UPDATE ON THE DEVELOPMENT OF COTTON GIN PM_{10} 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_{10} emission factors. This study develops emission factors from the PM_{10} 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} cyclone only; 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). ITRs were also calculated for source tests from the current AP-42. 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 seven "moderately" and ten "highly" representative emission factors, and a range of 0.017 (mote trash) to 0.240 lbs. of PM_{10} per bale (combined lint cleaning). These factors greatly improve the quality of the existing AP-42 PM10 emissions factors, which were all rated "D" (below average). Slides used in this presentation are shown in Figure 1.

Acknowledgements

The authors appreciate the cooperating gin managers and personnel who generously allowed and endured sampling at their gins. In addition, we thank California Cotton Ginners' and Growers' Association, Cotton Incorporated, San Joaquin Valleywide Air Pollution Study Agency, Southeastern Cotton Ginners' Association, Southern Cotton Ginners' Association, Texas Cotton Ginners' Association, Texas State Support Committee, and The Cotton Foundation for funding this project. This project was support in-part by the USDA National Institute of Food and Agriculture Hatch Project OKL02882. The authors also thank the Cotton Gin Advisory Group and Air Quality Advisory Group for their involvement and participation in planning, execution, and data analyses for this project that is essential to developing quality data that will be used by industry, regulatory agencies, and the scientific community. The advisory groups included: the funding agencies listed above, California Air Resources Board, Missouri Department of Natural Resources, National Cotton Council, National Cotton Ginners' Association, North Carolina Department of Environment and Natural Resources, San Joaquin Valley Air Pollution Control District, Texas A&M University, Texas Commission on Environmental Quality, USDA-NRCS National Air Quality and Atmospheric Change, and U.S. Environmental Protection Agency (national, Region 4 and 9).

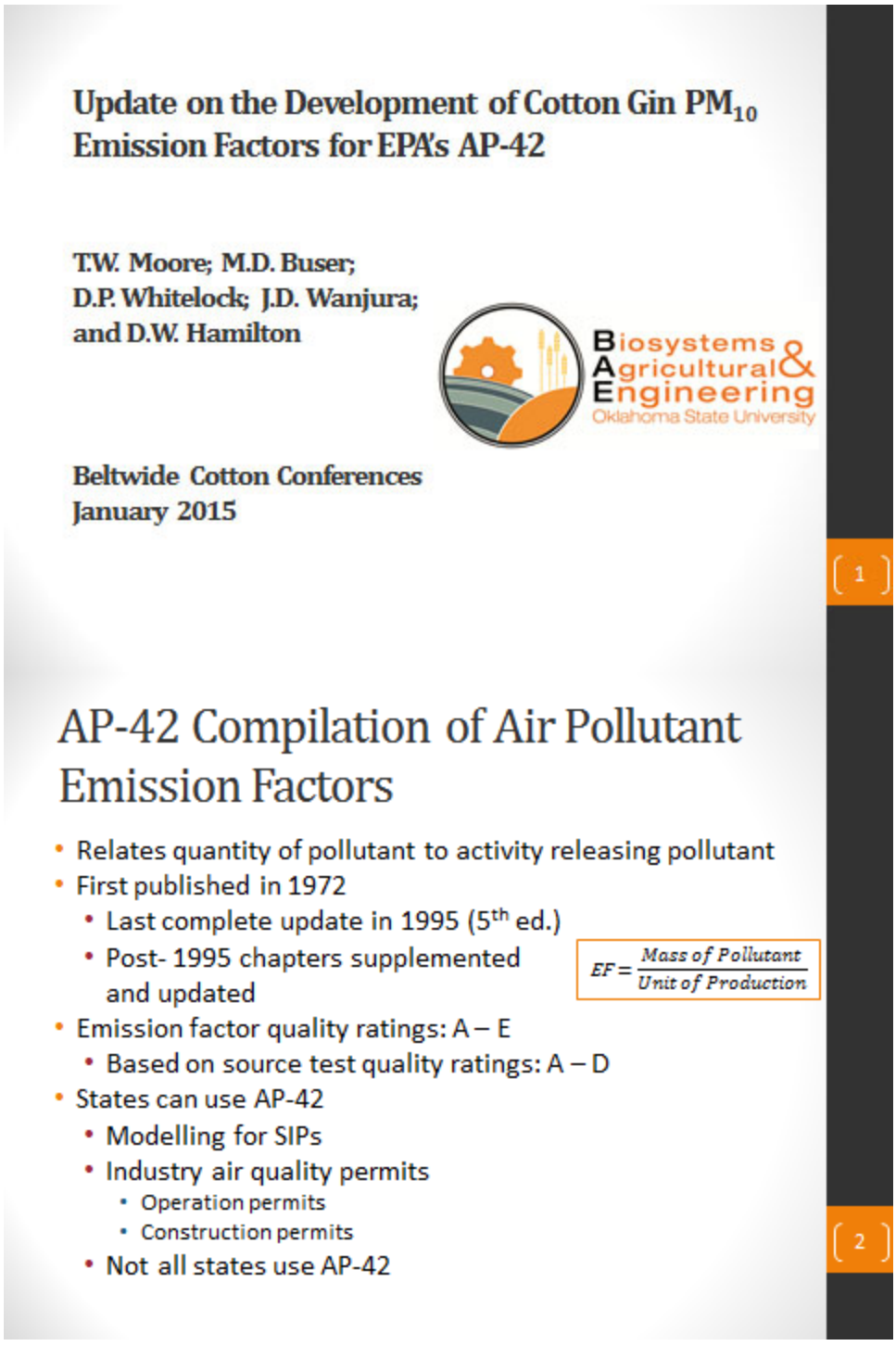
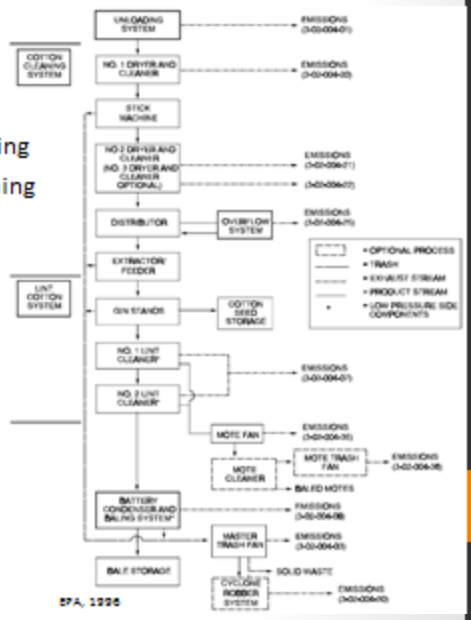


Figure 1. Slides used in the conference presentation.

Typical Cotton Gin

- Typical emission points
  - Unloading
  - 1st stage seed-cotton cleaning
  - 2nd stage seed-cotton cleaning
  - Overflow
  - Combined lint cleaning
  - Combined mote
  - Battery condenser
  - Master trash



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Issues with 1996 AP-42 for Cotton Gins

System	PM_{10} (lb./bale)	Factor Rating
Unloading	0.12	D
1st Stage Seed-Cotton Cleaning	0.12	D
2nd Stage Seed-Cotton Cleaning	0.093	D
3rd Stage Seed-Cotton Cleaning	0.033	D
1st Stage Lint Cleaning	-	-
2nd Stage Lint Cleaning	-	-
Combined Lint Cleaning	0.24	D
Battery Condenser	0.014	D
Cyclone Robber	0.052	D
1st Stage Mote	-	-
2nd Stage Mote	-	-
Combined Mote	0.13	D
Mote Cyclone Robber	-	-
Mote Cleaner	-	-
Mote Trash	0.021	D
Master Trash	0.074	D
Overflow	0.026	D
Typical Gin	**0.82**	

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

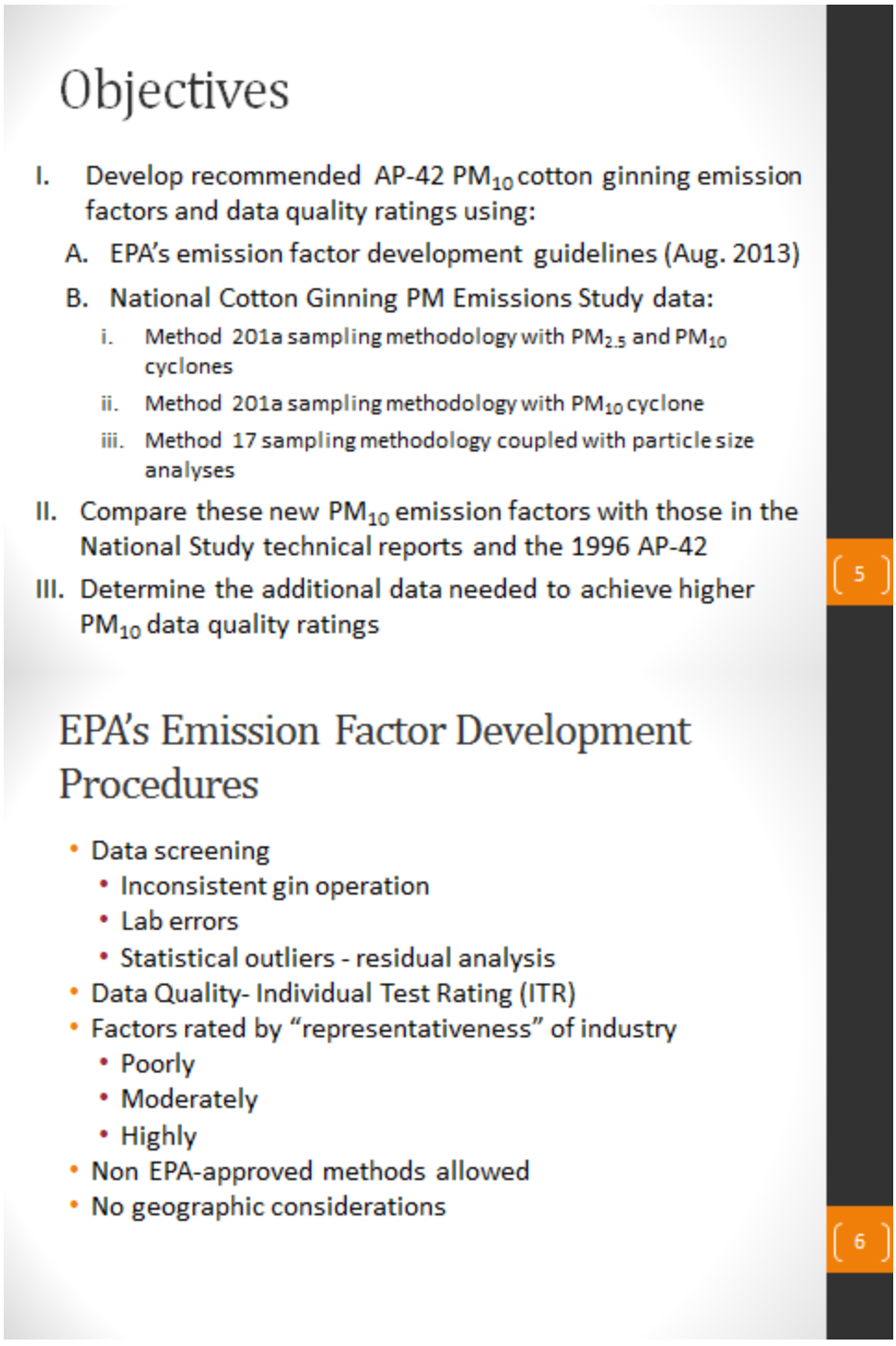

Figure 1 (cont.). Slides used in the conference presentation.

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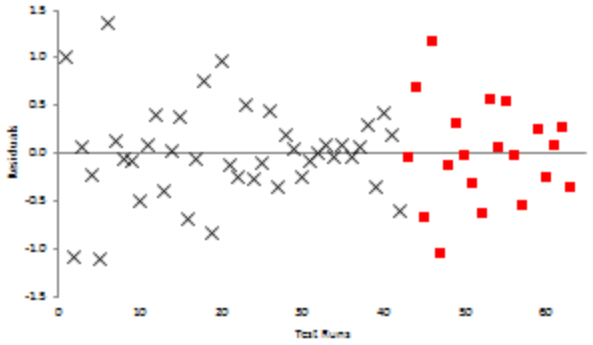
Figure 1 (cont.). Slides used in the conference presentation.

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	Data Screening	ProUCL Results
Unloading	(1) IGO	
1st Stage Lint Cleaning	(1) LE	
2nd Stage Lint Cleaning	(1) IGO	
Combined Lint Cleaning	(1) IGO	
2nd Stage Mote	(1) IGO	
Battery Condenser	(1) IGO	
Cyclone Robber	(1) IGO	(3) Test Runs
Mote Cyclone Robber	(3) IGO	
Master Trash	(1) LE	
Total	11	3

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

2.4% of total dataset removed

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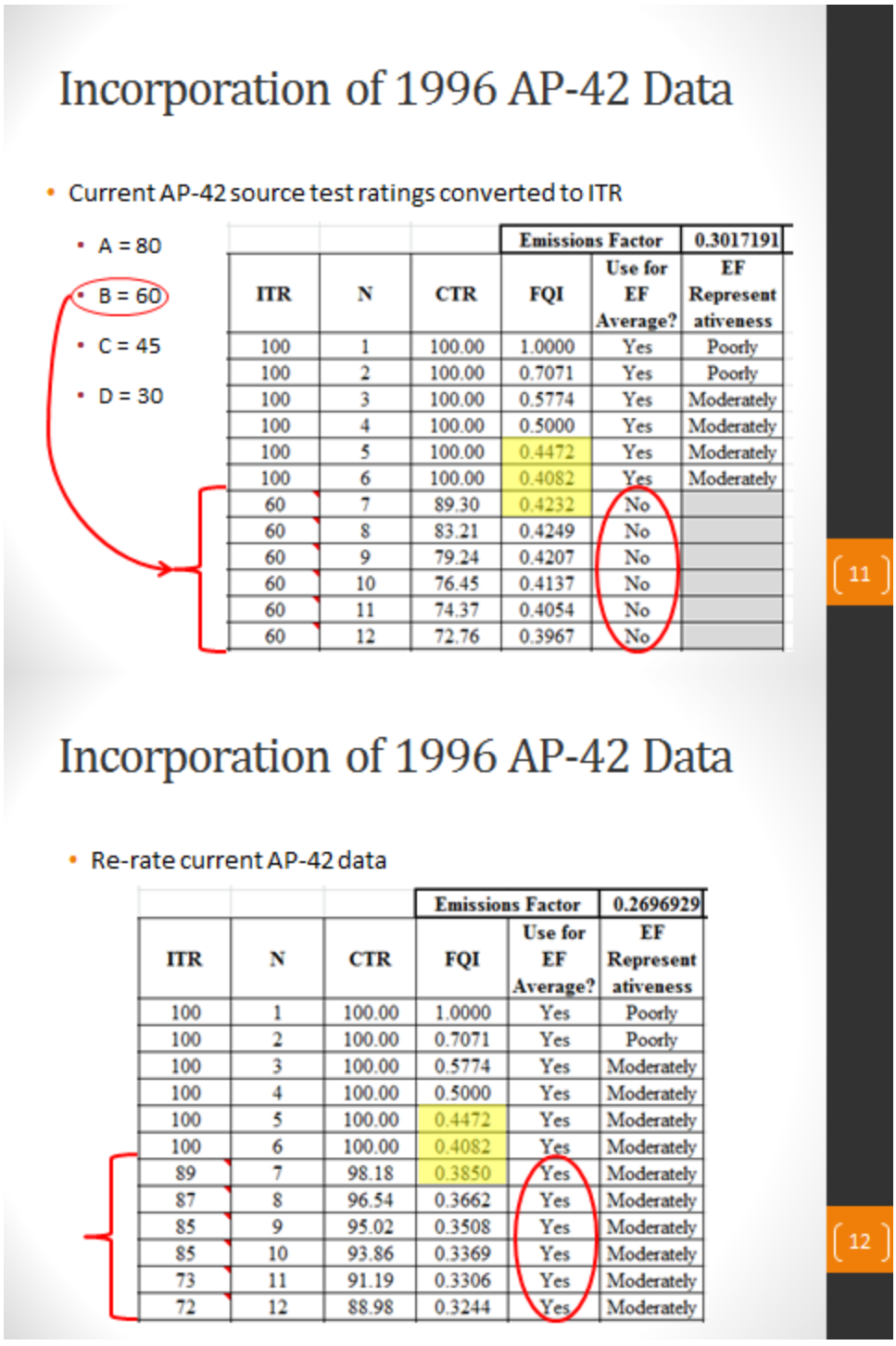
Figure 1 (cont.). Slides used in the conference presentation.



Incorporation of 1996 AP-42 Data

- Current AP-42 source test ratings converted to ITR
  - A = 80
  - B = 60
  - C = 45
  - D = 30

			Emissions Factor	0.3017191	
ITR	N	CTR	FQI	Use for EF Average?	EF Representativeness
100	1	100.00	1.0000	Yes	Poorly
100	2	100.00	0.7071	Yes	Poorly
100	3	100.00	0.5774	Yes	Moderately
100	4	100.00	0.5000	Yes	Moderately
100	5	100.00	0.4472	Yes	Moderately
100	6	100.00	0.4082	Yes	Moderately
60	7	89.30	0.4232	No	
60	8	83.21	0.4249	No	
60	9	79.24	0.4207	No	
60	10	76.45	0.4137	No	
60	11	74.37	0.4054	No	
60	12	72.76	0.3967	No	

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Incorporation of 1996 AP-42 Data

- Re-rate current AP-42 data

			Emissions Factor	0.2696929	
ITR	N	CTR	FQI	Use for EF Average?	EF Representativeness
100	1	100.00	1.0000	Yes	Poorly
100	2	100.00	0.7071	Yes	Poorly
100	3	100.00	0.5774	Yes	Moderately
100	4	100.00	0.5000	Yes	Moderately
100	5	100.00	0.4472	Yes	Moderately
100	6	100.00	0.4082	Yes	Moderately
89	7	98.18	0.3850	Yes	Moderately
87	8	96.54	0.3662	Yes	Moderately
85	9	95.02	0.3508	Yes	Moderately
85	10	93.86	0.3369	Yes	Moderately
73	11	91.19	0.3306	Yes	Moderately
72	12	88.98	0.3244	Yes	Moderately

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

Final Recommended PM_{10} Emission Factors

System	Emission Factor†	Rating*
Unloading	0.1834	H
1st Stage Seed Cotton Cleaning	0.1682	H
2nd Stage Seed Cotton Cleaning	0.0786	H
3rd Stage Seed Cotton Cleaning	0.0398	M
1st Stage Lint Cleaning	0.0820	H
2nd Stage Lint Cleaning	0.0339	M
Combined Lint Cleaning	0.2401	H
1st Stage Mote	0.0365	H
2nd Stage Mote	0.0175	H
Combined Mote	0.1509	M
Battery Condenser	0.0283	H
Cyclone Robber	0.0237	M
Mote Cyclone Robber	0.0511	M
Master Trash	0.1111	H
Overflow (Distributer)	0.0353	H
Mote Cleaner	0.1081	M
Mote Trash	0.0167	M
Typical Gin (A)	**0.9959**	
Typical Gin (B)	**0.7747**	

* M = Moderately
H = Highly

† lbs./bale

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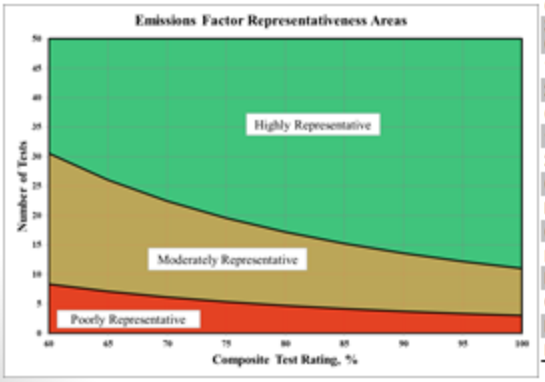
Determine Additional Data Needs

- 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	-
1st Stage Seed Cotton Cleaning	-
2nd Stage Seed Cotton Cleaning	-
3rd Stage Seed Cotton Cleaning	5
1st Stage Lint Cleaning	-
2nd Stage Lint Cleaning	1
Combined Lint Cleaning	-
1st Stage Mote	-
2nd Stage Mote	-
Combined Mote	2
Battery Condenser	-
Cyclone Robber	3
Mote Cyclone Robber	3
Master Trash	-
Overflow (Distributer)	-
Mote Cleaner	5
Mote Trash	4
Total	23

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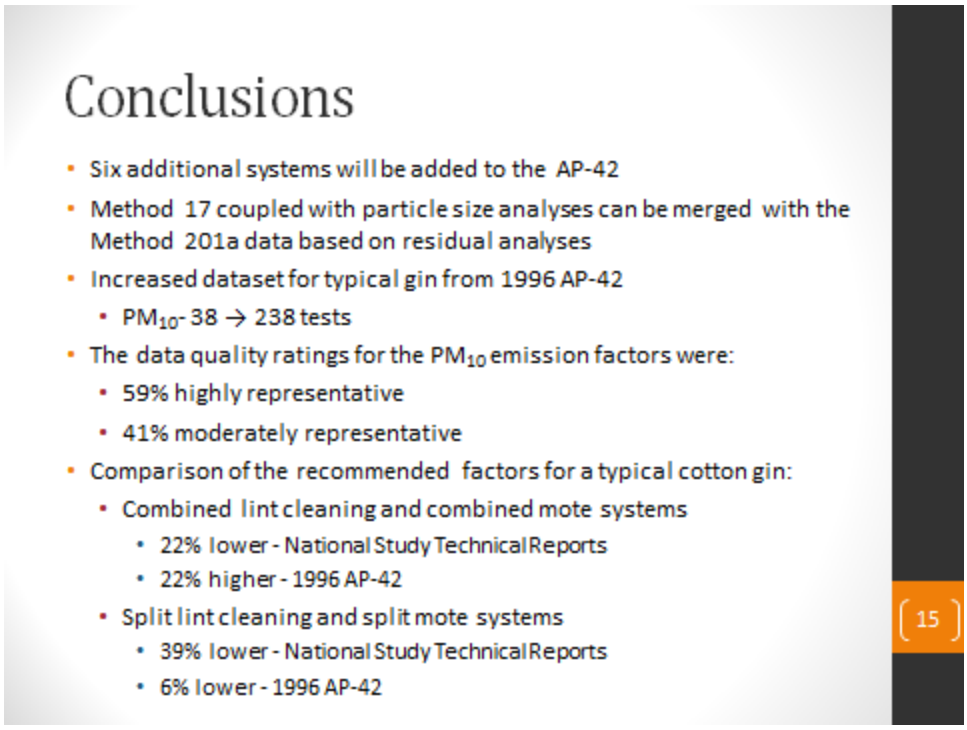
Figure 1 (cont.). Slides used in the conference presentation.



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