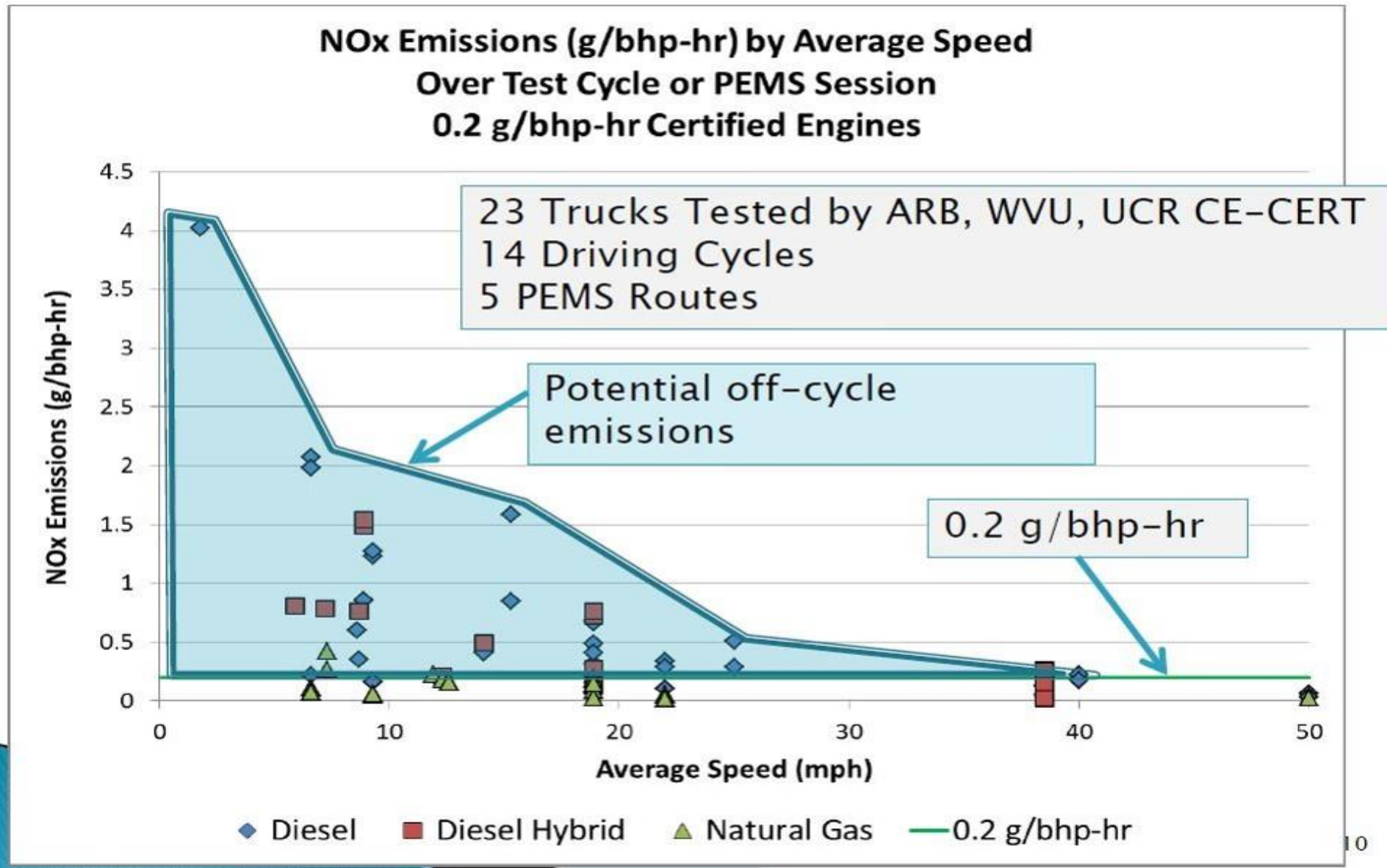


NORTH AMERICAN  
**REPOWER**



# Potential Excess NOx Emissions



Only means to actually lower emissions under all driving conditions

## N.A. Repower Gets CARB Certification

March 25, 2016 in *certifications, CNG, NGVs* by *Rich Piellisch* | *No Comments*

### First for a Heavy Duty Natural Gas Retrofit, Company Says

The California Air Resources Board has certified North American Repower's dedicated-natural gas, spark-ignition version of the 7.6-liter International DT466 engine Class 5-8 trucks and buses, the Southern California company says.



North American Repower offers a complete retrofit package including spark-ignition dedicate-natural gas DT466 engine, CNG fuel tanks and fill panel, fully installed with approximately three days of downtime.



NORTH AMERICAN  
**REPOWER**

## Pete Petersen

Baytech, Sturman, IMPCO, AFS,  
Clean Air Power, SwRI, FORD

## **Engines Converted while at BKM/Clean Air Power**

- Cat C13 and C15 for Diesel Dual Fuel
- GM 4.3L Turbo Lean Burn for UPS
- Mercedes OM352 for Diesel Dual Fuel
- Cummins L10 and M11 – Diesel Dual Fuel

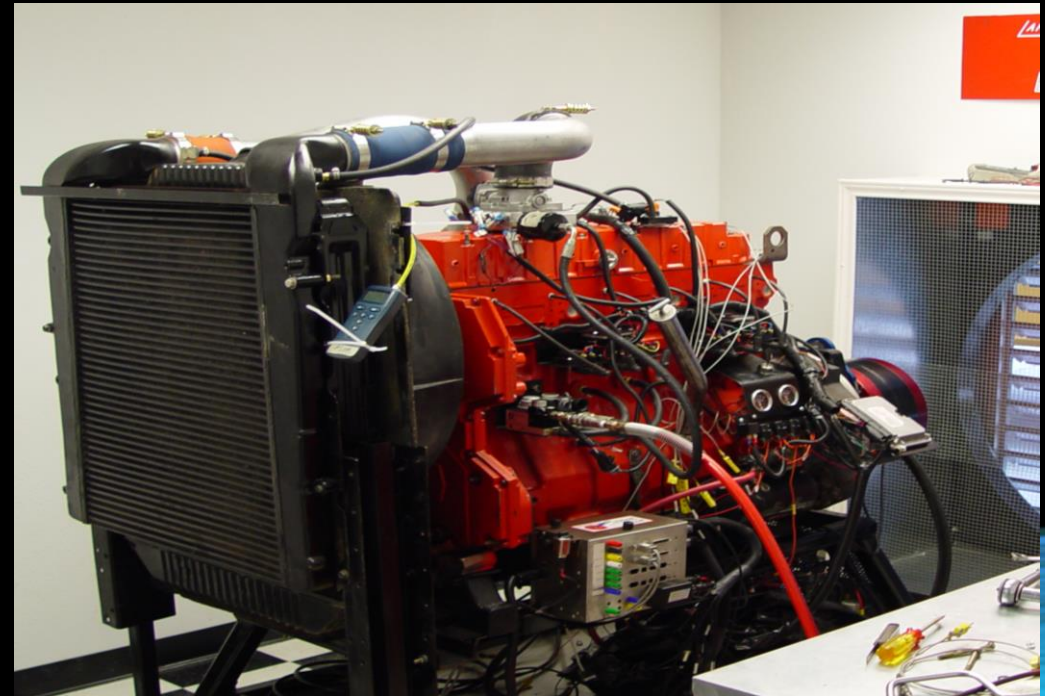
# Engines Converted Prior to NAR

- Cummins 5.9, 855, L10
- Navistar DT466, DT530
- Mercedes OM366, OM407, OM447, OM457
- Mitsubishi – Many
- Hino H07C, J08C, P11, K13, EF750
- Deutz – 4 and 6 cylinder air cooled including EPA cert.
- Scania 12L



# Navistar DT466/530 for ESI

- Designed Fuel System
- Designed Fuel Injector
- Designed Air Fuel Mixer
- Assisted with test cell and on drivability development
- Assisted with CARB certification effort.





**Wiley McCoy**  
Founder & CEO McLaren,  
Linamar



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## Tim Cyrus

Former Chief Global  
Engineer for GM



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**John Knepp**  
Founder and CEO  
Nissan  
Performance  
Technologies,  
Electromotive  
Engineering

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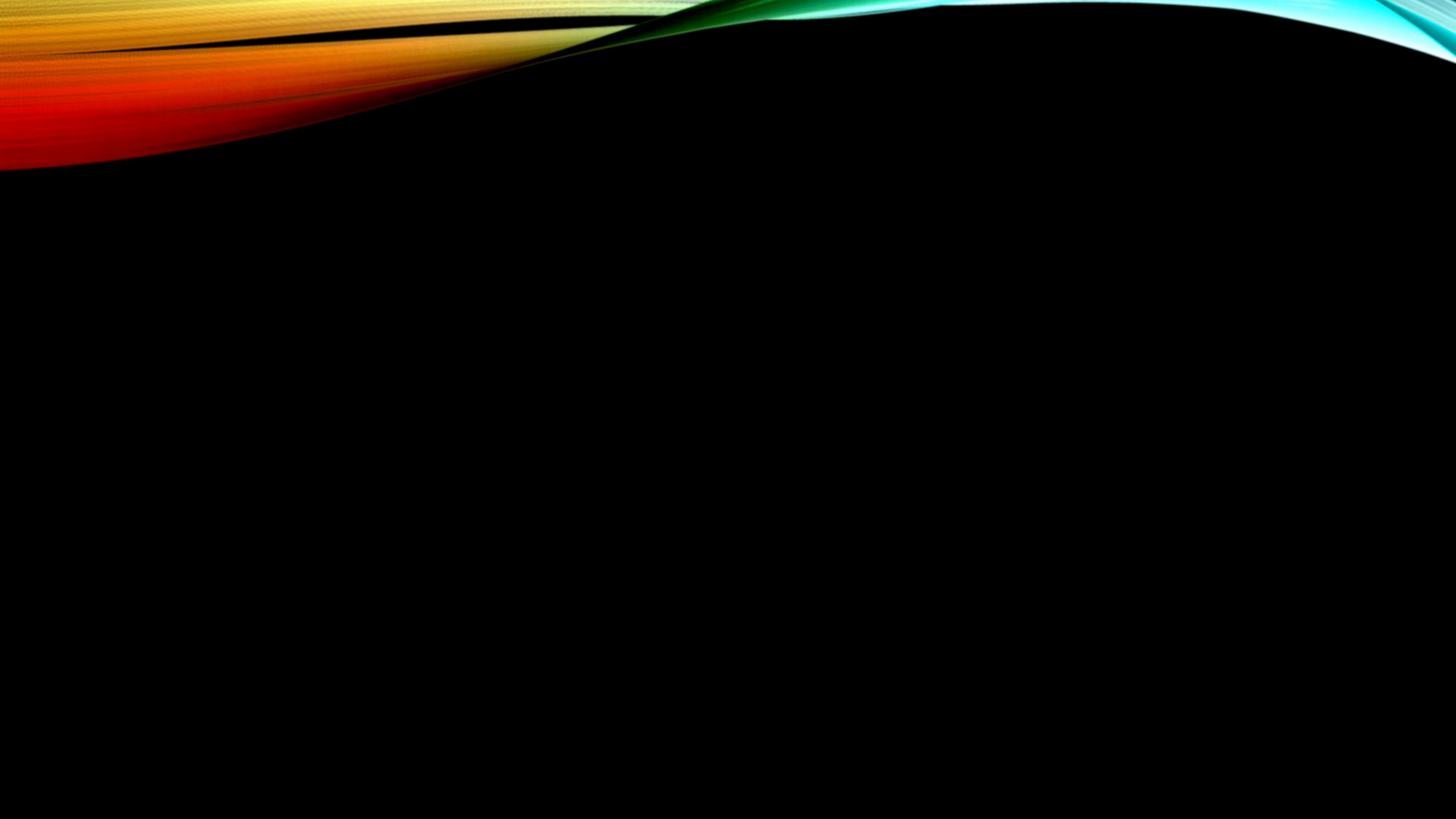


**Evan Williams**  
Founder and CEO  
Cambrian Energy



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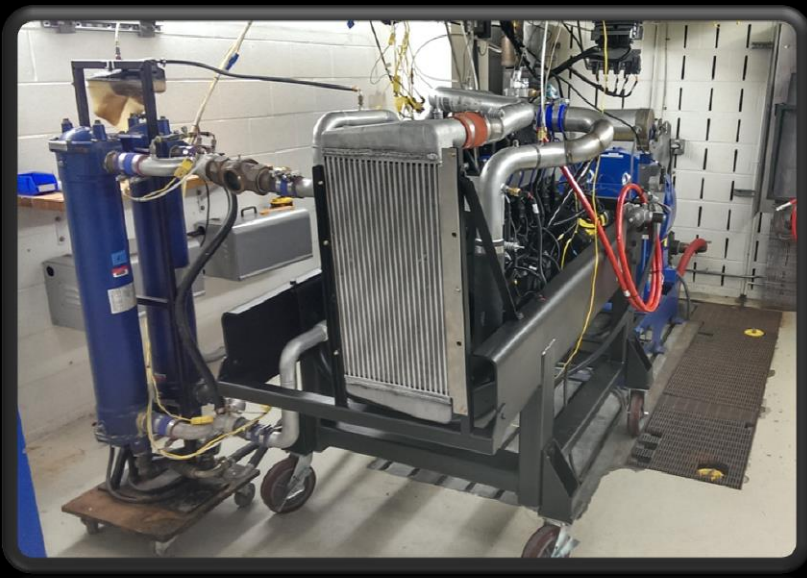
- ▶ **Richard Oppmann, COO-** Rich was with GM for over 30 years, eventually becoming Program & Brand Manager for Medium Duty and Commercial vehicles, responsible for restructuring the new product role out strategy for this division. Rich has brought with him several colleagues from this program, creating RINGVA-NAR's marketing arm.



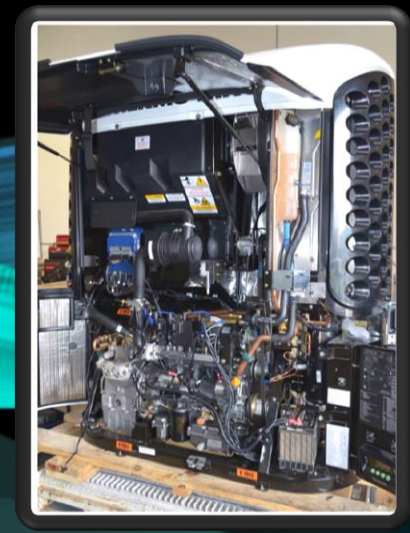
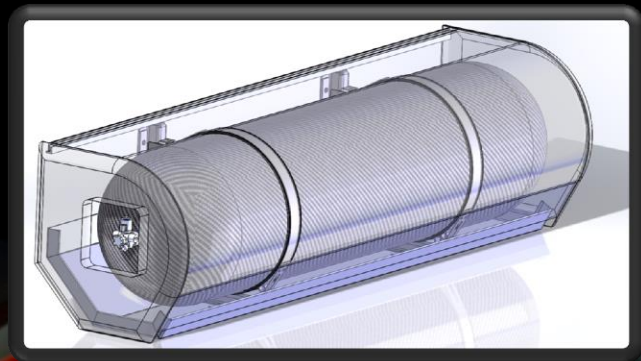
- ▶ **Jim Morrow, Advisor-** Jim is known for his long run as Head of Detroit Diesel Corporation. After DDC, Jim founded ESR, LLC which provides reman electronics to the heavy duty market. Jim was crucial in helping NAR initiate its work with OEM remanufacturing divisions.



- ▶ **Al Weverstad, Advisor-** Al was the head of GM's Environment and Energy Division, responsible for emissions compliance and all regulatory issues with CARB and EPA. Al has been fundamental in ensuring NAR's certification processes are Tier 1 OEM quality.



# HEAVY DUTY NATURAL GAS ENGINES & VEHICLE SYSTEMS



## NAR Achievements to Date



- Proven ability to CARB/EPA certify
- Development Project with TRU OEM in third year
- Strategic Partnerships with OEM Diesel Engine Remanufacturing Groups
- Strategic partnerships with Fuel/Service providers
- Qualified NAR Products for Extended Warranty Coverage from Leader in Commercial Truck Warranties
- Qualified NAR Products for Financing from Major lenders at rates similar to new

Developed in California by NAR In conjunction with McLaren

**McLaren**

Performance Technologies



OEM designated Remanufacturers

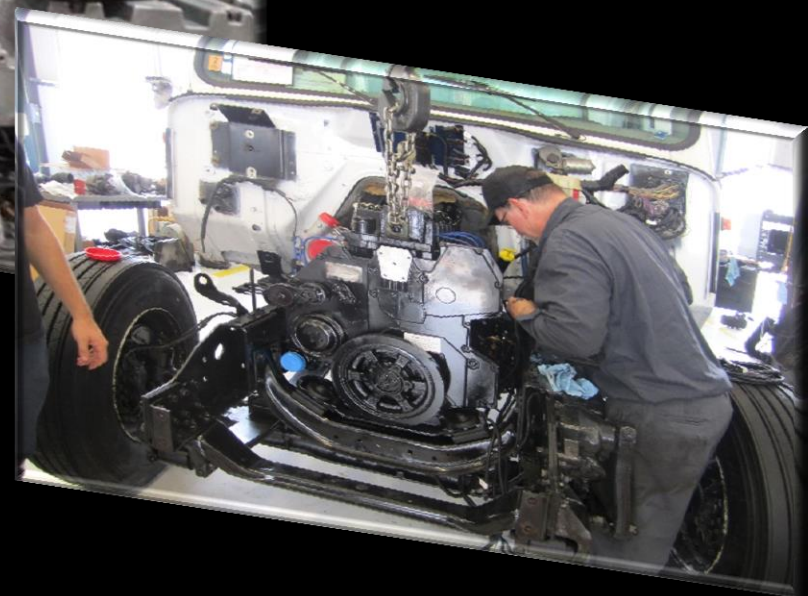
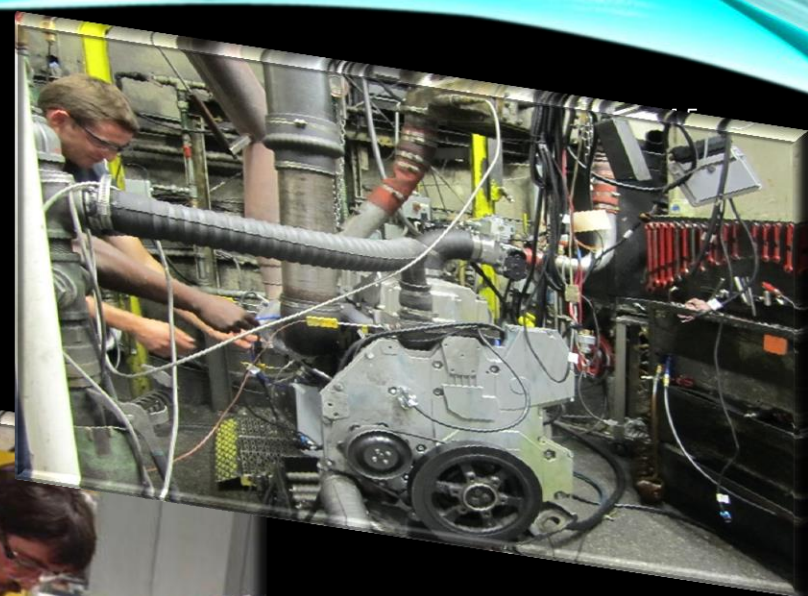


**DETROIT**  
REMAN

Qualified Installers



**WheelTime**  
Quality Truck Care



# Advanced Technology Programs at NAR

California Energy Commission funded Projects

1. Advanced Ignition for Ultra Low NO<sub>x</sub> Heavy Duty Engines-
  - Plasma Ignition Product- proven ability to run at Lambda 2.0
  - High Intensity Ignition product-proven ability to run at Lambda 2.0
2. Heavy Duty Near Zero NO<sub>x</sub> CNG-Electric Drive Hybrid Demo
  - Six Armored Trucks Converted from Diesel to CNG-Electric Drive Hybrid
3. Advanced Pre-Chamber Ignition for Heavy Duty Natural Gas Engines
  - In testing to reach Lambda 2.2



Lean-burn engine technology increases efficiency, reduces NOx emissions

> White paper  
By Keith Packham,  
Gas Applications Manager, Energy Solutions



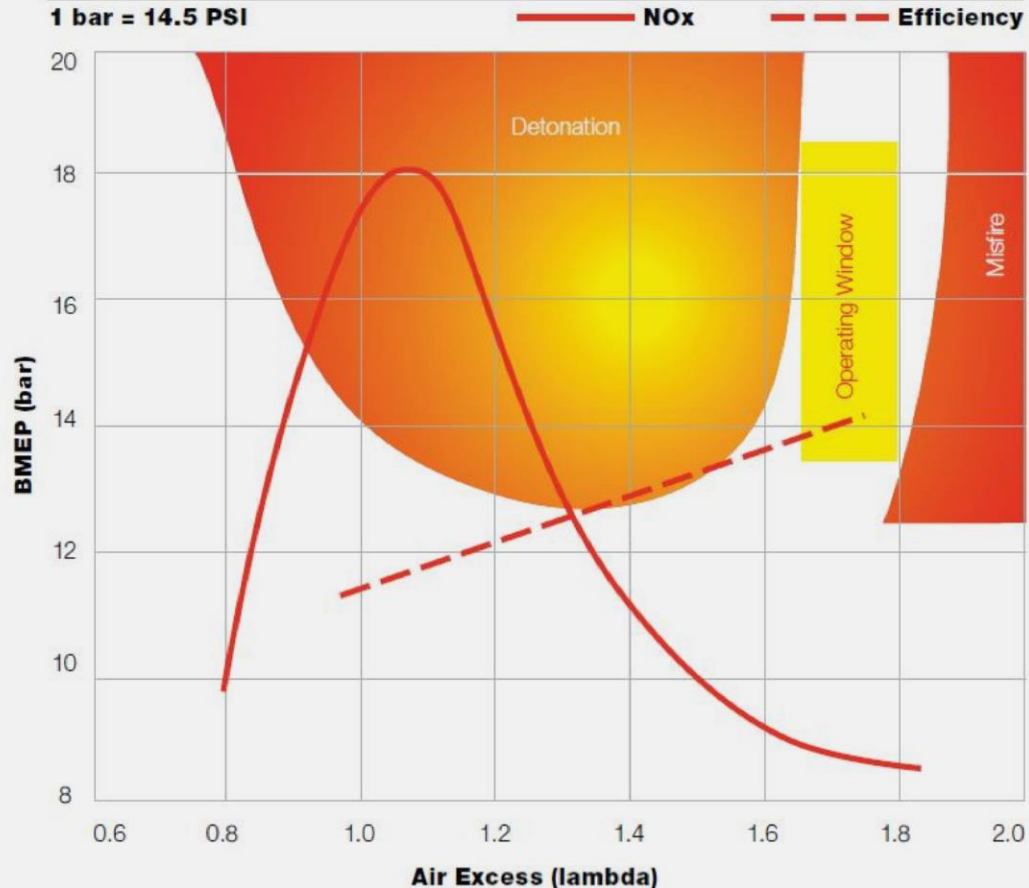
Our energy working for you.™

# STOICHIOMETRIC VS. LEAN BURN

- Both are Closed Loop Operation-O<sub>2</sub> Sensor feedback Computer Controlled Engine Management
- NAR uses proprietary O<sub>2</sub> Sensor technology

## DETONATION CHART

1 bar = 14.5 PSI



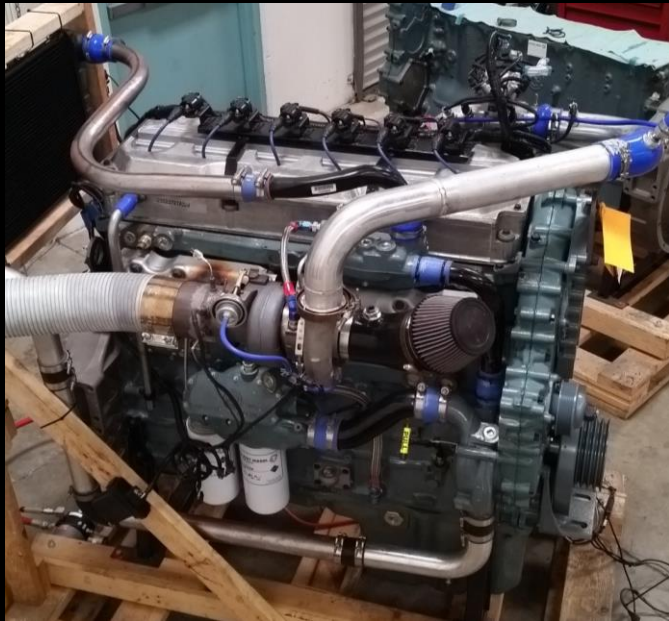
### Stoichiometric

- High In Cylinder Temps
- High Engine temps
- Knock Limited BMEP
- High Engine Out NOx, CO
- EGR Failures
- Catalyst Failures
- Oil Nitration and sludge

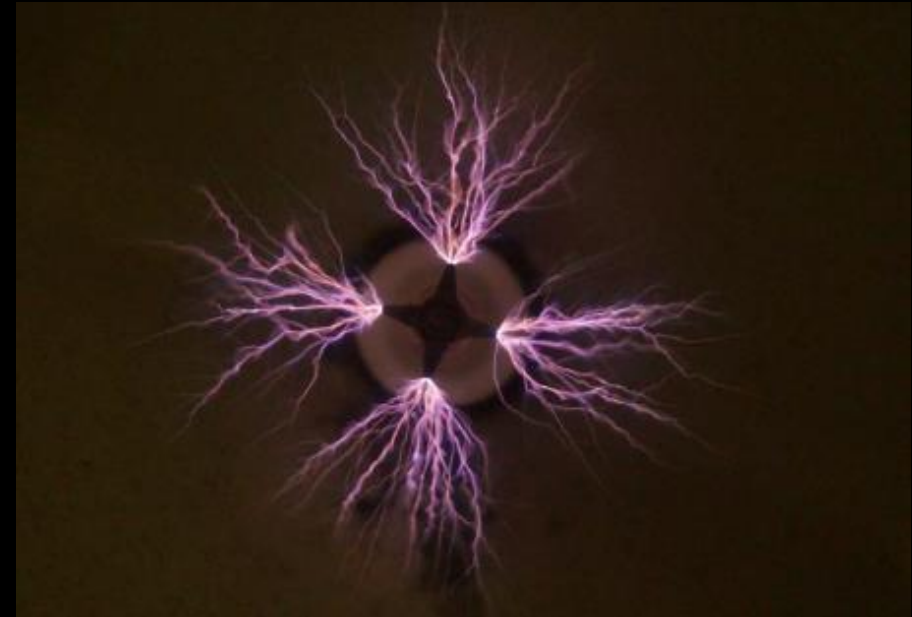
### Lean Burn

- Cooler in Cylinder Temps
- Normal Engine temps
- BMEP outside of Knock Area
- Low Engine Out NOx, CO
- No EGR
- No Catalyst
- No Sludge

# PLASMA IGNITION



12.7 liter DD Series 60  
450hp, 1600ft/lb@1200RPM



Federal Mogul ACIS

# PRE -CHAMBER



Tested to Lambda 2.2  
Unique jet metered design  
Awaiting metallurgy wear studies



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