UPDATE ON THE DEVELOPMENT OF COTTON GIN $PM_{2.5}$ EMISSION FACTORS FOR EPA'S AP-42

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Abstract

A cotton ginning industry-supported project was initiated in 2008 to update the U.S. Environmental Protection Agency's (EPA) Compilation of Air Pollution Emission Factors (AP-42) to include $PM_{2.5}$ emission factors. This study develops emission factors from the $PM_{2.5}$ emission factor data collected from the industry supported project (hereafter referred to as "National Study") for 17 cotton gin systems and rates their quality using EPA's new Emission Factor Development Procedures (published August 2013). Stack emissions were collected using Method 201a with a PM_{10} and $PM_{2.5}$ cyclone and Method 17 in combination with particle size analysis. Unrepresentative test runs were removed from the National Study dataset if gin operation was erratic, laboratory errors occurred, or if indicated to be an outlier by either of two outlier tests. The remaining test runs were assessed for quality using the EPA's Test Quality Rating Tool and assigned Individual Test Ratings (ITRs).The test runs and ITRs were averaged for each method used at a gin. The averages were used to develop emission factors and their representativeness ratings. This resulted in eight "poorly" and nine "moderately" representative emission factors, and a range of 0.002 (mote trash) to 0.032 lbs. of $PM_{2.5}$ per bale (unloading). While no factors received a rating of "highly representative," having $PM_{2.5}$ emission factors developed from sampled data, as opposed to being estimated from PM_{10} factors, will provide science based data for regulating the industry. Slides used in this presentation are shown in Figure 1.

Acknowledgements

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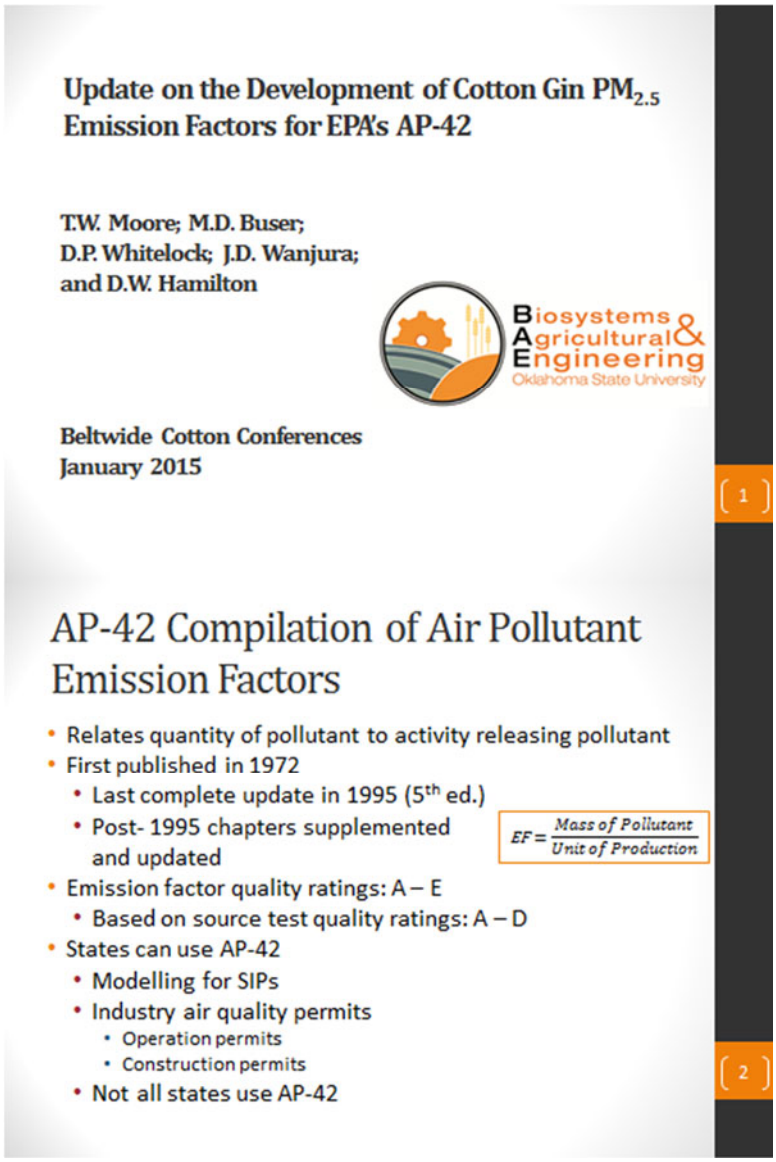
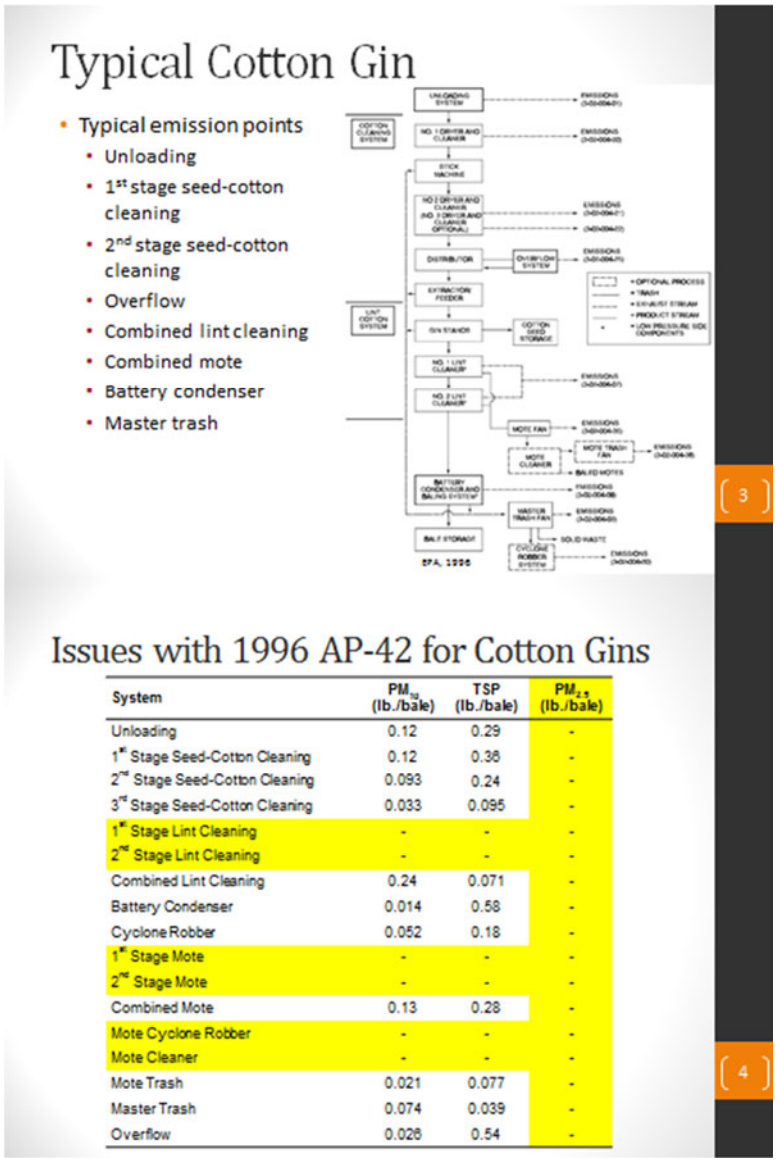


Figure 1. Slides used in the conference presentation.



System	PM_{10} (lb./bale)	TSP (lb./bale)	$PM_{2.5}$ (lb./bale)
Unloading	0.12	0.29	-
1st Stage Seed-Cotton Cleaning	0.12	0.36	-
2nd Stage Seed-Cotton Cleaning	0.093	0.24	-
3rd Stage Seed-Cotton Cleaning	0.033	0.095	-
1st Stage Lint Cleaning	-	-	-
2nd Stage Lint Cleaning	-	-	-
Combined Lint Cleaning	0.24	0.071	-
Battery Condenser	0.014	0.58	-
Cyclone Robber	0.052	0.18	-
1st Stage Mote	-	-	-
2nd Stage Mote	-	-	-
Combined Mote	0.13	0.28	-
Mote Cyclone Robber	-	-	-
Mote Cleaner	-	-	-
Mote Trash	0.021	0.077	-
Master Trash	0.074	0.039	-
Overflow	0.026	0.54	-

Figure 1 (cont.). Slides used in the conference presentation.

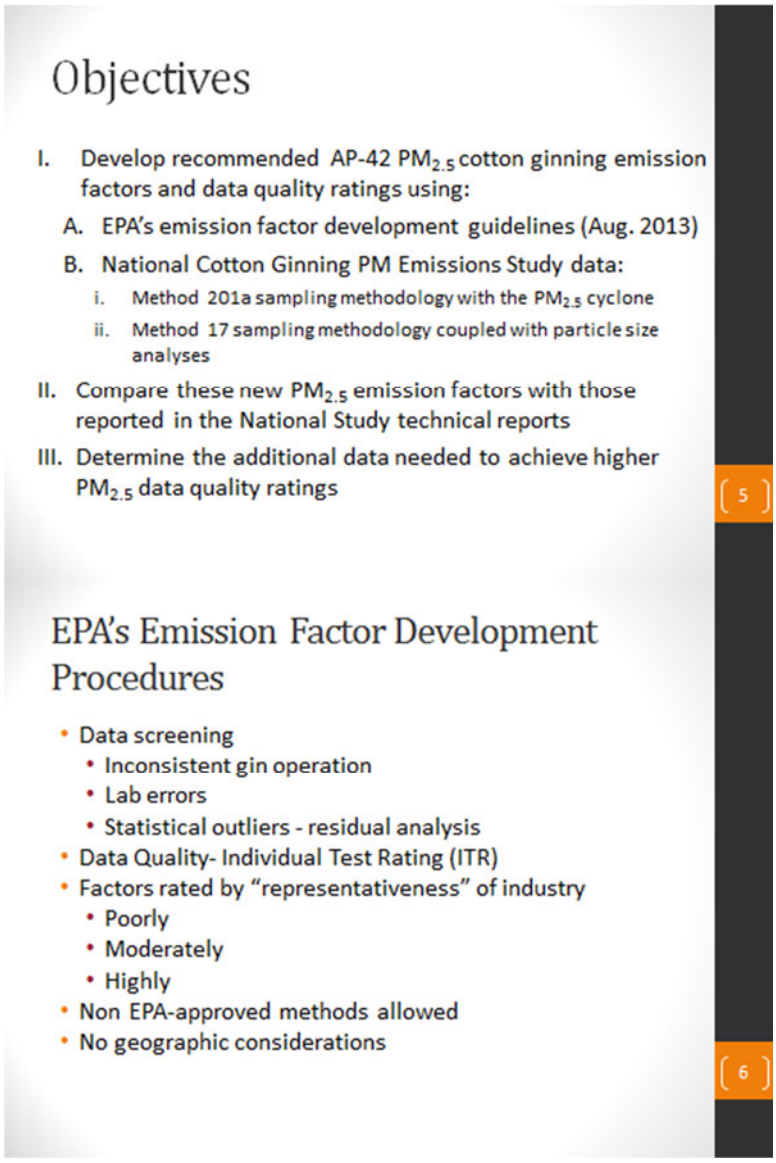
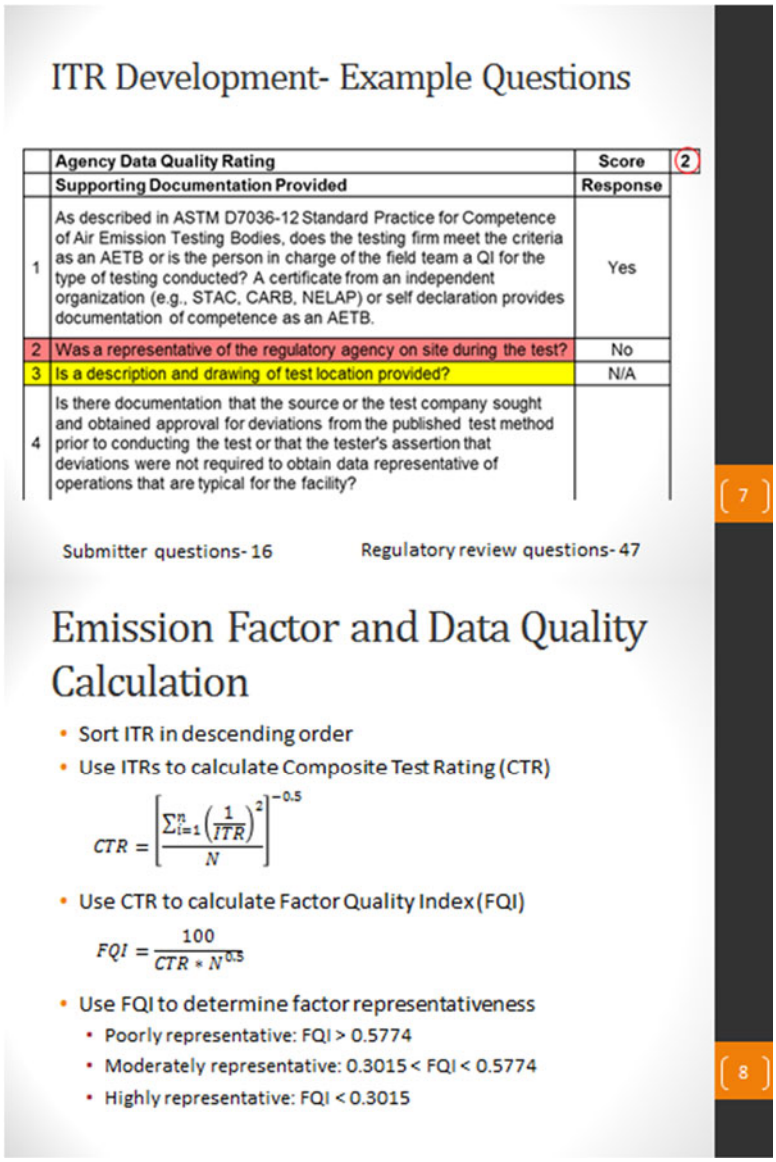


Figure 1 (cont.). Slides used in the conference presentation.



ITR Development- Example Questions

	Agency Data Quality Rating	Score	2
	Supporting Documentation Provided	Response	
1	As described in ASTM D7036-12 Standard Practice for Competence of Air Emission Testing Bodies, does the testing firm meet the criteria as an AETB or is the person in charge of the field team a QI for the type of testing conducted? A certificate from an independent organization (e.g., STAC, CARB, NELAP) or self declaration provides documentation of competence as an AETB.	Yes	
2	Was a representative of the regulatory agency on site during the test?	No	
3	Is a description and drawing of test location provided?	N/A	
4	Is there documentation that the source or the test company sought and obtained approval for deviations from the published test method prior to conducting the test or that the tester's assertion that deviations were not required to obtain data representative of operations that are typical for the facility?		

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Submitter questions- 16 Regulatory review questions- 47

Emission Factor and Data Quality Calculation

- Sort ITR in descending order
- Use ITRs to calculate Composite Test Rating (CTR)

$$CTR = \left[\frac{\sum_{i=1}^{n}\left(\frac{1}{ITR}\right)^2}{N}\right]^{-0.5}$$

- Use CTR to calculate Factor Quality Index (FQI)

$$FQI = \frac{100}{CTR * N^{0.5}}$$

- Use FQI to determine factor representativeness
  - Poorly representative: FQI > 0.5774
  - Moderately representative: 0.3015 < FQI < 0.5774
  - Highly representative: FQI < 0.3015

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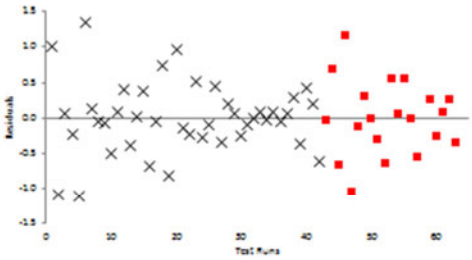
Figure 1 (cont.). Slides used in the conference presentation.

Residual Analysis

- No outliers based on residuals



- No outliers found by ProUCL
- PSD could be combined with EPA-approved methods

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Screening Results

System	Screening Results	ProUCL Results
2nd Stage Seed Cotton Cleaning		(3) Test Runs
1st Stage Lint Cleaning	(1) LE	
Battery Condenser	(1) IGO	(3) Test Runs
Mote Cyclone Robber	(2) IGO	(3) Test Runs
Mote Trash	(1) Outlier	
Total Test Runs	5	9

IGO = Inconsistent gin operation
LE = Lab error
Outlier = Residual test outlier

3.7% of total dataset removed

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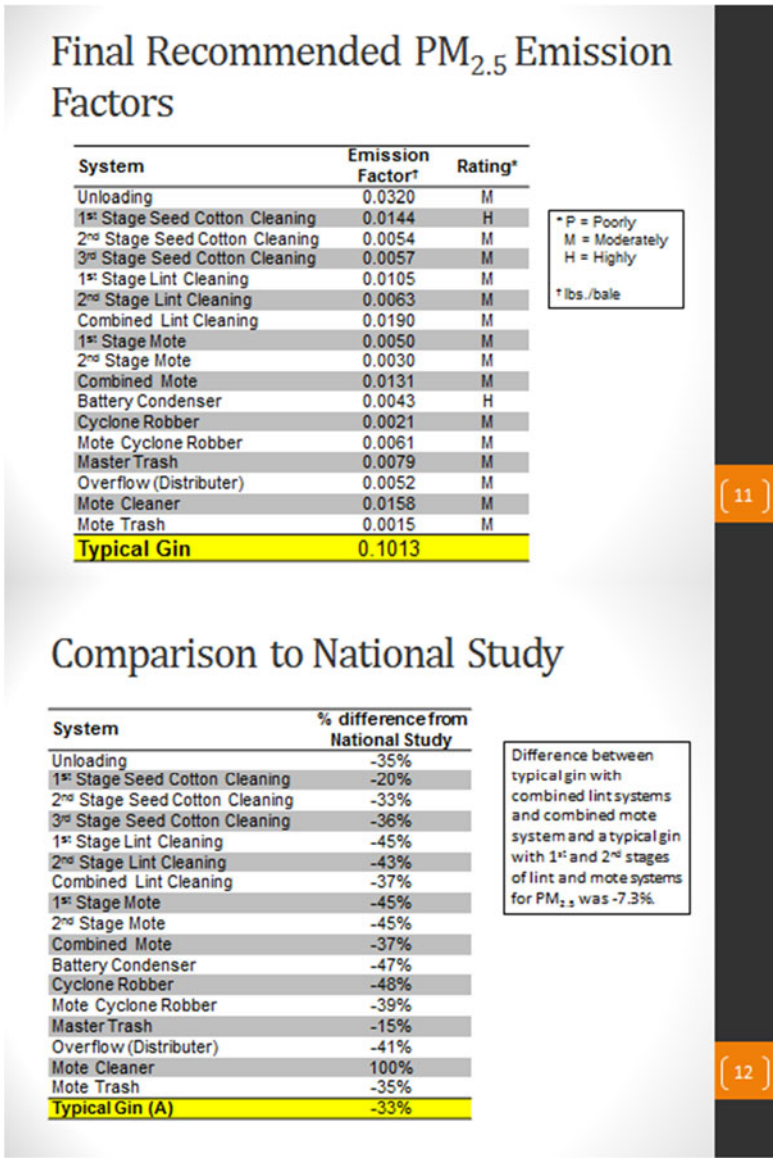
Figure 1 (cont.). Slides used in the conference presentation.



Final Recommended $PM_{2.5}$ Emission Factors

System	Emission Factor†	Rating*
Unloading	0.0320	M
1st Stage Seed Cotton Cleaning	0.0144	H
2nd Stage Seed Cotton Cleaning	0.0054	M
3rd Stage Seed Cotton Cleaning	0.0057	M
1st Stage Lint Cleaning	0.0105	M
2nd Stage Lint Cleaning	0.0063	M
Combined Lint Cleaning	0.0190	M
1st Stage Mote	0.0050	M
2nd Stage Mote	0.0030	M
Combined Mote	0.0131	M
Battery Condenser	0.0043	H
Cyclone Robber	0.0021	M
Mote Cyclone Robber	0.0061	M
Master Trash	0.0079	M
Overflow (Distributer)	0.0052	M
Mote Cleaner	0.0158	M
Mote Trash	0.0015	M
Typical Gin	0.1013	

* P = Poorly
M = Moderately
H = Highly

† lbs./bale

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Comparison to National Study

System	% difference from National Study
Unloading	-35%
1st Stage Seed Cotton Cleaning	-20%
2nd Stage Seed Cotton Cleaning	-33%
3rd Stage Seed Cotton Cleaning	-36%
1st Stage Lint Cleaning	-45%
2nd Stage Lint Cleaning	-43%
Combined Lint Cleaning	-37%
1st Stage Mote	-45%
2nd Stage Mote	-45%
Combined Mote	-37%
Battery Condenser	-47%
Cyclone Robber	-48%
Mote Cyclone Robber	-39%
Master Trash	-15%
Overflow (Distributer)	-41%
Mote Cleaner	100%
Mote Trash	-35%
Typical Gin (A)	-33%

Difference between typical gin with combined lint systems and combined mote system and a typical gin with 1st and 2nd stages of lint and mote systems for $PM_{2.5}$ was -7.3%.

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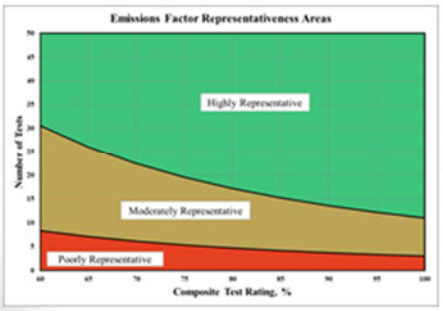
Figure 1 (cont.). Slides used in the conference presentation.

Additional Data Needs to Improve Data Quality

- Tests needed using final CTR
- Moderately representative: $N = 30{,}000 * CTR^{-2}$
- Highly representative: $N = 110{,}000 * CTR^{-2}$



(Eastern Research Group, 2015)

System	Additional N
Unloading	5
1st Stage Seed Cotton Cleaning	-
2nd Stage Seed Cotton Cleaning	2
3rd Stage Seed Cotton Cleaning	7
1st Stage Lint Cleaning	4
2nd Stage Lint Cleaning	5
Combined Lint Cleaning	5
1st Stage Mote	1
2nd Stage Mote	1
Combined Mote	7
Battery Condenser	-
Cyclone Robber	5
Mote Cyclone Robber	6
Master Trash	1
Overflow (Distributer)	3
Mote Cleaner	7
Mote Trash	7
Total	66

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Conclusions

- Six additional systems will be added to the AP-42
- Method 17 coupled with particle size analyses can be merged with the Method 201a data based on residual analyses
- The data quality ratings for the $PM_{2.5}$ emission factors were:
  - 12% highly representative
  - 88% moderately representative
- Comparison of the recommended factors to National Study Technical Reports for a typical cotton gin:
  - 33% lower
- Comparison of recommended factors to 2008 CA $PM_{2.5}$ estimates
  - 87% lower

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Figure 1 (cont.). Slides used in the conference presentation.