Status Report on CRC and ASTM Activities Related to NIST HB 130 Model Gasoline Regulation

2015 NCWM Interim Meeting

R. P. Lewis

January 18 - 21, 2015

Hilton Dayton Beach Resort at Dayton Beach, FL

CRC Project CM-138-13-1 Overview

Basis

- Regulators at NCWM to Remove Existing 1 psi Waiver Allowance for non-VOC Ethanol Blends in May 2016; Wants Harmonization with ASTM
- OEMs Concerned with Starting/Warm-up/ Hot Driveability Issues on High Volatility Ethanol-Extended Fuels in GDI Engines
- ASTM Requested CRC to Generate Data to Use at ASTM to Revise Limits as Needed
- Cost: $1.365 Million (Largest Ever CRC Driveability Project)

Purpose – RVP, T50 and Tv/l=20 Effects

- Evaluate Vehicle Performance at Maximum Vapor Pressure
  - With and Without the 1 psi Waiver for Ethanol Blends
  - Include minimum T50 and Tv/l=20 Limits in Test Fuel Design
  - Include Older Vehicles in Fleet Matrix
- Volatility Classes/Program Dates: C to E in Mar-May; AA to B in Jul-Aug
- GM Proving Grounds in Yuma, AZ
- Russ Lewis - Marathon, Bill Studzinski – GM are Key Planners

CRC Project CM-138-13-1 Overview

Program Outline

- Fleet:
  - 40 Vehicles Screened
  - 18 Selected for Program from 3 Categories
    - (1998 – 2005 PFI, 2006 – 2013 PFI, 2013+ DI)
- Time Frame:
  - March thru May 2014: Classes C through E
  - July thru August 2014: Classes AA through B
- Ambient Test Temperatures:
  - Class E from 65°F to 75°F
  - Class D from 80°F to 90°F
  - Class C from 90°F to 100°F
  - Classes B through AA from 100°F to 120°F
- Location:
  - Yuma, AZ at the GM Proving Grounds

18 Vehicle Fleet: 15 Cars & 3 Trucks

Year	Make	Model	Veh. Series	Mileage	FFV?	PFI or DI?	Boosted?	Curb Wt. (kg) (w/o driver & Empty)	Engine Disp. (L)	Curb Wt. Load Factor (kg/L)	Cylinders	FWD, AWD, 4WD?	Emissions Cat. - Fed.
2003	CHEVY	IMPALA	LS	62,042	No	PFI	No	1566	3.8	412	6	FWD	T2
2014	FORD	MUSTANG	---	22,809	No	PFI	No	1604	3.7	433	6	RWD	T2 B4
2013	DODGE	CHALLENGER	---	26,847	No	PFI	No	1735	3.6	482	6	RWD	T2 B4
2013	TOYOTA	COROLLA	LE	16,904	No	PFI	No	1211	1.8	673	4	FWD	T2 B5
2014	FORD	ESCAPE	SE	20,258	No	GDI	Turbo	1605	1.6	1003	4	FWD	T2 B5
1999	BUICK	CENTURY	---	129,298	No	PFI	No	1502	3.1	484	6	FWD	"Meets 1999"
2013	KIA	OPTIMA	---	27,767	No	GDI	No	1440	2.4	600	4	FWD	T2 B5
2013	MAZDA	2	---	17,031	No	PFI	No	1021	1.5	681	4	FWD	T2 B5
2014	FORD	FIESTA	SE	8,913	No	PFI	No	1128	1.6	705	4	FWD	T2 B4
2014	CHEVY	CRUZE	LT	1,553	No	PFI	Turbo	1370	1.4	979	4	FWD	T2
2013	INFINITY	G37	---	27,027	No	PFI	No	1566	3.7	423	6	FWD	T2 B5
2013	DODGE	DART	SXT	21,956	No	PFI	No	1444	2.0	722	4	FWD	T2 B4
2013	NISSAN	SENTRA	SV	23,008	No	PFI	No	1255	1.8	697	4	FWD	T2 B5
2013	VOLKS	GOLF	---	18,602	No	PFI	No	1346	2.5	538	4	FWD	T2 B3
2013	FORD	FUSION	SE	21,179	No	PFI	No	1529	2.5	612	4	FWD	T2 B5
2014	JEEP	GCHE	Limited	1,939	FFV	PFI	No	2059	3.6	572	6	RWD	T2 B4
2013	CHEVY	TAHOE	---	20,410	FFV	PFI	No	2551	5.3	481	8	4x4	T2
2014	CHRYSLER	200	---	2,050	No	PFI	No	1502	2.4	626	4	FWD	California Only
2 Old					2 FFV	2 GDI	2 Turbo			412 - 1003 LF	1 V8	1 4 x4	

Company	
Chrysler	4
Ford	4
GM	4
Hyundai	0
Kia	1
Mazda	1
Nissan	2
Toyota	1
Volkswagen	1
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CRC 2014 Hot Fuel Handling Driveability Project Fuel Inspections (Avg of 4 Labs)

Fuel Code		E-TF1-E10	E-TF2-E10	E-TF3-E10	E-TF4-E15	E-TF5-E15	E-TF6-E10	E-TF7-E10	E-TF8-E15
Property	Units								
API Gravity@60°F	°F	62.7	63.2	65.3	63.7	64.9	64.5	60.6	61.9
Antiknock Index, (R+M)/2		89.3	89.1	88.1	89.8	89.8	88.5	89.6	90.6
Ethanol Content	Vol%	9.8	9.8	10.0	14.8	14.6	9.8	9.9	14.8
DVPE Vapor Pressure	psi	15.9	15.2	15.9	15.8	15.8	14.4	13.3	14.3
Temperature V/L=20 (TVL20)	°F	100.6	104.2	98.6	99.8	98.6	105.3	110.3	106.3
D86 Distillation									
10% Evaporated	°F	98.6	100.7	94.3	95.6	96.7	100.3	106.4	102.4
50% Evaporated		149.5	150.3	146.0	151.4	147.4	145.8	149.5	149.2
90% Evaporated		320.1	321.0	317.6	315.5	309.7	310.7	310.2	310.7

Fuel Code		E-TF9-E10	E-TF10-E10	E-TF11-E10	E-TF12-E10	E-TF13-E10	E-TF14-E10	E-TF15-E15	E-TF16-E15
Property	Units								
API Gravity@60°F	°F	59.8	59.4	58.8	59.1	55.9	55.8	56.0	56.0
Antiknock Index, (R+M)/2		90.7	90.9	91.4	91.1	89.4	89.4	94.7	94.7
Ethanol Content	Vol%	9.8	9.8	10.4	9.5	10.1	10.0	15.2	15.2
DVPE Vapor Pressure	psi	12.3	11.3	11.1	9.8	9.0	8.0	9.9	9.9
Temperature V/L=20 (TVL20)	°F	114.9	118.7	120.2	126.8	130.6	132.4	129.2	129.2
D86 Distillation									
10% Evaporated	°F	112.5	118.6	118.2	126.1	125.7	127.9	129.2	129.2
50% Evaporated		169.2	168.0	179.6	180.9	187.0	184.5	175.7	175.7
90% Evaporated		321.9	313.0	300.8	309.4	326.1	324.8	325.9	325.9

HFH Vehicle Test Procedure and Recorded Data

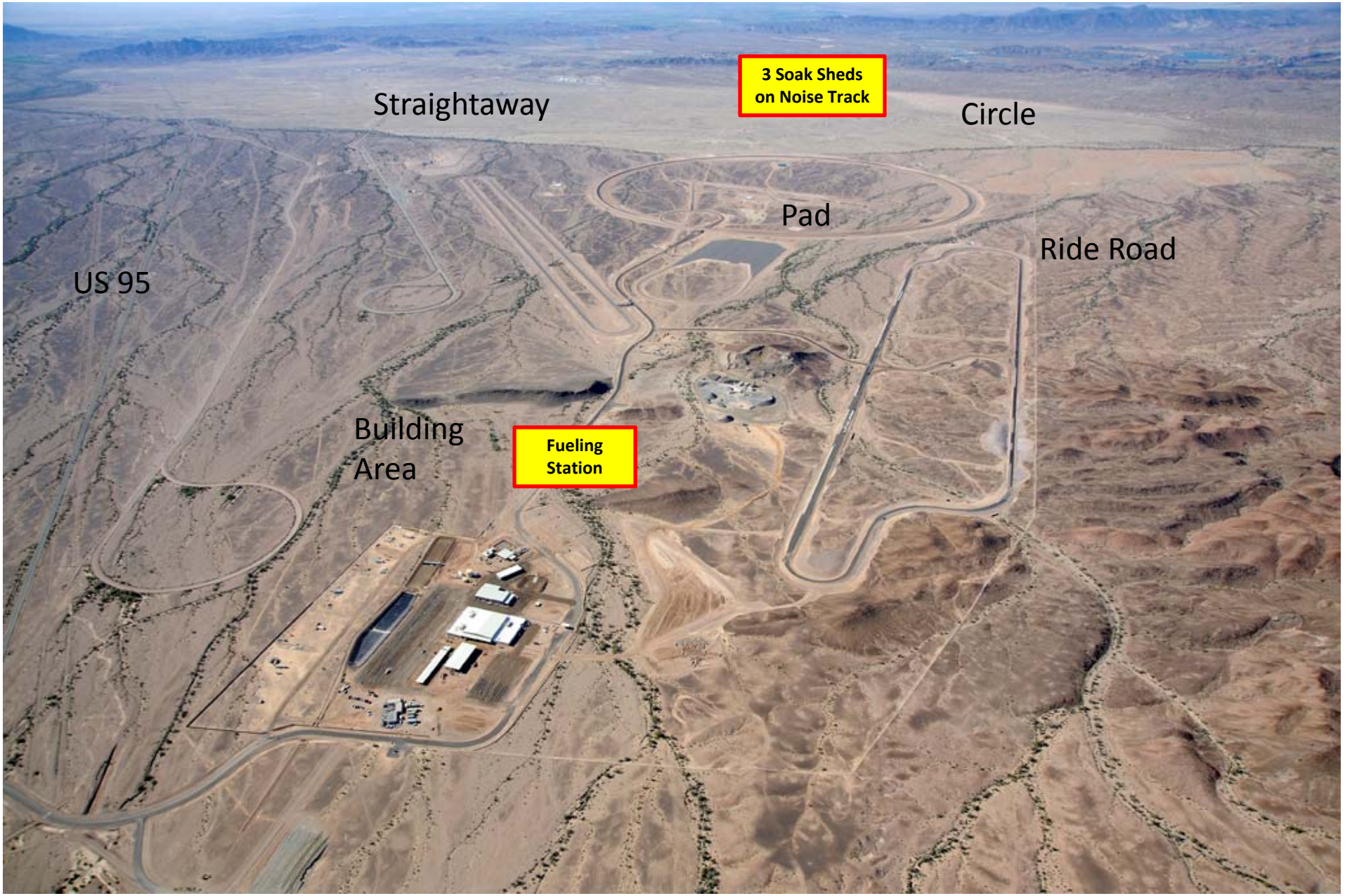
Test Procedure - Abbreviated

- Double flush each vehicle with Test Fuel.
- Wait for desired ambient temperature range + 2 hrs. (Sun Load)
- Final fuel fill = 4 gallon then immediately pre-condition vehicle for 20 miles
- Pull vehicle into soak shed. Turn off engine. 20 minute hot soak.
- Re-start vehicle. Rate Idle quality. Rate WOT acceleration to 35 mph.
- Park vehicle in soak shed. Idle 20 minutes. Rate idle quality. Rate light throttle acceleration to 35 mph.
- Park vehicle in soak shed. Turn off engine. 20 minute hot soak.
- Restart vehicle. Rate Idle quality. Rate light acceleration to 35 mph.
- Return vehicle to fueling station.
- Elapsed time per vehicle: ~ 1 hr 30 min

Additional Data Recorded

- Ambient Temps.
- Wind Speed
- Underhood Temp.
- Fuel Rail Skin Temp.
- Vehicle characteristic details for correlations

Aerial View of GM Proving Grounds – Yuma, AZ



CM-138-13-1 Status

- Field Testing Completed!
  - 14 Weeks, Divided in Spring and Summer Sessions
  - >56,000 man-hours on-site: 8 CRC Contract Workers; 6 Contracted Warm-Up Drivers; ~70 “Volunteers”
  - 1 Screening Fuel; 16 Test Fuels; 20 Fuel Sets Tested
    - All Fuels Tested by All 3 Raters Under All Designed Conditions (Original Plan was for 2/3 Factorial)
    - Completed 3 missed fuels from Spring during Summer
  - Approximately $1.4 MM for Program
- >1,000 Vehicle Runs = Lots of Statistics
- Multiple Meetings of Data Analysis Panel
  - Face-to-Face on September 22nd and October 23rd
  - Several Netmeetings

Data Analysis Panel Roster

- Russ Lewis – Marathon (DAP Lead)
- Bill Studzinski – General Motors
- Lew Gibbs – CRC Consultant
- Beth Evans – CRC Consultant
- Harold Archibald – CRC Consultant
- Chris Tennant - CRC
- Jerry Horn – Chevron
- Jo Martinez – Chevron (Statistician for Project)
- Anindya Ghosal – Shell
- Asim Iqbal – Chrysler
- Jeff Farenback-Brateman – Exxon
- Jenny Sigelko – VW
- Ron Osman – FHR Consultant
- Bruce Alexander – BP
- Marie Valentine - Toyota

*Draft Conclusions from Project

- No statistically significant differences in TWD for ASTM compliant vapor pressure fuels and those with 1 psi higher vapor pressure tested in the same volatility class for the fuels and vehicles tested in this program.
- No statistically significant differences in TWD for ASTM Classes D and E fuels with 150°F vs. 145°F T50.
- No statistically significant differences in TWD between older vehicles (Pre-2005) and newer models (2013 & 2014).

*Final report on the project has yet to be approved by the CRC Performance Committee.

Next Steps

- CRC completion and approval of CM-138-13-1 Report – Jan 2015
- ASTM Subcommittee Ballot – Feb 2015
  - Incorporate 1 psi vapor pressure “waiver” for Non-VOC ethanol-blends into D4814
- ASTM Subcommittee Ballot – Feb 2015
  - Relax T_{50} min for Classes D/E ethanol-blends from 150°F to 145°F in D4814
- Complete Subcommittee and Main Committee ASTM Ballots – Goal by Jan 2016
- NIST HB 130 Model Gasoline Regulation to Harmonize with ASTM D4814