EPA's PM Augmentation Procedure

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PM Augmentation

- Describe Problem
- EPA's Fix – PM Augmentation
- Weaknesses of Current PM Aug Methodology
- Suggested Improvements
- EPA Recommendations for Submitters

Definitions

- PM10-FIL
  - filterable particulate matter less than or equal to 10 microns in aerodynamic diameter, usually measured at stack conditions (elevated temperatures)
- PM2.5-FIL
  - filterable particulate matter less than or equal to 2.5 microns in aerodynamic diameter, usually measured at stack conditions (elevated temperatures)
- PM-CON
  - condensible particulate matter, which is matter that exists as a vapor at stack conditions but exists as a liquid or a solid after exiting the stack and cooled by ambient conditions.
- PM10-PRI
  - The sum of PM10-FIL and PM-CON
- PM2.5-PRI
  - The sum of PM2.5-FIL and PM-CON

The Goal

- Consistency among PM species
  - Keeping it real
    - Data needs to make sense
- Completeness in terms of all PM species present for every process

The Problem

- Submitted data can violate certain known physical relationships
  - Example, PM2.5-FIL > PM10-FIL
- PM data submitted to the EPA is sometimes not complete.
  - Missing PM species
    - Example, PM10-PRI only PM pollutant code submitted

Our job

- Resolve apparent errors
- Augment missing PM species
- Note that current methodology only applies to point sources

PM Augmentation Methodology, Resolve Inconsistencies

- First Step is to review submitted data and resolve inconsistencies
  - If PM10-FIL>PM10-PRI, then PM10-PRI is replaced with null
  - If PM2.5-FIL>PM2.5-PRI, then PM2.5-PRI is replaced with null
  - If PM10-FIL+PM-CON>PM10-PRI, then PM10-PRI is replaced with sum of PM10-FIL+PM-CON
  - If PM2.5-FIL+PM-CON>PM2.5-PRI, then PM2.5-PRI is replaced with sum of PM2.5-FIL+PM-CON
  - If PM2.5-PRI>PM10-PRI, then PM10-PRI is replaced with PM2.5-PRI
  - If PM25-FIL> PM10-FIL, PM10-FIL is replaced with PM2.5-FIL

Resolve Inconsistencies, Continued

- If PM-CON>PM2.5-PRI or PM-CON>PM10-PRI, then 2 cases are considered.
  - PM-CON is much higher than PMxx-PRI, which is inconsistent, so if difference is larger than 10%, then PM-CON is replaced with null
  - PM-CON is higher than PMxx-PRI but not by much and might be rounding error, so if difference is by less than 10%, then PM-CON is replaced with PMxx-PRI

Trivial Updates

- Addition and Subtraction based on the definition of filterable and primary.
  - Example, If both PM10-FIL and PM-CON are available, then PM10-PRI = PM10-FIL + PM-CON.

Non-Trivial Updates

- Non-Trivial updates – uses a process based on the PM Calculator, which is an EPA software program (no longer supported) that used particle size information from AP42 to fractionate filterable PM data
  - Appendix B.1
    - PARTICLE SIZE DISTRIBUTION DATA AND SIZED EMISSION FACTORS FOR SELECTED SOURCES
  - Appendix B.2
    - GENERALIZED PARTICLE SIZE DISTRIBUTIONS
  - Are used to convert PM10-FIL to PM25-FIL and vice versa
- Converted PM Calculator information into MS Access® files
  - Need SCC and PM controls
- Also has process to produce records with condensible emissions

1.8 BAGASSE-FIRED BOILER: EXTERNAL COMBUSTION

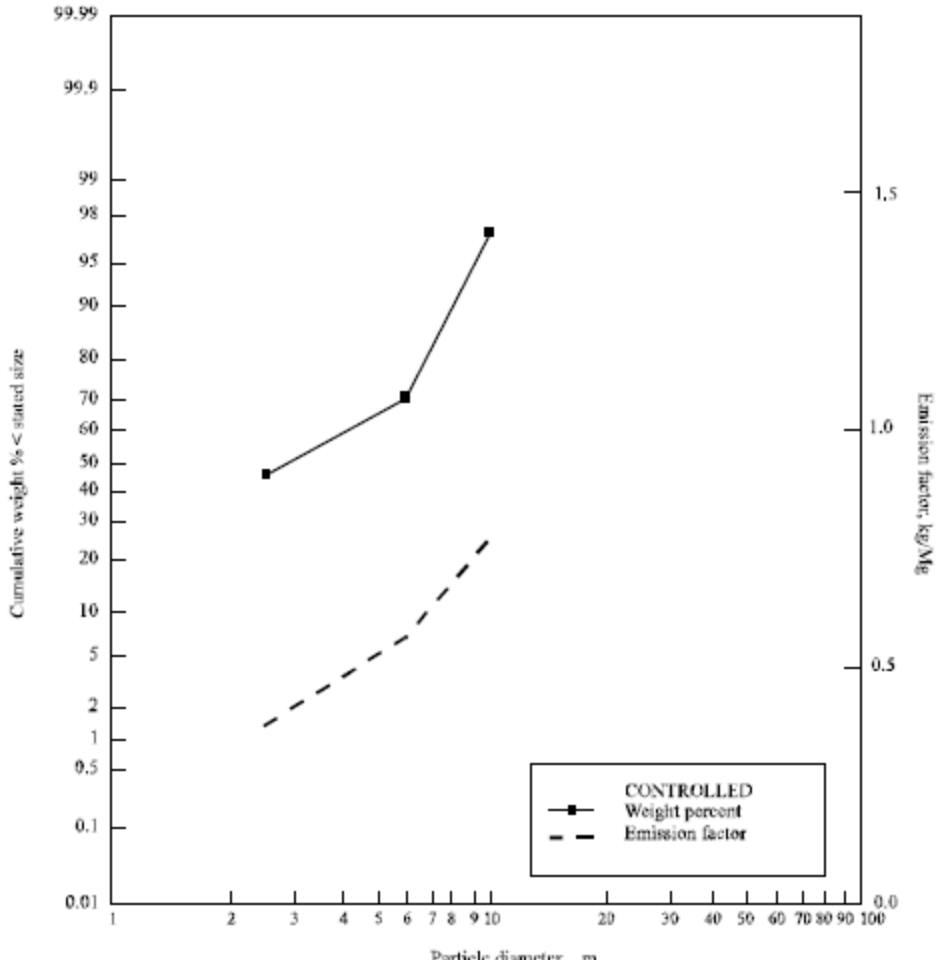


Table B.2-1. PARTICLE SIZE CATEGORY BY AP-42 SECTION

AP-42 Section	Source Category	Category Number*
	External combustion	
1.1	Bituminous and subbituminous coal combustion	a
1.2	Anthracite coal combustion	a
1.3	Fuel oil combustion	
	Residual oil	
	Utility	a
	Commercial	a
	Distillate oil	
	Utility	a
	Commercial	a
	Residential	a
1.4	Natural gas combustion	a
1.5	Liquefied petroleum gas	a
1.6	Wood waste combustion in boilers	a
1.7	Lignite combustion	a
1.8	Bagasse combustion	b
1.9	Residential fireplaces	a
8.5.3	Ammonium phosphates	
	Reactor/ammoniator-granulator	
	Dryer/cooler	
8.7	Hydrofluoric acid	
	Spar drying	
	Spar handling	
	Transfer	
8.9	Phosphoric acid (thermal process)	
8.10	Sulfuric acid	
8.12	Sodium carbonate	
	Food and agricultural	
9.3.1	Defoliation and harvesting of cotton	
	Trailer loading	
	Transport	
9.3.2	Harvesting of grain	
	Harvesting machine	
	Truck loading	
	Field transport	

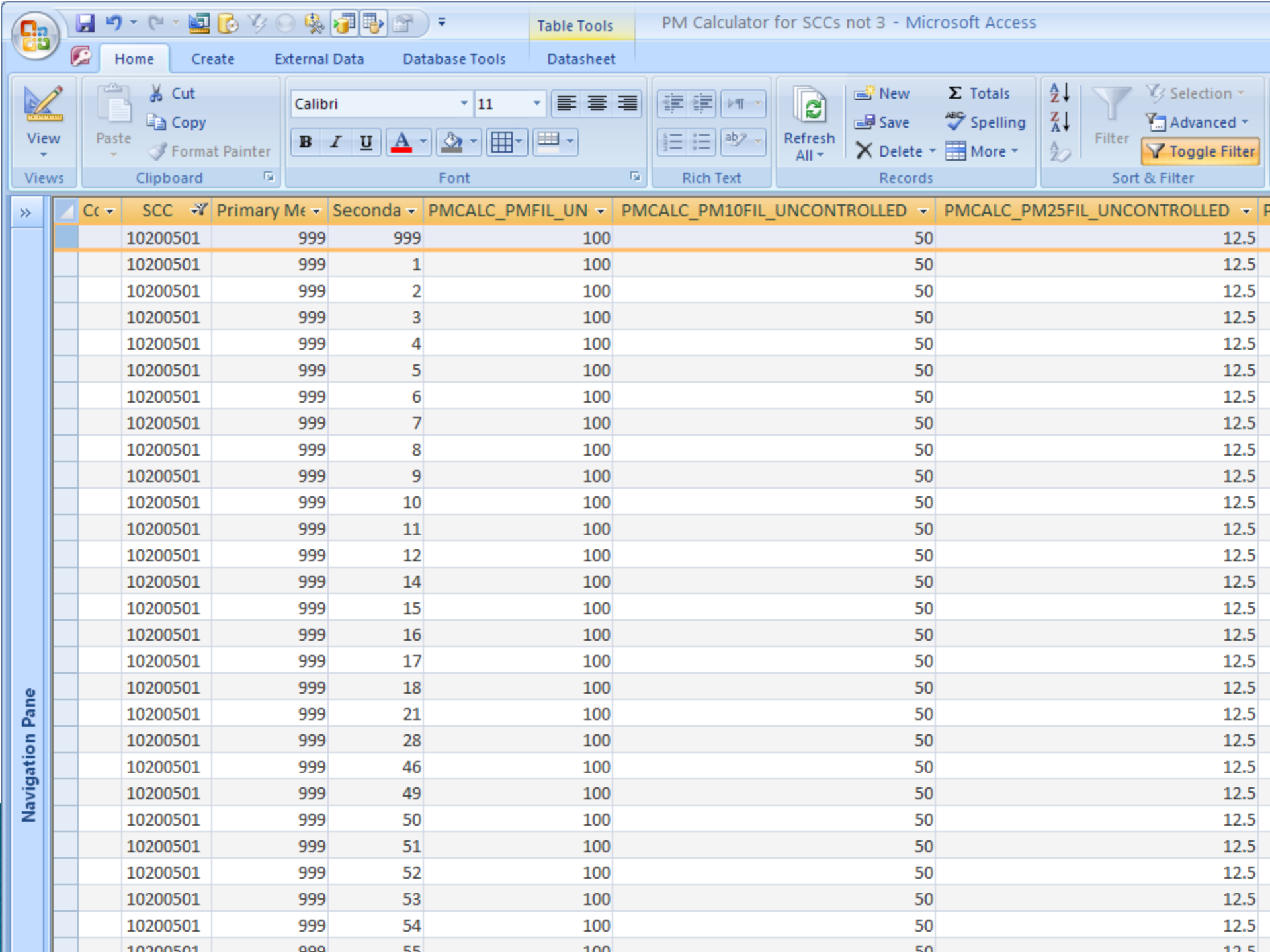
emissions, and controlled size specific emission is shown in Figure B.2-1. A blank Calculation Sheet is provided in Figure B.2-2.

Table B.2-3. TYPICAL COLLECTION EFFICIENCIES OF VARIOUS PARTICULATE CONTROL DEVICES[a]
(%)

AIRS Code[b]	Type Of Collector	Particle Size (μm)		
		0 - 2.5	2.5 - 6	6 - 10
001	Wet scrubber - hi-efficiency	90	95	99
002	Wet scrubber - med-efficiency	25	85	95
003	Wet scrubber - low-efficiency	20	80	90
004	Gravity collector - hi-efficiency	3.6	5	6
005	Gravity collector - med-efficiency	2.9	4	4.8
006	Gravity collector - low-efficiency	1.5	3.2	3.7
007	Centrifugal collector - hi-efficiency	80	95	95
008	Centrifugal collector - med-efficiency	50	75	85
009	Centrifugal collector - low-efficiency	10	35	50
010	Electrostatic precipitator - hi-efficiency	95	99	99.5
011	Electrostatic precipitator - med-efficiency			
	boilers	50	80	94
	other	80	90	97
012	Electrostatic precipitator - low-efficiency			
	boilers	40	70	90
	other	70	80	90
014	Mist eliminator - high velocity >250 FPM	10	75	90
015	Mist eliminator - low velocity <250 FPM	5	40	75

Sample Calculation

- Process = industrial boiler burning distillate oil, reported PM10-FIL emissions of 16.0 tons.
  - SCC = 10200501
  - PM controls = none
- To estimate PM25-FIL, use PM Calculator File, select SCC, and set both primary and secondary controls to “999” (uncontrolled) , get multiplier



Cc	SCC	Primary Me	Seconda	PMCALC_PMFIL_UN	PMCALC_PM10FIL_UNCONTROLLED	PMCALC_PM25FIL_UNCONTROLLED
	10200501	999	999	100	50	12.5
	10200501	999	1	100	50	12.5
	10200501	999	2	100	50	12.5
	10200501	999	3	100	50	12.5
	10200501	999	4	100	50	12.5
	10200501	999	5	100	50	12.5
	10200501	999	6	100	50	12.5
	10200501	999	7	100	50	12.5
	10200501	999	8	100	50	12.5
	10200501	999	9	100	50	12.5
	10200501	999	10	100	50	12.5
	10200501	999	11	100	50	12.5
	10200501	999	12	100	50	12.5
	10200501	999	14	100	50	12.5
	10200501	999	15	100	50	12.5
	10200501	999	16	100	50	12.5
	10200501	999	17	100	50	12.5
	10200501	999	18	100	50	12.5
	10200501	999	21	100	50	12.5
	10200501	999	28	100	50	12.5
	10200501	999	46	100	50	12.5
	10200501	999	49	100	50	12.5
	10200501	999	50	100	50	12.5
	10200501	999	51	100	50	12.5
	10200501	999	52	100	50	12.5
	10200501	999	53	100	50	12.5
	10200501	999	54	100	50	12.5

Sample Calculation, Cont

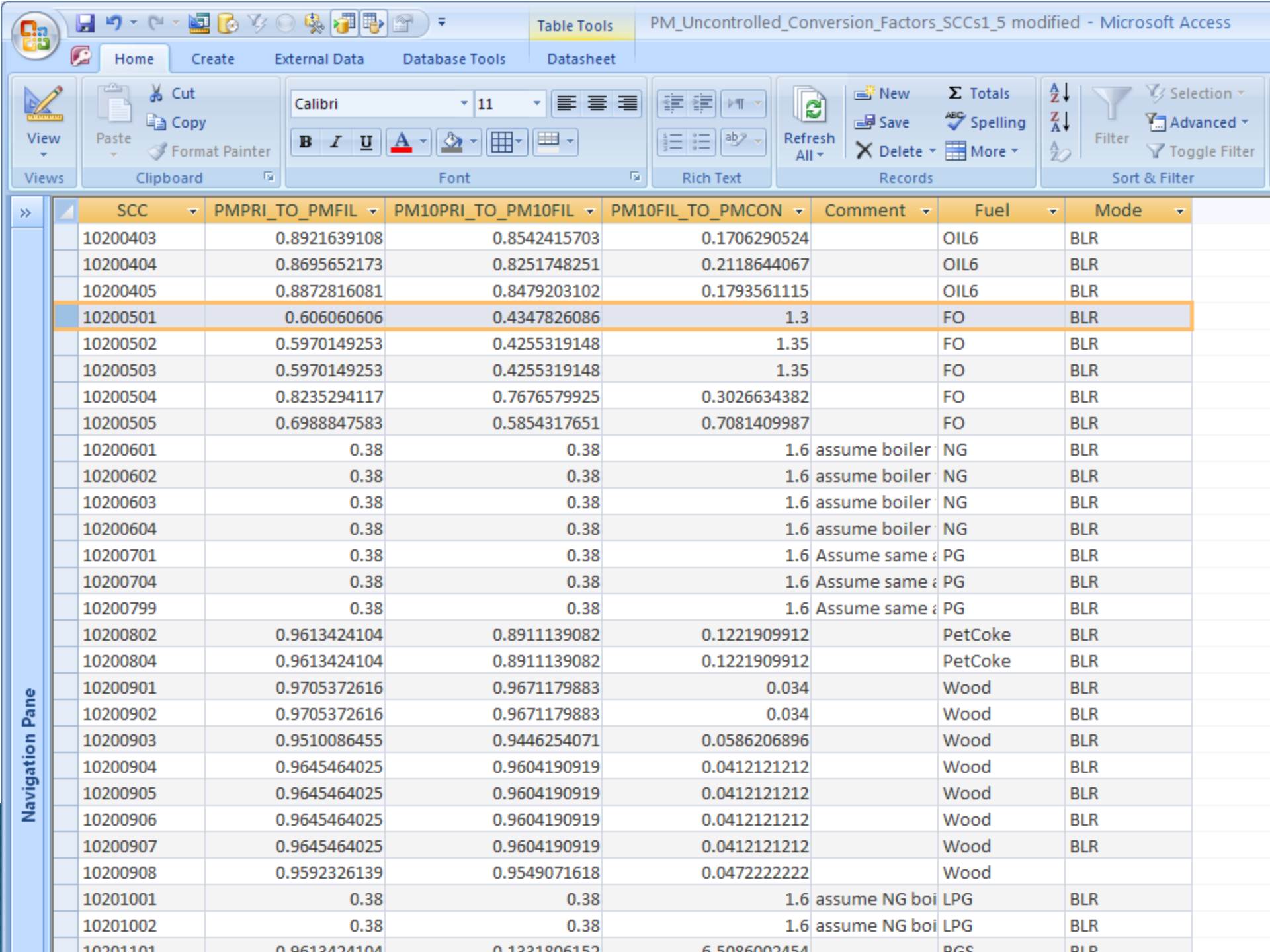
- PM25-FIL = PM10-FIL * conversion factor
- Conversion factor = 12.5/50= 0.25
- 16.0 tons * 0.25 = 4.0 tons

PM Condensibles

- PM calculator only for filterable PM
  - PM-FIL to PM10-FIL and PM25-FIL and vice versa
- For PM condensables, we use AP42 (again)
  - Ratio of Emission Factors to calculate missing PM emissions.
- Example – section 1.3 of AP-42,
  - PM10-FIL emission factor = 1.0 lbs/thousand gallons (table 1.3-6, AP42)
  - PM-CON emission factor = 1.3 lbs/thousand gallons (table 1.3-2, AP42)
  - Multiply PM10-FIL emissions by the ratio of PM-CON to PM10-FIL will get you PM-CON

Sample Calculation using Condensables

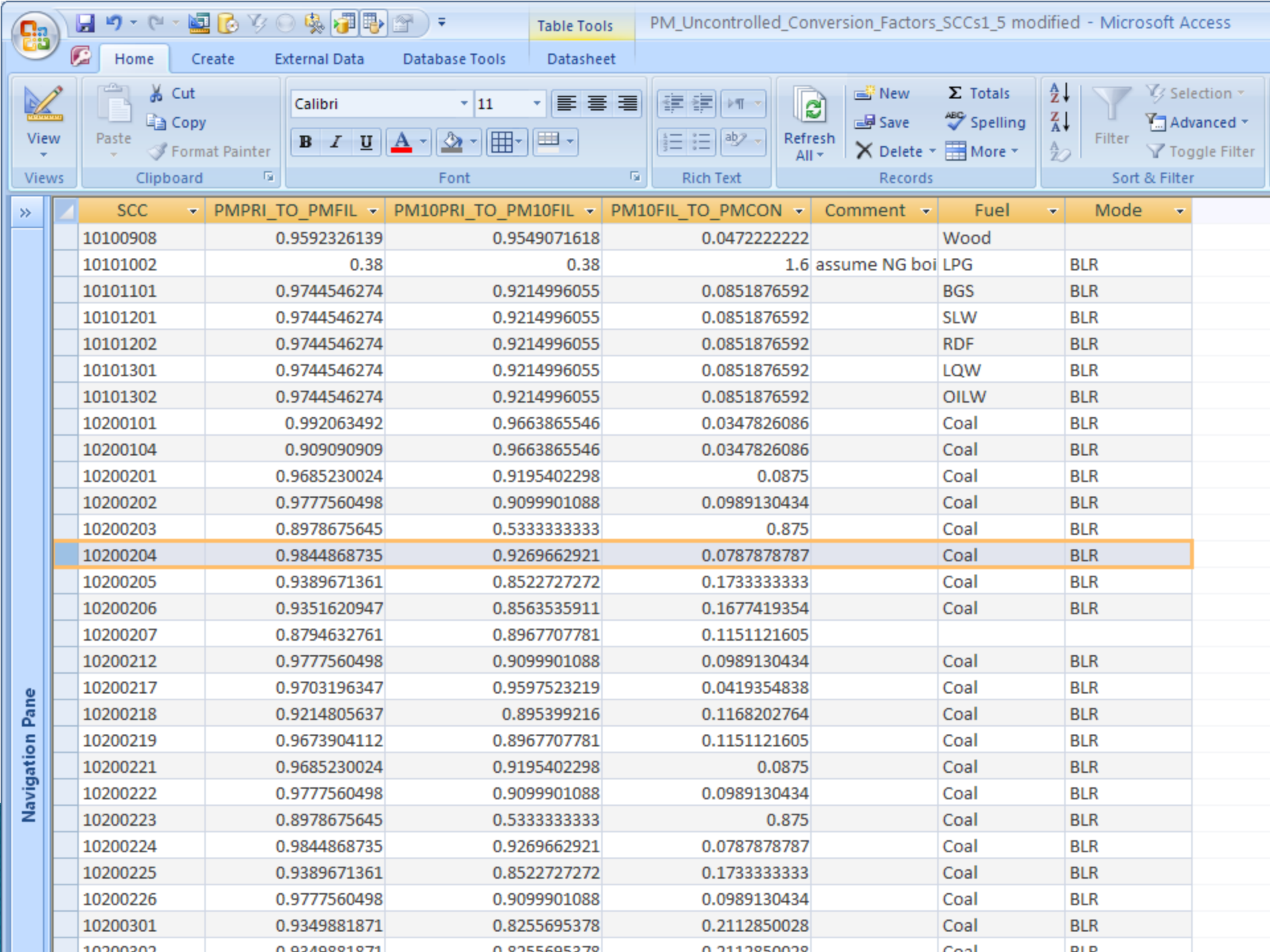
- PM10-FIL Emissions* (PM-CON EF/PM10-FIL EF) = PM-CON Emissions
- 16.0 tons * 1.3/1.0 = 20.8 tons
- PM-CON + PM10-FIL = PM10-PRI
- 20.8 + 16.0 = 36.8 tons
- PM-CON + PM25-FIL = PM25-PRI
- 20.8 + 4.0 = 24.8 tons



SCC	PMPRI_TO_PMFIL	PM10PRI_TO_PM10FIL	PM10FIL_TO_PMCON	Comment	Fuel	Mode
10200403	0.8921639108	0.8542415703	0.1706290524		OIL6	BLR
10200404	0.8695652173	0.8251748251	0.2118644067		OIL6	BLR
10200405	0.8872816081	0.8479203102	0.1793561115		OIL6	BLR
10200501	0.606060606	0.4347826086	1.3		FO	BLR
10200502	0.5970149253	0.4255319148	1.35		FO	BLR
10200503	0.5970149253	0.4255319148	1.35		FO	BLR
10200504	0.8235294117	0.7676579925	0.3026634382		FO	BLR
10200505	0.6988847583	0.5854317651	0.7081409987		FO	BLR
10200601	0.38	0.38	1.6	assume boiler	NG	BLR
10200602	0.38	0.38	1.6	assume boiler	NG	BLR
10200603	0.38	0.38	1.6	assume boiler	NG	BLR
10200604	0.38	0.38	1.6	assume boiler	NG	BLR
10200701	0.38	0.38	1.6	Assume same a	PG	BLR
10200704	0.38	0.38	1.6	Assume same a	PG	BLR
10200799	0.38	0.38	1.6	Assume same a	PG	BLR
10200802	0.9613424104	0.8911139082	0.1221909912		PetCoke	BLR
10200804	0.9613424104	0.8911139082	0.1221909912		PetCoke	BLR
10200901	0.9705372616	0.9671179883	0.034		Wood	BLR
10200902	0.9705372616	0.9671179883	0.034		Wood	BLR
10200903	0.9510086455	0.9446254071	0.0586206896		Wood	BLR
10200904	0.9645464025	0.9604190919	0.0412121212		Wood	BLR
10200905	0.9645464025	0.9604190919	0.0412121212		Wood	BLR
10200906	0.9645464025	0.9604190919	0.0412121212		Wood	BLR
10200907	0.9645464025	0.9604190919	0.0412121212		Wood	BLR
10200908	0.9592326139	0.9549071618	0.0472222222		Wood	
10201001	0.38	0.38	1.6	assume NG boi	LPG	BLR
10201002	0.38	0.38	1.6	assume NG boi	LPG	BLR
10201101	0.9613424104	0.1221906152	6.5086002454		PGS	BLR

Another Example

- Spreader Stoker Industrial Boiler burning coal (SCC=10200204), reports 67 tons of PM10-PRI, need rest of PM species



SCC	PMPRI_TO_PMFIL	PM10PRI_TO_PM10FIL	PM10FIL_TO_PMCON	Comment	Fuel	Mode
10100908	0.9592326139	0.9549071618	0.0472222222		Wood	
10101002	0.38	0.38	1.6	assume NG boi	LPG	BLR
10101101	0.9744546274	0.9214996055	0.0851876592		BGS	BLR
10101201	0.9744546274	0.9214996055	0.0851876592		SLW	BLR
10101202	0.9744546274	0.9214996055	0.0851876592		RDF	BLR
10101301	0.9744546274	0.9214996055	0.0851876592		LQW	BLR
10101302	0.9744546274	0.9214996055	0.0851876592		OILW	BLR
10200101	0.992063492	0.9663865546	0.0347826086		Coal	BLR
10200104	0.909090909	0.9663865546	0.0347826086		Coal	BLR
10200201	0.9685230024	0.9195402298	0.0875		Coal	BLR
10200202	0.9777560498	0.9099901088	0.0989130434		Coal	BLR
10200203	0.8978675645	0.5333333333	0.875		Coal	BLR
10200204	0.9844868735	0.9269662921	0.0787878787		Coal	BLR
10200205	0.9389671361	0.8522727272	0.1733333333		Coal	BLR
10200206	0.9351620947	0.8563535911	0.1677419354		Coal	BLR
10200207	0.8794632761	0.8967707781	0.1151121605			
10200212	0.9777560498	0.9099901088	0.0989130434		Coal	BLR
10200217	0.9703196347	0.9597523219	0.0419354838		Coal	BLR
10200218	0.9214805637	0.895399216	0.1168202764		Coal	BLR
10200219	0.9673904112	0.8967707781	0.1151121605		Coal	BLR
10200221	0.9685230024	0.9195402298	0.0875		Coal	BLR
10200222	0.9777560498	0.9099901088	0.0989130434		Coal	BLR
10200223	0.8978675645	0.5333333333	0.875		Coal	BLR
10200224	0.9844868735	0.9269662921	0.0787878787		Coal	BLR
10200225	0.9389671361	0.8522727272	0.1733333333		Coal	BLR
10200226	0.9777560498	0.9099901088	0.0989130434		Coal	BLR
10200301	0.9349881871	0.8255695378	0.2112850028		Coal	BLR

Coal Fired Boiler

- PM10-PRI * conversion factor = PM10-FIL
- 67 tons * 0.926966 = 62.1tons

- (PM10-PRI) – (PM10-FIL) = PM-CON
- 67 – 62.1 =4.9 tons

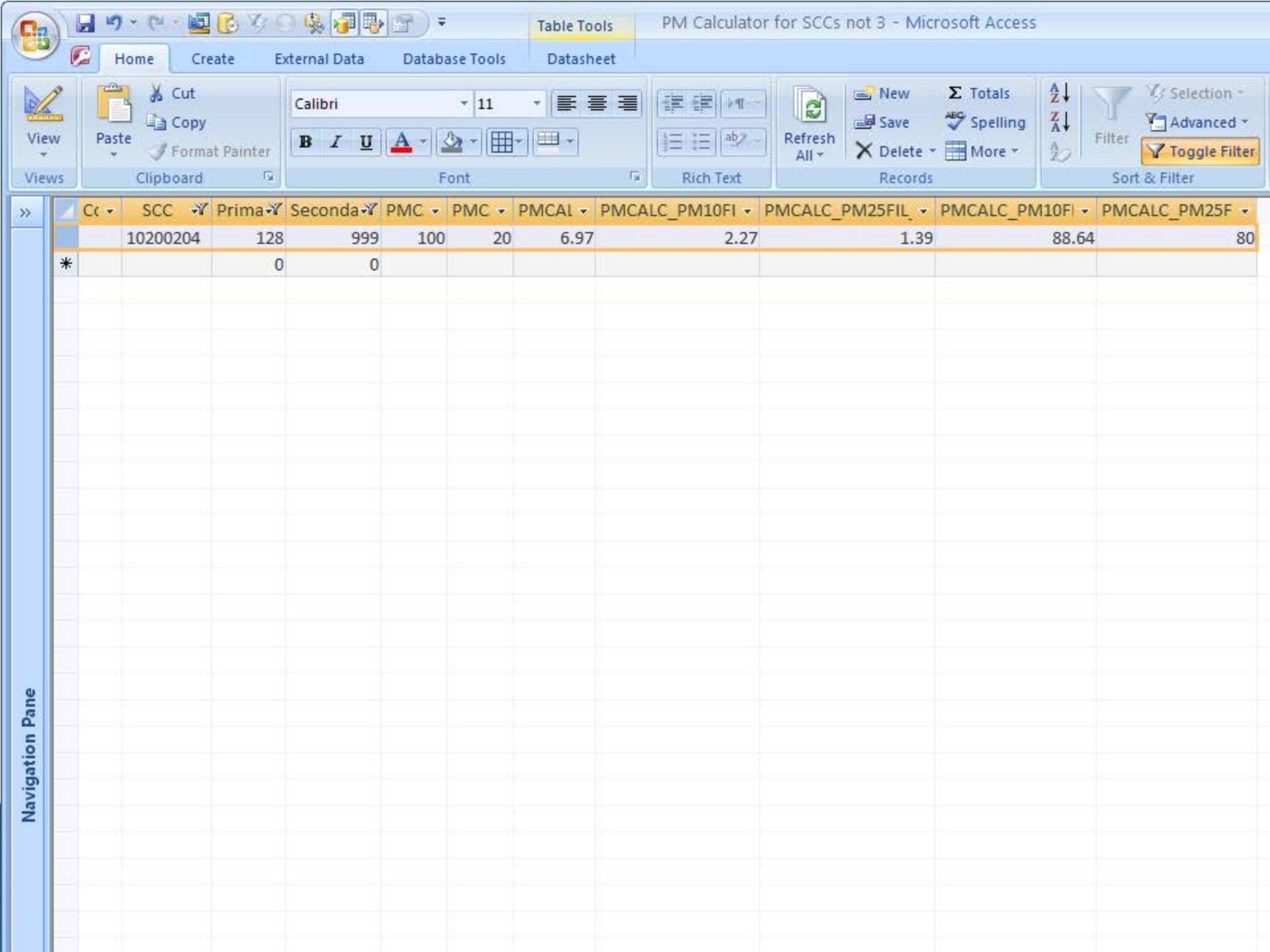


Table Tools
PM Calculator for SCCs not 3 - Microsoft Access
Home
Create
External Data
Database Tools
Datasheet
View
Paste
Cut
Copy
Format Painter
Views
Clipboard
Calibri
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Font
Rich Text
Refresh All
New
Save
Delete
Totals
Spelling
More
Records
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Advanced
Toggle Filter
Sort & Filter
Navigation Pane
Cc
SCC
Prima
Seconda
PMC
PMC
PMCAl
PMCALC_PM10FI
PMCALC_PM25FIL
PMCALC_PM10FI
PMCALC_PM25F
10200204
128
999
100
20
6.97
2.27
1.39
88.64
80
0
0

Left overs

- SCC coverage is not 100%, so records remain null after procedure
- To ensure that all PM10-PRI and PM25-PRI records are populated, we fill in remaining null records as follows

Pollutant with Null Record	Gap-filling Priority List (Null Record Set Equal to First Non-null Value in List)
PM2.5-PRI	1. PM2.5-FIL 2. PM10-PRI 3. PM10-FIL 4. PM-CON
PM10-PRI	1. PM10-FIL 2. PM2.5-PRI

Batch Processing Tool

- EPA Contractor has built batch processing tool that performs the tasks described in this presentation
  - Pre-screening of data and self consistency checks
  - Trivial updates
  - Non-trivial updates
  - Repeat self consistency checks
- MS Access Tool
  - Not available for public use

PM Augmentation Assumptions and Shortcomings

- PM Augmentation uses AP42 emission factors to create other PM species
  - Natural gas corrections have been made
- PM Augmentation uses EPA default values for control efficiencies
- Only 2 control devices were considered
- For coal, assumes ash content of 8%
- SCC coverage is not 100%
  - Remaining null values filled in with other data
- When deriving PM species containing condensables, potential for underestimate of PMxx-PRI and PM-CON
  - Mostly affect coal combustion

Future Improvements (if resources are available)

- Improve SCC coverage for Point
- Expand utility of Tool to Include Nonpoint Sources
- Improve Batch Processing Tool

Recommendations to Submitters

- As a minimum, Submit PMxx-FIL and PM-CON only
- Or PMxx-PRI and PM-CON only
- Let us do the simple math