Discussion of Emissions Factor Uncertainty

Agricultural Air Quality
Task Force
October 3, 2007

Overview

- What are Emissions Factors?
- What's wrong with Emissions Factors?
- How has MPG Responded?
- What's in the Uncertainty Assessment?
- What's Next?

What are Emissions Factors?

- Emissions Factors (EFs) are low cost, low burden means to estimate emissions
- EFs are average values derived from limited emissions tests at a subset of sources
  - Typical EF units are lbs of pollutant per fuel input
  - EFs developed for use in the national emissions inventory

$$Emissions = EF\left(\frac{pounds}{mmBTU}\right) \times Consumption\left(\frac{mmBTU}{year}\right)$$

What's wrong with EFs?

- Nothing when used in proper context
  - Developing annual, national inventory
- However, EFs are used out of context
  - Individual sites use EFs rather than direct measurements
    - To determine program applicability
    - To establish permit limits
    - To demonstrate compliance
    - To calculate fees
    - As basis for TRI reporting

What's wrong with EFs? (cont.)

- Such out of context use often ignores potential consequences
  - Half of sources' emissions exceed values determined by using EFs
- Inspector General and other stakeholders found:
  - Few high quality EFs
  - Difficult process for generating new EFs
  - No accounting for EF uncertainty
  - No guidance for using EFs out of context

How has MPG responded?

- Convened stakeholders
- Created streamlined EF development process
  - Captures emissions test data electronically, assigns quality rating automatically, and will post results online
- Drafted and is seeking comments on method to estimate EF uncertainty

What's in the Uncertainty Assessment?

- 6 step process to estimate uncertainty
  - Get data
  - Visualize data
  - Develop probability distribution function
  - Simulate population
  - Get 10,000 values from specific sample sizes
  - Calculate ratios for target statistics

Step 1
CO Emissions Data from AP-42

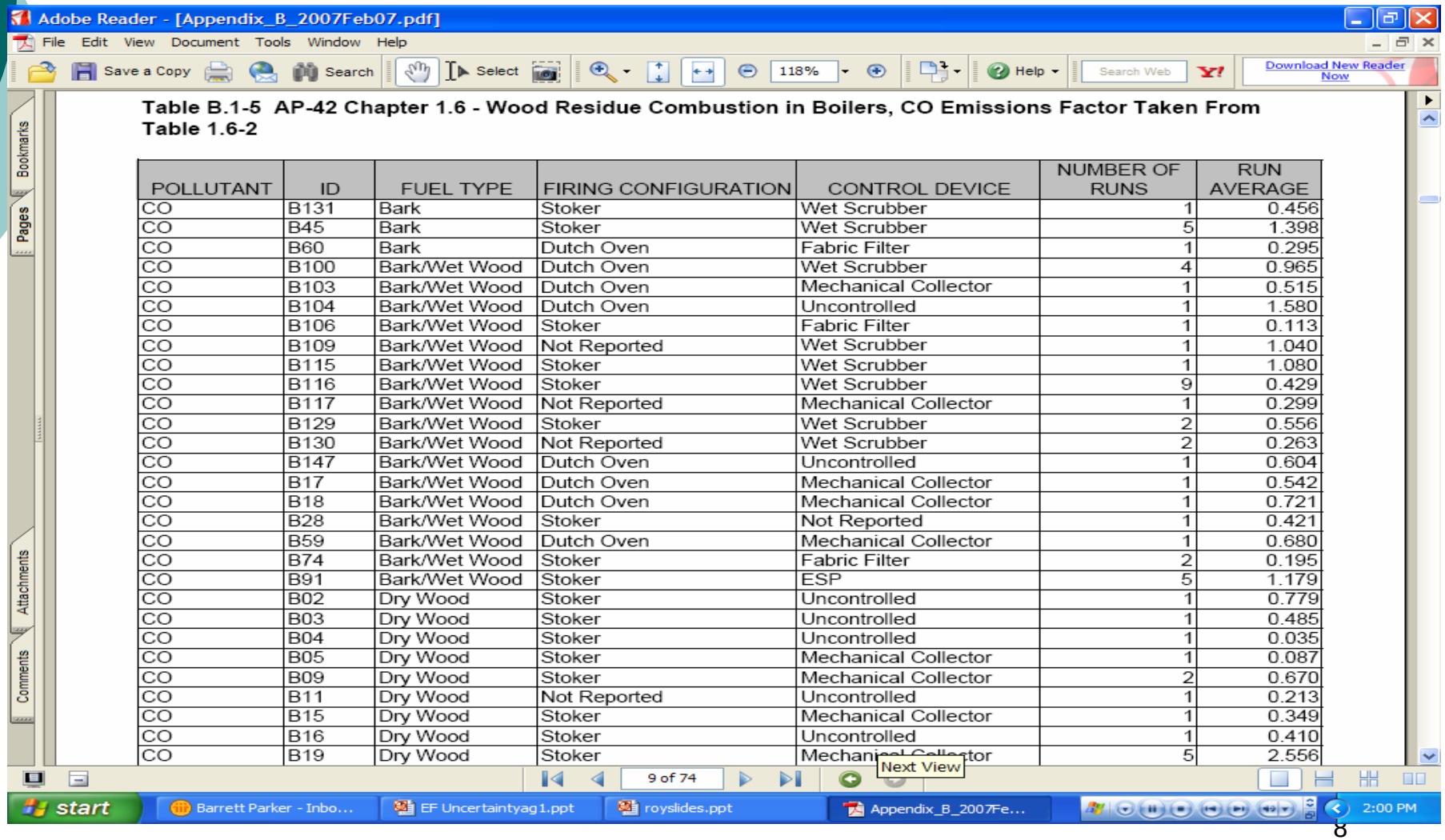
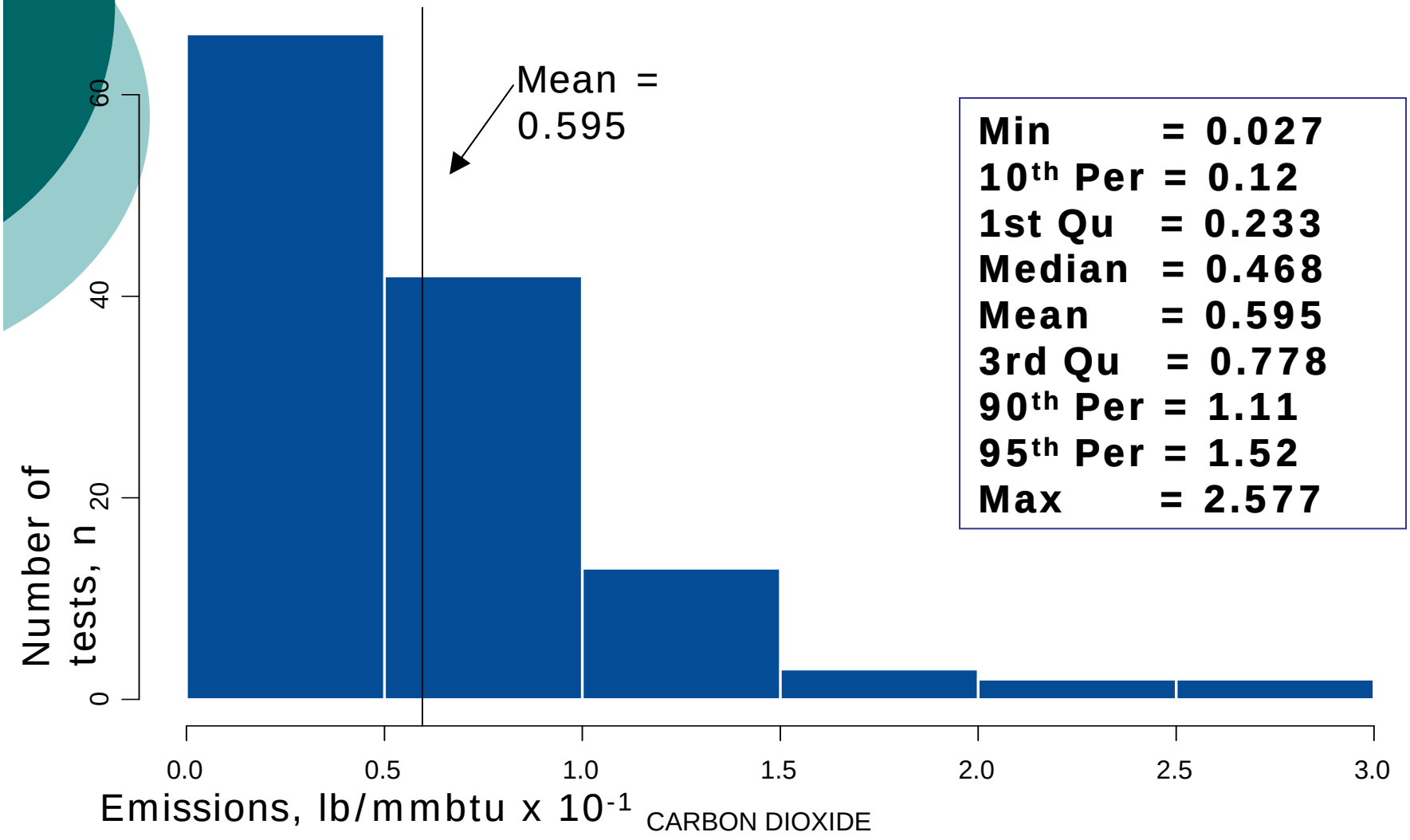


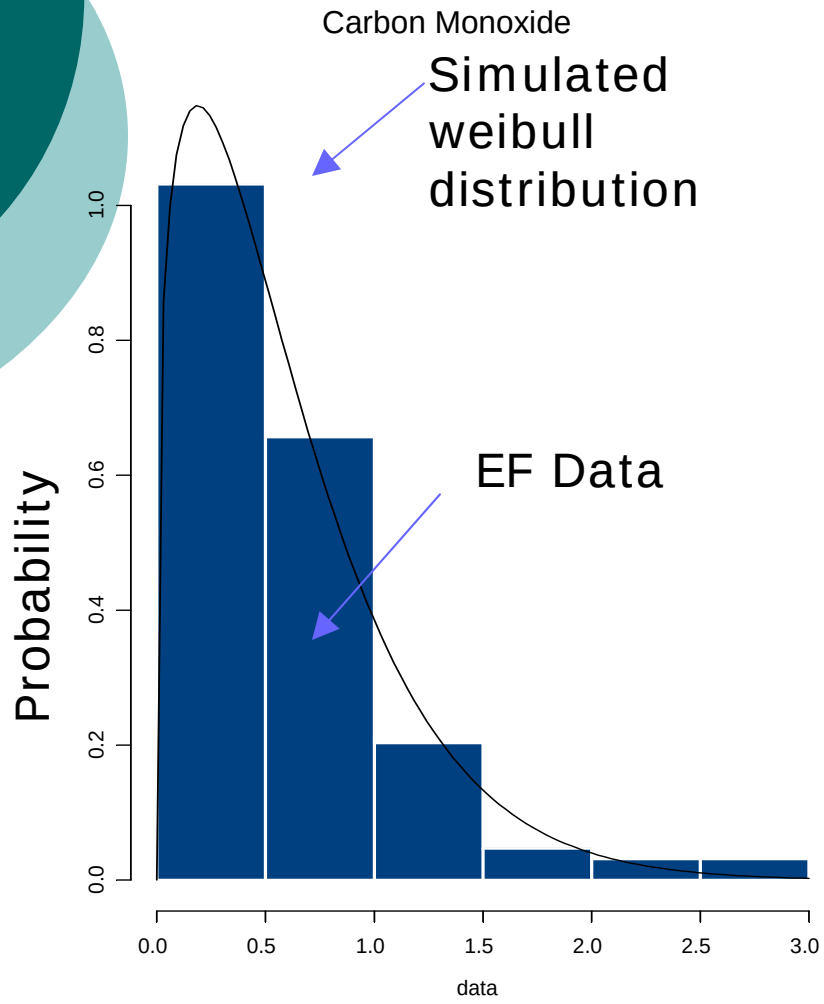
Table B.1-5 AP-42 Chapter 1.6 - Wood Residue Combustion in Boilers, CO Emissions Factor Taken From Table 1.6-2

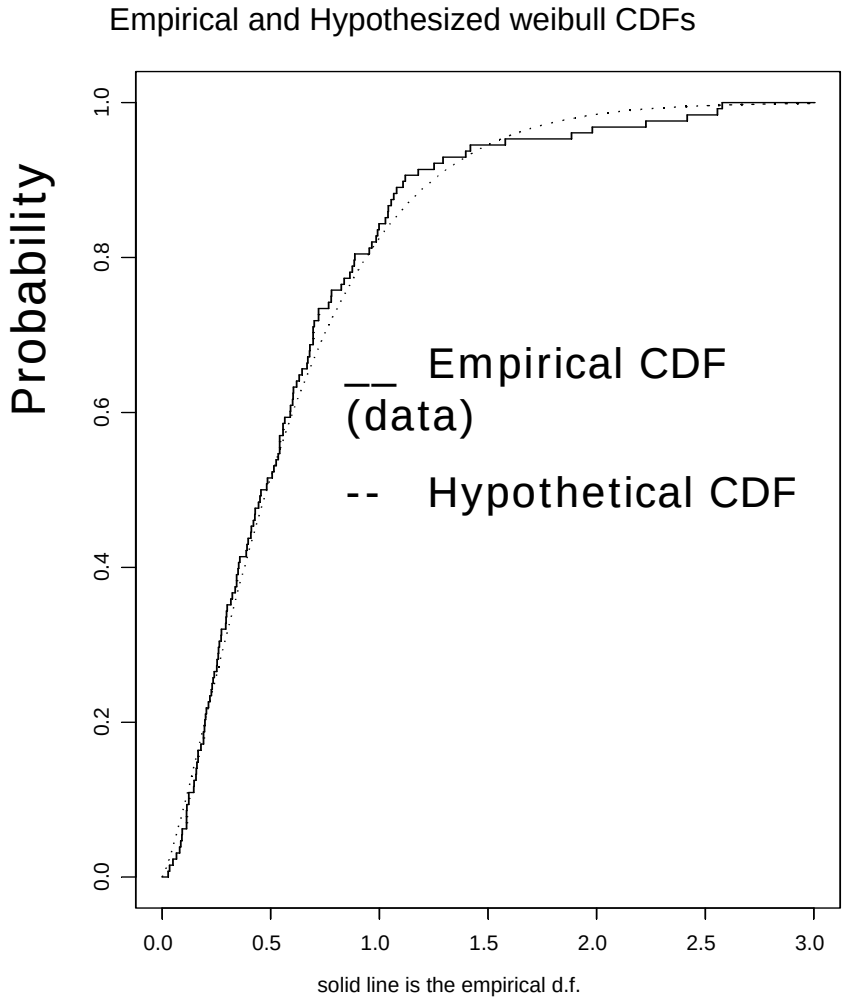
POLLUTANT	ID	FUEL TYPE	FIRING CONFIGURATION	CONTROL DEVICE	NUMBER OF RUNS	RUN AVERAGE
CO	B131	Bark	Stoker	Wet Scrubber	1	0.456
CO	B45	Bark	Stoker	Wet Scrubber	5	1.398
CO	B60	Bark	Dutch Oven	Fabric Filter	1	0.295
CO	B100	Bark/Wet Wood	Dutch Oven	Wet Scrubber	4	0.965
CO	B103	Bark/Wet Wood	Dutch Oven	Mechanical Collector	1	0.515
CO	B104	Bark/Wet Wood	Dutch Oven	Uncontrolled	1	1.580
CO	B106	Bark/Wet Wood	Stoker	Fabric Filter	1	0.113
CO	B109	Bark/Wet Wood	Not Reported	Wet Scrubber	1	1.040
CO	B115	Bark/Wet Wood	Stoker	Wet Scrubber	1	1.080
CO	B116	Bark/Wet Wood	Stoker	Wet Scrubber	9	0.429
CO	B117	Bark/Wet Wood	Not Reported	Mechanical Collector	1	0.299
CO	B129	Bark/Wet Wood	Stoker	Wet Scrubber	2	0.556
CO	B130	Bark/Wet Wood	Not Reported	Wet Scrubber	2	0.263
CO	B147	Bark/Wet Wood	Dutch Oven	Uncontrolled	1	0.604
CO	B17	Bark/Wet Wood	Dutch Oven	Mechanical Collector	1	0.542
CO	B18	Bark/Wet Wood	Dutch Oven	Mechanical Collector	1	0.721
CO	B28	Bark/Wet Wood	Stoker	Not Reported	1	0.421
CO	B59	Bark/Wet Wood	Dutch Oven	Mechanical Collector	1	0.680
CO	B74	Bark/Wet Wood	Stoker	Fabric Filter	2	0.195
CO	B91	Bark/Wet Wood	Stoker	ESP	5	1.179
CO	B02	Dry Wood	Stoker	Uncontrolled	1	0.779
CO	B03	Dry Wood	Stoker	Uncontrolled	1	0.485
CO	B04	Dry Wood	Stoker	Uncontrolled	1	0.035
CO	B05	Dry Wood	Stoker	Mechanical Collector	1	0.087
CO	B09	Dry Wood	Stoker	Mechanical Collector	2	0.670
CO	B11	Dry Wood	Not Reported	Uncontrolled	1	0.213
CO	B15	Dry Wood	Stoker	Mechanical Collector	1	0.349
CO	B16	Dry Wood	Stoker	Uncontrolled	1	0.410
CO	B19	Dry Wood	Stoker	Mechanical Collector	5	2.556

Step 2
Distribution of CO Data Used in AP-42

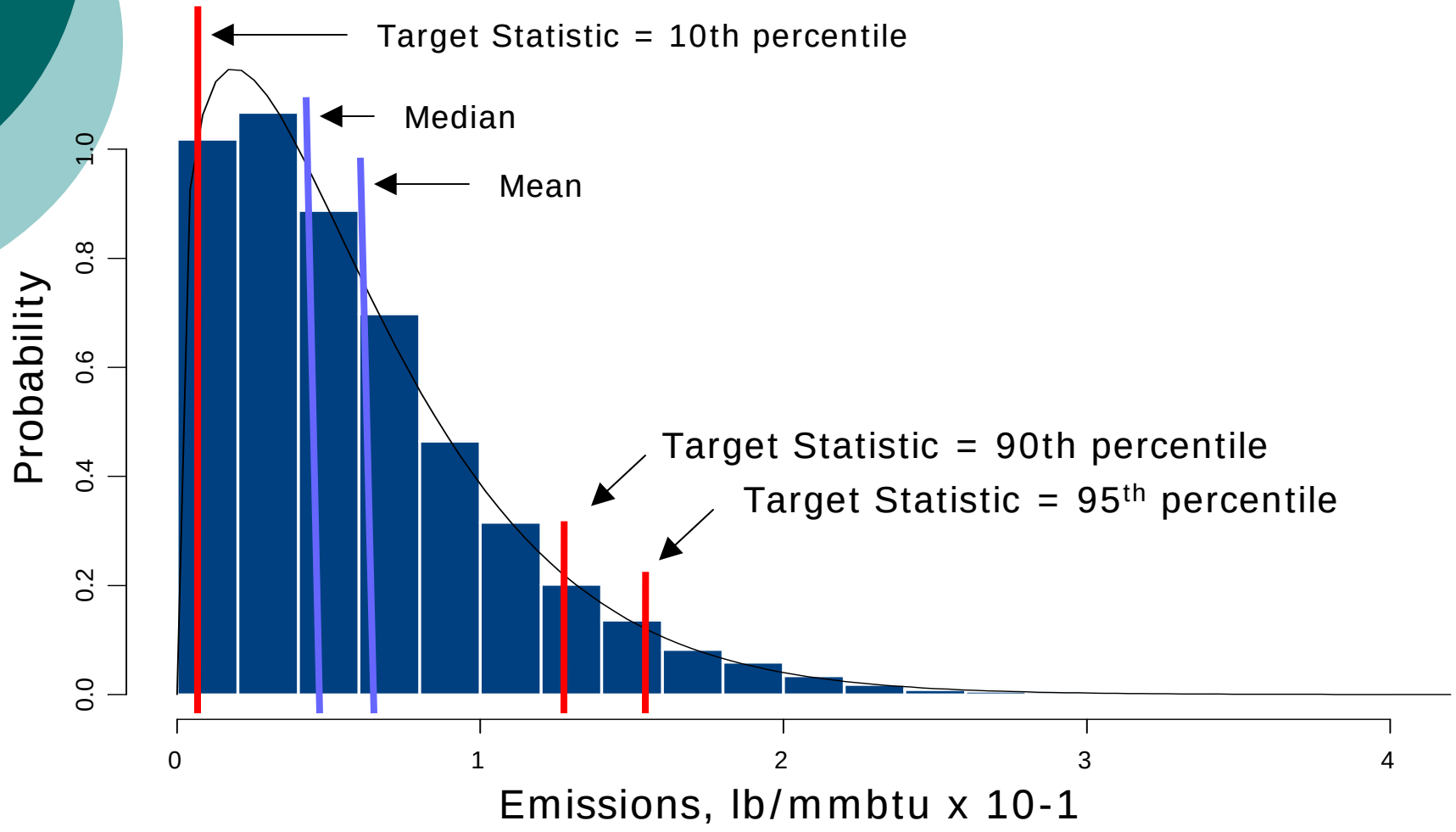


Step 3
PDF (and CDFs)

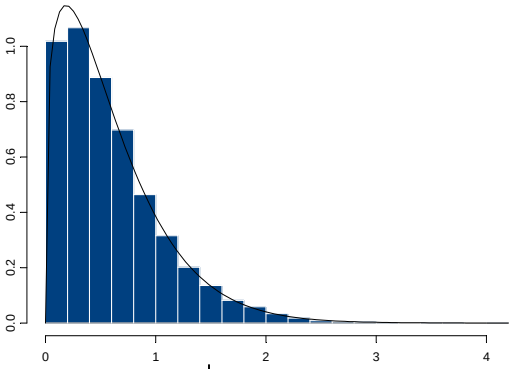


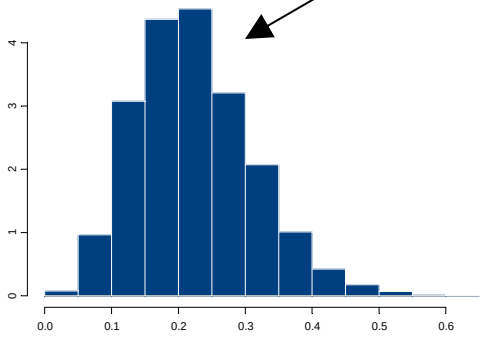


Step 4
Hypothetical CO Population

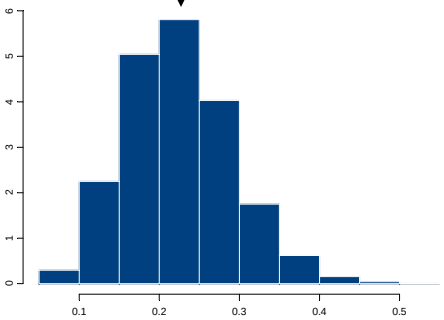


Step 5a
Hypothetical CO Population Sample

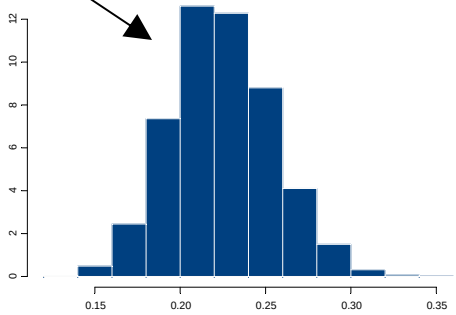




n = 3
10,000 samples



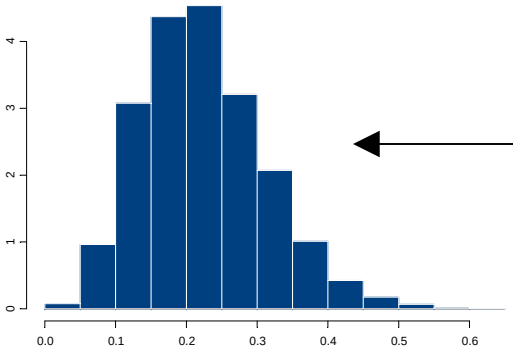
n = 5
10,000 samples

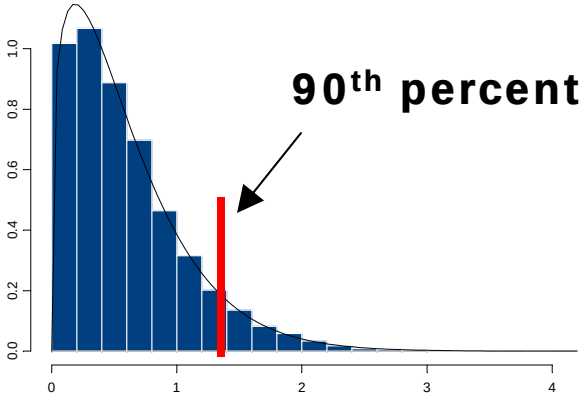


n = 25
10,000 samples

Step 5b - Distribution of Ratios for Selected Target Statistics

EF Distribution
n = 3
10,000 samples

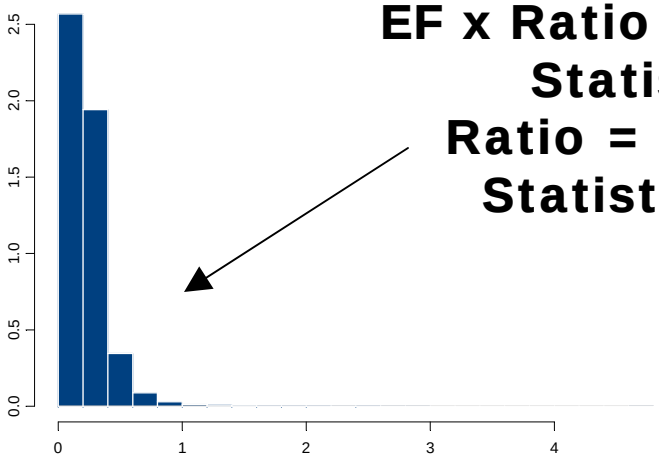


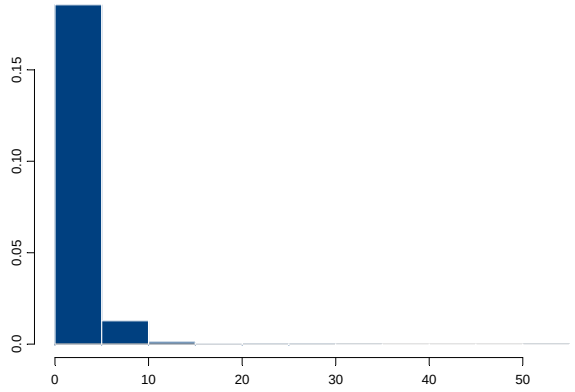


90th percentile

Hypothetical population

10,000 calculations:
EF x Ratio = Target Statistic
Ratio = Target Statistic / EF



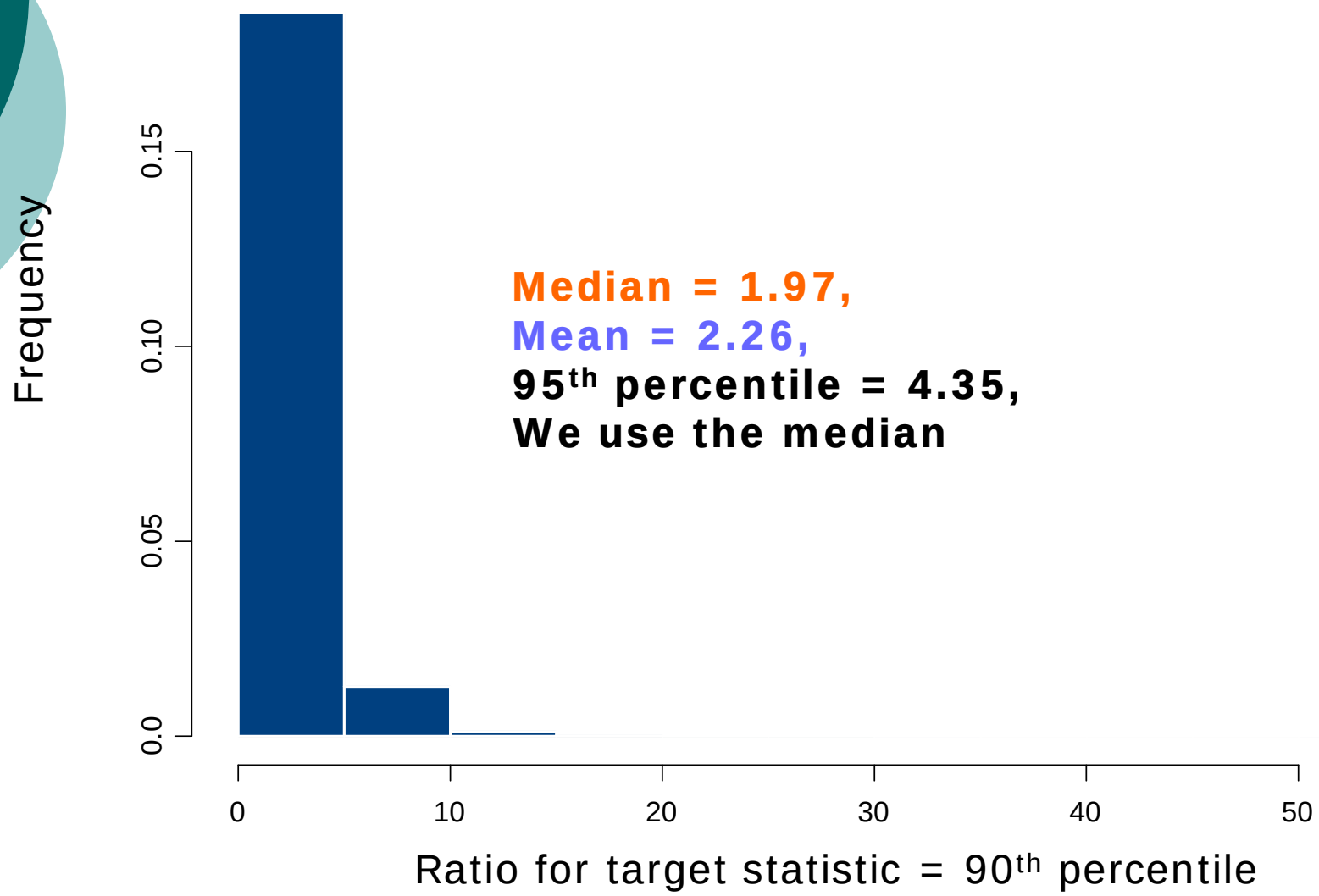


Ratio:
Target statistic = 10th percentile

Ratio:
Target statistic = 90th percentile

Step 6a - Monte Carlo Distribution of Ratios:

Target Statistic = 90th percentile, n=3 Tests



Step 6b
Example Ratios for CO using median

n	Target Statistic				
	Percentile		Mean	Percentile	
	5th	10th		90th	95th
1	0.19	0.30	1.2	2.2	2.7
3	0.17	0.27	1.0	**2.0**	2.4
5	0.16	0.26	1.0	1.9	2.3
25	0.16	**0.26**	1.0	1.9	2.3

- Estimate 90th percentile of true population for n=3:
  Ratio*EF = **2.0***0.6 = 1.2
- Estimate 10th percentile of true population for n=25:
  Ratio*EF = **0.3***0.6 = 0.18

What's in the Uncertainty Assessment? (cont.)

- Peer reviewed statistical analysis of highest rated EFs shows uncertainty dependent on
  - Type of pollutant (gaseous, PM, or HAP)
  - Use of controls (controlled or uncontrolled)
  - Number of emissions tests performed
  - Decision level (percentile appropriate for program)
- Uncertainty reduced with more supporting data (additional emissions tests)
  - Effects diminish after 10 tests

What's in the Uncertainty Assessment? (cont.)

- Expected EF values range

Pollutant	Less than 3 emissions tests		25 or more emissions tests	
	10th percentile	95th percentile	10th percentile	95th percentile
HAP	**0.2** * EF	**13.4** * EF	0.1 * EF	3.9 * EF
PM condensable	0.2 * EF	6.9 * EF	0.1 * EF	3.6 * EF
PM filterable, controlled	0.4 * EF	3.9 * EF	0.3 * EF	2.7 * EF
PM filterable, uncontrolled	0.5 * EF	2.7 * EF	**0.4** * EF	**2.2** * EF
Gaseous criteria pollutants	0.3 * EF	5.4 * EF	0.3 * EF	2.8 * EF

What's in the Uncertainty Assessment? (cont.)

- Comment period extended 3 times – 10/31 is new deadline
- Commenters overly concerned about perceived impact of potential guidance instead of focusing on 6 step process

What's next?

- Respond to comments and finalize uncertainty method
- Begin internal Agency discussions with programs concerning EF use
- Continue updating stakeholders of program progress