Calibration of Australian Raw Exhaust DPM Measurement Instrumentation

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History of DPM Raw Exhaust DPM Measurement in Australia

- Tower colliery project (1992 -2004)
- DPI Research project (2002 – 2004)
- Coal Services H & S Trust – Davies (2013)
- Coal Services H & S Trust – Mason (2014)
- Current project

Tower Colliery Project (1992 – 2004)

Commercial DPM Instrumentation– Australia

AVT 530

MAHA

ChekMate

Aims of Current Project

- To compare the three different devices used in Australia to measure raw exhaust DPM
- To highlight the issue of instrument analytical uncertainty

ERP Pty Ltd – Test Rig

DPM Source – Detroit 706 LTE

Sampling Protocol

- Steady state load at five different levels
- CO_2 measured continuously to monitor engine load stability
- Sampling from before any control technologies
- Used ERP mixing unit
- NIOSH 5040 samples collected in two ways
  - ChekMate filters (25 mm quartz filters)
  - High flow sampling pump on 37mm SKC DPM filter cassettes

ERP Pty Ltd Mixing Unit

Load Parameters

Load Level	Initial rpm	Load (psi)	Resultant rpm	% $C0_2$
1	1400	Nil	1400	2.2
2	1400	600	1350	2.9
3	1400	1800	1230	4.9
4	1400	2200	1200	5.6
5	1400	2450	1150	6.4

Sample Numbers

Load level	AVT 530 (2)	AVT 530 (3)	MAHA (1)	MAHA (2)	Chek - Mate (1)	Chek – Mate (2)	NIOSH 5040 Method (1) (Chek - Mate)	NIOSH 5040 Method (2) (37mm filters)
1	6	6	6	6	6	6	12	2
2	6	6	6	6	6	6	12	2
3	6	6	6	6	6	6	12	2
4	6	6	6	6	6	6	12	2
5	6	6	6	6	6	6	12	2
	30	30	30	30	30	30	60	10

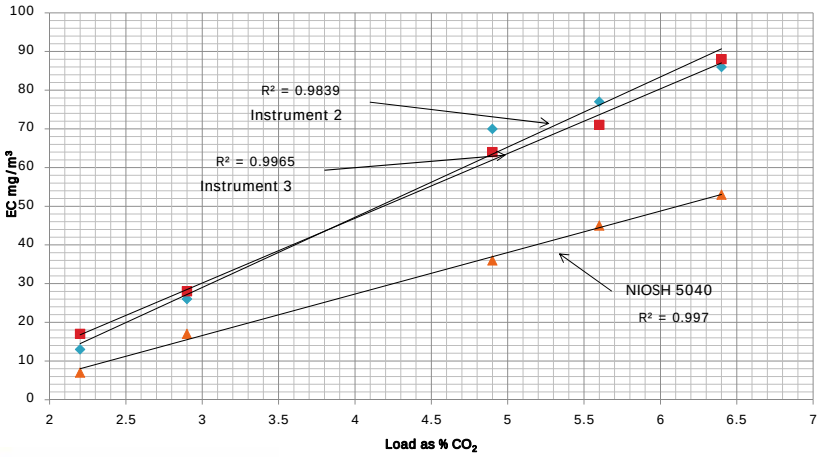
Sampling 19th May 2015

Instruments Tested

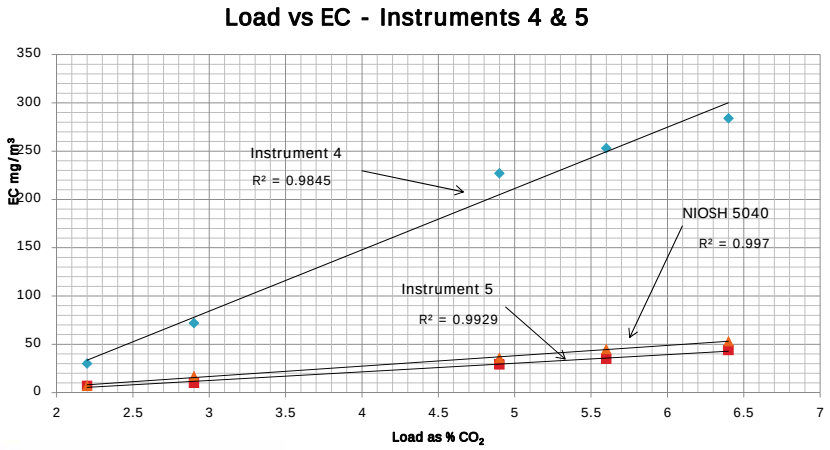
19th May 2015 Results

Load Level	Inst. 1 EC mg/m³	Inst. 2 EC mg/m³	Inst. 3 EC mg/m³	Inst. 4 EC mg/m³	Inst. 5 EC mg/m³	Inst. 6 EC mg/m³	Inst. 7 EC mg/m³	NIOSH 5040 Method 1 EC mg/m³	NIOSH 5040 Method 2 EC mg/m³
1	NA	13 (12-14)	17 (17-18)	30 (28-32)	7 (5-8)	6 (6-7)	6 (6-7)	6 (6-7)	7
2	NA	26 (25-27)	28 (29-30)	72 (70-74)	10 (10-11)	10 (9-11)	11 (10-13)	15 (14-15)	17
3	NA	70 (62-77)	64 (60-66)	227 (204-250)	29 (28-29)	+	+	32 (31-33)	36
4	NA	77 (72-82)	71 (67-75)	253 (241-266)	35 (33-36)	19 (17-21)	18 (17-19)	39 (36-42)	45
5	NA	86 (79-92)	88 (86-91)	284 (266-302)	44 (42-46)	32 (29-36)	29 (27-30)	49 (48 – 50)	53

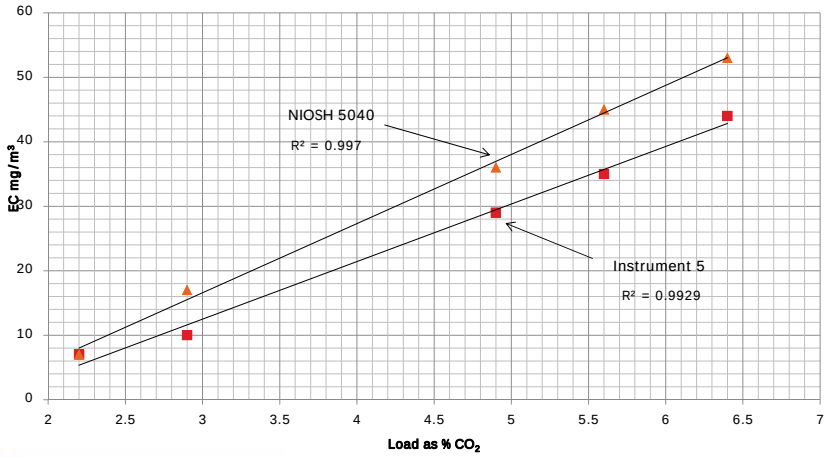
Instruments 2 & 3 vs NIOSH 5040



Instruments 4 & 5 vs NIOSH 5040



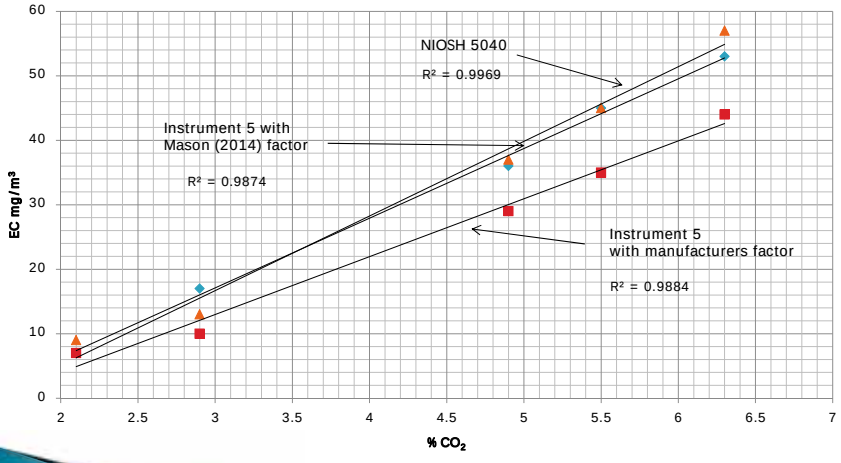
Instrument 5 vs NIOSH 5040



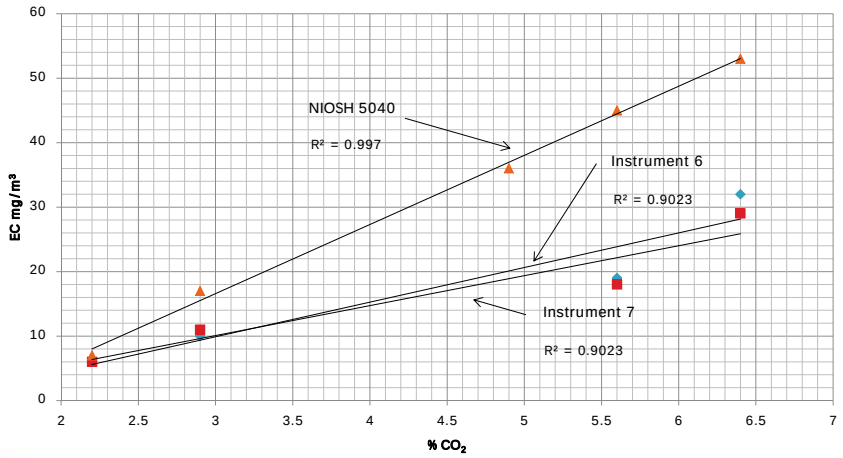
Mason (2014)

- Coal Services Health & Safety Trust project
- Confirmed that these was good correlation between EC at the manifold vs tailpipe
- Recommended the MAHA – 4M TSP/EC factor be increased from 0.46 (CMTS instrument) to 0.65 for tailpipe and 0.67 for manifold

Instrument 5 vs NIOSH 5040 using Manufacturers & Mason (2014) Factors



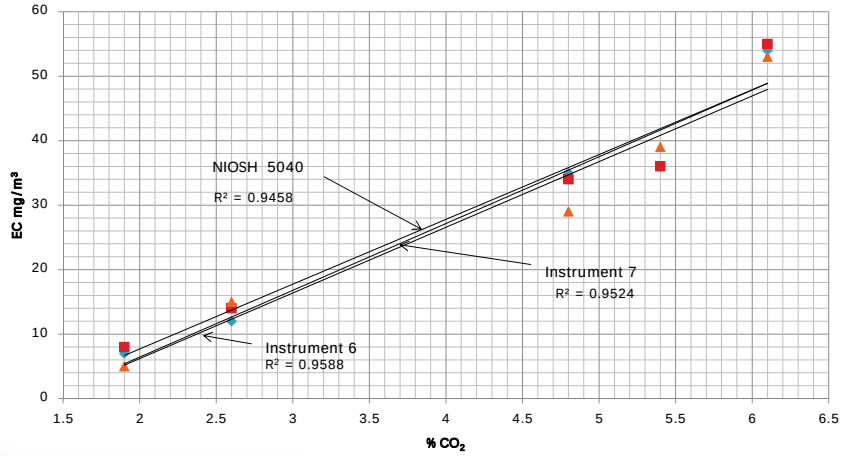
Instruments 6 & 7 vs NIOSH 5040



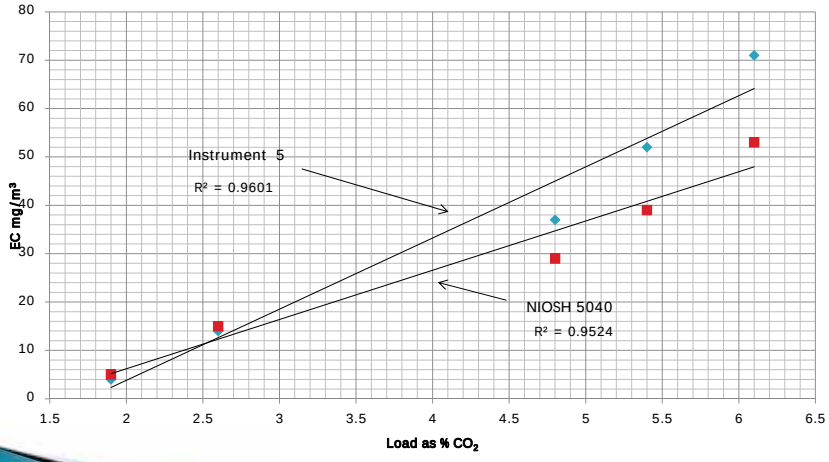
29th June 2015 Results

Load Level	% CO_2 Average	Instrument 5 EC mg/m³	Instrument 6 EC mg/m³	Instrument 7 EC mg/m³	NIOSH 5040 Method 1 EC mg/m³	NIOSH 5040 Method 2 EC mg/m³
1	1.9	4	7	8	5 (4-5)	5
2	2.6	14	12	14	13	15
3	4.8	37 (34-41)	35	34	34 (32–36)	29
4	5.4	52 (49-55)	36 (34-38)	36 (35-38)	38 (36-39)	39
5	6.1	71 (66-77)	54 (48-62)	55 (48-66)	51 (49-54)	53

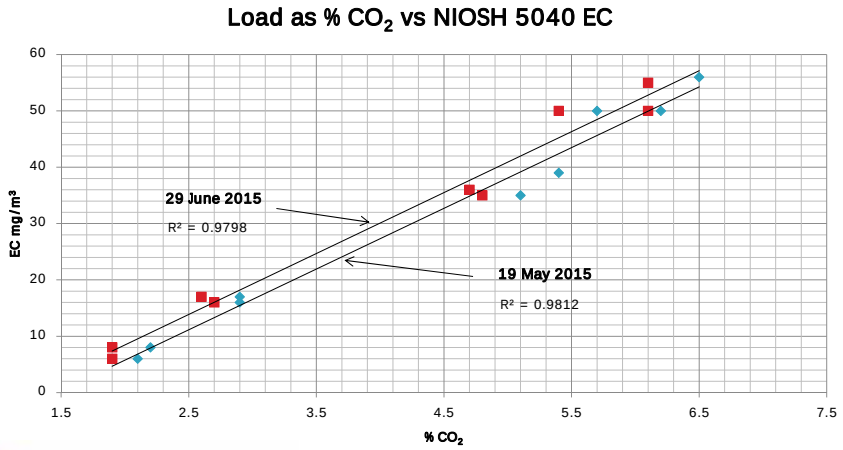
Instruments 6 & 7 vs NIOSH 5040 on 29 June 2015



Instrument 5 vs NIOSH 5040 on 29 June 2015



Engine Load 19 May vs 29 June



Conclusions

- All instruments must be calibrated on the same engine load basis as routine testing
- Instruments 5, 6 & 7 showed good correlation to NIOSH 5040 if the appropriate factors were used and in good working order
- Instruments 2 & 3 need review by their manufacturer

Conclusions

- Devices to control the inflow of water need to be used when sampling post a water filled scrubber tank
- Need for a standard method of sampling that provides a suitable sample for analysis
- The current practice of reporting results to the number of decimal places an instrument reads should cease & stakeholders informed as to the uncertainty of results especially when setting statutory requirements

Acknowledgements & Contact Details

- The authors would like to thank all the participants for providing access to their instrumentation and their contribution to this project

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