Federal Diesel Research Study

March 26, 2010
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California Environmental Protection Agency

Air Resources Board

Chassis Dyno Testing Status

- Test Plan Ready for Final Approval (today)
- Chassis dyno installation complete
  - Commissioning and training week of 4/6
- 10 test vehicles
  - 2007 MBE4000, 2006 Cummins, 2000 Caterpillar, 2008 Cummins ISL
  - Additional vehicles being acquired through Craigslist

Updated Test Plan

- Changed test sequence
  - Every other vehicle alternate fuels A & B
  - 2007+ put regen in place of 1st test on fuel
- Vehicle matrix contingencies
  - Older vehicles would be moved to newer vehicle categories
  - 2010 vehicle moved to 2007-2009
- Test weights – utilize MEL or equivalent

Chassis Dyno Test Matrix

- Changed test sequence
  - Every other vehicle alternate fuels A & B
  - 2007+ put regen in place of 1st test on fuel
    - 9 tests on CARB – 10 on Fed A &B

Test Day	Morning Schedule (assumes 6 replicates)	Afternoon Schedule (assumes 6 replicates)
ARB HHDDT Cruise Test Cycle		
Day 1	(C/R)CC (A/R)AA	AAA (B/R)BB
Day 2	BBB (C/R)CC	CCC (A/R)AA
Day 3	AAA (B/R)BB	BBB (C/R)CC

C = CARB diesel fuel, A = Federal A diesel fuel, B = Federal B diesel fuel, R = Regeneration
(C/R), (A/R), (B/R) This denotes either a test on a particular fuel for a pre-2007 vehicle or a regeneration for a post-2007

Chassis Dyno Vehicle Test Matrix

1991-1993	1 vehicle
1994-1997	1 vehicle
1998-2002	2 vehicle (UCRs 2000 Caterpillar C-15 + 1 retrofit)
2002-2006	3 vehicles (one will be 2006 Cummins ISM + 1 retrofit)
2007-2010	2 vehicles (one will be 2007 MBE4000)
2010+	1 vehicle

Initial Vehicle Recruitment

1991-1993	1 vehicle
1994-1997	1 vehicle --- 1994 Caterpillar 3176
1998-2002	2 vehicles --- 2000 Caterpillar C-15* --- DDC Series 60 w/ Longview retrofit --- 2001 DDC Series 60 --- 1998 Caterpillar 3406
2002-2006	3 vehicles --- 2006 Cummins ISM
2007-2010	2 vehicles --- 2007 MBE4000 --- 2008 Cummins ISX
2010+	1 vehicle

Recruitment Contingencies

- 2010+ not found move to 2007-2009
- 1991-1993 not found move to 1998-2002
- 1994-1997 not found move to 1998-2002
- 1991-1993 & 1994-1997 not found
  - Add one to 1998-2002 and one to 2002-2006
- 1998-2002 not found distribute between 2002-2006 and 2007-2009

Test Weights

- Three trucks utilized for Biodiesel

- 2006 Cummins Engine 58,744 lbs
- 2000 Caterpillar Engine 66,000 lbs
- 2007 MBE 4000 57,490 lbs

- Remaining trucks using

- CE-CERT Mobile Emissions Laboratory

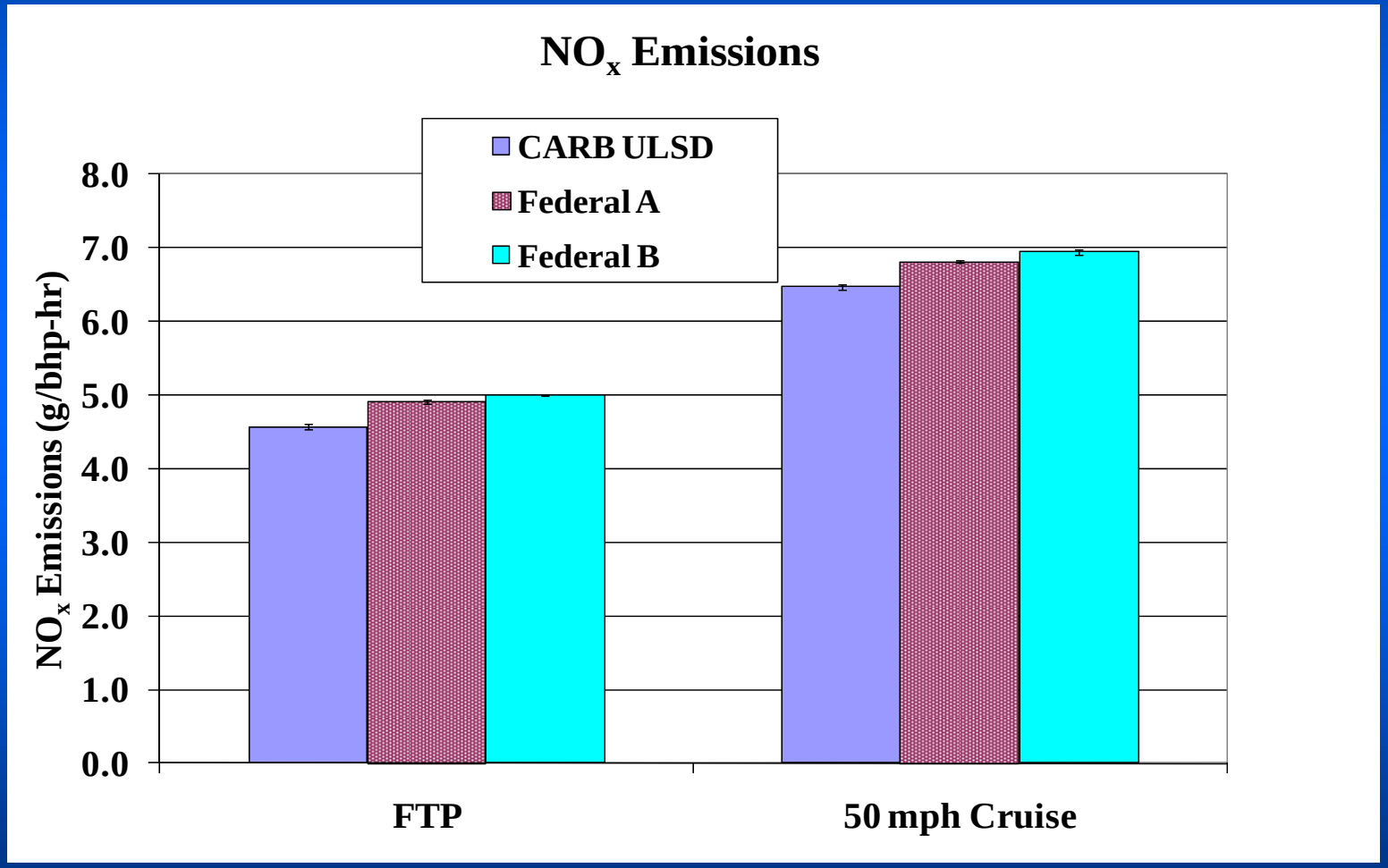
(MEL) ~ 65,000 lbs

- Or equivalent

Engine Testing Status

- Draft Memorandum on engine testing provided to CARB for review
- Additional results from 1991 DDC 60 discussed in this presentation

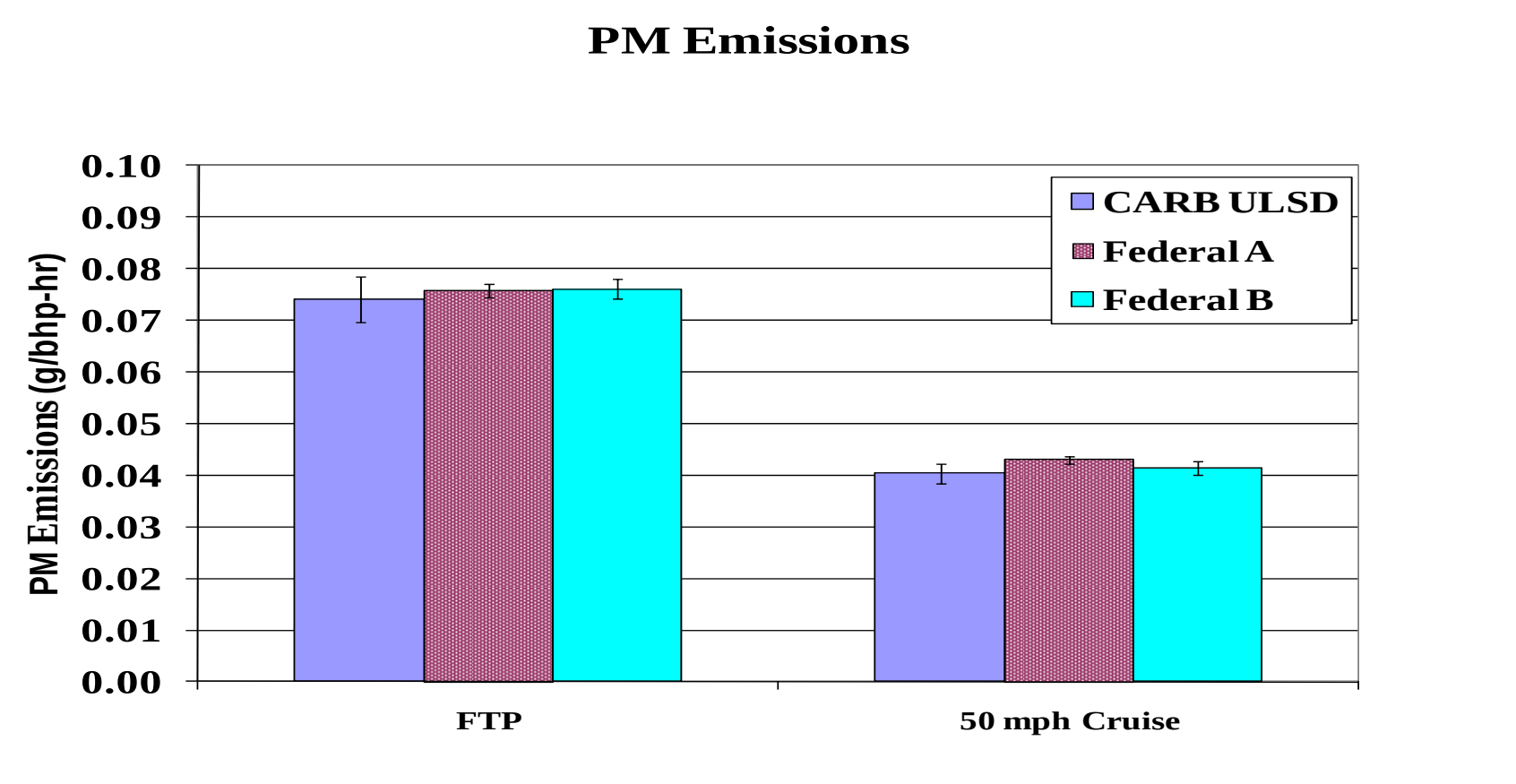
NO_x Results 1991 DDC 60



NO_x Engine Results

		2007 MBE4000			2006 Cummins ISM			1991 DDC 60		
	CARB vs.	Ave.	% Diff	P-values	Ave.	% Diff	P-values	Ave.	% Diff	P-values
FTP	CARB	1.275			2.096			4.572		
	Federal A	-	-	-	2.236	6.7%	0.000	4.913	7.5%	0.000
	Federal B	1.368	7.3%	0.000	2.263	7.9%	0.000	4.997	9.3%	0.000
50 mph Cruise	CARB	1.137			1.643			6.470		
	Federal A		-	-	1.799	10%	0.001	6.810	5.3%	0.000
	Federal B	1.190	4.7%	0.000	1.775	8.1%	0.020	6.945	7.3%	0.000

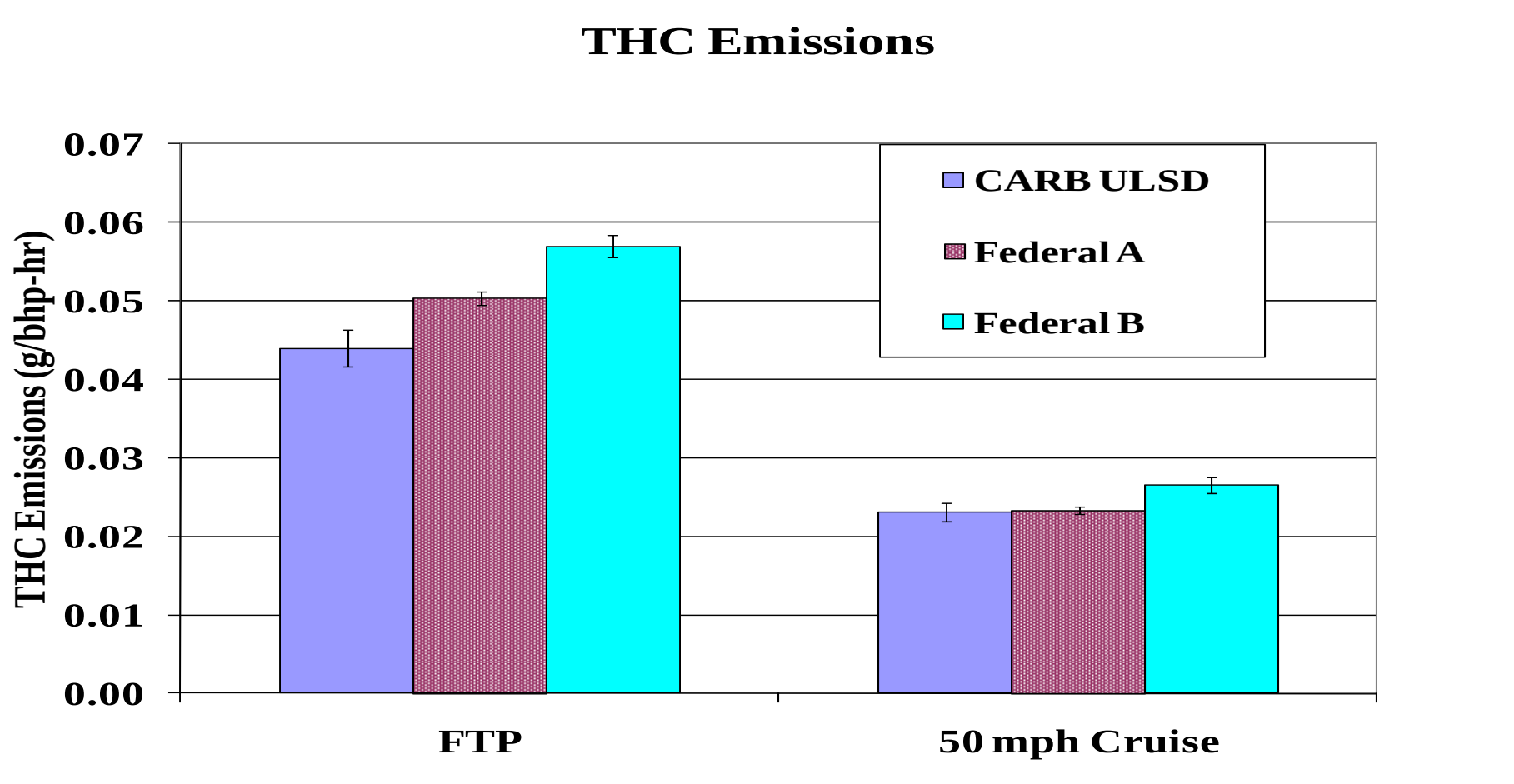
PM Results 1991 DDC 60



PM Engine Results

		2007 MBE4000			2006 Cummins ISM			1991 DDC 60		
	CARB vs.	Ave.	% Diff	P. values	Ave.	% Diff	P. values	Ave.	% Diff	P. values
FTP	CARB	-0.00018			0.070			0.074		
	Federal A		-	-	0.073	5%	0.000	0.076	2.1%	0.425
	Federal B	-0.00009	53%	0.752	0.076	8%	0.000	0.076	2.6%	0.341
50 mph Cruise	CARB	0.00011			0.053			0.040		
	Federal A		-	-	0.052	0%	0.831	0.043	6.5%	0.011
	Federal B	0.00022	109%	0.297	0.054	3%	0.278	0.041	2.4%	0.330

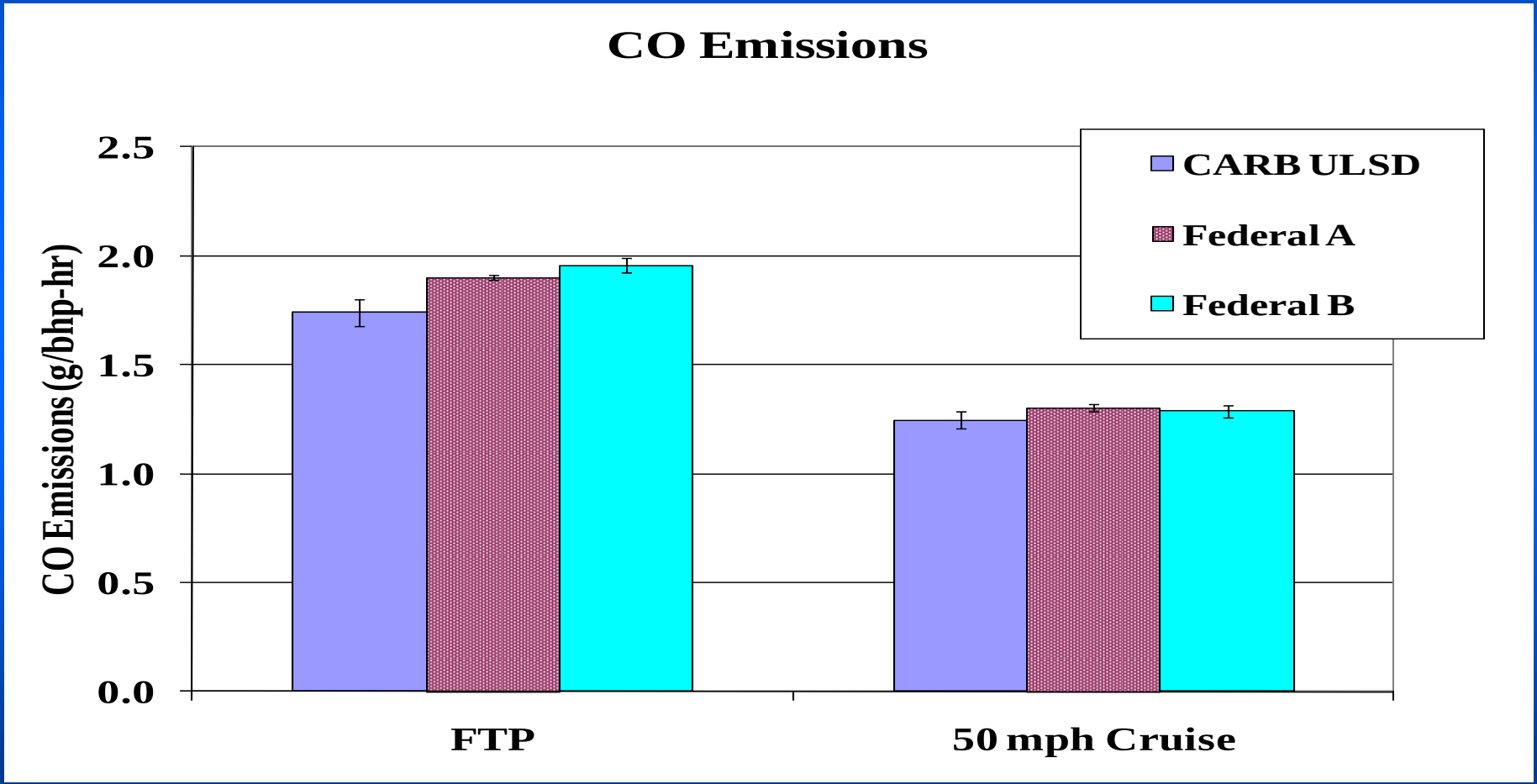
THC Results 1991 DDC



THC Engine Results

		2007 MBE4000			2006 Cummins ISM			1991 DDC 60		
	CARB vs.	Ave.	% Diff	P-values	Ave.	% Diff	P-values	Ave.	% Diff	P-values
FTP	CARB	0.006			0.143			0.044		
	Federal A		-	-	0.142	-0.7%	0.633	0.050	14.4%	0.000
	Federal B	0.007	27%	0.135	0.160	12.0%	0.000	0.057	29.5%	0.000
50 mph Cruise	CARB	0.004			0.077			0.023		
	Federal A		-	-	0.067	-13%	0.000	0.023	0.7%	0.756
	Federal B	0.003	-14%	0.270	0.077	0%	0.904	0.027	14.4%	0.000

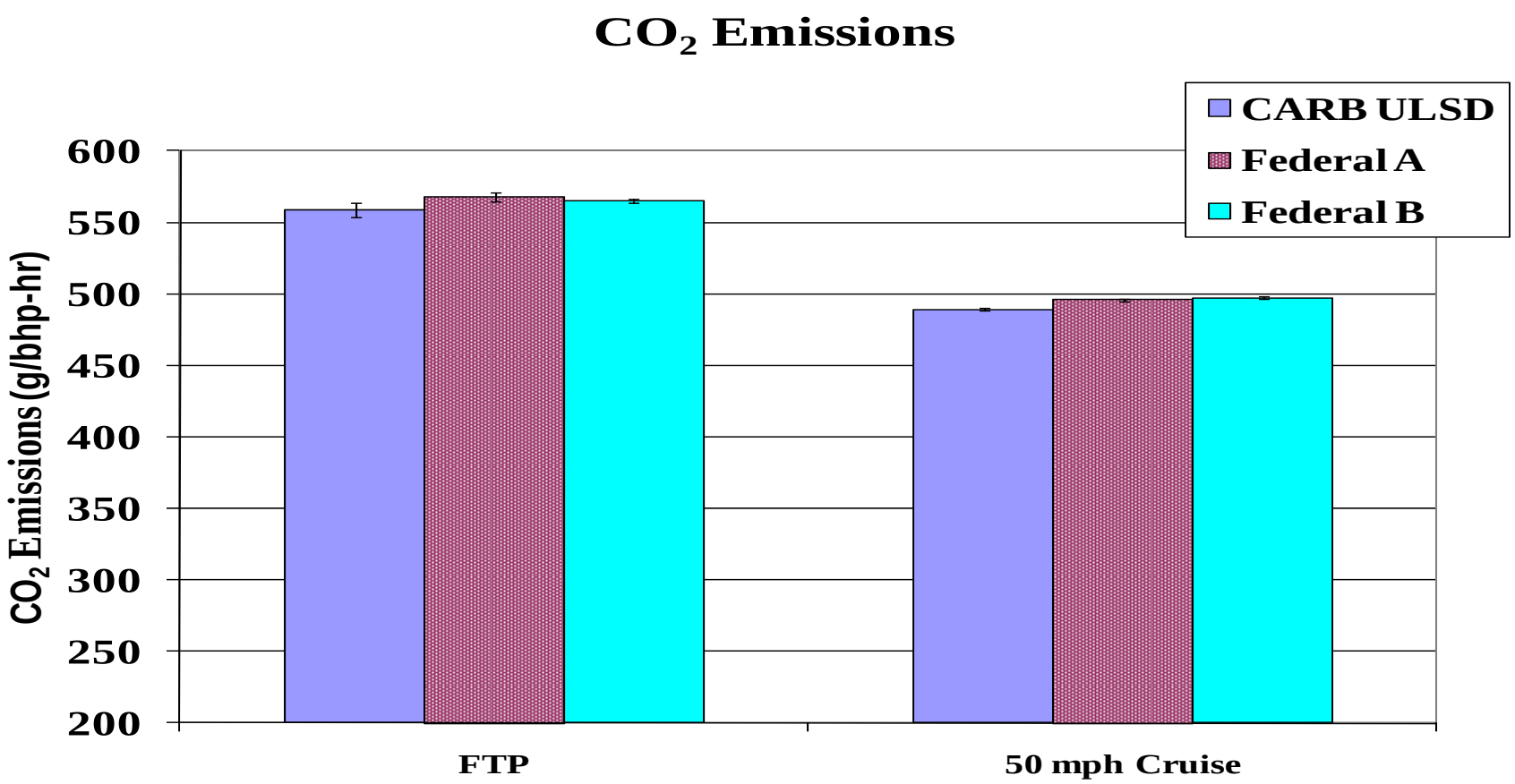
CO Results 1991 DDC 60



CO Engine Results

		2007 MBE4000			2006 Cummins ISM			1991 DDC 60		
	CARB vs.	Ave.	% Diff	P-values	Ave.	% Diff	P-values	Ave.	% Diff	P-values
FTP	CARB	0.093			0.809			1.742		
	Federal A		-	-	0.945	16.8%	0.000	1.901	9.1%	0.000
	Federal B	0.021	51%	0.000	0.991	22.5%	0.000	1.955	12.2%	0.000
50 mph Cruise	CARB	0.141			0.534			1.247		
	Federal A		-	-	0.559	5%	0.041	1.303	4.5%	0.009
	Federal B	0.027	31%	0.024	0.585	9%	0.002	1.287	3.2%	0.070

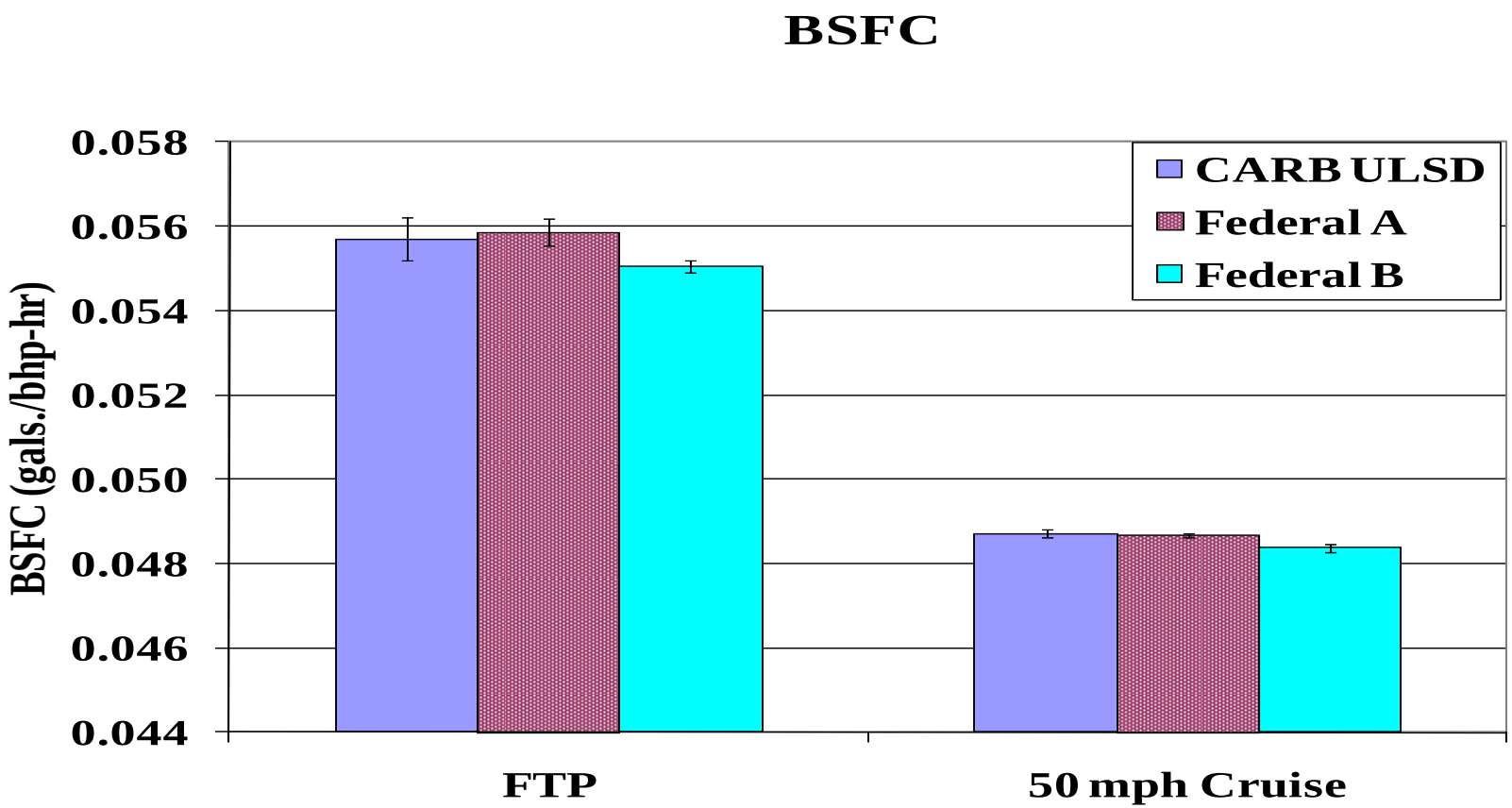
CO_2 Results 1991 DDC 60



CO_2 Engine Results

		2007 MBE4000			2006 Cummins ISM			1991 DDC 60		
	CARB vs.	Ave.	% Diff	P-values	Ave.	% Diff	P-values	Ave.	% Diff	P-values
FTP	CARB	591.624			628.574			568.080		
	Federal A		-	-	636.977	1%	0.000	568.080	2%	0.003
	Federal B	600.145	1.4%	0.000	636.855	1.3%	0.000	565.055	1.2%	0.013
50 mph Cruise	CARB	520.339			549.941			489.017		
	Federal A		-	-	555.102	1%	0.004	495.740	1.4%	0.000
	Federal B	530.551	2.0%	0.000	561.112	2.0%	0.000	497.295	1.7%	0.000

BSFC Results 1991 DDC 60



BSFC Engine Results

		2007 MBE4000			2006 Cummins ISM			1991 DDC 60		
	CARB vs.	Ave.	% Diff	P-values	Ave.	% Diff	P-values	Ave.	% Diff	P-values
FTP	CARB	0.059			0.063			0.0557		
	Federal A		-	-	0.062	0%	0.667	0.0559	0%	0.524
	Federal B	0.058	-0.9%	0.000	0.062	-1.0%	0.002	0.0550	-1.2%	0.014
50 mph Cruise	CARB	0.052			0.055			0.049		
	Federal A		-	-	0.054	0%	0.080	0.049	-0.1%	0.589
	Federal B	0.051	-0.4%	0.255	0.054	-0.4%	0.348	0.048	-0.7%	0.000