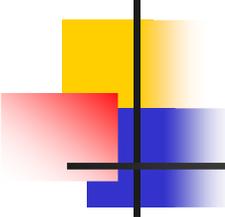


California Air Resources Board and California Energy Commission Workshop

**August 3, 2005
Sacramento, California**

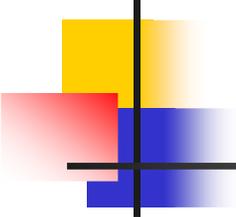
**PRESENTATION OF THE
ENGINE MANUFACTURERS ASSOCIATION**





Scope of EMA Representation

- **Foreign and domestic manufacturers of diesel, gasoline and alternate-fueled internal combustion engines**
- **Principally, non-integrated manufacturers of loose engines for on-highway and off-highway mobile applications, marine, locomotive and stationary applications**
- **Wide range of engine sizes, from 1 hp to over 7000 hp**

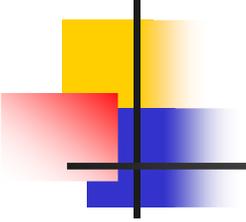


Current Specifications for CNG*

	California CCR § 2292.5	U.S. EPA ** 40CFR Part 1065.715
Hydrocarbons		
Methane	88.0% (min.)	87.0% (min.)
Ethane	6.0% (max.)	5.5% (max.)
C ₃ and higher	3.0% (max.)	n/a
Propane (C ₃)	n/a	1.2% (max.)
Butane (C ₄)	n/a	0.35% (max.)
Pentane (C ₅)	n/a	0.13% (max.)
C ₆ and higher	0.2% (max.)	0.10% (max.)
Other Species		
Hydrogen	0.1% (max.)	n/a
Carbon Monoxide	0.1% (max.)	n/a
Oxygen	1.0% (max.)	1.0% (max.)
Inert Gases		
Sum of CO ₂ and N ₂	1.5%-4.5% (range)	5.1% (max.)

* Compressed Natural Gas, values expressed as mole percent

** U.S. EPA Certification Fuel specification

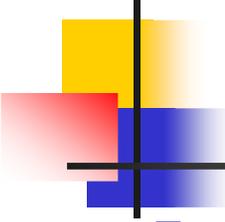


ARB Draft Proposed Concept

Hydrocarbons	California CCR § 2292.5	ARB Proposed Concept
Methane	88.0% (min.)	n/a
Ethane	6.0% (max.)	n/a
C ₃ and higher	3.0% (max.)	n/a
C ₄ and higher	n/a	1.5% (max.)
Butane (C ₄)	n/a	n/a
Pentane (C ₅)	n/a	n/a
C ₆ and higher	0.2% (max.)	n/a
Other Species		
Hydrogen	0.1% (max.)	n/a
Carbon Monoxide	0.1% (max.)	n/a
Oxygen	1.0% (max.)	0.2% (max.)*
Inert Gases		
Sum of CO ₂ and N ₂	1.5%-4.5% (range)	4.0% (max.)*
Methane Number	n/a	80 (73**) min.
Wobbe Index	n/a	TBD

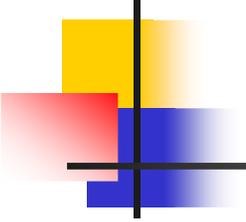
* - Based on Rule 30

** - Regional



Engine Design and Fuel Specification

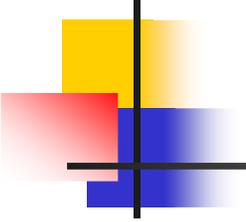
- **Engines are designed to operate on the fuel specified by the manufacturer**
 - **Emission compliance**
 - **Customer satisfaction**
 - **Adequate engine performance**
 - **Engine durability**
- **Engine manufacturers cannot conduct performance/emission testing on multiple fuel formulations**
- **For gaseous fuels engine manufacturers rely on knock sensitivity measured by octane, knock index or methane number**



Engine Design Variations

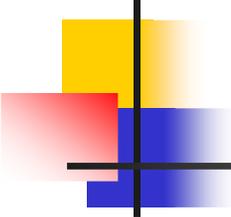
There are a wide variety of gaseous fueled engine designs in the market:

- **Lean burn engines**
- **Stoichiometric/Rich burn engines**
- **Engines with mechanical fuel control**
- **Engines with electronic fuel control**
- **Engines with or without knock sensing**



Fuel Specification Changes Raise Concerns

- **Negative impact on air quality**
 - Increased HC and/or NOx emissions
 - Increased ozone potential
- **Customer dissatisfaction**
 - Increased engine maintenance
 - Increased repair costs
 - Increased operating costs
 - Increased unscheduled downtime
- **Adverse effects on performance**
 - Propensity for engine knock
 - Negative impact on long-term engine durability
 - Greater adverse impact on older engines



CNG SPECIFICATION

EMA Perspective

- **Engines require stable fuel quality for continuous reliability and customer acceptance**
- **Knock resistance is critical**
- **Energy content is important**
- **A detailed certification fuel specification is required for mobile source engines**
- **Variations in methane number will require multiple fuel availability and labeling due to multiple engine configurations**
- **Engine Development is in process for 2007 / 2010 emission standards based on current fuel**