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California LEVIII Certification Fuel Gasoline - Alliance Fuels Group Comments

California LEVIII/ Phase 3 Reformulated Gasoline (CaRFG3) E10 Gasoline

ARB Public Workshop, El Monte, Calif.

July 19, 2011

Presented by Jim Frusti, Chrysler, for the Alliance

Alliance of Automobile Manufacturers

Automotive Industry Primary Objectives

- **Fuel properties that enable emerging technologies to meet aggressive CO2, fuel economy and criteria pollutant requirements.**

- **Key enablers:**
  - **Vehicle and Fuel must be treated as a system**
  - **Lower carbon content fuels are essential to satisfy California's objective of 80% reduction in GHG/CO2 emissions by 2050**
  - **Single harmonized certification fuel (for Federal/EPA and California)**

CARB and EPA Tier 3: Why No Single Harmonized Cert Fuel?

- Original Goal was to Harmonize to a Single, 50 State Certification Test Fuel (CARB, Jan. 2011)
- Plan was to reduce regulatory certification burden and avoid complexity
- What we are ending up with is expectation of "reciprocity" that ARB and EPA will honor each other's respective test protocol and cert test fuel used for a vehicle, rather than requiring duplicative tests*

HOWEVER: A SINGLE CERT FUEL CAN BE HARMONIZED

- **One Single, Premium Octane Grade is Sufficient/Preferable for Cert Tests –** EPA and ARB proposed changes to use of regular and premium grade cert fuels would add complexity, with minimal emissions benefits
- **ARB and EPA Cert Fuel Ethanol Should Both Be E10**
- **RVP Needs More Discussion**
- **Alliance specific recommendations for critical properties: benzene, sulfur, detergent, etc. are below**
- **Alliance would also like to engage with EPA & ARB re harmonized "E85" Cert Fuel; Will need to Address New ASTM D5798 Standard**

*Need confirmation that reciprocity extends to "in use" testing requirements

Alliance's Understanding of Initial Draft Tier 3 & LEV III Certification Fuel Proposals

Parameter	Units	CARB LEVIII Proposal June 28, 2011	EPA Tier 3 Proposal July 2011
Octane			
AKI, min.	Calc.	**87 - 88.4***	**87 - 88.4***
Sensitivity, min	Calc.	**7.5, min**	**7.5, min.**
Volatility			
RVP (Tailpipe Emissions Tests)	psi	**6.9 - 7.2**	**8.0 - 9.2**
RVP Evap	psi		**8.7 - 9.2**
RVP Altitude	psi		**7.6 - 8.0**
RVP Cold CO (20F)	psi		**11.2 - 11.8**
IBP	deg. F		**---**
T10	deg. F	**130 - 150**	**120 - 140**
T50	deg. F	**205 - 215**	**170 - 190**
T90	deg. F	**310 - 320**	**310 - 330**
FBP, max.	deg. F	**390, max.**	**390, min.**
Residue, max.	vol. %	**2.0, max.**	**---**
Drivability Index	---		**---**
Chemical Composition			
Aromatics, max.	vol. %	**19.5 - 22.5**	**19.5 - 27.5**
Aromatics, Multi-substituted Alkyl	vol. %	**13 - 15**	**---**
Olefins, max.	vol. %	**4.0 - 6.0**	**4 - 10**
Saturates	vol. %		**---**
MTBE	vol. %		**---**
Ethanol	vol. %	**9.75 - 10.25**	**14.8 - 15.2**
Total Oxygen	wt. %	**3.3 - 3.7**	**---**
Benzene	vol. %	**0.6 - 0.8**	**0.6 - 0.8**
Sulfur	ppm m/m	**8 - 11**	**8 - 11**
Lead	g/gal	**0.0 - 0.01**	**0.01, max.**
Phosphorus	g/gal	**0.005, max.**	**0.005, max.**
Detergent Additives		**Title 13, CCR §2257**	**None**

* Premium Required Vehicles use a 91 AKI, min.

Yellow = Difference from CARB

CARB/EPA E10 Single Premium Octane Grade Cert is Sufficient

- **Rather than one octane grade as currently used, EPA and ARB now considering use of regular <u>or</u> premium octane grade cert fuels [as "required" for the vehicle being tested]**

- **Thus, we are ending up with Additional Test Fuels (Regulatory Cost Benefit Analysis ?)**
  - CARB E10 RUL, CARB E10 PUL, EPA E15 RUL, EPA E15 PUL – **4 Fuels**
  - EVAP Fuel ? Cold CO Fuels(2 Octane Grades)? Altitude Fuel? - **4 Fuels**
  - Mileage Accumulation Fuels - PUL & RUL ? (E10 and E15 versions?) – **2 to 4 Fuels**
  - E85 Cert Fuels – CARB and EPA - **1 Fuel?**
  - Total number of Cert Fuels potentially = **13**, not including Diesel and Alternative Fuels

- **All Grades Would Have to be Stored on Test Sites --Global OEM Test Facility Tank/Drum Fuel Storage Investments are Significant Costs, <u>and</u> current cert fuels also need to remain on site for a period of time.**
  - Many OEMs have Multiple Global Product Design & Testing Centers that need to purchase and <u>store all these fuels to be prepared for specific batteries of tests</u>
  - Bulk storage is preferred to minimize costly per gallon surcharges --of as much as 100% mark-up for drums -- but <u>multiple bulk storage requires expensive infrastructure investment</u>, some of which won't be needed once current cert fuels phase out in a few years

One E10 Single, Premium Octane Grade is Sufficient

- **The main driver of tailpipe emissions is the Fuel Chemical Composition for a given compression ratio; Octane is secondary.** However, Higher Octane Grade Enables Greater Engine Efficiency and Fuel Economy Benefits and Reduced Emissions for future engines and should be the ongoing cert test specification
  - Premium Grade octane enables maximum engine spark advance and therefore will show the highest N0x emissions; no need to use AKI 87-88
  - Don't force significant cost and emissions certification complexity into the tailpipe emissions regulation for minimal effect
  - Keep current Federal system-- PUL Cert Fuel w/RUL FE check for RUL calibrated vehicles
- **EPA and ARB should both use E10 Cert Fuel**
  - Ethanol concentration should match the predominant fuel expected at the time of early credit development for the LEVIII / TIER 3 rules – CY 2015? Alliance thinks this will be E10

Alliance LEVIII and Tier 3 Cert Fuel Spec Recommendations

- **Octane** - Continue to use a single 91 – 93 AKI Octane and 3% FE Audit (Federal Requirement)
- **T50 Range** - Set wider and lower T50 range to 170-190F to allow harmonization with Tier 3 and prevent too high of a base gasoline T50; allows more "market representative" HC and CO emissions -see backup slides
- **T90 Range** - Set Min. and Max. of 310-330F to add clarity for blenders and OEMS -see backup slides
- **Ethanol** - Max. should be 10.0 vol.%; still predominant fuel in CY 2015. Why ARB change 9.75-10.25?
- **Benzene** - Set 0.8 vol.%, max. Don't use "range" of 0.6-0.8. This prevents expensive blends from too narrow a target range, and specialty fuel blenders won't need to keep pure benzene to tweak blends.
- **Sulfur** - 5 ppm cap. Enables maximum effectiveness of near-future Lean Burn engine technology; market fuel sulfur levels should be dropping to support emerging new [FE] technologies.
- **Detergents** - Remove from cert fuel because Cert Tests are short in duration. Detergents should be part of Mileage Accumulation fuels.
- **Fuel Economy Test Procedure Adjustment** needs to comprehend more than just ethanol energy offset (3.5% for E10). Aromatics levels in cert fuels will be changing also.
  - Agencies will need suppliers to make LEVIII / Tier 3 Cert Fuel Hand-blends and measure the Energy Content difference from current fuels due to increased ethanol and lower aromatics
- **RVP and Ethanol** remain unnecessarily and significantly different for ARB and EPA.
- **Tier 3 / LEV III Certification Fuel properties should be able to be Harmonized.**

The Alliance of Automobile Manufacturers Thanks the Air Resources Board for their consideration!

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Back-up Material Slides 10-17

Alliance LEVIII /Tier 3 Certification Fuel Specs Proposal

Parameter	Units	CARB Phase II (with MTBE) Cert Gasoline	CARB LEVIII Proposed Targets dated June 28, 2011	Alliance Proposal - LEVIII Cert Fuel Jul 19, 2011 ****
Octane				
RON, min.	RON	---		---
MON, min.	MON	---		---
AKI, min.	Calc.	91	**87 - 88.4***	**91 , min.**
Sensitivity, min	Calc.	7.5	**7.5, min**	**7.5, min.**
Volatility				
RVP	psi	6.7 - 7.0	**6.9 - 7.2**	**6.5 - 7.0**
RVP Evap	psi	---		---
RVP Altitude	psi	---		---
IBP	deg. F	---		---
T10	deg. F	130 - 150	**130 - 150**	**130 - 150**
T50	deg. F	200 - 210	**205 - 215**	**170 - 190**
T90	deg. F	290 - 300	**310 - 320**	**305 - 315**
FBP, max.	deg. F	390	**390, max.**	**380 - 420**
Residue, max.	vol. %	2.0	**2.0, max.**	**2.0**
Drivability Index	---	---		**Report**
Chemical Composition / Other Physical Props.				
Aromatics, max.	vol. %	22 - 25	**19.5 - 22.5**	**19.5 - 22.5**
Aromatics, Multi-substituted Alkyl	vol. %	12 - 14	**13 - 15**	**13 - 15**
Olefins, max.	vol. %	4.0 - 6.0	**4.0 - 6.0**	**4 - 6**
Saturates	vol. %	---		**Report**
MTBE	vol. %	10.8 - 11.2		---
Ethanol	vol. %		**9.75 - 10.25**	**9.6 - 10.0**
Total Oxygen	wt. %	---	**3.3 - 3.7**	**3.5, min. ** **
Benzene	vol. %	0.8 - 1.0	**0.6 - 0.8**	**0.8, max.**
Sulfur	ppm m/m	30 - 40	**8 - 11**	**5.0, max. *** **
Lead	g/gal	0 - 0.01	**0.0 - 0.01**	**0.0 - 0.01**
Phosphorus	g/gal	0.005	**0.005, max.**	**0.005, max.**
Additives				**None**
Copper Corrosion	---	No. 1.	**No. 1**	**No. 1**
Existent Gum, Washed, max.	mg/100ml	3.0	**3.0, max.**	**3.0, max.**
Oxidation Stability, min.	minutes	1000	**1000, min.**	**1000, min.**
Specific Gravity	---	No limit, report	**Report**	**Report**
Heat of Combustion	---	No limit, report	**Report**	**Report**
Carbon	wt. %	No limit, report	**Report**	**Report**
Hydrogen	wt. %	No limit, report	**Report**	**Report**

Note (*): For vehicles / engines that require the use of premium fuel as part of their warranty, the Octane ((R+M)/2)

Note (**): The only Oxygenate allowed is Ethanol, and must meet ASTM D4806.

Note (***): See SAE Paper 2011-01-0300 "Effects of Fuel Sulfur on FTP NOx Emissions..."

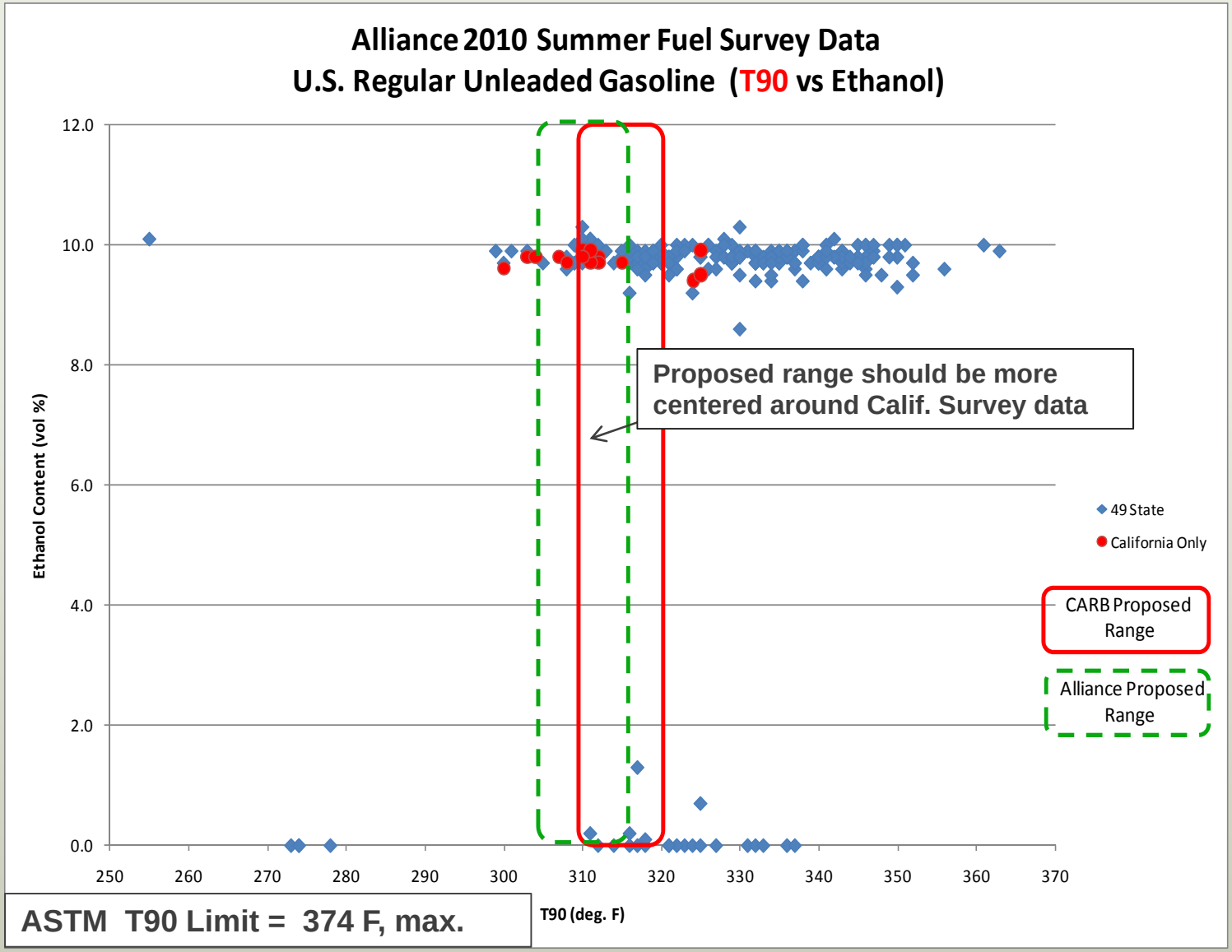
Note (****): Regulatory language is needed to cover test prodedure measurement tolerances and subsequent

Current ARB and EPA Certification Fuels

		California Cert Fuel	Federal Cert Fuels		
Parameter	Units	CARB Phase II (with MTBE) Cert Gasoline	Ambient	Cold CO - Low Octane	Cold CO - High Octane
Octane					
RON, min.	RON	---	93	---	---
MON, min.	MON	---	---	---	---
AKI, min.	Calc.	91	---	87.8 +/- 0.3	92.3 +/- 0.5
Sensitivity, min	Calc.	7.5	7.5	7.5	7.5
Volatility					
RVP	psi	6.7 - 7.0	8.0 - 9.2	11.5 +/-0.3	11.5 +/-0.3
RVP Evap	psi	---	8.7 - 9.2	---	---
RVP Altitude	psi	---	7.6 - 8.0	---	---
IBP	deg. F	---	75 - 95	76 - 96	76 - 96
T10	deg. F	130 - 150	120 - 135	98 - 118	105 - 125
T50	deg. F	200 - 210	200 - 230	179 - 214	195 - 225
T90	deg. F	290 - 300	300 - 325	316 - 346	316 - 346
FBP, max.	deg. F	390	415	413	413
Residue, max.	vol. %	2.0	---	---	---
Driveability Index	---	---	---	---	---
Chemical Composition / Other Physical					
Aromatics, max.	vol. %	22 - 25	35	26.4 +/- 4.0	32.0 +/- 4.0
Aromatics, Multi-substituted Alkyl	vol. %	12 - 14	---	---	---
Olefins, max.	vol. %	4.0 - 6.0	10	12.5 +/- 5.0	10.0 +/- 5.0
Saturates	vol. %	---	---	---	---
MTBE	vol. %	10.8 - 11.2	---	---	---
Ethanol	vol. %		---		
Total Oxygen	wt. %	---	---	---	---
Benzene	vol. %	0.8 - 1.0	---	---	---
Sulfur	ppm m/m	30 - 40	15 - 80	15 - 80	15 - 80
Lead, max.	g/gal	0 - 0.01	0.050	0.01	0.01
Phosphorus, max.	g/gal	0.005	0.005	0.005	0.005
Additives					
Copper Corrosion	---	No. 1.	---	---	---
Existent Gum, Washed, max.	mg/100ml	3.0	---	---	---
Oxidation Stability, min.	minutes	1000	---	---	---
Specific Gravity	---	No limit, report	---	---	---
Heat of Combustion	---	No limit, report	---	---	---
Carbon	wt. %	No limit, report	---	---	---
Hydrogen	wt. %	No limit, report	---	---	---

Distillation - T90

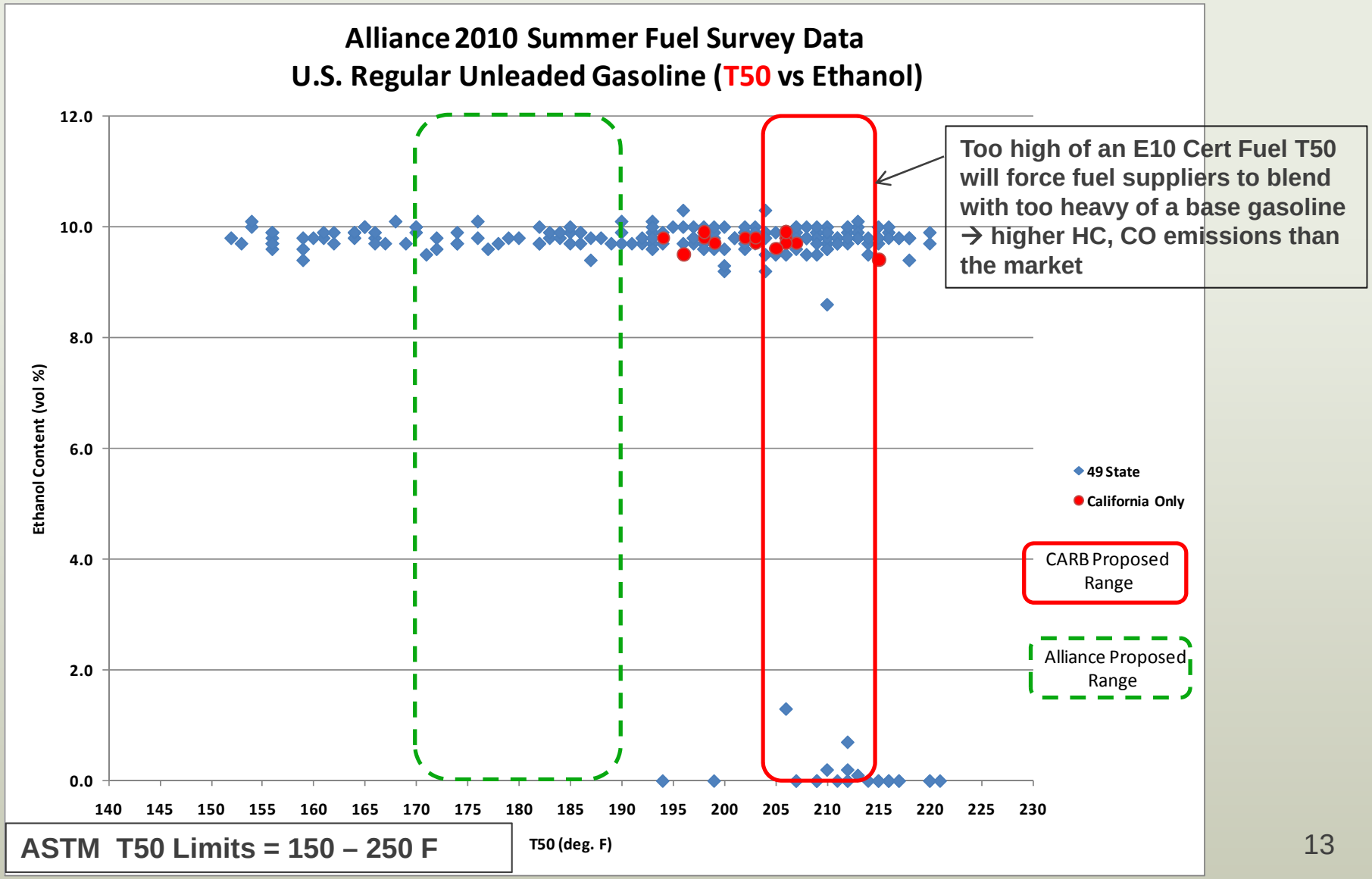
- Alliance proposed T90 range: 305 - 315F



ASTM T90 Limit = 374 F, max.

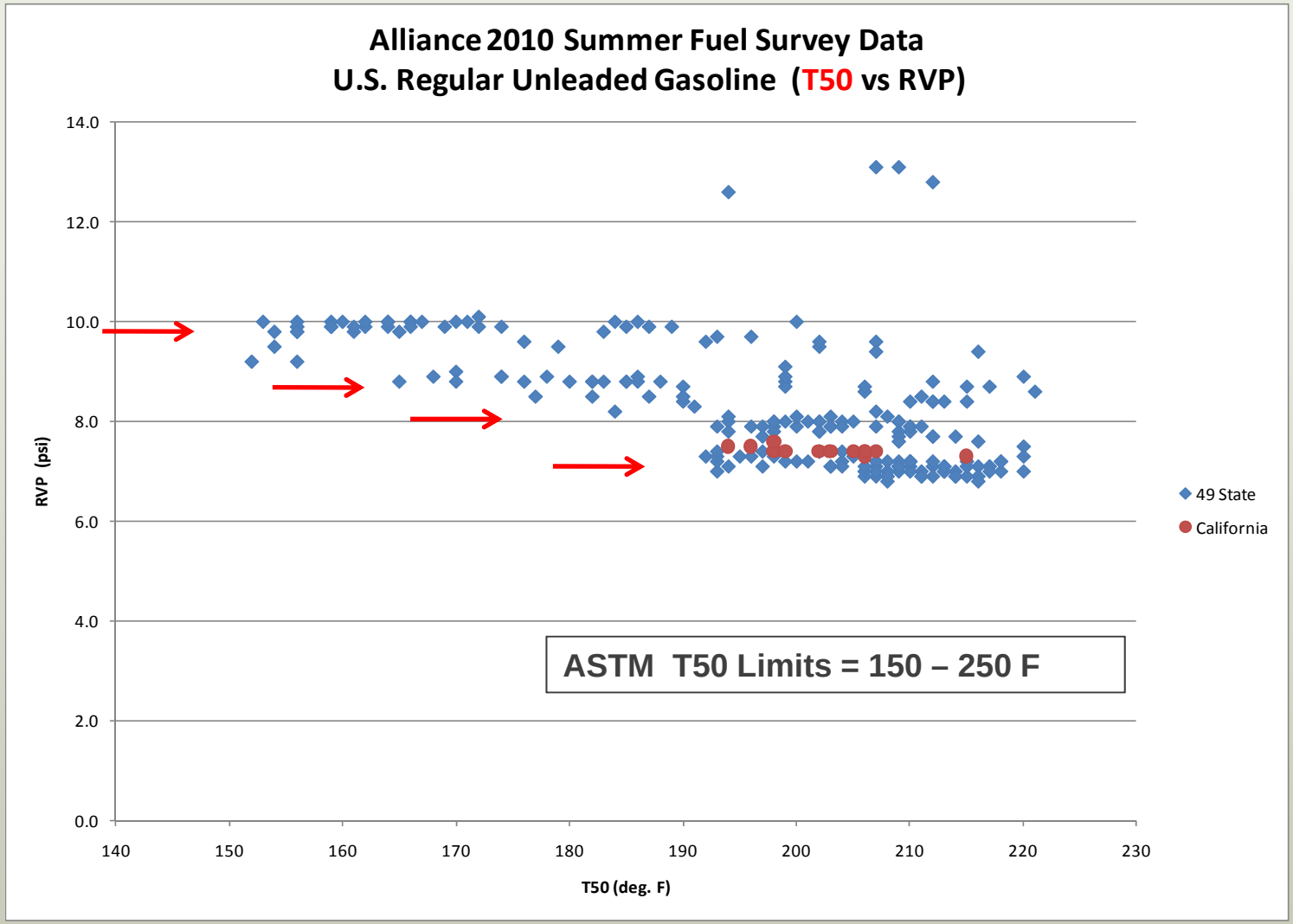
Distillation - T50

- Current California Alliance Survey Data for California suggest T50 Range: 190 - 210 F
- 49 State E10 data suggest T50 Range should be more like: 170 - 190F
- ASTM allows down to 150 F, min.



Correlation Between RVP and T50

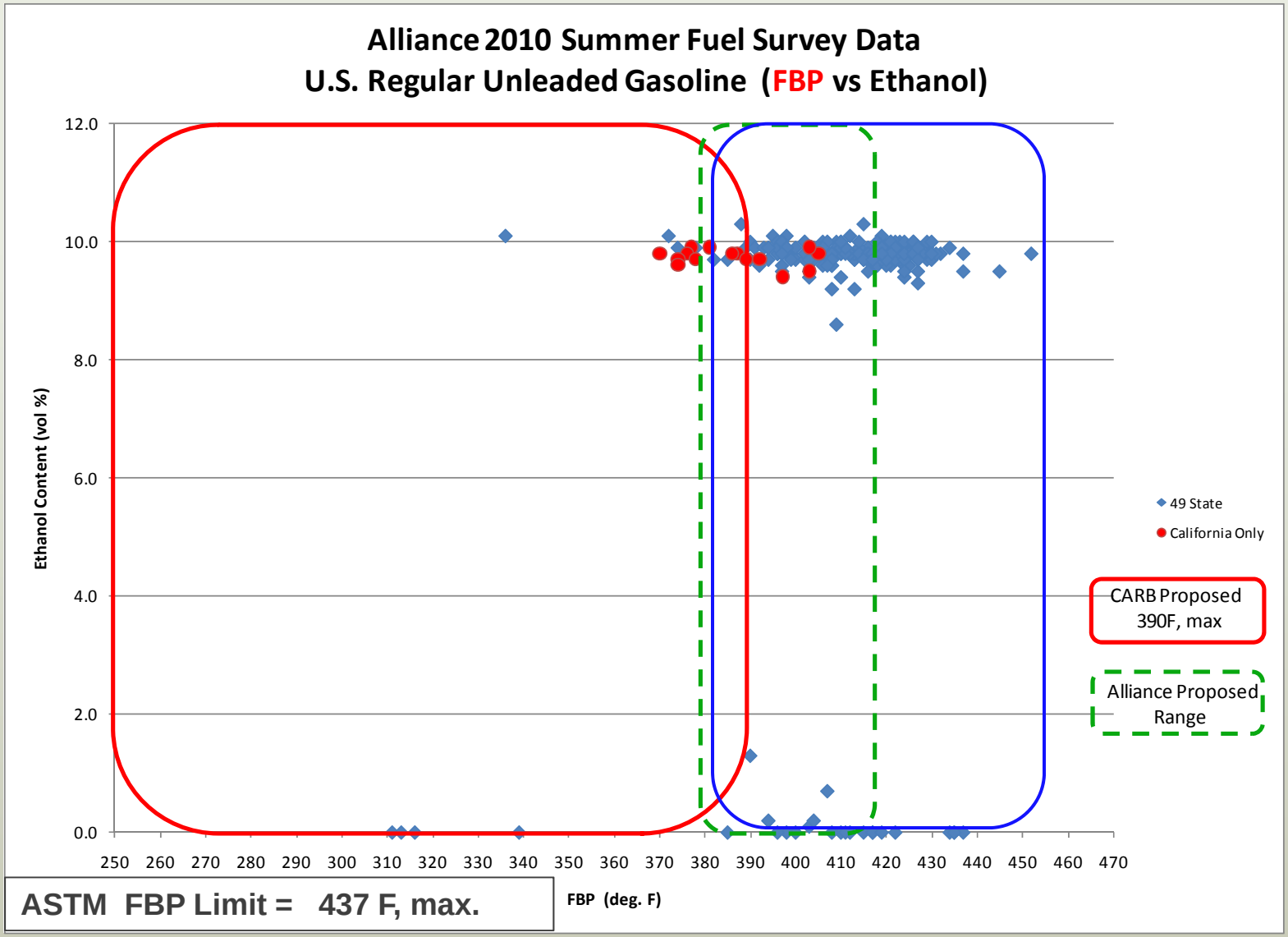
- As "Bands of Constant RVP" (red arrows) decrease, T50 range increases
- Difficult for CARB and EPA to have harmonized cert fuels with narrow T50 ranges
- CARB may need to expand the T50 fuel spec range to harmonize with Federal fuel (next slide)



Distillation – FBP

(Set Min / Max Range)

- Alliance proposed FBP range: 380 – 420F
- Enables harmonization with Tier 3



Why A Single, Premium Octane Grade CERT FUEL Suffices

During warm start emissions test cycles with lit-off catalysts, some spark retard as a result of low octane will lower in-cylinder pressures & temperatures, and therefore lower NOx. Any increases in HC & CO emissions will be oxidized by the hot catalyst, resulting in lower overall tailpipe emissions.

A premium cert fuel octane, that enables maximum spark advance for a given calibration and compression ratio, gives the highest NOx values. Adding regular grade won't provide incremental useful information about emissions, but adds complexity.

<u>And</u>

US FTP is a part load, non-knocking test cycle; first 30 - 90 sec. cold start is critical-- but engines don't knock when cold -- Does it make sense to have 87 Octane Cert Fuel?

New EPA/ARB "E85" Certification Fuel? - Overview

- **Like gasoline certification fuel, E85 certification fuel needs to represent the marketplace.**
- **ARB and EPA must address the newly revised, balloted and approved ASTM D5798 marketplace specification, "*Ethanol Fuel Blends for Flexible-Fuel Automotive Spark-Ignition Engines*".**
  - **Approved in June, 2011 – to be published in Summer 2011**
  - **CARB and EPA can get marketplace Fuel Survey data in late Fall**
- **Primarily, new specification includes increased hydrocarbon content to enable blending of fuel with compliant volatility in the colder months and in RFG areas**
  - **New Ethanol allowable range – 51 to 83 vol. %**
  - **Addition of 4th volatility class to ease blending concerns in warmer winter areas**
  - **See pending Revision of California Volatility Classes to correct errors in previous specification**
- **Status/Process for EPA and ARB Coordination? Timing?**
- **Alliance Interested in Working with Agencies on Single Harmonized "E85" Cert Fuel**

(END)