

An aerial, black and white photograph of Denver, Colorado. The city is visible in the lower half of the frame, surrounded by a valley. In the background, there are large, dark mountain ranges under a sky with scattered clouds. The overall image has a grainy, high-contrast appearance.

# CA Predictive Model for E10 in Denver

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Smog Reyes

# The CA Predictive Model for E10

- Three Key Points:
  - MOBILE6 does not address all E10 impacts from fuel parameters
  - CA Predictive Model contains E10 impacts
    - Provides both mass and ozone estimates
    - Updated in 2007 (many stakeholder meetings)
  - PM predicts E10 ozone neutral even with RVP waiver and permeation

# MOBILE6 does not address all E10 impacts on fuel parameters

- Permeation is missing
  - 1.2 g/veh in 2005, 0.75 in 2010, 0.5 in 2015
- T50 – 50% boiling point is missing
- Sulfur, olefins, aromatics, T90 are missing
- Oxygen on exhaust VOC is missing
  - CO simplistic and obsolete

# CA Predictive Model contains E10 impacts using latest data

- 1000 new full vehicle/fuel tests added to existing 9000 database
- Five technology/model-year categories
- Dozens of stakeholder meetings including special sub-committees (reactivity, statistics, and emissions)
- New statistical CO model responds to several fuel parameters in addition to oxygen

# CA Predictive Model contains E10 impacts using latest data

- Predictive Model exists as spreadsheet
  - Mass and ozone changes with fuel parameters can be extracted separate from RFG information
- Toxics information also provided

# CA CARBOB Model Also Useful

- Model used in CA to provide pre-ethanol clear (E0) gasoline specifications that meet CARFG regulations when ethanol is added
- Model gives estimates of T50 and T90 impacts from ethanol
- Model shows that all other fuel parameters are merely diluted by ethanol
- A 1 psi RVP increase is used for ethanol

# PM Fuel Parameters

- PM needs the following input parameters:
  - RVP
  - T50 and T90
  - Percent aromatics, olefins, oxygen, sulfur, and benzene
- Apart from oxygen (due to ethanol only) and RVP, the other parameters must be estimated for Denver

# Two Well Known Fuels as Brackets

- Auto/Oil Fuel A widely used to represent conventional gasoline (circa 1990)
  - Base fuel for 50 million dollar Auto/Oil study
  - Specifications in SAE Paper No. 92034
    - Fuel F shows 2 T50 points for RVP change
- CA RFG base fuel known as “flatline”

# Two Estimates for CO Reactivity

- PM uses well-known MIR reactivity factors
  - Derived from box-model set up for 39 cities with adjusted high NO<sub>x</sub> inputs
- CARB tested CO reactivity with photochemical grid model and found higher reactivity than MIR estimate

# PM Inputs for Denver

Base fuel parameters used to evaluate Denver gasolines with the CARB Predictive Model.					
Fuel/Parameter	Fuel A E0	Fuel A E10	CARBRFG E0	"Flatline"	CARBRFG E10
RVP	7.8	8.8	7.8	6.9	8.8
T50	220	213	215	213	208
T90	330	326	307	305	303
Aromatics	32	28.8	26.5	25	23.9
Olefins	9.2	8.3	6.4	6.0	5.7
Oxygen	0	3.5	0	2.0	3.5
Sulfur	100	90	100	20	90
Benzene	1.5	1.35	0.84	0.80	0.76

# Results from Adding Ethanol

	Fuel A	CARB RFG
Exhaust VOC	-4.36	-7.46
Evap. VOC	+12.46	+12.46
CO	-17.9	-18.25
NOx	+1.35	+2.1
Toxics	-8.38	-7.4
MIR Ozone	+0.51	-1.0
Grid Ozone	-0.72	-2.2

# Summary

- Average of bracketing gives -0.85 percent ozone reduction
  - Includes 1 psi waiver
  - Includes permeation