IOM

WORKING FOR A HEALTHIER FUTURE

eteam Project: Results of external validation exercise

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Aim of external evaluation

1. Determine whether Tier 1 tools are predictive of measured exposures over a range of situations
2. Determine whether Tier 1 tools are conservative

Available measured data

- Range of providers
  - from various countries
  - covering various exposure types and agents
  - inhalation exposure
- Three formats
  - Individual data points (1 or more measurement for each situation)
  - Aggregate exposure data (GM, GSD) for a single situation (type 1)
  - Aggregate exposure data (GM, GSD) across a range of situations (type 2)
- Separate comparison for each data format

Statistical analyses

- Plots of tool predictions against measurements
  - Individual data points against tool predictions
  - AM of measurements against tool predictions
  - AM of measurements against AM of tool predictions
- Ratio of the measurement data over the tool predictions (on log-scale)
- By
  - Tool
  - Data provider
  - Exposure type
  - PROC

Some differences between tools

- ECETOC TRAv2
  - Concentration adjustment for liquids only (not for dusts)
  - Exposure duration taken into account
- ECETOC TRAv3
  - Concentration adjustment for solids and liquids
  - Exposure duration taken into account
- MEASE
  - Concentration adjustment for solids, liquids & aqueous solutions
  - Exposure duration taken into account

Some differences between tools

- EMKG-EXPO-tool
  - No concentration adjustment
  - No adjustment duration of exposure
  - No option for absence of RMMs. If none present, lowest control approach was chosen (general ventilation)
- Stoffenmanager v 4.5
  - Concentration adjustment for liquids only (not for dust)
  - No adjustment for duration of exposure

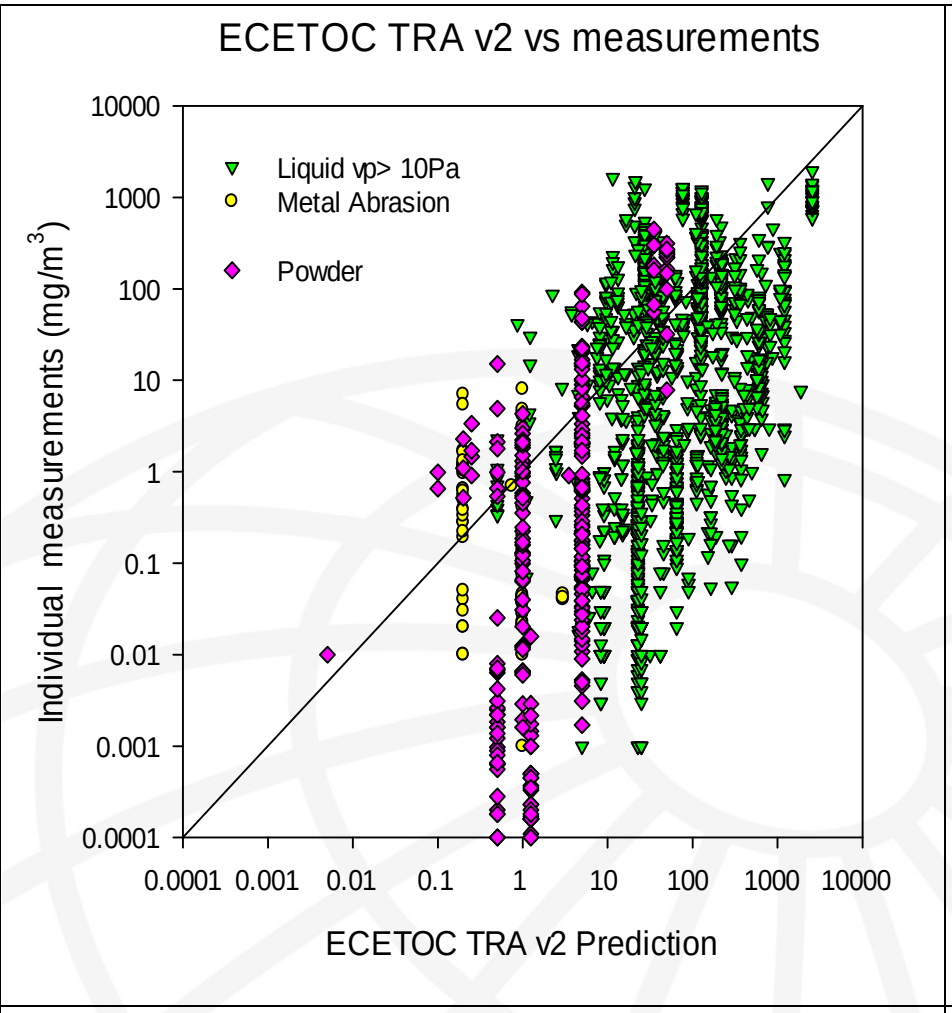
Comparison of tool estimates with individual measurement data

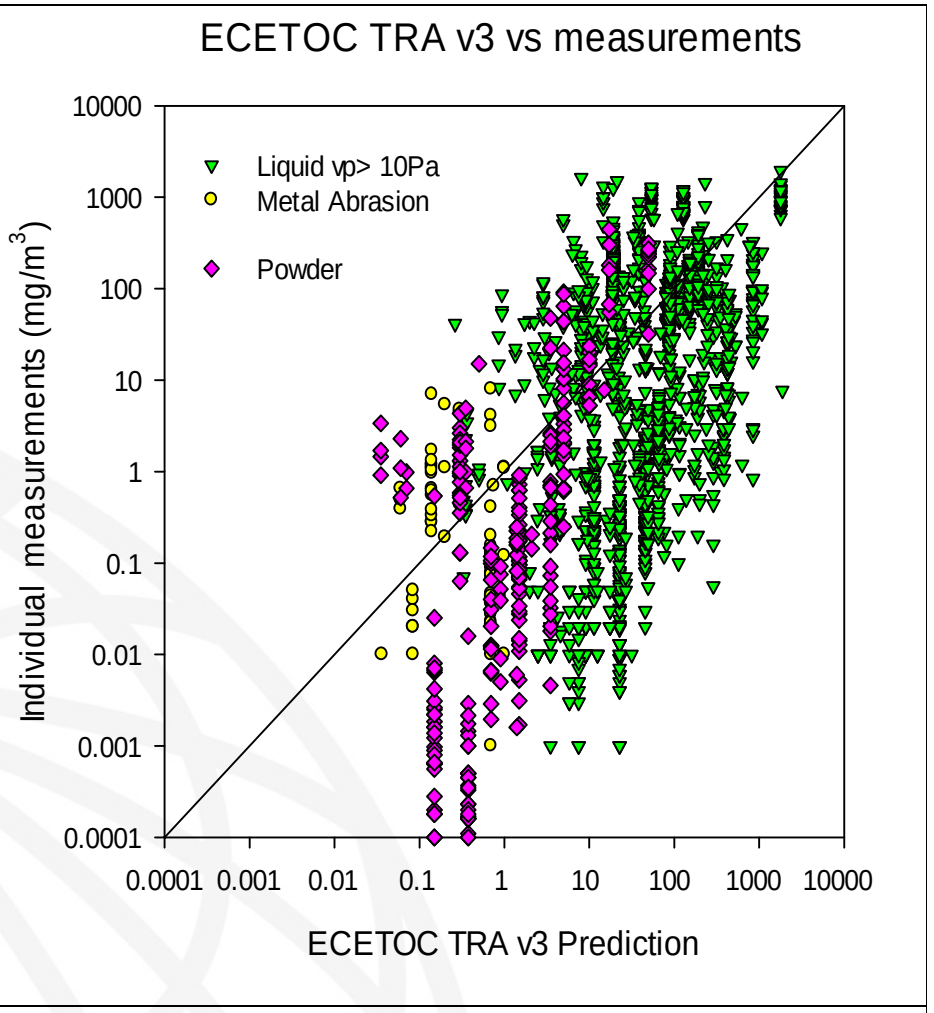
Exposure estimate from each tool for a situation was compared with the corresponding individual measurement value

The ratio of the measurement value over the tool estimate was then calculated

Ratios of <1 indicate a conservative tool estimate for that case

ECETOC TRA estimates vs individual measurements





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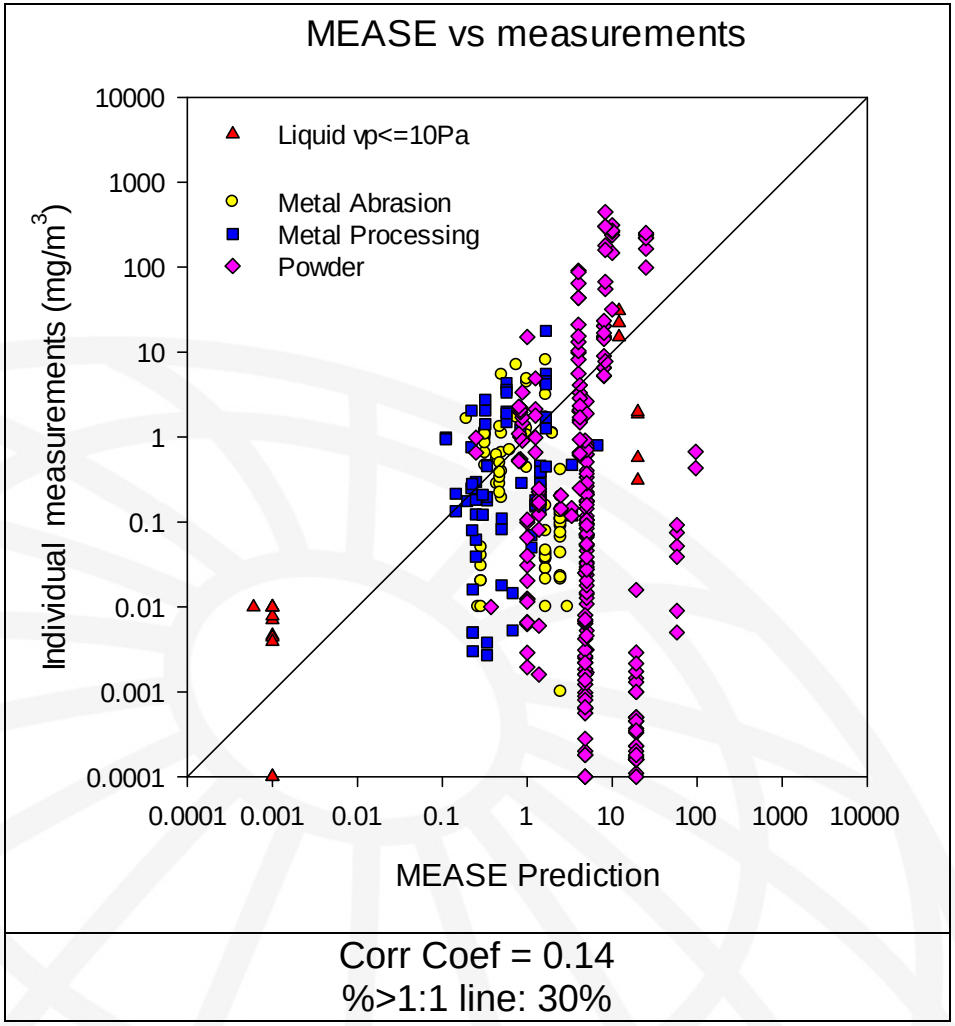
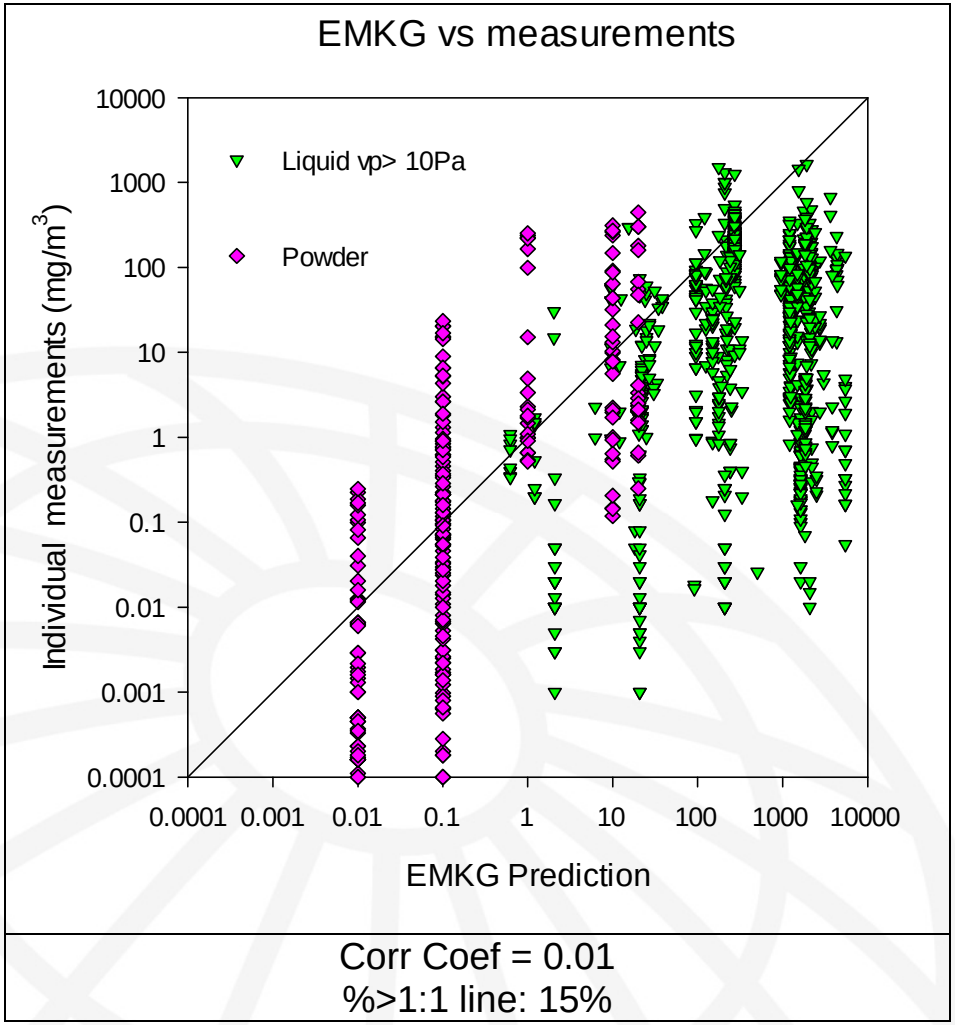
Liquid vp >10
Metal Abrasion
Powder

MEASE estimates vs individual measurements



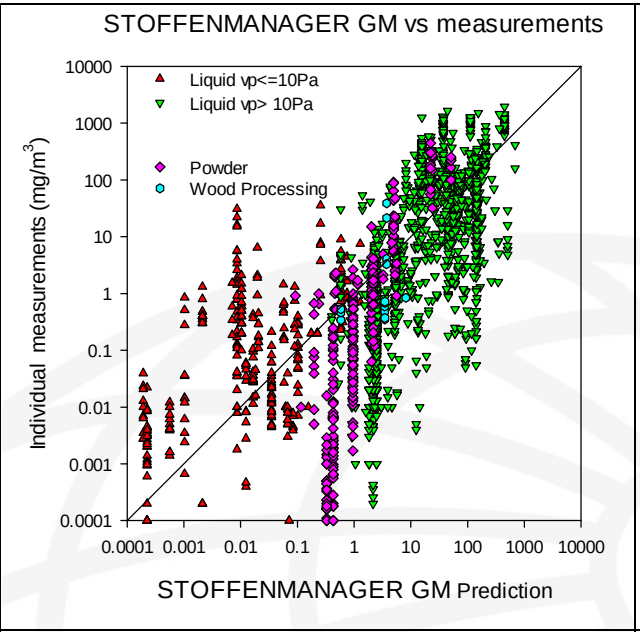
Liquid vp <=10
Metal Abrasion
Metal Procesisng
Powder

EMKG-EXPO-TOOL estimates vs individual measurements



Liquid vp >10
Powder

Stoffenmanager estimates vs individual measurements



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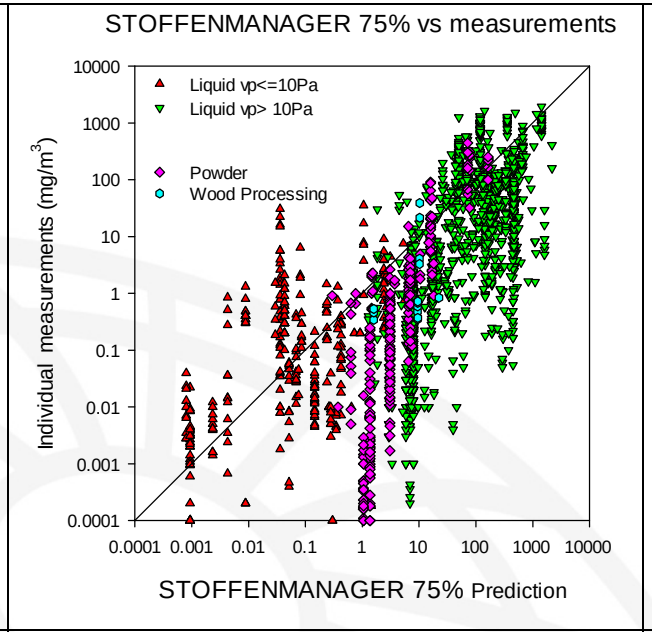

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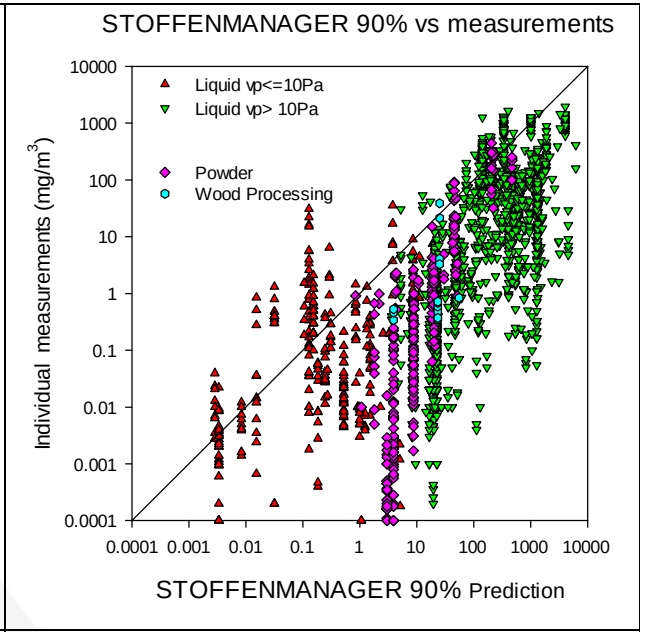

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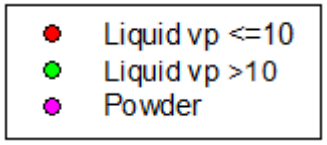
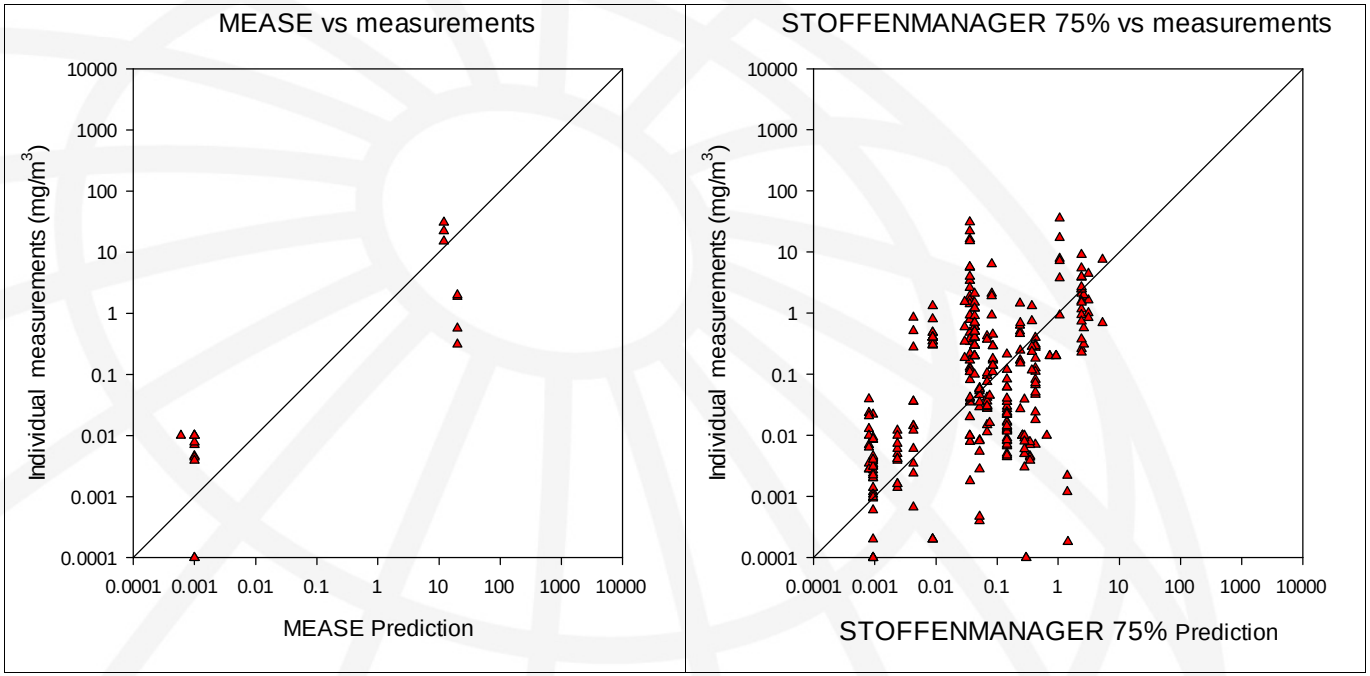


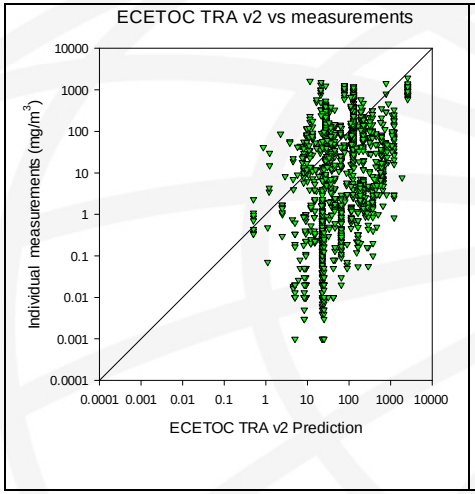
Tool comparison for low volatile liquids (individual measurements)

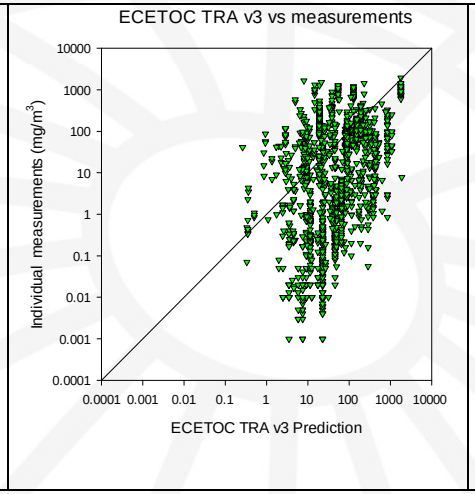
Lvp<=10Pa	nobs	GM	GSD	max	%>Tool	Corr Coef
TRA2	0					
TRA3	0					
MEASE	8	2.38	9.2	16.7	67	0.33
EMKG	0					
STM75PC	37	0.67	28.5	634.9	56	0.18

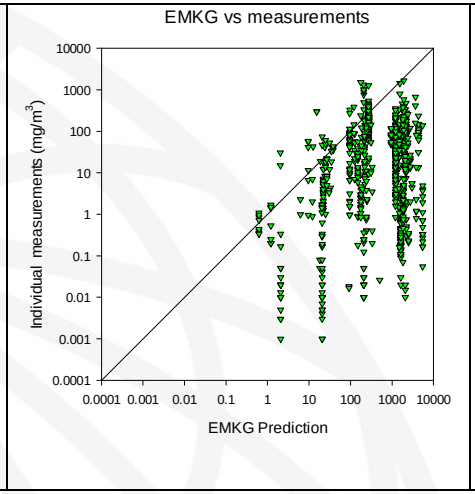


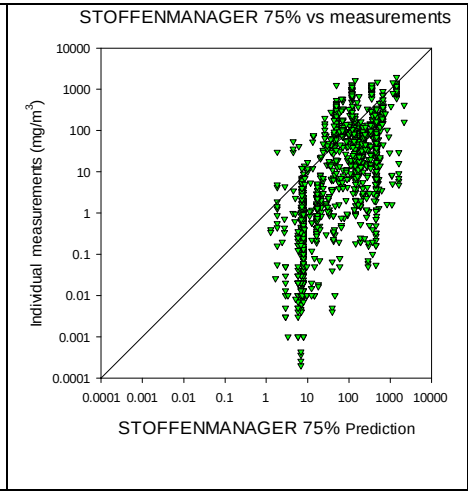
Tool comparison for volatile liquids (individual measurements)

Lvp> 10Pa	nobs	GM	GSD	max	%>Tool	Corr Coef
TRA2	283	0.21	12.1	71.0	29	0.39
TRA3	283	0.42	12.4	158.4	32	0.39
MEASE	0					
EMKG	209	0.04	16.0	19.2	7	-0.07
STM75PC	284	0.12	8.9	8.9	23	0.42



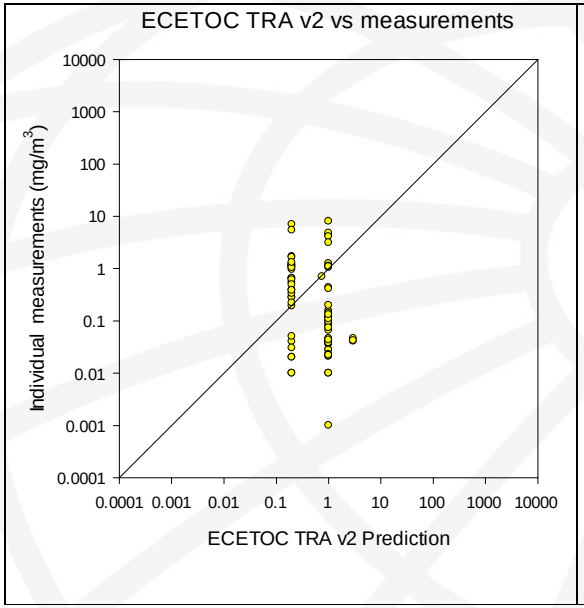


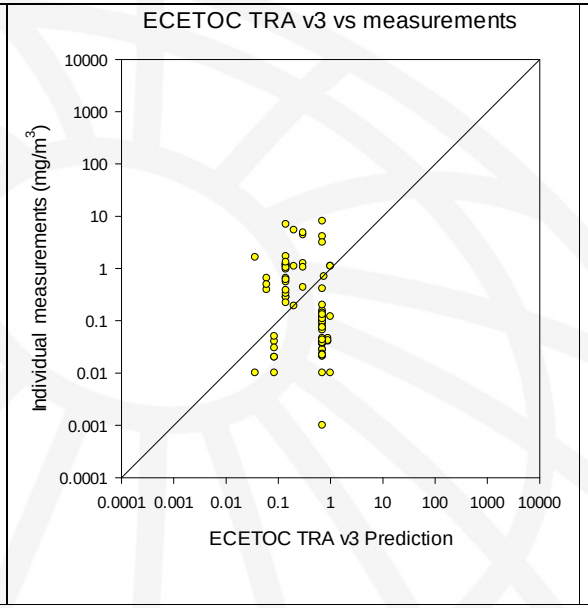


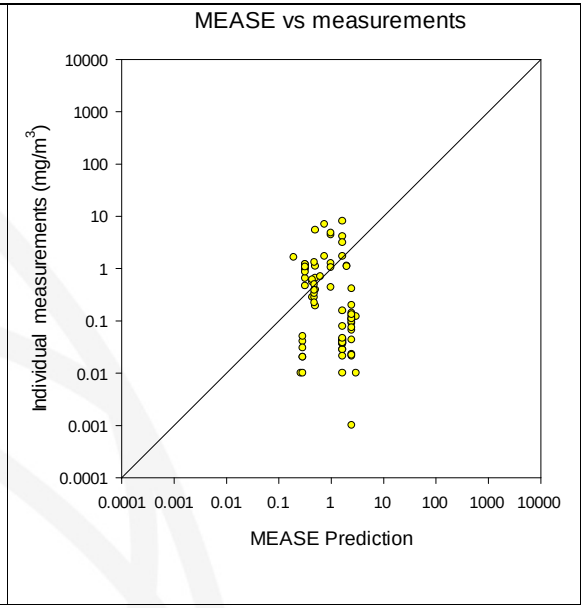


Tool comparison for metal abrasion (individual measurements)

Metal Abrasion	nobs	GM	GSD	max	%>Tool	Corr Coef
TRA2	24	0.81	9.8	21.8	41	-0.12
TRA3	24	1.45	10.4	45.3	42	-0.17
MEASE	25	0.55	8.6	8.5	37	-0.18
EMKG	0					
STM75PC	0					

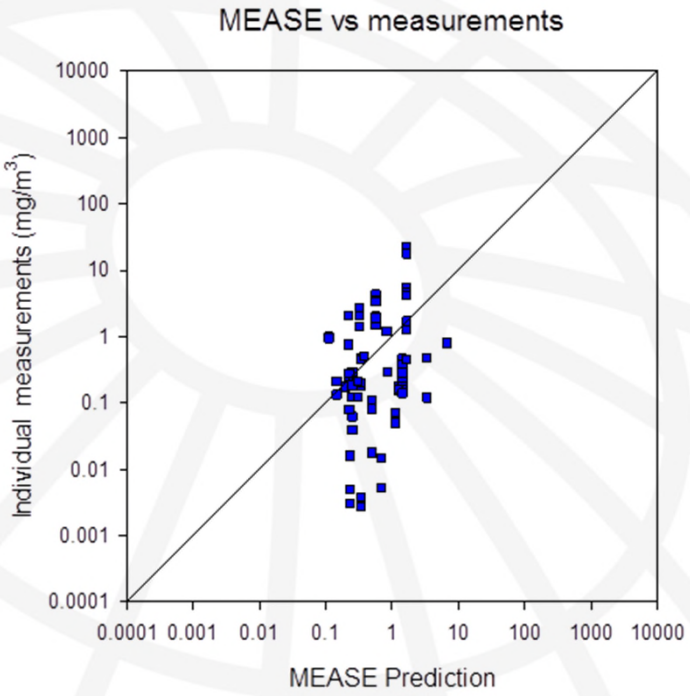






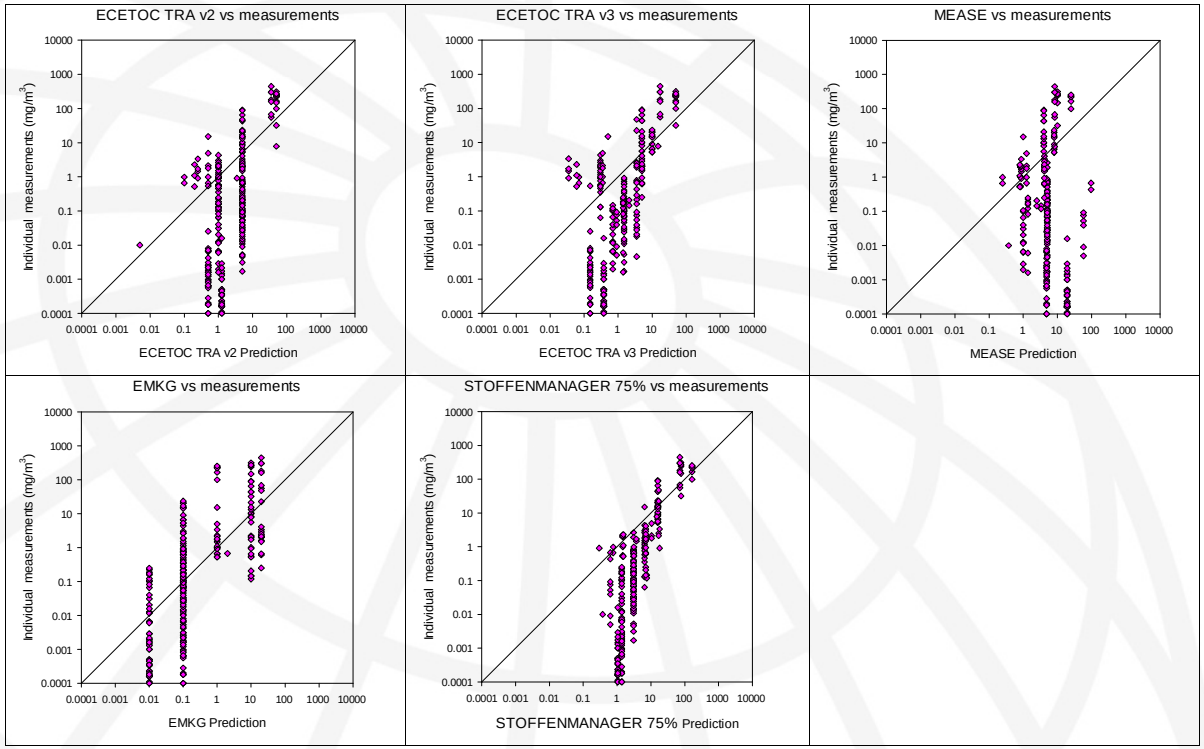
Tool comparison for metal processing (individual measurements)

Metal processing	nobs	GM	GSD	max	%>Tool	Corr Coef
TRA2	0					
TRA3	0					
MEASE	33	0.57	6.4	12.0	38	0.15
EMKG	0					
STM75PC	0					

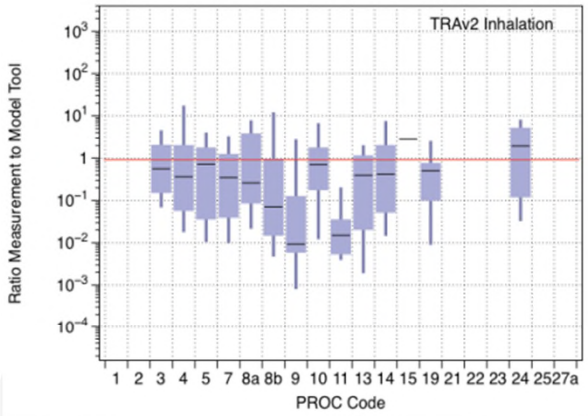


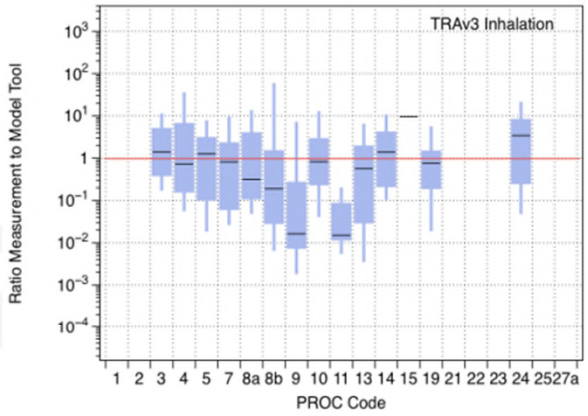
Tool comparison for powders (individual measurements)

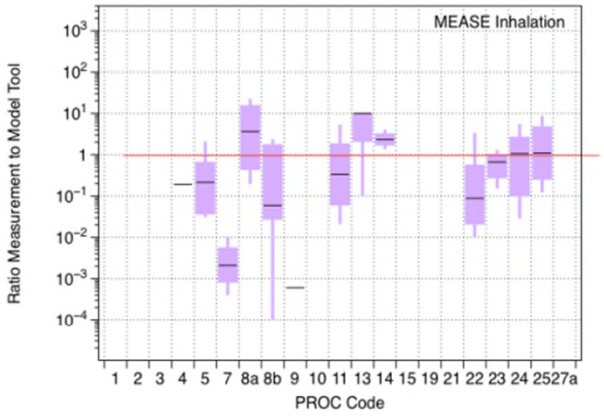
Powder	nobs	GM	GSD	max	%>Tool	Corr Coef
TRA2	32	0.53	13.0	30.2	28	0.83
TRA3	31	1.00	12.2	61.0	29	0.78
MEASE	30	0.28	24.0	26.0	23	0.09
EMKG	30	1.21	11.9	199.9	45	0.35
STM75PC	32	0.23	7.4	3.1	14	0.80

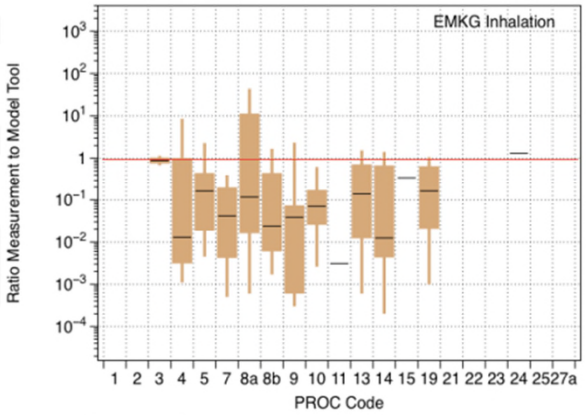


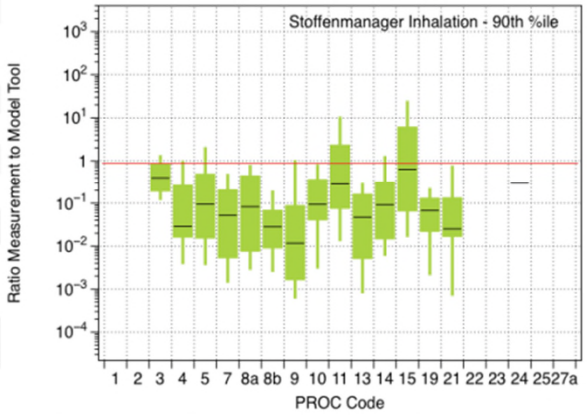
Comparison by PROC and Tool (all exposure categories combined)











Comparison of tool estimates with aggregated measurement data (type 1 and type 2)

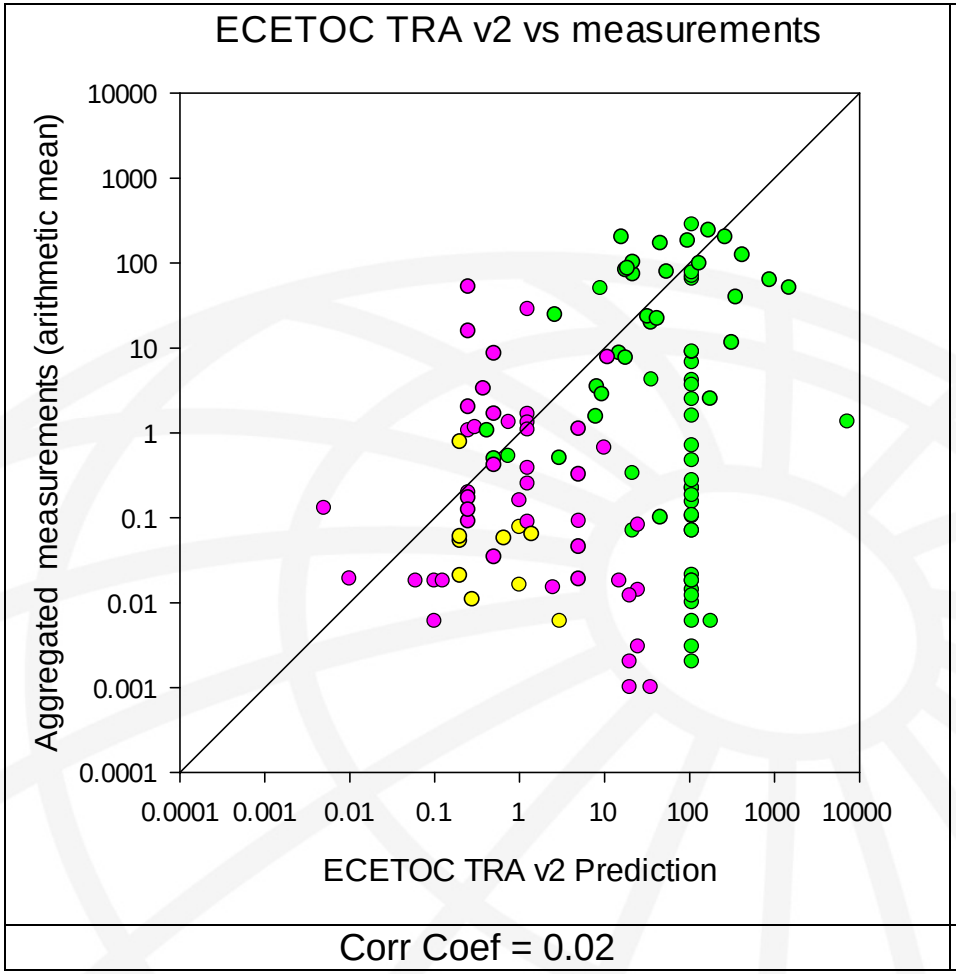
Type 1: Exposure estimate from the tool was compared with the corresponding arithmetic mean of the aggregated measurement data.

Type 2: Arithmetic mean of estimates from the tool was compared with the arithmetic mean of the corresponding grouped data

The ratio of the measurement value over the tool-based estimate calculated

Ratio of <1 indicates a conservative tool estimate for that case

Comparisons of tool estimates with aggregated measurement (Type 1 and 2) results (TRAv2 and TRAv3)



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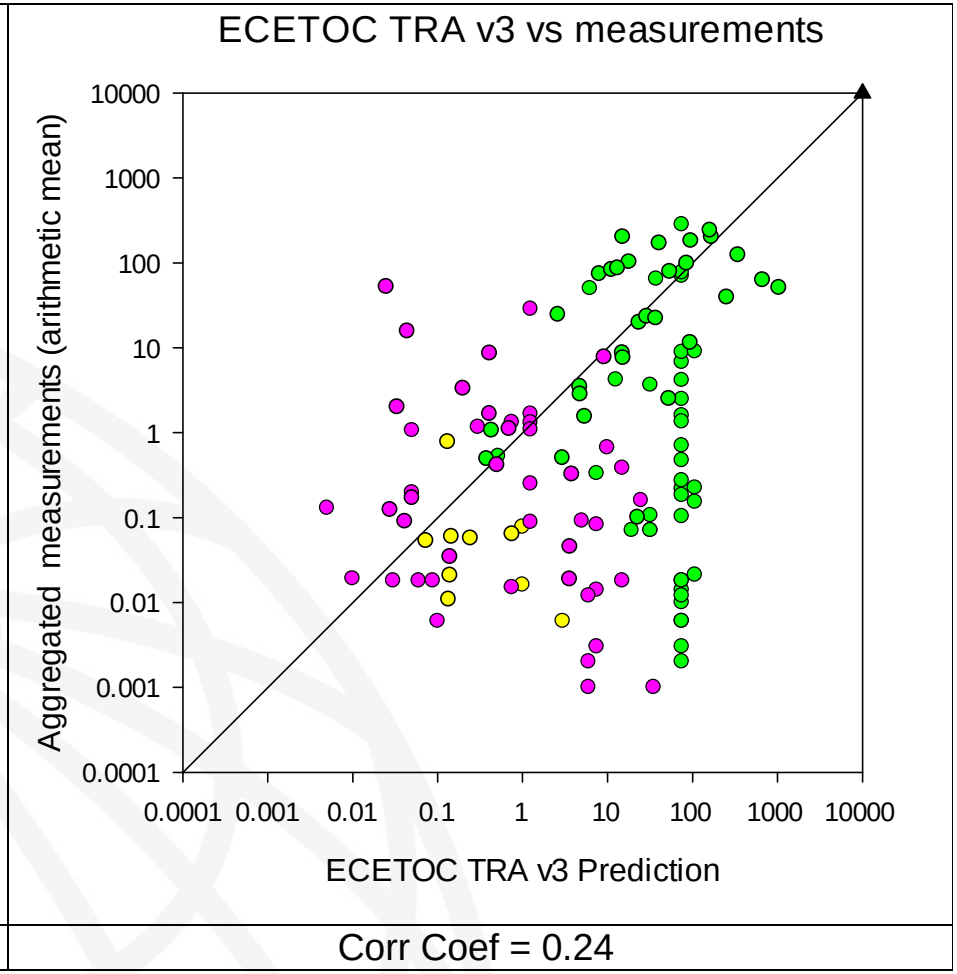
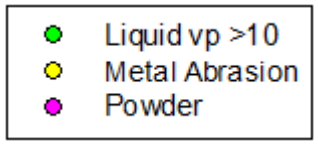
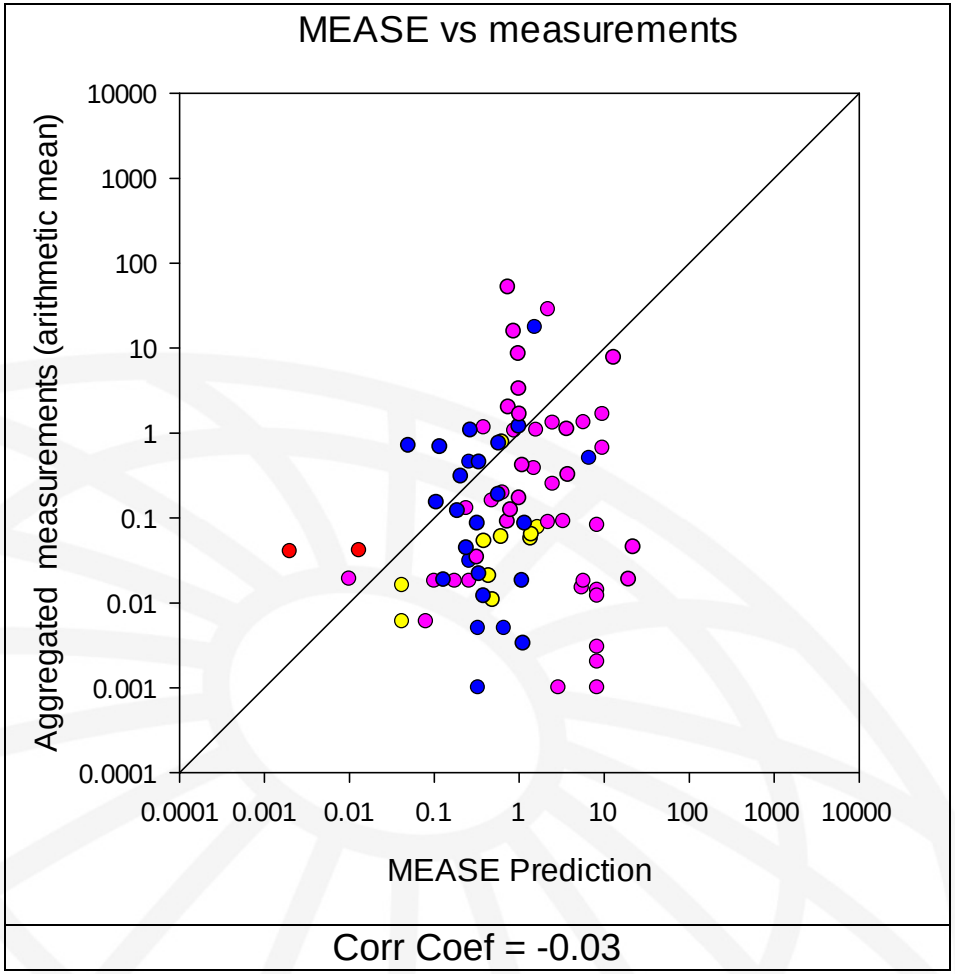
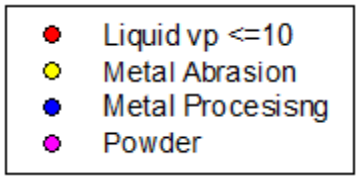


Corr Coef = 0.24

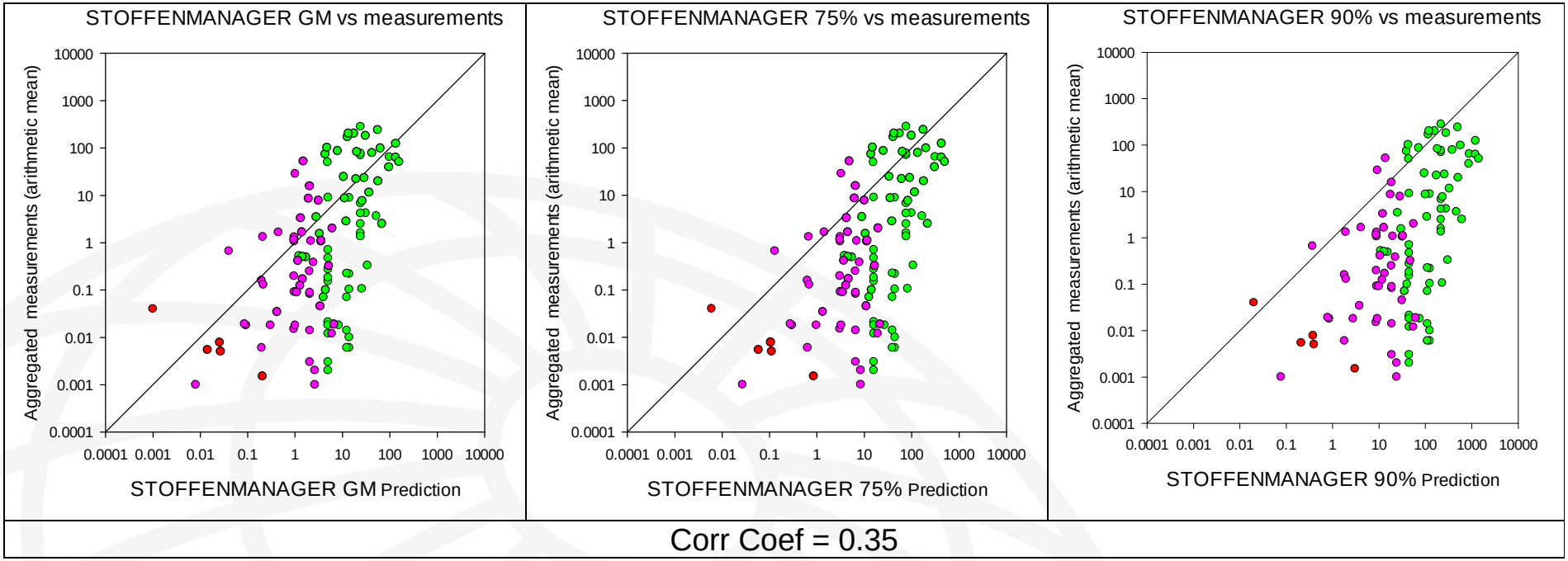


Comparisons of tool estimates with aggregated measurement results (MEASE)

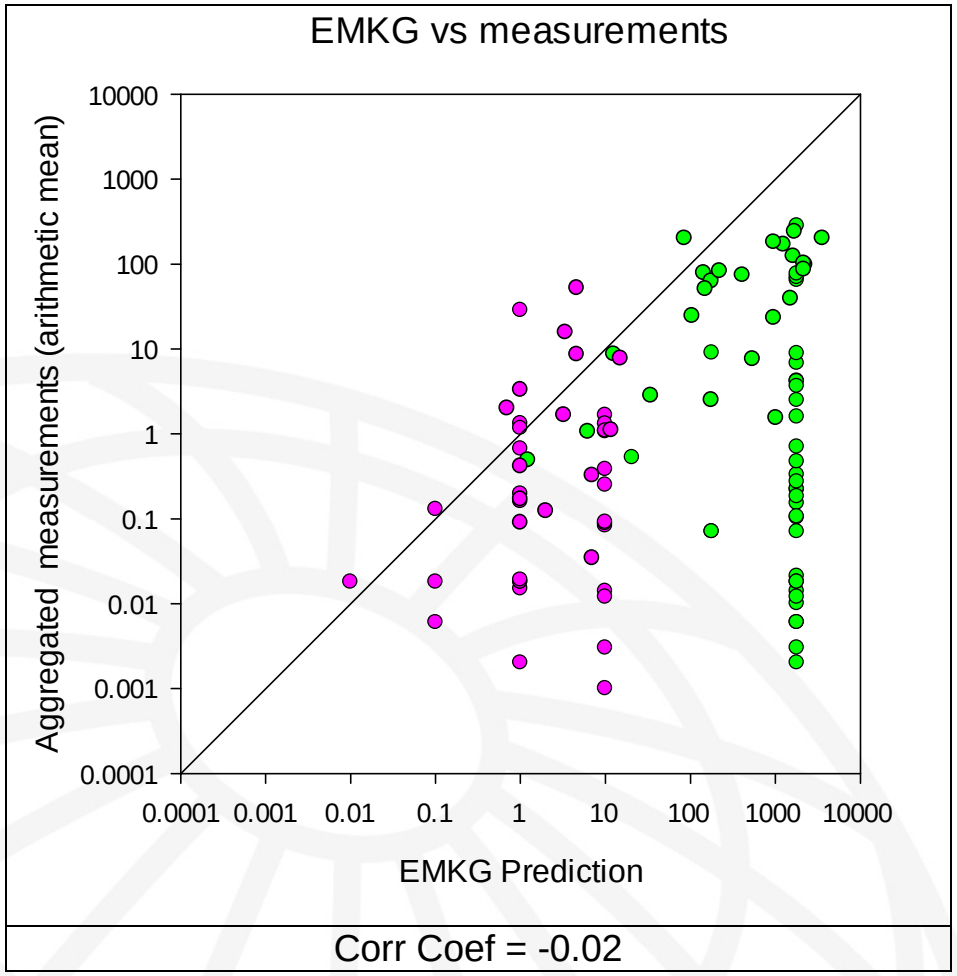


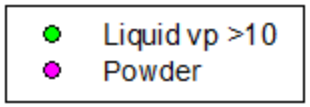


Comparisons of tool estimates with aggregated measurement results (STM)



Comparisons of tool estimates with aggregated measurement results (EMKG)





Comparison by exposure category for ECETOC TRAv2 and ECETOC TRAv3 (aggregated measurements)

	Type 1				Type 2			
TRA2	**nobs**	**GM**	**GSD**	**max**	**nobs**	**GM**	**GSD**	**max**
Liquid vp <=10Pa	0				0			
Liquid vp > 10Pa	38	<0.01	31.1	5.6	30	0.55	7.3	12.6
Metal abrasion	3	0.01	6.0	0.1	7	0.17	4.8	3.9
Metal processing	0				0			
Powder	29	0.06	54.9	25.9	16	0.87	20.3	207.9

	Type 1				Type 2			
TRA3	**nobs**	**GM**	**GSD**	**max**	**nobs**	**GM**	**GSD**	**max**
Liquid vp <=10Pa	0				0			
Liquid vp > 10Pa	38	0.01	30.9	7.9	30	0.77	6.3	13.2
Metal abrasion	3	0.01	6.0	0.1	7	0.33	4.5	5.9
Metal processing	0				0			
Powder	29	0.07	45.6	25.9	16	2.54	30.3	2079.4

Comparison by exposure category for MEASE (aggregated measurements)

	Type 1				Type 2			
MEASE	nobs	GM	GSD	max	nobs	GM	GSD	max
Liquid vp <=10Pa	2	7.92	3.7	19.9	0			
Liquid vp > 10Pa	0				0			
Metal abrasion	3	0.14	2.8	0.4	7	0.08	3.8	1.2
Metal processing	7	0.09	19.6	11.4	18	0.37	8.9	14.3
Powder	29	0.05	22.9	12.9	16	0.41	19.5	69.9

Comparison by exposure category for EMKG-EXPO tool (aggregated measurements)

	Type 1				Type 2			
EMKG	**nobs**	**GM**	**GSD**	**max**	**nobs**	**GM**	**GSD**	**max**
Liquid vp <=10Pa	0				0			
Liquid vp > 10Pa	37	<0.01	26.1	0.2	24	0.10	4.8	2.4
Metal abrasion	0				0			
Metal processing	0				0			
Powder	28	0.04	17.8	28.4	14	0.39	8.7	11.3

Comparison by exposure category for STM (aggregated measurements)

	Type 1				Type 2			max
STMGM	nobs	GM	GSD	max	nobs	GM	GSD	
Liquid vp <=10Pa	1	29.61		29.6	4	0.11	6.3	0.4
Liquid vp > 10Pa	38	0.03	17.0	11.7	30	1.11	5.8	21.3
Metal abrasion	0				0			
Metal processing	0				0			
Powder	29	0.12	17.7	28.1	16	0.35	11.6	34.4

	Type 1				Type 2			
STM75PC	nobs	GM	GSD	max	nobs	GM	GSD	max
Liquid vp <=10Pa	1	7.14		7.1	4	0.03	6.3	0.1
Liquid vp > 10Pa	38	0.01	17.0	3.7	30	0.35	5.8	6.7
Metal abrasion	0				0			
Metal processing	0				0			
Powder	29	0.04	17.7	8.7	16	0.11	11.6	10.7

	Type 1				Type 2			
STM90PC	nobs	GM	GSD	max	nobs	GM	GSD	max
Liquid vp <=10Pa	1	2.00		2.0	4	0.01	6.3	0.0
Liquid vp > 10Pa	38	<0.01	17.0	1.3	30	0.12	5.8	2.4
Metal abrasion	0				0			
Metal processing	0				0			
Powder	29	0.01	17.7	3.0	16	0.04	11.6	3.7

Discussion

- Limited data for low volatile liquids and metal processes
- Reasonable spread of data across PROCs, but clearly there are some missing (e.g. PROC 1 and 2)
- Across all data:
  - Tools appear to be conservative
    - at ~ 70% (based on individual measurements)
    - However, aggregated data show that average measurements for situation can be higher than tool predictions
  - Limited correlation with measurements (except powders)

Conclusions – non-volatile liquids

- Limited data, only comparison with MEASE and STM
- No evidence that these tools are conservative
- Low correlation between tool estimates and exposure

Conclusions – volatile liquids

- Reasonable amount of data
- Based on individual measurements the tools are conservative (but ECETOC TRAv3 less so than others)
- Some evidence from the aggregate data that the ECETOC TRAv2, ECETOC TRAv3 and STM are less conservative
- Correlation between tools estimates and measurement results
  - ~0.4 for ECETOC TRAv2, ECETOC TRAv3 and STM
  - No correlation for EMKG-EXPO-Tool

Conclusions – Metal abrasion

- Limited data
- Only for ECETOC TRAv2, ECETOC TRAv3 and MEASE
- No evidence that these tools are conservative
- No correlation with measured results

Conclusions – Metal processes

- Limited data
- Only for MEASE
- No evidence that MEASE is sufficiently conservative
- Little or no correlation with measured results

Conclusions – Powders

- Reasonable amount of data
- Tools appear to be conservative, although EMKG-EXPO-Tool less so than others
- Good correlation with measurement results for ECETOC TRAv2, ECETOC TRAv3 and STM (~0.8)
- Less correlation for EMKG-EXPO-Tool and no for MEASE

Summary

- Tools appear to be conservative, however:
  - not for all exposure categories
  - Is the level of conservatism is sufficient? Probably not!
  - What is the likelihood that false-negative conclusions are drawn?
  - For some tools (eg STM, EMKG) estimates were not corrected for concentration of the agent in the mixture and duration of the exposure (relative to the measurement duration). If this were to be included, the levels of conservatism will be reduced!

Summary

- Strong correlation between tool estimates from TRAvs2 and vs3 and STM for powders and measurement results
- Other tools and exposure categories correlation was low or absent.
- In particular, more data required for
  - non-volatile
  - metal abrasion
  - hot metal processes
  - but our results suggest that tools should be used very cautiously for these exposures (or not at all?)

Comparison of ECETOC TRAv2 estimates by PROC (individual measurements)

TRA2	nobs	GM	GSD	max
3 - Use in closed batch proces	2	0.56	6.4	2.1
4 - Use in batch and other pro	26	0.40	12.4	71.0
5 -Mixing or blending in batch	20	0.31	9.8	5.9
7 -Industrial spraying.....	63	0.22	11.0	17.7
8a -Transfer of chemicals from	24	0.41	12.4	30.2
8b -Transfer of chemicals from	28	0.12	17.7	38.6
9 -Transfer of chemicals into	8	0.02	20.6	5.7
10 - Roller application or bru	45	0.48	9.2	39.7
11 - Non industrial spraying..	9	0.02	4.4	0.2
13 -Treatment of articles by d	35	0.13	16.9	11.8
14 - Production of preparation	13	0.38	9.8	8.2
15 - Use of laboratory reagent	1	2.86		2.9
19 - Hand-mixing with intimate	40	0.25	8.3	6.2
24 - High (mechanical) energy	25	0.88	9.7	21.8

Comparison of ECETOC TRAv3 estimates by PROC (individual measurements)

TRA3	nobs	GM	GSD	max
3 - Use in closed batch proces	2	1.40	6.4	5.2
4 - Use in batch and other pro	26	0.96	12.7	158.4
5 -Mixing or blending in batch	20	0.56	9.9	8.4
7 -Industrial spraying.....	63	0.49	12.0	58.9
8a -Transfer of chemicals from	24	0.50	10.8	36.2
8b -Transfer of chemicals from	27	0.30	23.2	92.6
9 -Transfer of chemicals into	8	0.05	22.5	19.1
10 - Roller application or bru	45	0.76	9.2	56.8
11 - Non industrial spraying..	9	0.03	4.1	0.2
13 -Treatment of articles by d	35	0.25	17.3	39.2
14 - Production of preparation	13	1.10	5.2	11.7
15 - Use of laboratory reagent	1	9.53		9.5
19 - Hand-mixing with intimate	40	0.49	7.5	16.3
24 - High (mechanical) energy	25	1.62	10.5	45.3

Comparison of MEASE estimates by PROC (individual measurements)

MEASE	nobs	GM	GSD	max
4 - Use in batch and other pro	1	0.19		0.2
5 -Mixing or blending in batch	6	0.21	6.2	2.4
7 -Industrial spraying.....	2	0.00	4.1	0.0
8a -Transfer of chemicals from	12	2.53	7.2	26.0
8b -Transfer of chemicals from	6	0.05	47.9	2.4
9 -Transfer of chemicals into	1	0.00		0.0
11 - Non industrial spraying..	2	0.33	11.6	1.9
13 -Treatment of articles by d	5	3.54	7.5	10.0
14 - Production of preparation	2	2.35	1.6	3.3
22 - Potentially closed proces	7	0.12	9.1	4.6
23 - Open processing and trans	8	0.53	2.3	1.3
24 - High (mechanical) energy	26	0.57	8.3	8.5
25 - Other hot work operations	18	1.08	5.8	12.0

Comparison of EMKG-EXPO-Tool estimates by PROC (individual measurements)

EMKG	nobs	GM	GSD	max
3 - Use in closed batch proces	2	0.89	1.3	1.0
4 - Use in batch and other pro	24	0.03	26.8	11.1
5 -Mixing or blending in batch	20	0.10	11.6	3.0
8a -Transfer of chemicals from	21	0.20	73.1	199.9
8b -Transfer of chemicals from	23	0.05	13.3	4.4
9 -Transfer of chemicals into	6	0.02	33.3	3.4
10 - Roller application or bru	44	0.05	10.8	4.0
13 -Treatment of articles by d	35	0.07	22.5	19.2
14 - Production of preparation	13	0.03	34.3	12.5
15 - Use of laboratory reagent	1	0.34		0.3
19 - Hand-mixing with intimate	40	0.09	13.0	5.8

Comparison of STM75PC estimates by PROC (individual measurements)

STM75PC	nobs	GM	GSD	max
3 - Use in closed batch proces	2	1.13	3.0	2.4
4 - Use in batch and other pro	26	0.15	8.0	6.8
5 -Mixing or blending in batch	20	0.25	11.7	8.9
7 -Industrial spraying.....	64	0.09	10.9	7.6
8a -Transfer of chemicals from	25	0.18	10.0	3.0
8b -Transfer of chemicals from	29	0.06	5.3	0.9
9 -Transfer of chemicals into	8	0.04	16.7	4.4
10 - Roller application or bru	49	0.23	8.3	7.1
11 - Non industrial spraying..	31	1.15	15.8	634.9
13 -Treatment of articles by d	40	0.08	9.3	4.5
14 - Production of preparation	13	0.20	7.9	4.0
15 - Use of laboratory reagent	2	2.02	30.2	22.5
19 - Hand-mixing with intimate	42	0.10	7.9	2.1
21 - Low energy manipulation o	7	0.09	11.3	2.9