

Effects of High-Octane E25 on Two Vehicles Equipped with Turbocharged, Direct-Injection Engines



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**EFFECTS OF HIGH-OCTANE E25 ON TWO VEHICLES EQUIPPED WITH
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2.1 MINI COOPER S



Figure 1. 2015 MINI Cooper S in the ORNL Vehicle Laboratory.

downspeeding

downsizing

Table 1. EPA Shift Schedule and ORNL downspeed schedule for MINI Cooper.

Gear Change	EPA Schedule (mph)	ORNL Downspeed Schedule (mph)
1 → 2		
2 → 3		
3 → 4		
4 → 5		
5 → 6		

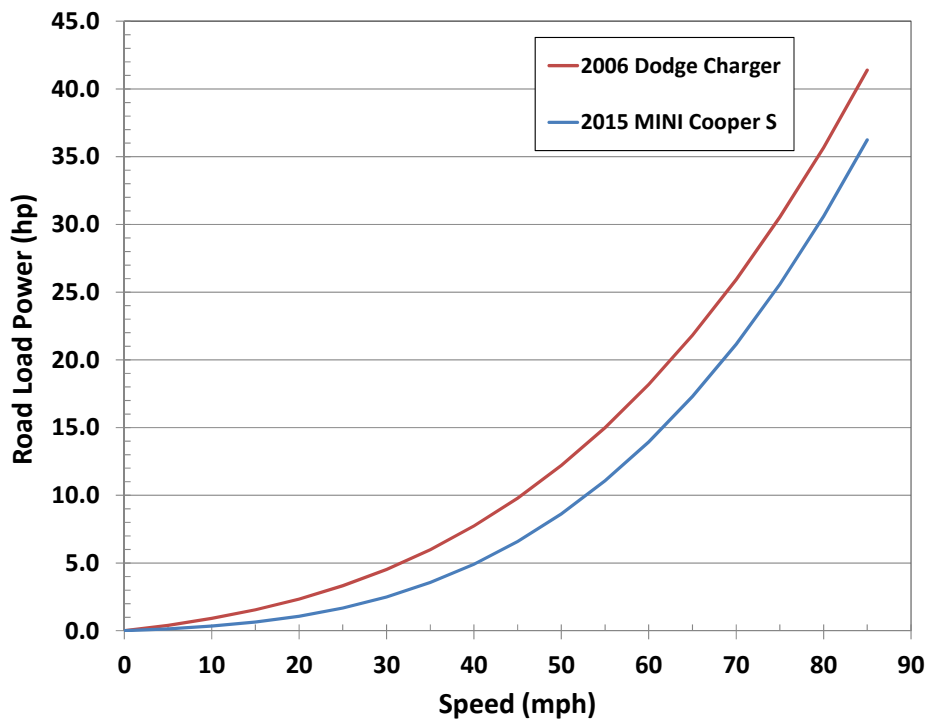


Figure 2. Road Load Horsepower for 2015 MINI Cooper S and 2006 Dodge Charger.

2.2 FORD F150 ECOBOOST



Figure 3. 2016 Ford F150 in the ORNL Vehicle Laboratory.

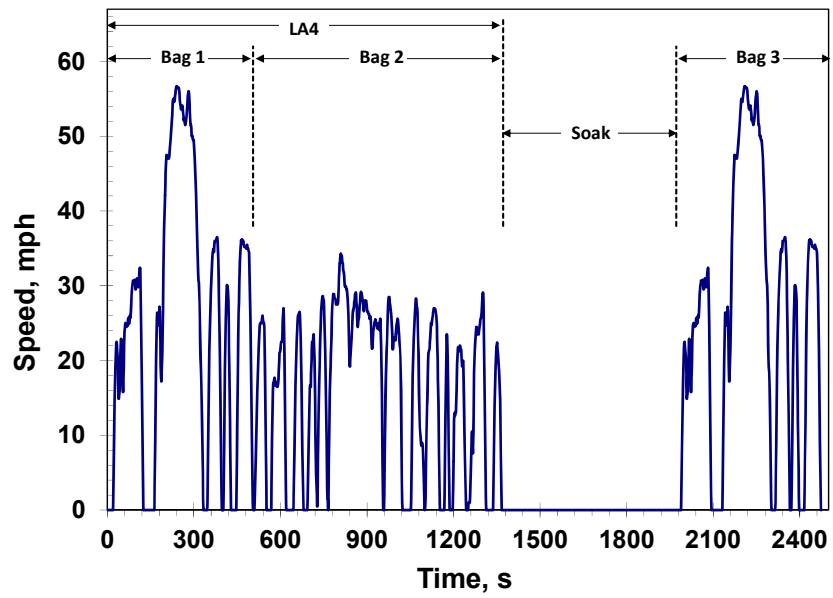


Figure 4. Federal Test Procedure for City Fuel Economy



Figure 5. Ford F150 pistons.

2.3 TEST FACILITY

3. TEST FUELS AND GASOLINE EQUIVALENT FUEL ECONOMY

efficiency

$$MPG_{ge} = \text{test fuel MPG} \times \frac{\text{reference fuel BTU/gal}}{\text{test fuel BTU/gal}}$$

reference fuel

$$MPG_{\text{avg}} = \frac{n}{\sum_{i=1}^n \frac{1}{MPG_i}}$$

Table 2. Selected Properties of Test Fuels.

Property (Units)	Method	Tier 3 E10			"Tier 3 E25"		
		Gage CofA	SwRI	E10 Avg	Gage CofA	SwRI	E25 Avg
RON				92.3			98.7
MON				84.4			87.2
Sensitivity				7.9			11.5
Antiknock Index				88.3			93.0
Carbon Content (wt%)				82.98			77.36
Hydrogen Content (wt%)				13.62			13.44
Oxygen Content (wt%)				3.61			9.04
Net Heat of Combustion (MJ/kg)				41.56			39.09
Specific Gravity (60F)				0.7481			0.7553
Density (g/cc 15C)				0.7476			0.7549
Ethanol Content (vol%)				9.80			24.765
Particulate Matter Index ²²				1.924			1.550
Water (ppm)				1192			2676

4. RESULTS

4.1 MINI COOPER FUEL ECONOMY/EFFICIENCY

Table 3. Average fuel economy in MPGge for MINI Cooper S experiments at two test weights with two fuels with two shift schedules.

Test weight and Road Load	Fuel	Shift Schedule	FTP MPGge	HFET MPGge	US06 MPGge
MINI Cooper, 3125 lb					
Dodge Charger Emulation, 4500 lb					

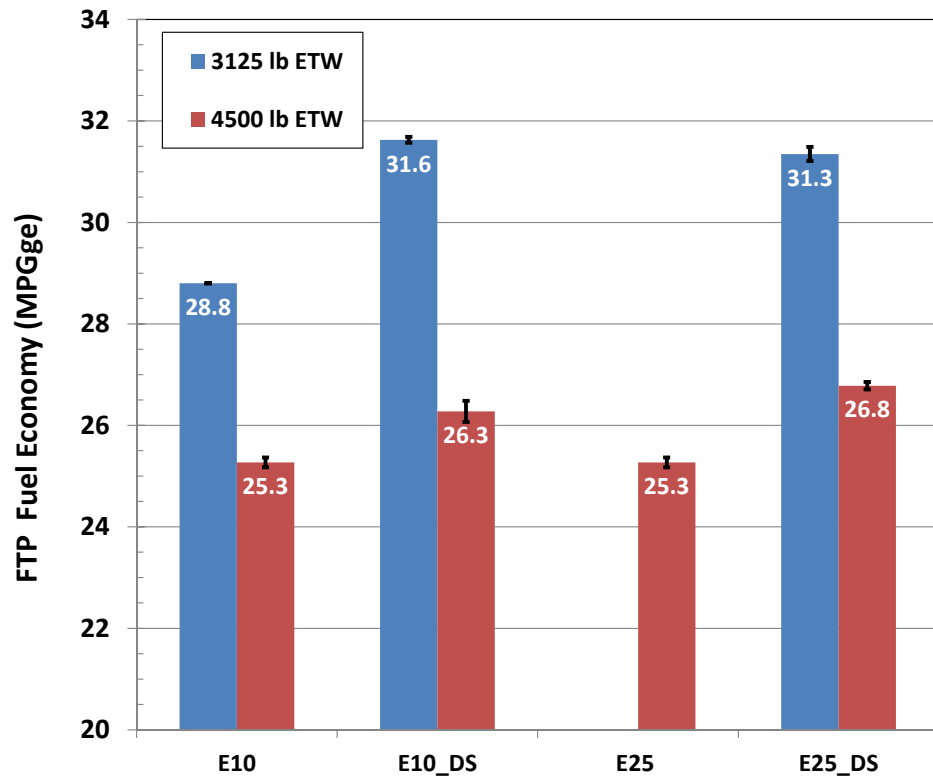


Figure 6. FTP Fuel Economy for MINI Cooper S at two test weights, with two fuels, and two shift schedules.

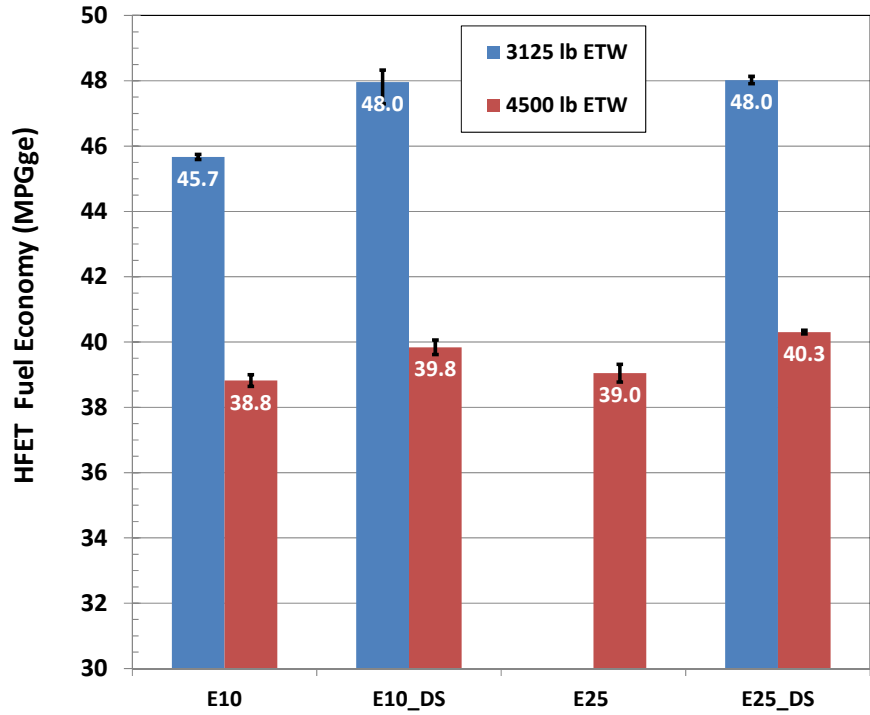


Figure 7. Highway Fuel Economy Test Results for MINI Cooper S at two test weights, with two fuels and two shift schedules.

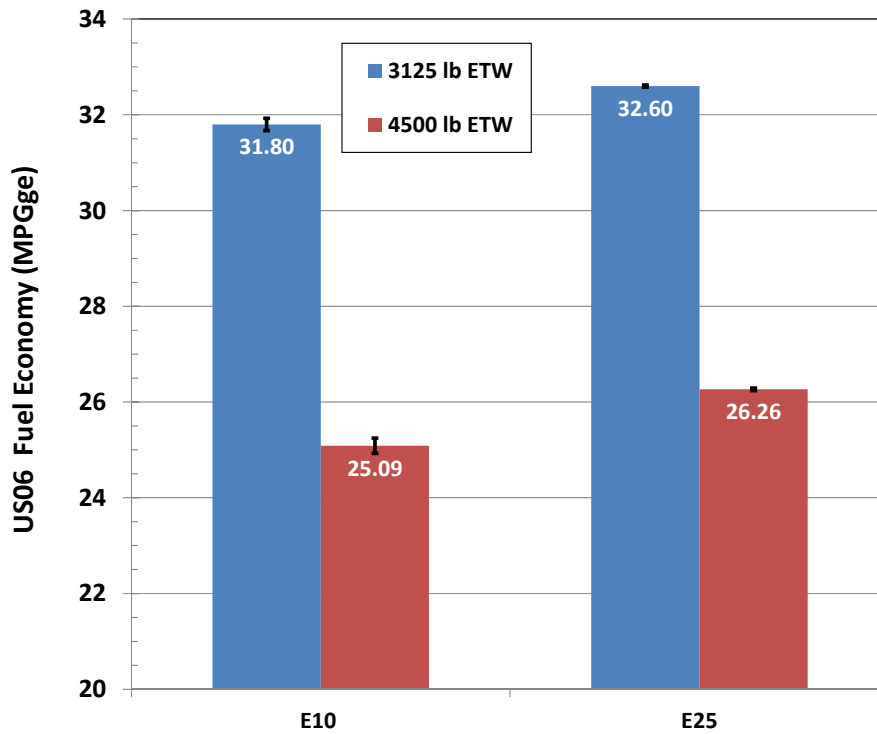


Figure 8. US06 Fuel Economy for MINI Cooper S at two test weights with two fuels.

4.2 MINI COOPER VEHICLE EMISSIONS

Table 4. Average NMOG Emissions for MINI Cooper S experiments at two test weights with two fuels and two shift schedules.

Test weight and Road Load	Fuel	Shift Schedule	FTP NMOG mg/mi	HFET NMOG mg/mi	US06 NMOG mg/mi
MINI Cooper, 3125 lb					
Dodge Charger Emulation, 4500 lb					

Table 5. Average NOx Emissions for MINI Cooper S experiments at two test weights with two fuels and two shift schedules.

Test weight and Road Load	Fuel	Shift Schedule	FTP NOx mg/mi	HFET NOx mg/mi	US06 NOx mg/mi
MINI Cooper, 3125 lb					
Dodge Charger Emulation, 4500 lb					

Table 6. Average NMOG+NOx Emissions for MINI Cooper S experiments at two test weights with two fuels and two shift schedules.

Test weight and Road Load	Fuel	Shift Schedule	FTP NMOG+NOx mg/mi	HFET NMOG+NOx mg/mi	US06 NMOG+NOx mg/mi
MINI Cooper, 3125 lb					
Dodge Charger Emulation, 4500 lb					
EPA Tier 3, Bin 30 Emissions Standard					

Table 7. Average CO Emissions for MINI Cooper S experiments at two test weights with two fuels and two shift schedules.

Test weight and Road Load	Fuel	Shift Schedule	FTP CO mg/mi	HFET CO mg/mi	US06 CO mg/mi
MINI Cooper, 3125 lb					
Dodge Charger Emulation, 4500 lb					
EPA Tier 3, Bin 30 Emissions Standard					

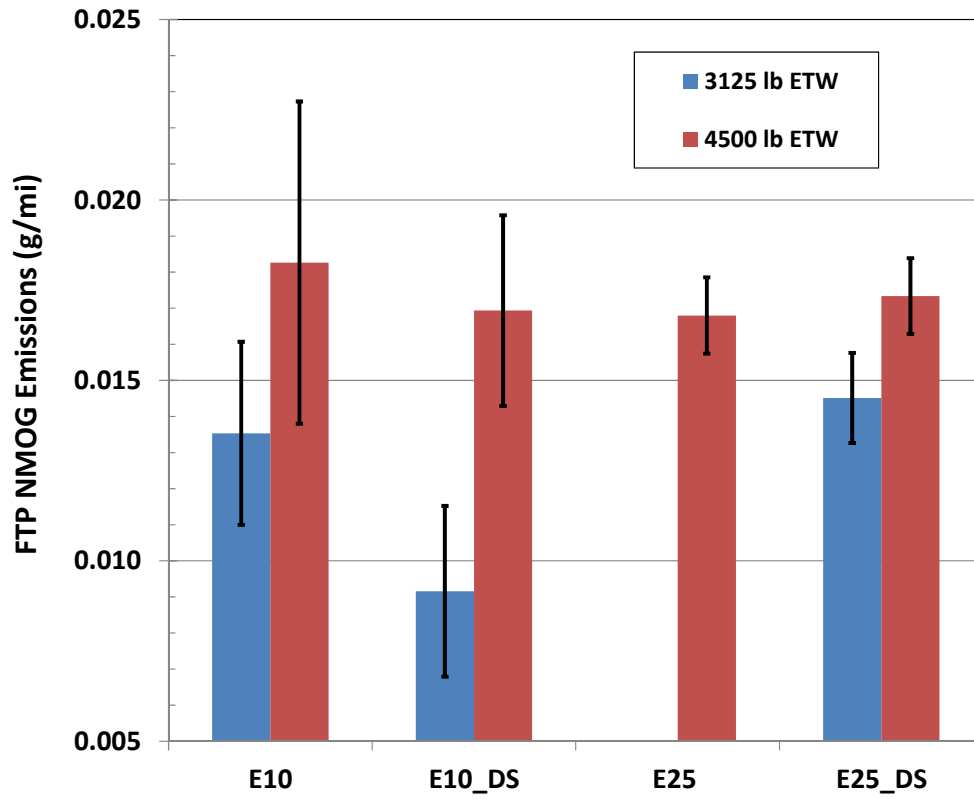


Figure 9. FTP NMOG emissions for 2015 MINI Cooper at two test weights, with two fuels and two shift schedules.

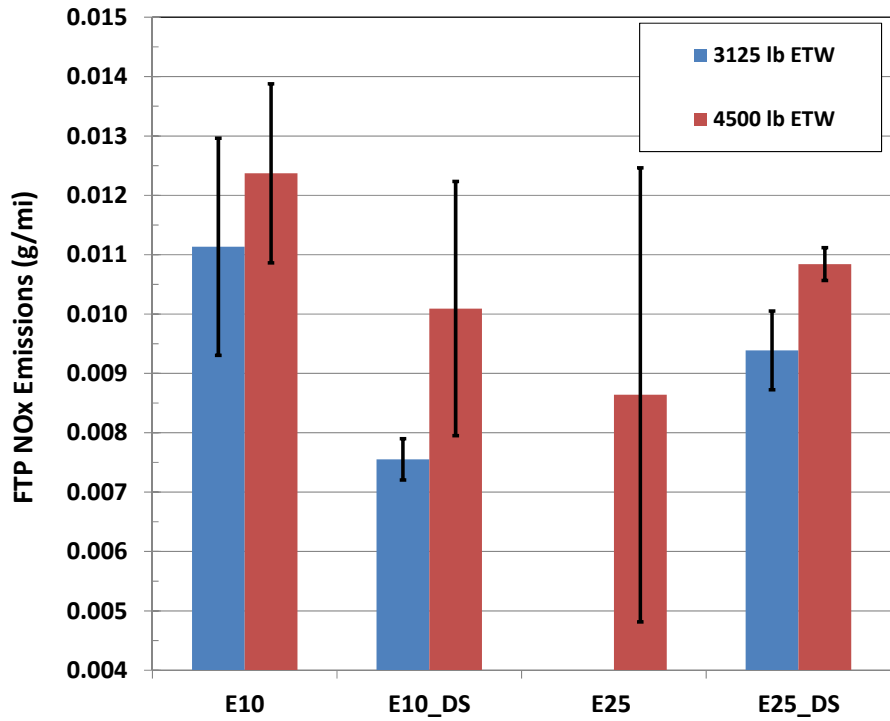


Figure 10. FTP NOx emissions for 2015 MINI Cooper at two test weights, with two fuels and two shift schedules.

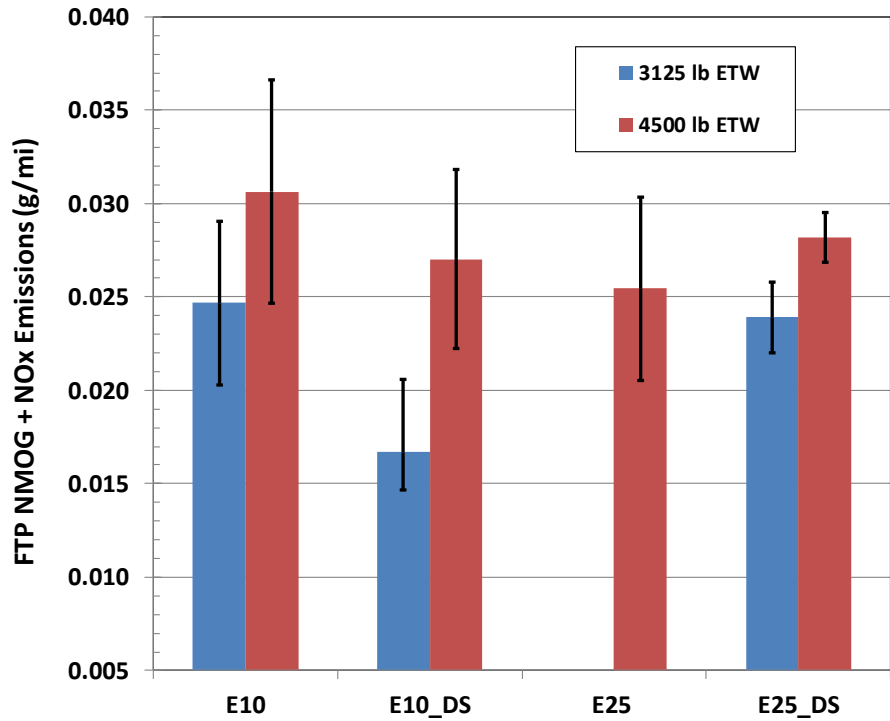


Figure 11. FTP NMOG + NOx emissions for 2015 MINI Cooper at two test weights, with two fuels and two shift schedules.

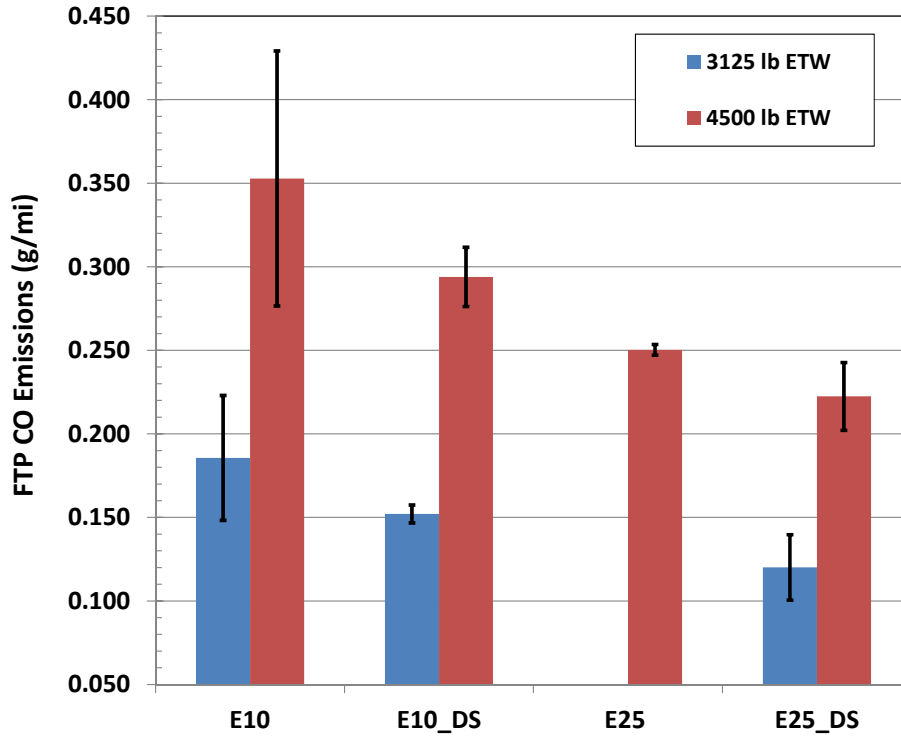


Figure 12. FTP CO emissions for 2015 MINI Cooper at two test weights, with two fuels and two shift schedules.

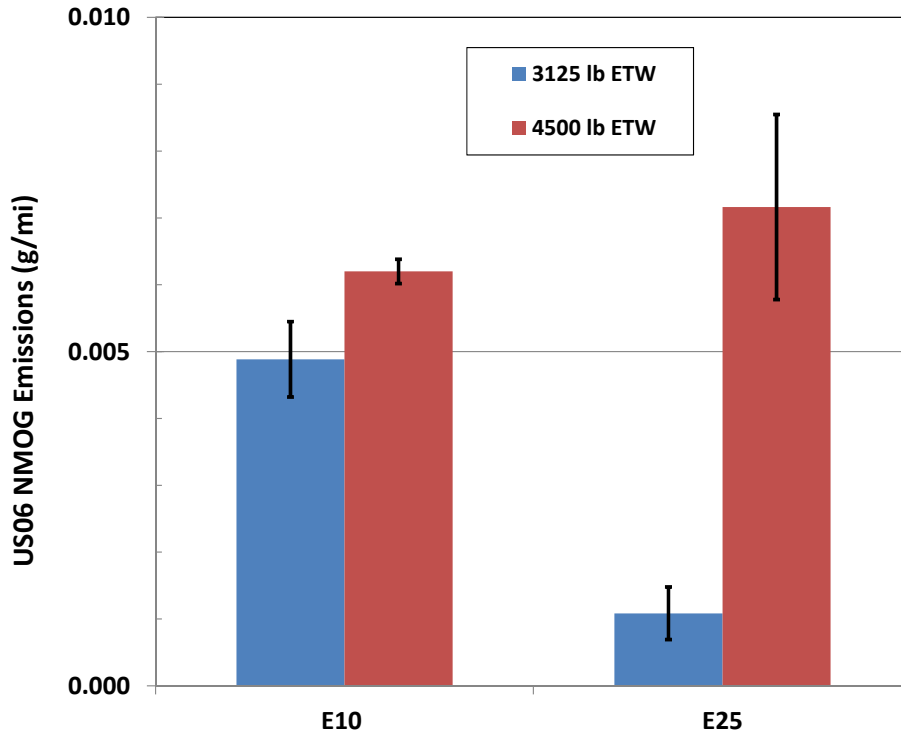


Figure 13. US06 NMOG emissions for 2015 MINI Cooper at two test weights with two fuels.

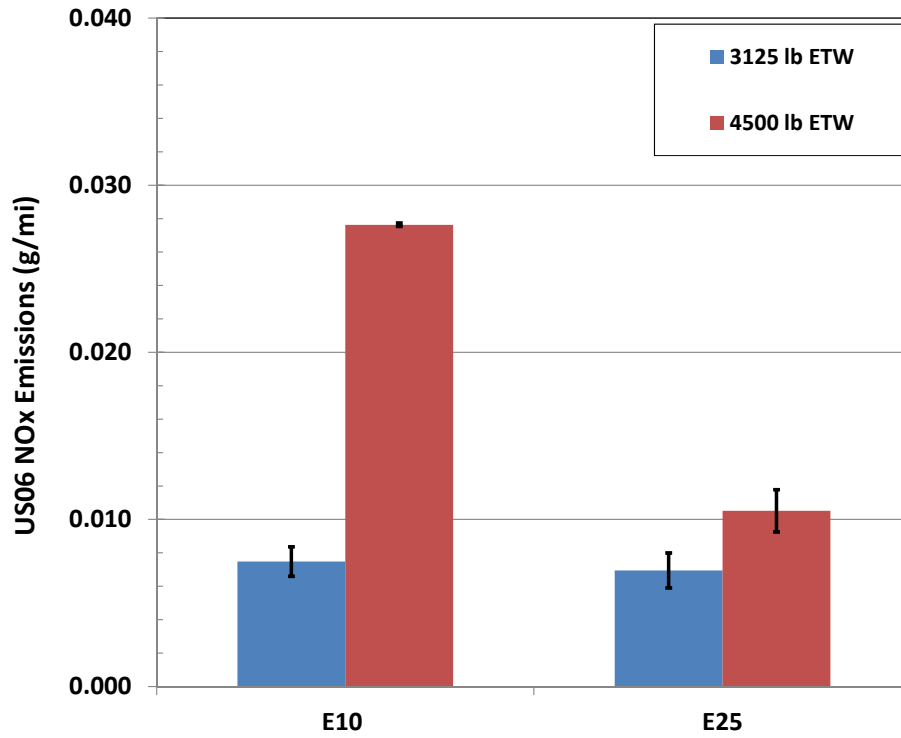


Figure 14. US06 NOx emissions for 2015 MINI Cooper at two test weights with two fuels.

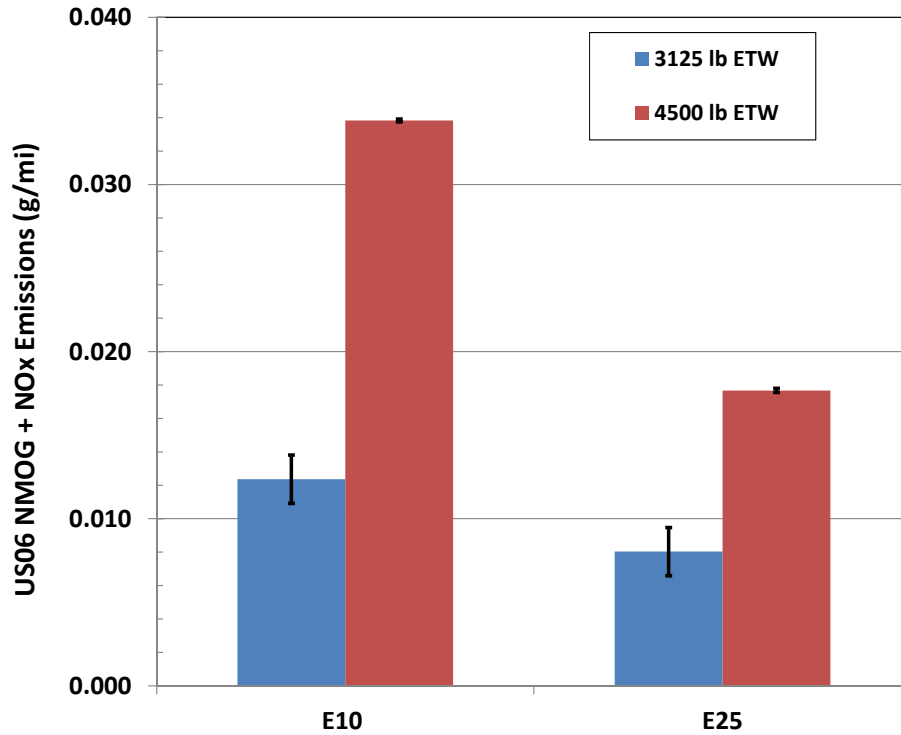


Figure 15. US06 NMOG+NOx emissions for MINI Cooper at two test weights with two fuels.

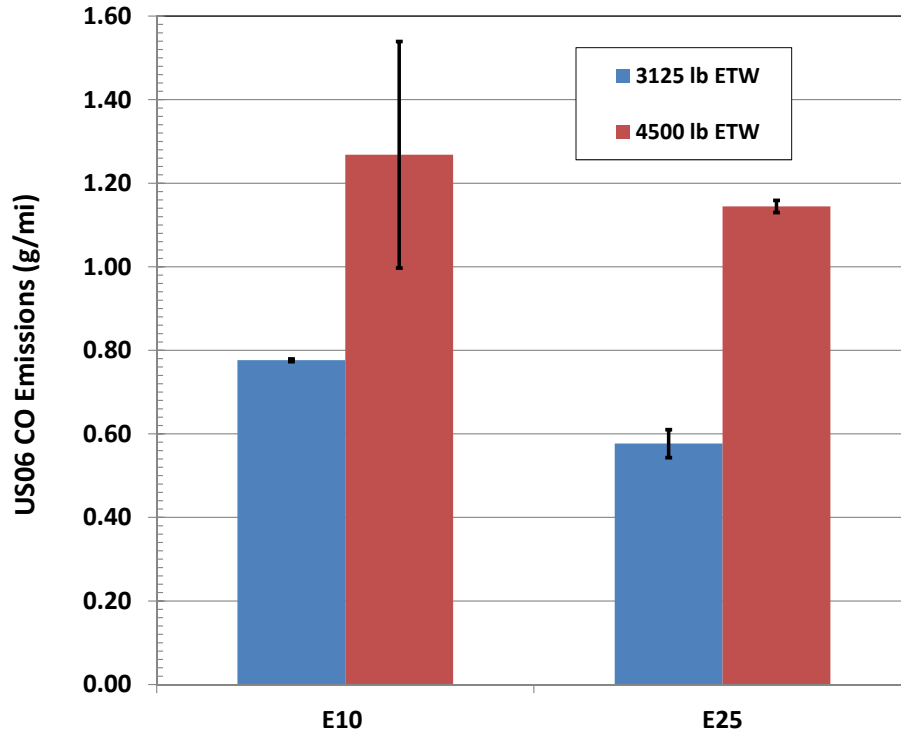


Figure 16. US06 CO emissions for MINI Cooper at two test weights with two fuels.

4.3 MINI COOPER VEHICLE ACCELERATION

Table 8. MINI Cooper S 15-80 mph acceleration times at two test weights with two fuels.

Run	MINI (3125 lb)		Dodge Charger Emulation (4500 lb)		
	E10	E25	E10	E25	E25 with Power Module
1					
2					
3					
4					
5					
Minimum					
Median					

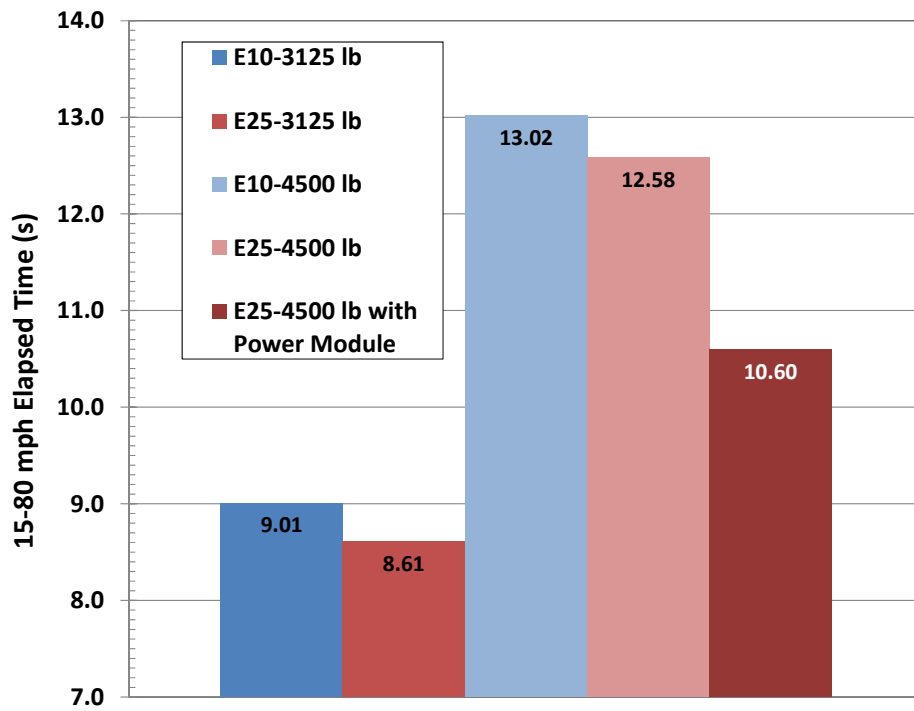


Figure 17. Minimum wide-open-throttle acceleration times for MINI Cooper with E10 and E25 at two test weights with two fuels.

4.4 FORD F150 FUEL ECONOMY/EFFICIENCY

Table 9. Average fuel economy in MPGge for 2016 Ford F150 experiments with two fuels.

Fuel (Compression Ratio)	Test Result	FTP MPGge	HFET MPGge	US06 MPGge
Tier 3 E10 (10:1)	Average	19.5	28.7	17.6
	Maximum			
	Minimum			
	U95			
Tier 3 E25 (10:1)	Average	19.4	28.8	18.0
	Maximum			
	Minimum			
	U95			
Tier 3 E25 (12.2:1)	Average	20.5	30.1	18.7
	Maximum			
	Minimum			
	U95			

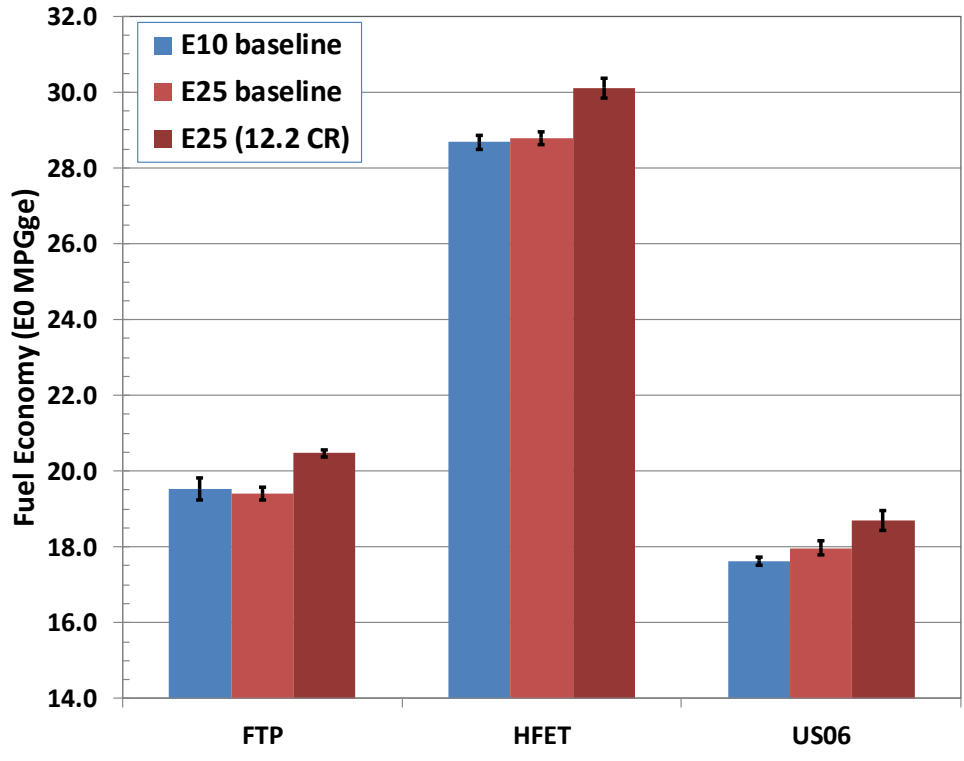


Figure 18. Ford F150 Fuel Economy in MPGge.

4.5 FORD F150 BASELINE EMISSIONS

Table 10. FTP NOx emissions for 2016 Ford F150 experiments with two fuels in the factory condition.

Run	E10 (10:1)	Average mg/mi	Maximum mg/mi	Minimum mg/mi	U95
1		10.3			
2					
3					
4					
5					
Run	E25 (10:1)	Average mg/mi	Maximum mg/mi	Minimum mg/mi	U95
1		12.7			
2					
3					
4					
5					

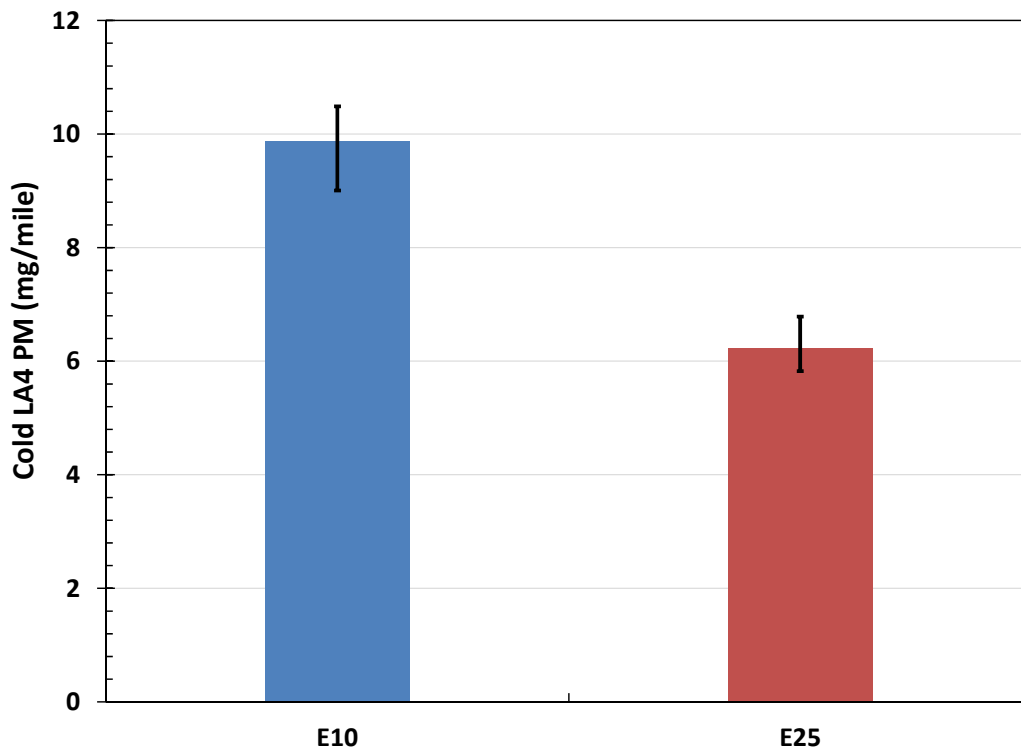


Figure 19. Cold LA4 particulate emissions for Ford F150 with two fuels.

4.6 FORD F150 ACCELERATION

Table 11. F150 15-80 mph Acceleration Time with two fuels

Run	E10 (10:1)	E25 (10:1)	E25 (12.2:1)
1			
2			
3			
4			
5			
6			
Minimum			
Median			

5. SUMMARY

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