1085 Documentation for Appendix P

All of the reference data used to support statements made in Appendix P: LEV III PM TECHNICAL SUPPORT DOCUMENT DEVELOPMENT OF PARTICULATE MATTER MASS STANDARDS FOR FUTURE LIGHT-DUTY VEHICLES is contained within the appendix. A copy of the test data and a description of how each table is used in the Appendix is explained below.

- Table 1 is used to support statements that describe PM emissions rates from GDI vehicles and support generalized statements regarding the PM mass rates following the FTP drive cycle profile.
- Table 2 is used to support statements that describe and compare the PM mass emissions rates from GDI and PFI vehicles following the US06 drive cycle profile.
- Table 3 is used to support statements that describe and compare PM mass emission s rates from various technologies for newer low mileage light-duty vehicles.
- Table 4 is used to support statements that describe and compare U.S. EPA PM mass emissions rates from various technologies for high mileage and oil burning Tier 2 light-duty vehicles.
- Table 5 is used to support statements that describe and compare PM solid particle number and mass emission rates using the original PMP method.

Table 1. FTP PM Mass Emissions Rates from GDI Vehicles

(California Commercial E6 Summer Fuel)

Vehicle No.	MY Make	Fuel Injector Type		Total PM Mass(mg/mi) Phase 1	Phase 2	Phase 3	FTP Weighted
1	2009 GMC	GDI - Wall-guided	Emissions	**35.13**	**1.29**	**1.53**	**8.38**
	Acadia		STDEV	2.84	0.43	0.21	0.75
			COV(%)	8.1	33.7	13.8	8.9
2	2008 Lexus	GDI - Wall-guided	Emissions	**25.12**	**0.55**	**1.75**	**5.97**
	IS350		STDEV	2.76	0.48	0.38	0.78
			COV(%)	11.0	87.6	21.7	13.1
3	2009 Mazda	GDI - Wall-guided	Emissions	**12.98**	**1.34**	**1.54**	**3.80**
	Speed3		STDEV	1.74	0.26	0.23	0.52
			COV(%)	13.4	19.1	14.7	13.7
4	2007 VW	GDI - Wall-guided	Emissions	**12.04**	**1.37**	**2.12**	**3.79**
	Passat		STDEV	1.15	0.23	1.07	0.40
			COV(%)	9.53	16.57	50.21	10.61
5	2009 Prosche	GDI - Wall-guided	Emissions	**12.46**	**0.53**	**1.57**	**3.29**
	Carrera		STDEV	3.73	0.47	0.45	0.69
			COV(%)	29.9	88.1	28.4	21.1
6	2008 VW	GDI - Wall-guided	Emissions	**7.05**	**2.04**	**2.01**	**3.07**
	GLI		STDEV	0.87	0.37	0.39	0.37
			COV(%):	12.4	18.0	19.2	12.2
7	2010 VW	GDI - Wall-guided	Emissions	**4.33**	**0.90**	**1.20**	**1.69**
	Jetta		STDEV	0.16	0.10	0.11	0.10
			COV(%)	3.7	10.8	9.2	5.7
8	2009 BMW	GDI - Spray-guided	Emissions	**4.77**	**0.70**	**0.71**	**1.55**
	335i		STDEV	0.54	0.22	0.26	0.10
			COV(%)	11.4	31.6	35.7	6.4
9	2009 BMW	GDI - Spray-guided	Emissions	**12.06**	**1.00**	**0.94**	**3.28**
	750i		STDEV	1.67	0.55	0.24	0.26
			COV(%)	13.8	55.1	25.5	7.8
		9 GDI Vehicle Avg:	Emissions	**13.99**	**1.08**	**1.49**	**3.87**
			STDEV	10.05	0.49	0.47	2.13
			COV(%):	71.8	45.0	31.3	55.0

Table 2. US06 PM Mass Emission Rates

Injector Type	Vehicle	USO6 PM mass (mg/mi) E6 Summer	Phase2Cert.	E10 Summer (Drum)
Wall GDI	2009 GMC Acadia	**2.7026**	na	na
	STDEV	0.3776		
	COV(%):	13.97		
	2008 Lexus IS350	**0.8241**	na	na
	STDEV	0.1968		
	COV(%):	23.88		
	2008 VW Jetta	**0.1387**	na	na
	STDEV	0.0699		
	COV(%):	50.4		
	2010 VW Jetta	**1.3834**	**0.9557**	**1.2007**
	STDEV	0.3107	0.1623	0.2599
	COV(%):	22.5	16.98	21.6
Spray GDI	2009 BMW 335i	**1.2904**	**1.5660**	na
	STDEV	0.3684	0.4287	
	COV(%):	28.5	27.4	
PFI	2007 Kia Spectra EX	**0.2757**	na	na
	STDEV	0.0948		
	COV(%):	34.4		
	2009 GMC Hummer3	**7.6763**	**3.4184**	na
	STDEV	1.6730	0.4395	
	COV(%):	21.8	12.9	
	2009 Nissan Altima	**0.7246**	**0.9316**	na
	STDEV	0.0298	0.1217	
	COV(%):	4.1	13.1	

Table 3. CARB Test Results for Newer Low Mileage LDVs

Vehicle		FTP Composite PM (mg/mi)	US06 PM (mg/mi)	Average of FTP and US06 PM (mg/mi)
2007 VW Passat GDI-wall (21k)		3.79		
2008 Lexus IS350 GDI-wall (67k)		5.97	0.82	3.4
2008 VW Jetta GDI-Wall (2k)		3.07	0.14	1.6
2009 Porsche GDI-wall (124k)		3.29		
2009 GMC Acadia GDI-wall (13k)		8.38	2.70	5.5
2009 Mazda Speed3 GDI-wall (1k)		3.80		
2009 BMW 335i GDI-center (2k)		1.55	1.29	1.4
2009 BMW 750i GDI-center (0k)		3.28		
2010 VW Jetta GDI-wall		1.69	1.38	1.5
2002 Saturn SL2 PFI (43k)		0.81		
2000 Maxima PFI (115k)		0.82		
2002 Lexus PFI (66k)		0.46		
2005 Honda Accord PFI (19k)		0.16		
2006 Toyota Camry PFI (42k)		0.21		
2006 Saturn VUE PFI (32k)		0.31		
2007 Ford Focus PFI (15k)		0.25		
2009 Hummer PFI (21k)		0.99	7.68	4.3
2009 Nissan Altima PFI (29k)		0.71	0.72	0.7
2007 Spectra PFI (34k)		0.30	0.28	0.3
Average	10 PFI (only 3 for US06)	0.5	2.9	1.8
	9 GDI (only 5 for US06)	3.9	1.3	2.7

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Table 4. U.S EPA Test Results for High Mileage and Oil Burning Tier 2 LDVs

Vehicle (all 2005 and newer)		FTP Composite PM	US06 PM	Average of FTP and US06 PM
GDI LDV 100+k		2.3	3.0	2.6
GDI LDT3 100+k		4.2	5.0	4.6
PFI LDV 100+k		0.3	0.9	0.6
PFI LDT2 100+k		0.6	2.4	1.5
PFI LDV 100+k		0.5	7.5	4.0
PFI LDT3 100+k		0.3	40.1	20.2
PFI LDV 100+k		0.3	1.9	1.1
PFI LDV 100+k		0.4	1.3	0.8
PFI LDV 100+k		0.4	1.1	0.8
PFI LDT2 100+k		1.3	19.7	10.5
PFI LDV 100+k		0.3	2.2	1.3
PFI LDT3/4 100+k		0.4	6.5	3.5
PFI LDV 100+k (OB)		9.5	37.8	23.7
PFI LDT3/4 100+k (OB)		1.3	28.8	15.1
PFI LDT3/4 <100k (OB)		1.0	9.4	5.2
PFI LDV <100k (OB)		0.8	1.9	1.4
PFI LDV <100k (OB)		1.2	3.2	2.2
Average, excluding non oil-burners	All 12 vehicles	1.0	7.6	4.3
	10 PFI vehicles	0.5	8.4	4.4
	2 GDI vehicles	3.3	4.0	3.6
Average, including oil burners	All 17 vehicles	1.5	10.2	5.8
	15 PFI vehicles	1.3	11.0	6.1

Table 5. Solid Particle Number Emission Rates Using Original PMP

Vehicle	MY	Fuel Injector	Fuel		Total PM Mass(mg/mi)				Solid Particle Number (#/mi)				
No.	Make	Type	Type		Phase 1	Phase 2	Phase 3	'P Weight	Phase 1	Phase 2	Phase 3	FTP Weighted	Comments
7	2010 VW	GDI-Wall-guided	E6 Summer Fuel	Emissions	**4.33**	**0.90**	**1.20**	**1.69**	**9.4E+12**	**3.3E+12**	**3.8E+12**	**4.7E+12**	Current PMP
	Jetta			STDEV	0.16	0.10	0.11	0.10	3.9E+11	3.0E+11	1.2E+11	1.7E+11	Method
				COV(%):	3.7	10.8	9.2	5.7	4.1	9.1	3.1	3.5	
			E10 Summer Fuel	Emissions	**5.04**	**0.68**	**1.08**	**1.69**	**1.1E+13**	**2.8E+12**	**4.1E+12**	**4.8E+12**	
				STDEV	0.11	0.02	0.06	0.01	5.9E+11	5.1E+11	2.3E+11	2.1E+11	
				COV(%):	2.2	2.5	6.0	0.7	5.5	18.4	5.7	4.4	
			Phase2Cert.Fuel	Emissions	**2.44**	**0.99**	**0.74**	**1.22**	**6.5E+12**	**3.6E+12**	**3.0E+12**	**4.0E+12**	
				STDEV	0.32	0.03	0.24	0.02	1.1E+12	2.3E+11	2.5E+11	3.7E+11	
				COV(%):	13.1	3.5	32.1	1.6	17.2	6.3	8.2	9.2	
8	2009 BMW	GDI - Spray-guided	E6 Summer Fuel	Emissions	**4.77**	**0.70**	**0.71**	**1.55**	na	na	na	na	
	335i			STDEV	0.54	0.22	0.26	0.10	na	na	na	na	
				COV(%):	11.4	31.6	35.7	6.4	na	na	na	na	
			Phase2Cert.Fuel	Emissions	**2.88**	**0.59**	**0.54**	**1.05**	**1.1E+13**	**1.1E+11**	**2.4E+11**	**2.4E+12**	Current PMP
				STDEV	0.44	0.24	0.11	0.24	9.7E+11	2.3E+10	2.8E+10	2.2E+11	Method
				COV(%):	15.3	40.1	21.0	22.7	8.7	21.7	11.5	8.9	
9	2009 BMW	GDI - Spray-guided	E6 Summer Fuel	Emissions	**12.06**	**1.00**	**0.94**	**3.28**	na	na	na	na	
	750i			STDEV	1.67	0.55	0.24	0.26	na	na	na	na	
				COV(%):	13.8	55.1	25.5	7.8	na	na	na	na	
			Phase2Cert.Fuel	Emissions	**3.66**	**0.65**	**0.91**	**1.34**	**9.3E+12**	**4.6E+11**	**8.5E+11**	**2.4E+12**	Current PMP
				STDEV	0.26	0.09	0.13	0.10	9.3E+11	2.3E+11	4.5E+11	2.7E+11	Method
				COV(%):	7.0	14.3	14.1	7.2	10.0	50.5	52.4	11.4	
10	2009 GMC	PFI	E6 Summer Fuel	Emissions	**3.22**	**0.36**	**0.50**	**0.99**	**9.7E+12**	**2.0E+11**	**1.4E+12**	**2.5E+12**	Current PMP
	Hummer3			STDEV	1.12	0.24	0.28	0.38	1.1E+12	4.5E+10	3.3E+11	3.4E+11	Method
				COV(%):	34.9	67.4	56.4	38.8	11.6	23.2	24.2	13.6	
			Phase2Cert.Fuel	Emissions	**2.18**	**0.13**	**0.16**	**0.56**	**9.5E+12**	**3.8E+10**	**5.9E+11**	**2.1E+12**	
				STDEV	0.44	0.12	0.15	0.12	9.1E+11	1.2E+10	1.4E+11	2.0E+11	
				COV(%):	20.4	92.2	94.8	21.1	9.7	31.1	22.9	9.4	
11	2009 Nissan	PFI	E6 Summer Fuel	Emissions	**1.72**	**0.44**	**0.48**	**0.71**	**3.6E+12**	**4.8E+10**	**6.9E+10**	**8.0E+11**	Current PMP
	Altima			STDEV	0.32	0.13	0.16	0.04	1.3E+12	1.8E+10	2.6E+10	2.7E+11	Method
				COV(%):	18.5	29.9	34.6	5.4	34.6	37.8	37.8	34.1	
			E10 Summer Fuel	Emissions	**1.45**	**0.11**	**0.26**	**0.43**	**3.8E+12**	**3.2E+10**	**7.4E+10**	**8.3E+11**	
				STDEV	0.74	0.10	0.17	0.17	8.5E+11	3.1E+10	6.3E+10	2.0E+11	
				COV(%):	50.9	90.5	65.7	39.8	22.2	95.2	84.4	23.7	