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Pete Petersen

Baytech, Sturman, IMPCO,

AFS, Clean Air Power, SwRI







Wiley McCoy
Founder & CEO McLaren,
Linamar







Tim Cyrus
Former Chief Global
Engineer for GM





John Knepp
Founder and CEO
Nissan Performance
Technologies, Electromotive





Evan WilliamsFounder and CEO
Cambrian Energy

NATURAL GAS HD ENGINES

Brief History and Current Developments

Don Fites, CEO Caterpillar 1990-1999

In 2001, when asked about the future of Natural Gas Engines and Caterpillar

"CAT MAKES DIESELS-END OF STORY"



Potential Excess NOx Emissions

NOx Emissions (g/bhp-hr) by Average Speed **Over Test Cycle or PEMS Session** 0.2 g/bhp-hr Certified Engines

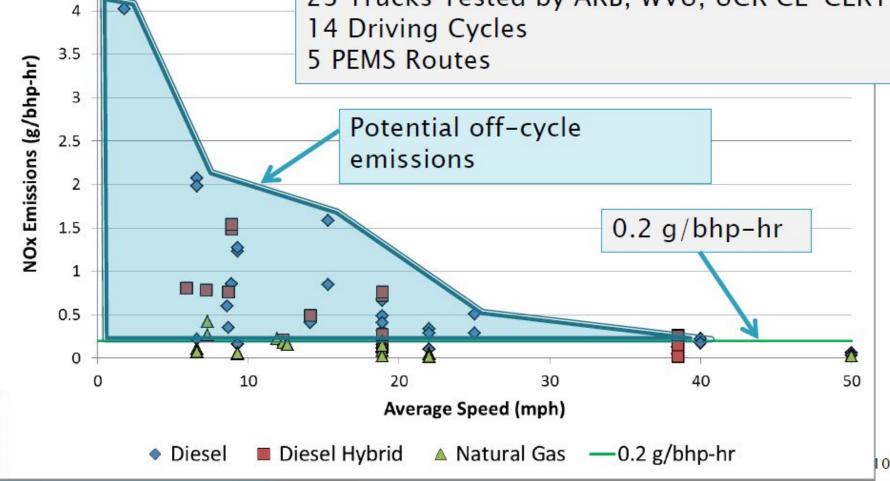
4.5 23 Trucks Tested by ARB, WVU, UCR CE-CERT 14 Driving Cycles 3.5 5 PEMS Routes

Ox

• 2008-

Pre-2004

• 2010-



EXECUTIVE ORDER A-021-0629 New On-Road Heavy-Duty Engines Page 1 of 2 Pages

Pursuant to the authority vested in the Air Resources Board by Health and Safety Code Division 26, Part 5, Chapter 2; and pursuant to the authority vested in the undersigned by Health and Safety Code Sections 39515 and 39516 and Executive Order G-14-012;

IT IS ORDERED AND RESOLVED: The engine and emission control systems produced by the manufacturer are certified as described below for use in on-road motor vehicles with a manufacturer's GVWR over 14,000 pounds. Production engines shall be in all material respects the same as those for which certification is granted

MODEL	ENGINE FAMI		ENGINE	FUEL TYPE 1	STANDARDS & TEST	SERVICE	ECS & SPECIAL FEATURES 3	DIAGNOSTIC 6 EMD+
YEAR	21101112111111		SIZES (L)	Service vol. 0	PROCEDURE	CLASS 2	TBI, TC, CAC, ECM, EGR, TWC.	
2016	016 GCEXH0540LBI		DLBI 8.9 CNG/LNG		Diesel	UB	HO2S	EMD+
	ENGINE'S IDLE			AD	DITIONAL IDLE EN	IISSIONS CO	5 N. 101 5	
EX	EMPT				N.	/A		
ENGINE (L)			ENGINE MO	DELS / CODES (ra	ted power, in	hp)	
8.9	ISL G 250 / 4	4836;FR95	359 (258), 19	L G 280 / 4836;FR95	354 (280), ISL G	300 / 4836	FR95351 (300), ISL G 320 / 4836;F	FR95348 (320)
CNG/LN	horsepower; kw=kil G=compressed/lique DD=light/medium/he	owatt; hr=hou fied natural ga avy heavy-dut;	r; is; LPG=liquefie / diesel; UB=urb	d petroleum gas; E85=85% o can bus; HDO=heavy duty O	ethanol fuel; MF=mult tto;	ifuel a.k.a. BF	R 86.abc=Title 40, Code of Federal Regulations =bi fuel; DF=dual fuel; FF=flexible fuel; clive calalytic reduction – urea / – ammonia; W	

uper charger, CAC=charge air cooler; EGR / EGR.C=exhaust gas recirculation / cooled EGR; PAIR/AIR=pulsed/secondary air injection; SPL=smoke puff limiter; ECM/PCM=engine/gowertrain control module; EM=engine modification; 2 (prefix)=parallel; (2) (suffix)=in series; 5 ESS-engine shutdown system (per 13 CCR 1956 8(a)(6)(A)(1): 30g-30 ghr NOx (per 13 CCR 1956 8(a)(6)(C); APS =internal combustion auxiliary power system; ALT=alternative method (per 13 CCR 1956 8(a)(6)(D); Exempt=exempted per 13 CCR 1956 8(a)(6)(B) or for CNG/LNG fuel systems; N/A=not applicable (e.g., Otto engines and vehicles);

EMD#engine manufacturer diagnostic system (13 CCR 1971); OBD=on-board diagnostic system (13 CCR 1971.1);

Following are: 1) the FTP exhaust emission standards, or family emission limit(s) as applicable, under 13 CCR 1956.8; 2) the SET and NTE limits under the applicable California exhaust emission standards and test procedures for heavyduty diesel engines and vehicles (Test Procedures); and 3) the corresponding certification levels, for this engine family. "Diesel" CO, SET and NTE certification compliance may have been demonstrated by the manufacturer as provided under the applicable Test Procedures in lieu of testing. (For flexible- and dual-fueled engines, the CERT values in brackets [] are those when tested on conventional test fuel. For multi-fueled engines, the STD and CERT values for default operation permitted in 13 CCR 1956.8 are in

in	NMHC		NOx		NMHC+NOx		co		PM		нсно	
g/bhp-hr	FTP	SET	FTP	SET	FTP	SET	FTP	SET	FTP	SET	FTP	SET
STD	0.14	0.14	0.02	0.02	•	•	15.5	15.5	0.01	0.01		
CERT	0.01	0.000	0.01	0.004			1.5	0.3	0.001	0.000		
NTE	0.21		0.	.03		•	15	9.4	0.	.02		•

g/bhp-hr-grams per brake horsepower-hour. Re-Federal Tour-rocedure: SET= Supplemental emissions testing: NTE=Not-to-Exceed. Settendard or emission test cap; =family emission limit; CERT=certification level; In-

BE IT FURTHER RESOLVED: That the listed engine family is certified to the Optional Low NOx Emission Standards as specified in 13 CCR 1956.8(a)(2)(A) and section 11.B.7 of the incorporated "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy Duty Diesel-Engines and Vehicles" adopted Dec. 27, 2002, as last amended Oct. 21, 2014.

BE IT FURTHER RESOLVED: For the listed engine family, the manufacturer has demonstrated compliance with the Greenhouse Gas Emission Standards as specified in Title 13 CCR 1956.8 and part 1036 of the incorporated "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy Duty Diesel-Engines and Vehicles (HDDE Test Procedures) adopted Dec. 27, 2002, as last amended Oct. 21, 2014.

	EPA CERTIFICATI	OF CONFORMITY	PRIMARY INTENDED SERVICE CLASS				
	_		VOCAT	TONAL			
In .	C	O ₂	CH,				
g/bhp-hr	FTP	SET	CH ₄	ED SERVICE CLASS TIONAL N ₂ O 0.10 0.02			
STD	555		0.10	0.10			
FCL	476						
FEL	490	•	0.65				
CERT	465		0.56	0.02			

hour; FTP=Federal Test Procedure; SET=Supplemental emissions testing; STD = standard or emission test cap; FEL=family emission limit; g/bhp-hr=grams per brake hot FCL=family certification level; CERT=certification level; CO₂=cerbon dioxide; CH₄=methane; N₂O=nitrous oxide; VOCATIONAL=vocational engine; TRACTOR=tractor engine

BE IT FURTHER RESOLVED: That the listed engine family is certified to the Alternate Phase-in CO₂ Emission Standards as specified in 13 CCR 1956.8 and section 40 CFR 1036.150 (e) as incorporated in the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy Duty Diesel-Engines and Vehicles" adopted Dec. 27, 2002, as last amended Oct. 21, 2014.



CUMMINS INC.

EXECUTIVE ORDER A-021-0456-1 New On-Road Heavy-Duty Engines Page 1 of 1 Pages

Pursuant to the authority vested in the Air Resources Board by Health and Safety Code Division 26, Part 5, Chapter 2: and pursuant to the authority vested in the undersigned by Health and Safety Code Sections 39515 and 39516 and Executive Order G-02-003:

IT IS ORDERED AND RESOLVED: The engine and emission control systems produced by the manufacturer are certified as described below for use in on-road motor vehicles with a manufacturer's GVWR over 14,000 pounds. Production engines shall be in all material respects the same as those for which certification is greated

MODEL	ENGINE FAM	IILY	ENGINE SIZES (L)	FUEL TYPE 1	STANDARDS & TEST	SERVICE	ECS & SPECIAL FEATURES 3	DIAGNOSTIC 6			
TEAR			SIZES (L)	GEORGE STREET, STATE OF	PROCEDURE	CLASS "	TBI, TC, CAC, ECM, EGR, TWC.	EMD			
2008	8CEXH0540	LBC	8.8	CNG/LNG	Diesel	MHDD	HO2S	EMD			
PRIMARY ENGINE'S IDLE		SIDLE									
EXEMPT		N/A									
ENGINE (L)				ENGINE M	ODELS / CODES (ra	ated power, in	hp)				
8.8	2000	MALE NATION	15	SL G 320 / 0887;FR92	2424 (320), ISL C	3 300 / 0887	;FR92104 (300)				
8.8				887;FR92738 (280), ISL G 260 / 0887;FR92739 (260), ISL G 250 / 0887;FR92847 (250)							
•											

=not applicable: GVWR=gross vehicle weight rating: 13 CCR xyz=Title 13, California Code of Regulations, Section xyz; 40 CFR 85.abc=Title 40, Code of Federal Regulations, Section 85.abc;

CNG/LNG=compressed/liquefied natural gas; LPG=liquefied petroleum gas; E85=85% ethanol fuel; MF=multi fuel a.k.a. BF=bi fuel; DF=dual fuel; FF=fexblic fuel;

L/M/H HDD=light/medium/heavy heavy-duty diesel; UB=urban bus; HDO=heavy duty Otto;

ECS=emission control system; TWC/OC=three-way/oxidizing catalyst; NAC=NOx adsorption catalyst; SCR-U / SCR-N=selective catalytic reduction – urea / – ammonis; WU (prefix) =warm p calalyst. DP=cleset perticulate filter; PTOX=periodic trap oxidizer; H02S/02S-heated/coxypen sensor; HAFS/AFS=heated/air-fuel-ratio sensor (a.k.a. unversal or linear oxygen sensor); IBI=finotite body fuel injection; SPIME*insequential/hulti port fuel injection; DCI=direct gasoline injection; GCARB=gaseous carburator. IDI/DDI=indirect/direct dieset injection; TCRS=in/tho/super charger; CAC-scharge air cooler; EQR / EGR-C=exhalust gas recirculation / cooled EGR; PAIR/AIR=pulsed/secondary air injection; SPI_esmoke pull limiter; ECMPCM=engine/powertrain portifical module; EM=engine modification; 2 (preftx)=parallet; (2) (sufftx)=in_series;

ESS-engine shutdown system (per 13 CCR 1956.8(a)(6)(A)(1); 33g=33 g/hr NOx (per 13 CCR 1956.8(a)(6)(C); APS =internal combustion auxiliary power system; ALT=alternative method per 13 CCR 1956.8(a)(6)(D); Exempt=exempled per 13 CCR 1956.8(a)(6)(B) or for CNG/LNG fuel systems; N/A=not applicable (e.g., Otto engines and vehicles); EMD=engine manufacturer diagnostic system (13 CCR 1971); OBD=on-board diagnostic system (13 CCR 1971,1);

Following are: 1) the FTP exhaust emission standards, or family emission limit(s) as applicable, under 13 CCR 1956.8; 2) the EURO and NTE limits under the applicable California exhaust emission standards and test procedures for heavyduty diesel engines and vehicles (Test Procedures); and 3) the corresponding certification levels, for this engine family "Diesel" CO. EURO and NTE certification compliance may have been demonstrated by the manufacturer as provided under the applicable Test Procedures in lieu of testing. (For flexible- and dual-fueled engines, the CERT values in brackets [] are those when tested on conventional test fuel. For multi-fueled engines, the STD and CERT values for default operation permitted in 13 CCR 1956.8 are in

in g/bhp-hr	NMHC		NOx		NMHC+NOx		co		F	M	нсно	
	FTP	EURO	FTP	EURO	FTP	EURO	FTP	EURO	FTP	EURO	FTP	EURO
STD	0.14	0.14	0.20	0.20	9/8)	•	15.5	15.5	0,01	0.01	•	
FEL	•		300,000				•				•	
CERT	0.13	0.04	0.10	0.01			1.2	0.4	0,009	0.000		
NTE	0.21		0	.30			1	9.4	0.	.02		•
7										-	_	

ghthp-hregrams per brake horsepower-hour; — sa Procedure; EURO=Euro III European Steady-State Cycle, Indusing Rw. SETuram mode die supplemental errissions esting; NTE=Not-to-Exceed; STD=standard or emission lest cap; FEL CO=carbon monoxide; PM=particulate matter; HCHO=formaldehyde;

BE IT FURTHER RESOLVED: Certification to the FEL(s) listed above, as applicable, is subject to the following terms, limitations and conditions. The FEL(s) is the emission level declared by the manufacturer and serves in lieu of an emission standard for certification purposes in any averaging, banking, or trading (ABT) programs. It will be used for determining compliance of any engine in this family and compliance with such ABT programs,

BE IT FURTHER RESOLVED: For the listed engine models the manufacturer has submitted the materials to demonstrate certification compliance with 13 CCR 1965 (emission control labels) and 13 CCR 2035 et seq. (emission control warranty).

Engines certified under this Executive Order must conform to all applicable California emission regulations.

The Bureau of Automotive Repair will be notified by copy of this Executive Order.

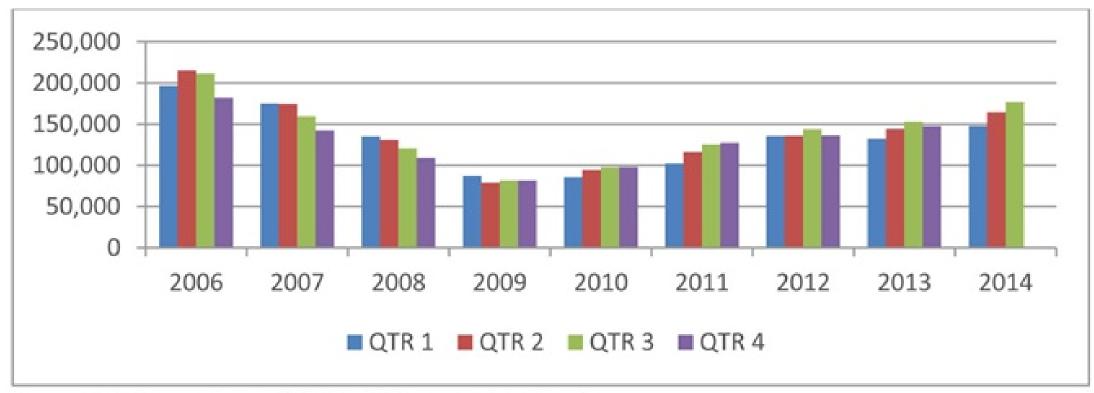
This Executive Order hereby supersedes Executive Order A-021-0456 dated August 23, 2007.

Executed at El Monte, California on this

day of October 2008.

Mobile Source Operations Division

New Commercial Registrations (GVW 3-8) quarterly units by calendar year



Source: IHS Automotive, Polk 2006-2014 new registration data

Air Resources Board

Home Reducing Air Pollution Air Quality Business Assistance Laws & Regulations Health

uesday, December 1, 2015

educing Air Pollution - ARB

Diesel Program o Mobile Vehicles and

Equipment n Mobile Sources o Operators

Off-Road Diesel

PROGRAM LINKS

Archived Documents Background Current Regulation

(PM) and Diesel Exhaust Retrofits California DOORS Public Information language : EIN Label Vendors buttons abd

Emails Sent to Fleets Fact Sheets, FAQS.

Fleet Average Calculators Low Population Counties ORIAG

Related Links

Reporting Forms and Tools Rulemaking Documents o Original Regulation

o Jan 2009 Amendments 6 July 2009 Amendments

Dec 2010 Amendments Water-Well Drilling Rig

Guidance What's New Archive

Workshops / Meetings RESOURCES

Contact Us

Join the Ordiesel Email list

In-Use Off-Road Diesel Vehicle Regulation

This page last reviewed November 9, 2015

Knowledge Center Website http:// MAM dip to don authod enregd/partitrack/postfrack him

Difficulty Hard

California Domiciled Only? No

On July 26

What's N

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Posted Au

. Trucks 26K+ GVWR used for transporting cargo, such as con-tamerured, bulk, or break-bulk poods, that operates on or through port or intermedal rad yard property or.

· Off port or intermedal rail yard. properly transporting cargo or prophy containers or chasses that originated from or is destroot to a port or intermedal rail yard prop-erty. (aka "Dray Off") * Corres-ARB interpretation includes yard trucks on terminal prop-

 Trucks less than 26K+ GVWR . Um-body type trucks not used for

CLICK HERE TO YEW EX-

. The Ports of Los Angeles and Long Beach have adhitional TRANSCENCES.

· "Ports" are defined as any facility which receives waterborne cargo As a result, many projet facilities have been designated as "ports" for the purpose of this

"VDECS" = Venfied Diesel Emission Control System. VDECS can be other type of treatments as well, but typically are filters of some kind.

Exhaust

Drayage Truck Rule

What is the Drayage Truck Rule?

Currently, all Class 8 drayage

trucks must be

1 1994-2003 model year along in the South Coast basin. and a level 3 VDECS for PM emissions

emissions.

After December 31, 2011, 20 decime of the current non-model year engines must be authority of approved MNx equipped with the highest reduction retrofies, Plance From Part College and March 2015 for PM emissions.

Soons.

The Dispage Truck Rule consists of two compliance dispage trucks with 5005. He precision Respirations and Dispage Trucks with 5005. Phases.

2006 model your complex. The Dispage Trucks need to make the equipment with the regiment of the Dispage Highest level VIHCS for PM.

Phase Class.

CLICK HERE TO ACCESS

After December 31, 2011 all THE DTR Class 7 Drayage Trucks operengine certified to California mass be equipped with the or federal enussion standards between VDECS for PM container destined to or origi-

milyard from a compliant 2. 2004 or newer model year Both Class 7 and 8 Drayage or visa-versa off por prog-engine certified to California Trucks must meet or exceed of 127011. There is no mile Phase Iwo truck so a mon-or or federal emission standards, 2007 EPA emissions stan-"radius" away from the worts occur within of California

2007 or newer OEM engine.

Resources

End a level 3 VDECS
 Report Dray-Off by

Find a certified VDECS

Subscribe to the Prop 1B

Website: http:// www.arb.ca.gov/msprog/ onrdiesel/onrdiesel.htm

Difficulty: Hardest

California Damiciled Only?: No

Applies to:

. Trucks 14k+ GVWR, includes diesel-fuel, dual-fuel, or alternative diesel-fuel that are registered to be driven on public highways, were originally designed to be driven on public highways whether or not they are registered.

· Also includes vard trucks with on-road engines or yard trucks with off-road engines used for agricultural operations, both engines of two-engine sweep-

Exemptions

· Trucks operated less than 1.000 miles and 100hrs annually. These trucks must meet reporting and recordkeeping requirements.

 Trucks subject to Dravage Rule until 1/1/2023

· Generally, equipment subject to other rules (public utility, cargo handling, refuse, etc.)



Statewide Truck and Bus Rule

The Statewide Truck and Bus Rule is a multi-billion dollar rule which affects all owners/ operators of commercial diesel vehicles over 14,000lbs.

All fleets operating in or through California should immediately begin planning for this rule as major deadlines begin 1/1/2012. The average lead time for obtaining the retrofits required to comply can take several

On the following pages we'll discuss compliance options and the practical steps your fleet should take to cope with



Resources

- Find a level 3 VDECS
- Find a certified VDECS installer
- Subscribe to the Prop 1B funding email list for the latest news.
- Carl Mover Program Contact List
- ARB's Fleet Compliance Calculator (updated 2/2012)
- Report to ARB (Initial deadline passed, must report mileage for low

use provisions annually)

Truck and Bus Rule Email List

www.arb.ca.oprient.bdvig/ helvig htm

(Maly Lat

California Demiciled Dely? PSIP. Yes (actudes IRP II (A base pleted) ECL/MOVER No

Applies to

Website: http://

www.ark.ca.gov/msgrog/

California Demiciled Dely?: No

• Diesel Fueled Commercial

Vehicles 10;000+ GVWR

· You are stuck or traffic

· When alling it necessary for

· You are operating a power

moderical failure

residential area):

any residential area.

Exceptions:

track-iding/track-idling htm

Caldinas-based track and but from with 2 or more heavy thaty diesel reductes (14k+ the GVWR except for 1998-older,

Heavy-Duty Vehicle Inspection Program (HDVIP)/Periodic Smoke Inspection (PSIP)

What is HDVIP/PSIP/ECL?

PSIP (smoke tests) E(L (labels)

Heavy Duty Vehicle Idling

Emission Reduction Program

(5-Minute Idling)

PSIP (smoke tests) E(L (labels) location originally intalled location orig

What is the Five Minute Idling Program?

One of CARB's simplest programs, the Heavy-Dusy Vehicle Idling Emission Reduction Program simply testricts idle times to five minutes, one of 47 state or

. You cannot move became of afverse weather conditions or local ordinances to do so. The American Transportation

Research Institute (ATRI) publishes a handy guide to · You are surrous treat he beyond 100 feet from any saling restrictions · Your truck's engine meets the

Still, despite this program's optional NOs affing emission standard and your track is focused beyond 100 first from



Still, depute this program's sense of the program o

and newer engines to control particulate matter (PM) It is also seportant as note that there is no exception make for cits construction make for cits construction.

Per targo of the track majore to per tertoffining the direct APS with a verified level 3.

Resources

- Last of afte reduction Softmologies
- Mic Reputation Fact
 Short

AIAIA

Advanced

Home

Reducing Air Pollution | Air Quality

Business Assistance

Laws & Regulations

Health

Tuesday, December 1, 2015

UP LINKS

- Reducing Air Pollution -ARB Programs
 - Mobile Sources
 - Manufacturers
 - On-Road New Vehicle and Engine Certifications
 - Alternative Fuel Conversion Certification

PROGRAM LINKS

- Alternative Fuel Conversion Requirements Background
- Light-Duty Emissions Certification Requirements

Alternative Fuel Conversion Certification Procedures for New and In-Use On-Road Vehicles and Engines

This page last reviewed February 21, 2013

Background

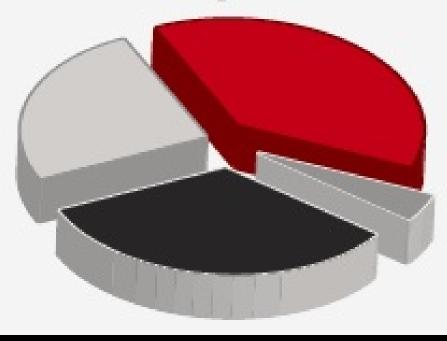
California regulations prohibit the conversion of emission-controlled vehicles to operate on an alternative fuel, such as natural gas or propane, unless the conversion has been evaluated and certified by the Air Resources Board (ARB). If the conversion is done before the legal title has been transferred to an ultimate purchaser the conversion manufacturer is considered the Original Equipment Manufacturer (OEM) and must comply with ARB's new vehicle or engine certification requirements. Conversions done after the legal title has been transferred are considered in-use conversions and must comply with ARB's alternative fuel retrofit system certification procedures. For an overview of these requirements please view the presentation materials and guidance documents from our August 14, 2012 public workshop located here.

This page provides a list of the most common ARB new and in-use on-road vehicle and engine emission-related regulations and test procedures that manufacturers are required to follow to obtain an alternative fuel conversion certification. Manufacturers are strongly encouraged to contact the appropriate certification section prior to submitting an application to schedule a pre-certification meeting to assist them in determining the requirements specific to their application.

Trucks operating in California by model year



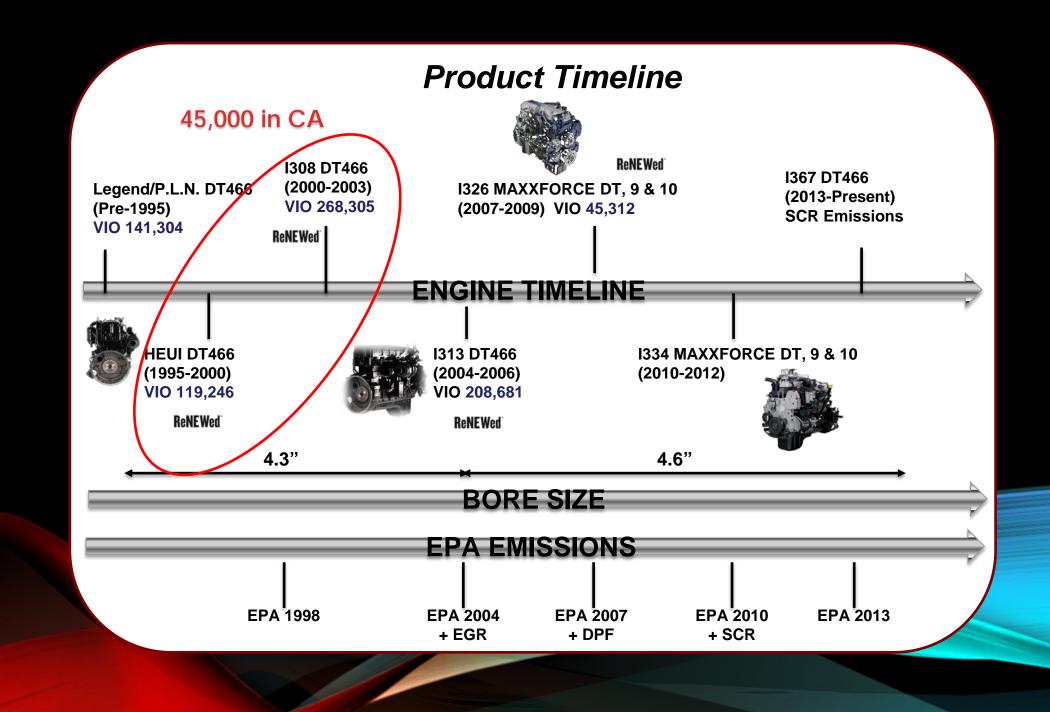
2010 and newer 33%

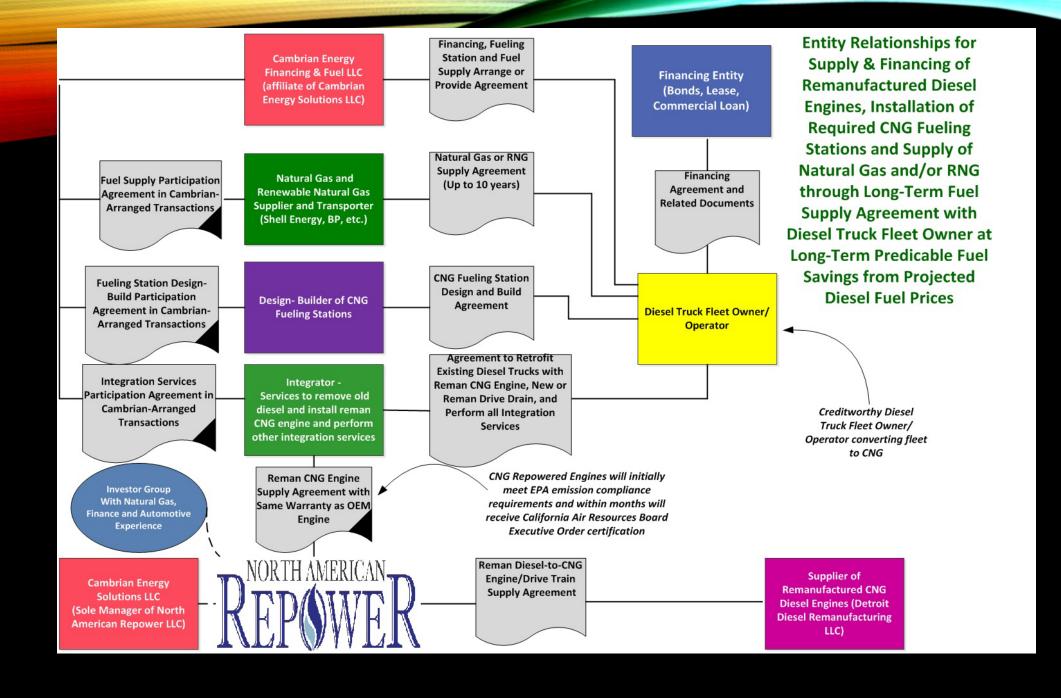


1996-06 38%

1995 and older

4%

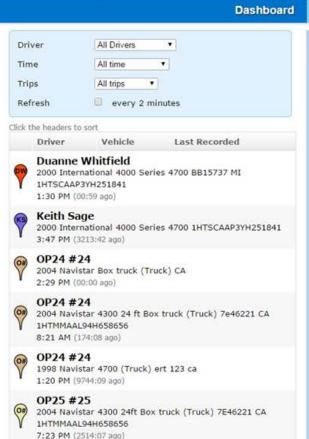


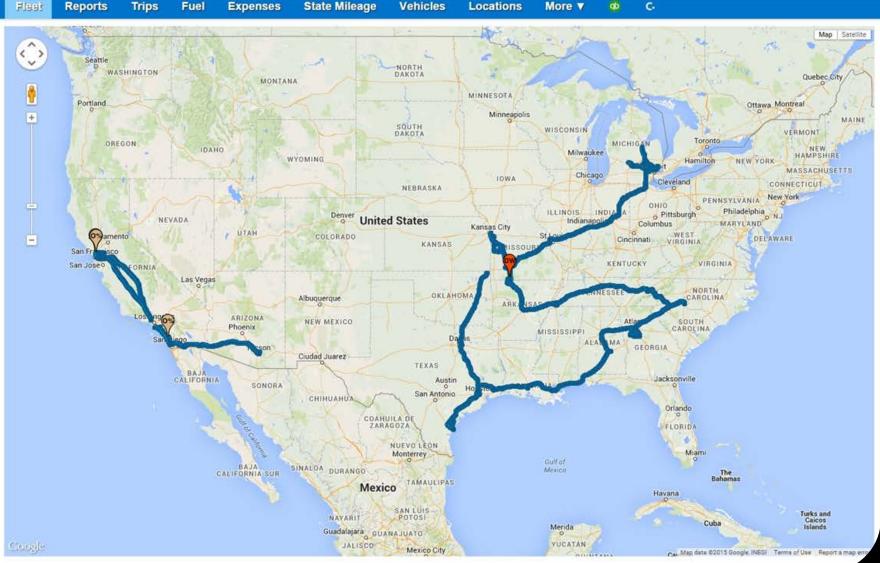




North American Repower

Help | Feedback





DR. JOHN REED

jreed@NorthAmericanRepower.com



