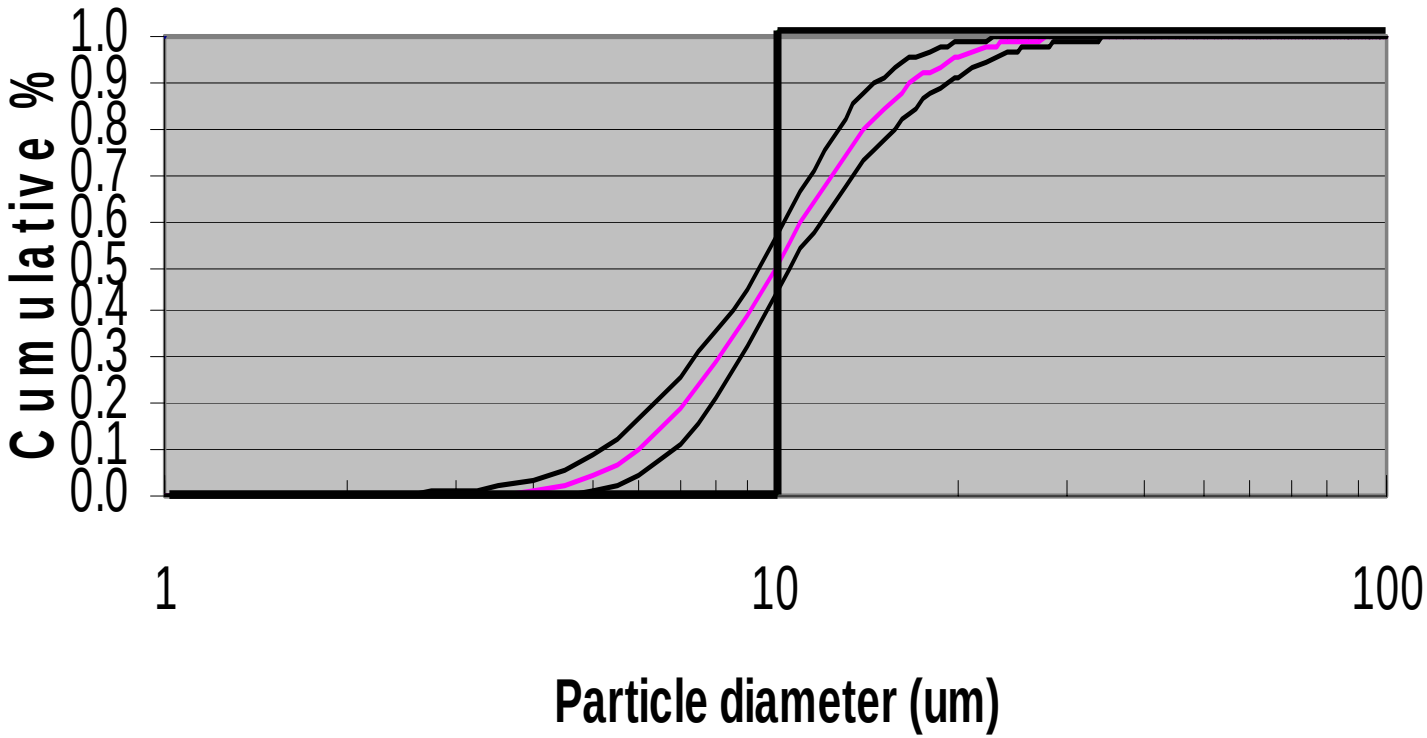
Performance of FRM PM_{10} Samplers (EPA Criteria Document)

- Cut-off is 10 ± 0.5 µm (@50% efficiency)
- Slope is 1.5 ± 0.1 (Hinds, 1982)



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PM Size Distributions Used in Sampler Performance Evaluation

Scenario	Mode	MMD μm	GSD	TSP μg/m^3	PM_{10} μg/m^3	PM2.5 μg/m^3	PMcf μg/m^3
Urban 1	Coarse	10	1.6	124.29	62.14	0.20	61.95
	Fine	1	1.2	82.86	82.86	82.85	0.01
	TOTAL			207.14	145.00	83.04	61.96
Urban 2	Coarse	8	2.3	154.43	93.52	12.55	80.97
	Fine	0.3	2.05	51.48	51.48	51.40	0.08
	TOTAL			205.91	145.00	63.95	81.05
Urban 3	Coarse	14	2	225.00	70.58	1.46	69.12
	Fine	0.5	2	75.00	74.99	74.24	0.75
	TOTAL			300.00	145.57	75.70	69.87

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PM Size Distributions Used in Sampler Performance Evaluation

Scenario	Mode	MMD μm	GSD	TSP μg/m^3	PM_{10} μg/m^3	PM2.5 μg/m^3	PMcf μg/m^3
Feedyard	Coarse	20	2.2	913.94	145.00	1.23	143.77
	Fine	0	0	0.00	0.00	0.00	0.00
	TOTAL			913.94	145.00	1.23	143.77
Broiler	Coarse	24	1.6	4639.51	145.00	0.00	145.00
	Fine	0	0	0.00	0.00	0.00	0.00
	TOTAL			4639.51	145.00	0.00	145.00
Dairy	Coarse	19	2.1	749.39	145.00	2.35	142.65
	Fine	0	0	0.00	0.00	0.00	0.00
	TOTAL			749.39	145.00	2.35	142.65
Cotton Gin	Coarse	23	1.8	1853.33	145.00	0.15	144.85
	Fine	0	0	0.00	0.00	0.00	0.00
	TOTAL			1853.33	145.00	0.15	144.85

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$PM_{2.5}$ Sampler Performance for the Scenarios Evaluated[1]

Scenario	True $PM_{2.5}$ $\mu g/m^3$	Ideal Lower $PM_{2.5}$ $\mu g/m^3$	Ideal Upper $PM_{2.5}$ $\mu g/m^3$
Urban 1	83.04	83.02	83.40
Urban 2	63.95	62.34	66.95
Urban 3	75.70	75.06	76.70
Feedyard	1.23	1.12	2.30
Broiler	0.00	0.01	0.03
Dairy	2.35	2.08	3.89
Cotton Gin	0.15	0.16	0.43

[1] Ideal Lower and Ideal Upper refer to performance characteristics from 40 CFR parts 50 and 53.

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PM_{10} Sampler Performance for the Scenarios Evaluated[1]

Scenario	True PM_{10} $\mu g/m^3$	Ideal Lower PM_{10} $\mu g/m^3$	Ideal Upper PM_{10} $\mu g/m^3$
Urban 1	145.00	141.17	148.65
Urban 2	145.00	139.70	145.98
Urban 3	145.57	147.36	157.25
Feedyard	145.00	170.91	201.84
Broiler	145.00	378.65	495.51
Dairy	145.00	161.12	187.17
Cotton Gin	145.00	222.44	275.65

[1] Ideal Lower and Ideal Upper refer to performance characteristics from 40 CFR parts 50 and 53.

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PM_{CF} Measurement Range for the Samplers and Scenarios Evaluated

Scenario	True PM_{cf} $\mu g/m^3$	Lower PM_{cf} $\mu g/m^3$	Upper PM_{cf} $\mu g/m^3$
Urban 1	61.96	57.76	65.82
Urban 2	81.05	72.75	83.64
Urban 3	69.87	69.31	82.19
Feedyard	143.77	143.95	200.72
Broiler	145.00	159.74	495.51
Dairy	142.65	141.59	185.09
Cotton Gin	144.85	149.79	275.49

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Concerns with NAAQS in Rural Environment

- **Basis for NAAQS development**
  - **Questionable association between PM_{CF} and health effects**
  - **Few epidemiological studies show association – those admit potential confounding…**
  - **No rural based epidemiological studies**
    - **Population limits statistical power**

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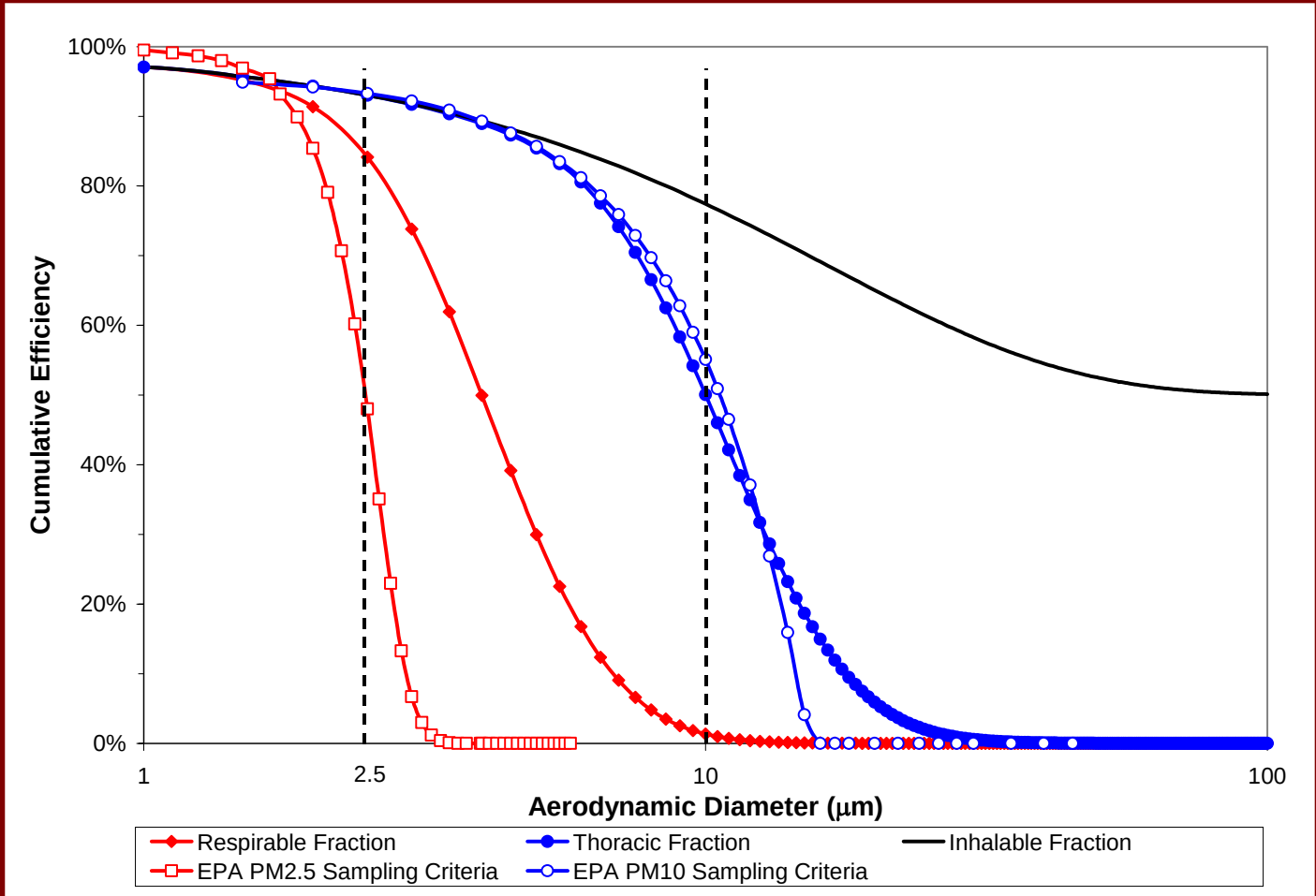
Rationale for the Use of PM_{10} Samplers



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Concerns with NAAQS in Rural Environment

- **Basis for NAAQS development**
  - **Epidemiological study issues**
    - **Data confounded by measurement error**
    - **Data confounded by other pollutants**
    - **Single variable analysis**
    - **Lag time selection**

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Conclusions

- Application of PM NAAQS in Rural/Agricultural environment is questionable at best
- Overestimation must be corrected
- Sampler performance in coarse particulate matter environment must be addressed
- Risk analysis approach needs improvement

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Conclusions

- **Failure to address these issues will result in:**
  - Inappropriate burden for sources of coarse particulate matter
  - Resources used to correct perceived environmental problems instead of more critical issues
  - Create distrust with the regulated industries

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