

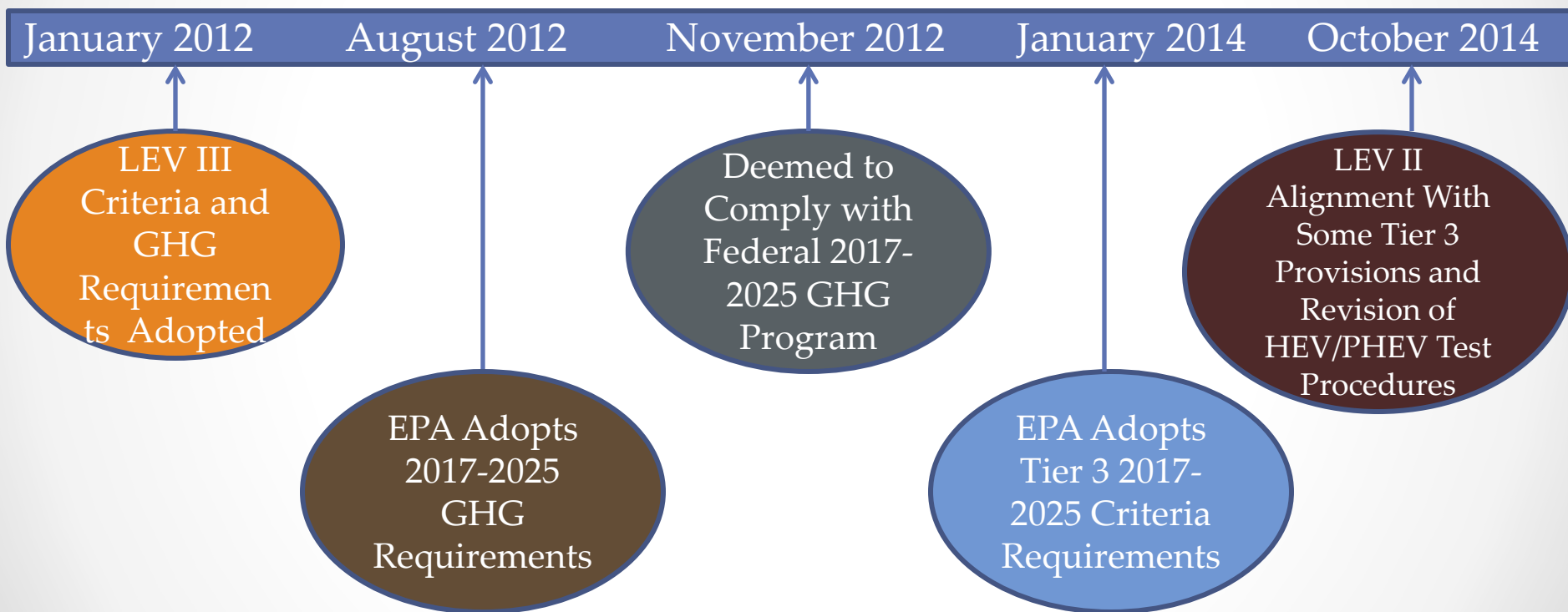
Technical Training on California and US Federal Light-Duty Vehicle Criteria and Greenhouse Gas Emission Standards

Allen Lyons

April 2015

Mexico City

Status and Timing of California /US Emission Standards



Status and Timing of California/US Emission Standards

- NMOG+NOx fleet average emission standards
 - LEV III phase-in 2015-2025
 - Tier 3 phase-in 2017-2025
- Both programs require all vehicles to meet LEV III/Tier 3 requirements by 2022
 - E10 certification fuel, 15 year/150K mile durability
 - Prior to 2022, fleet composed of vehicle meeting either LEV II/Tier 2 or LEV III/Tier 3 requirements
 - Beginning in 2017, Tier 3 designates vehicles meeting Tier 2 requirements as interim Tier 3 vehicles
- GHG Emission standards
 - LEV III/Federal GHG standards phase-in 2017-2025
 - Same CO₂, CH₄, and N₂O standards
 - Differences in compliance demonstration

Federal GHG and Fuel Economy Regulations

- Federal law limits NHTSA fuel economy rulemakings to not more than five years at a time.
- Accordingly, NHTSA has adopted fuel economy requirements for 2022-2025 that are “augural.”
 - meaning that they represent NHTSA’s current best estimate of what levels of stringency might be maximum feasible in those model years.
 - NHTSA to formally adopt final fuel economy requirements for 2022-2022
- ARB, USEPA and NHTSA currently conducting a mid-term review of 2022-2025 GHG and fuel economy requirements

Mid-Term Review of GHG and Fuel Economy Requirements

- The mid-term evaluation reflects the rules' long time frame and, for NHTSA, the agency's statutory obligation to conduct a *de novo* rulemaking in order to establish final standards for MYs 2022–2025.
- Technical Assessment Report reflecting results of mid-term review to be published in mid 2016
- NHTSA must provide 18 month lead-time when adopting final fuel economy requirements for 2022–2025.

Mid-Term Review of 2022-2025 GHG and Fuel Economy Standards

- The review shall take into account
 - (i) The availability and effectiveness of technology, and the appropriate lead time for introduction of technology;
 - (ii) The cost on the producers or purchasers of new motor vehicles or new motor vehicle engines;
 - (iii) The feasibility and practicability of the standards;
 - (iv) The impact of the standards on reduction of emissions, oil conservation, energy security, and fuel savings by consumers;
 - (v) The impact of the standards on the automobile industry;
 - (vi) The impacts of the standards on automobile safety;
 - (vii) The impact of the greenhouse gas emission standards on the Corporate Average Fuel Economy standards and a national harmonized program; and
 - (viii) The impact of the standards on other relevant factors

Extensive Work in Progress by ARB and Federal Partners

Refinement of Vehicle Simulation and Models

Testing and benchmarking of advanced engines and drivetrains

Update Technology Assumptions and Costs

Teardowns of new vehicle technologies

Load and mass reduction studies

Consumer Response

Review of market acceptance of emerging GHG technologies

Vehicle Safety

Vehicle attribute and safety analysis



LEV III Structure and Overview

LEV III Structure and Review (Certification Fuel)

- Certification fuel
 - LEV III and Tier 3 certification fuel similar
 - Both require 9.6-10% ethanol
 - Federal fuel has higher RVP – 9.0 vs 7.0
 - Federal fuel has wider limits on some fuel parameters
- California allows use of federal certification fuel

LEV III Structure and Overview (Certification Fuel)

Property	CARB E10	Unit	EPA E10	Unit
R+M/2	87.0 - 88.4 91 (min)*	-	87.0 - 88.4 91 (min)*	-
Sensitivity	7.5 min	-	7.5 min	-
RVP	6.9-7.2	psi	8.7-9.2	psi
RVP Cold CO	-	-	11.2-11.8	psi
RVP High Altitude	-	-	7.6-8.0	psi
Distillation				
10% evap	130-150	°F	120-140	°F
50% evap	205-215	°F	190-210	°F
90% evap	310-320	°F	315-335	°F
FBP	390 max	°F	380-420	°F
Residue	2.0 max	vol. %	2.0 Max	millimeter
Total Aromatic Hydrocarbons	19.5-22.5	vol. %	21.0-25.0	vol. %
Aromatics, MSAA hydrocarbons	13-15	vol. %	-	-
Olefins	4.0-6.0	vol. %	4-10	vol. %
MTBE	0.05 max	vol. %	-	-
Ethanol	9.6-10.0	vol. %	9.6-10.0	vol.%
Oxygen	3.3-3.7	wt. %	-	-
Sulfur	8-11	ppm by wt	8.0-11.0	mg/kg
Benzene	0.6-0.8	vol. %	0.6-0.8	vol.%
Lead	0-0.01 max	g/gal	0.0026 max	g/liter
Phosphorus	0.005 max	g/gal	0.0013	g/liter
Performance Additives	Sufficient to meet requirements of Title 13, CCR 2257	-	-	-
Copper Corrosion	No. 1 max	-	No. 1 max	-
Solvent-Washed Gum Content	3.0 max	mg/100 ml	3.0 Max	mg/100 ml
Oxidation Stability	1000 min	minute	1000 min	minute
Specific Gravity	Report	-	Report	g/cm ³
Net Heat of Combustion	Report	-	Report	MJ/kg
Carbon	Report	wt. %	Report	mass %
Hydrogen	Report	wt. %	Report	mass %

* Octane value for vehicles requiring use of premium gasoline

LEV III Structure and Overview (Commercial Fuel)

- California allows use of a predictive model to govern composition of commercial gasoline.
- The Predictive Model is a set of mathematical equations that relate emission rates of exhaust hydrocarbons, oxides of nitrogen (NO_x), and combined exhaust toxic species to the values of the eight gasoline properties regulated under CaRFG3.
- Allows producers to certify alternative formulations of gasoline by comparing the emission predictions for a candidate set of property limits to the predictions for the flat or averaging limits.
- The model allows a producer to use one or more limits greater than flat or averaging limits in exchange for compensating reductions in other limits.
 - Flat limit: Option 1 - limits apply to all gasoline supplied by producer
 - Averaging limit: Option 2 - Gasoline batches above averaging limits must be offset by batches below averaging limits
 - Cap limits: Gasoline must not exceed cap limits at any time

LEV III Structure and Overview (Commercial Fuel)

Property	Flat Limits	Averaging Limits	Cap Limits ⁽¹⁾
Reid Vapor Pressure, psi, max	7.00	---	6.40-7.20 ⁽²⁾
Benzene, vol%, max	0.8	0.70	1.10
Sulfur, ppmw, max	20	15	30
Aromatic HC, vol%, max	25	22	35.0
Olefins, vol%, max	6.0	4.0	10.0
Oxygen, wt%	1.8 to 2.2	---	1.8-3.5 ⁽³⁾
T50 (temp. at 50% distilled) °F, max	213	203	220
T90 (temp. At 90% distilled) °F, max	305	295	330

(1) Cap limits apply to all gasoline at any place in the marketing system and are not adjustable

(2) The 7.20 psi RVP cap limit only applies during the RVP regulatory control period (Summertime). The minimum 6.40 psi RVP limit applies year round.

(3) The 1.8 wt. percent minimum applies only during the winter and only in certain areas

[California Environmental Protection Agency](#)

LEV III/Tier 3 Diesel Certification Fuel Specifications

Property, unit	California	Federal
	Limit	
Cetane Number	47-55	40-50
Distillation		
Initial Boiling Point, °F	340-420	340-400
10% point, °F	400-490	400-460
50% point, °F	470-560	469-540
90% point, °F	550-610	560-630
End Point, °F	580-660	610-690
API Gravity	33-39	32-37
Nitrogen content, ppmw	100-500	
Total Sulfur, ppm	7-15	7-15
Total Aromatic Hydrocarbons, vol%	8-12	100 (g/kg)
Polycyclic Aromatic Hydrocarbons (PAH), wt.%	1.4	
Flashpoint, °F	130	129
Viscosity @ 40 °F, centistokes	2.0-4.1	2.0-3.2

California Commercial Diesel Fuel Specifications

Property, Units	Specification	Designated Equivalent Limits
Sulfur content, ppm	15	15
Aromatic hydrocarbon content, vol%	10	21.0
	Small refiner: 20	15
API Gravity	N/A	36.9 (min)
Lubricity, microns	520	520
<i>Below are additional parameters specified for Certified Diesel Formulations (alternative formulations) ⁽²⁾</i>		
Polynuclear Aromatic Hydrocarbon content (PAH) wt.%		3.5
Nitrogen content, ppm		500
Cetane number		55 (min)

LEV III Structure and Overview (Vehicle Definitions)

- Passenger Car (PC)
 - LEV III - "Any motor vehicle designed primarily for transportation of persons and having a design capacity of 12 persons or less."
 - NOM 042 - "Car, or its derivative, except for all-purpose vehicle and trailer or utility designed for transport up to 10 people."
- Light-Duty Truck (LDT)
 - LEV III - "Any motor vehicle rated at 8,500 pounds gross vehicle weight or less, that is designed primarily for purposes of transportation of property or is a derivative of such a vehicle, or is available with special features enabling off-street or off-highway operation and use."
 - LDT1 - "A light-duty truck with a loaded vehicle weight of 0-3750 pounds."
 - LDT2 - "A light-duty truck with a loaded vehicle weight of 3751 to a gross vehicle weight rating of 8,500 pounds."
 - Includes federal LDT2, LDT3, and LDT4 truck categories
 - NOM 042
 - Light trucks (CL1)
 - "Light trucks (group one) with gross vehicle weight of up to 2,722 kg and test weight (PP) up to 1,701 kg."
 - Light Trucks (CL2)
 - "Light trucks (group two) with gross vehicle weight of up to 2,722 kg and test weight (PP) greater than 1,701 and up to 2,608 kg."
 - Light Trucks (CL3)
 - "Light trucks (group three) with gross vehicle weight greater than 2,722 and up to 3,857 kg and test weight (PP) of up to 3,857 kg."
 - Light trucks (CL4)
 - "Light trucks (group four) with gross vehicle weight greater than 2,722 and up to 3,857 kg and test weight (PP1) greater than 2,608 and up to 3,857 kg."

LEV III Structure and Overview

(Vehicle Definitions)

- Medium-Duty Passenger Vehicle (MDPV)
 - Any heavy-duty vehicle (as defined in this subpart) with a gross vehicle weight rating (GVWR) of less than 10,000 pounds that is designed primarily for the transportation of persons. The MDPV definition does not include any vehicle which:
 - (1) Is an “incomplete truck” as defined in this subpart; or
 - (2) Has a seating capacity of more than 12 persons; or
 - (3) Is designed for more than 9 persons in seating rearward of the driver's seat; or
 - (4) Is equipped with an open cargo area (for example, a pick-up truck box or bed) of 72.0 inches in interior length or more. A covered box not readily accessible from the passenger compartment will be considered an open cargo area for purposes of this definition.
- Medium-Duty Vehicle (MDV)
 - “Any heavy-duty vehicle having a manufacturer’s gross vehicle weight rating (GVWR) between 8,501 and 14,000 pounds.”
- Heavy-Duty Vehicle
 - “Any motor vehicle having a manufacturer’s gross vehicle weight rating greater than 8,500 pound, except passenger cars.”

LEV III Structure and Overview (Vehicle Test Weights)

- Loaded vehicle weight (LVW)
 - Applies to passenger cars, light-duty trucks and medium-duty passenger vehicles
 - Curb weight plus 300 pounds
 - Curb weight - "The actual or the manufacturer's estimated weight of the vehicle in operational status with all standard equipment, and weight of fuel at nominal tank capacity, and the weight of optional equipment computed in accordance with §86.082-24."
- Adjusted Loaded Vehicle Weight (ALVW)
 - Applies to medium-duty vehicles, except MDPVs
 - "The numerical average of vehicle curb weight and GVWR."
- Gross Vehicle Weight Rating (GVWR)
 - "The value specified by the manufacturer as the maximum design loaded weight of a single vehicle."
 - Also referred to as gross vehicle weight (GVW) in the test procedures

LEV III Structure and Overview (Vehicle Classes)

Vehicle Class	Weight Range*	
Passenger Cars	All weights	
Light-Duty truck 1 (LDT1)	0-3750 lbs. LVW	0-1701 kg LVW
Light-Duty truck 2 (LDT2)	3751 lbs. LVW – 8,500 lbs GVWR	1701 kg LVW - 3856 kg GVWR
Medium-Duty Passenger Vehicle (MDPV)	8,501-10,000 lbs GVWR	3,856-4536 kg GVWR
Medium-Duty Vehicle	8,501-10,000 lbs GVWR	3,856-4536 kg GVWR
	10,001-14,000 lbs GVWR	4536-6350 kg GVWR

LEV III Structure and Overview: Criteria

(Fleet Average and Bins for PC, LDT1, LDT2, and MDPV)

- Fleet average
 - Emissions measured on FTP or Urban cycle
 - Declines every year
 - Sales weighted emissions must meet fleet average
 - Fleet average below requirement earns credits
 - Fleet average above requirement accrues debits
- Standards or Bins
 - Individual Test Groups certify to standards
 - Used to comply with fleet average

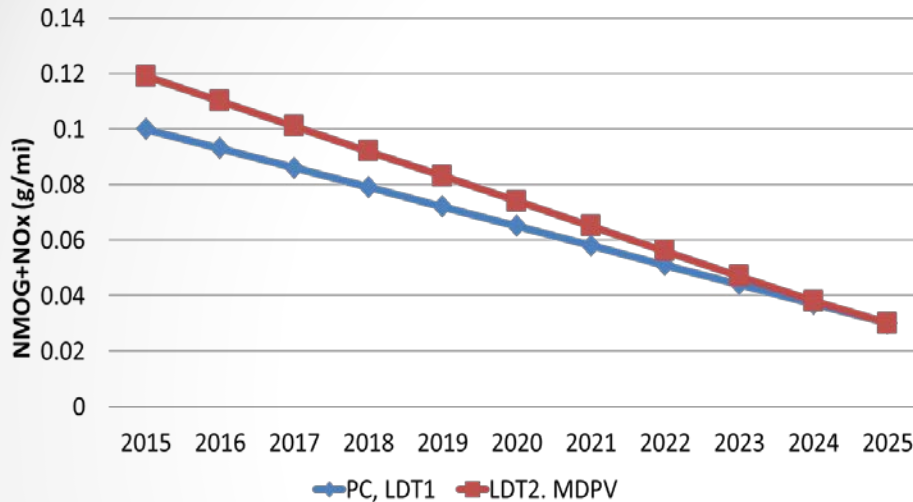
Category	Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PC/LDT1		0.100	0.093	0.086	0.079	0.072	0.065	0.058	0.051	0.044	0.037	0.030
LDT2		0.119	0.110	0.101	0.092	0.083	0.074	0.065	0.056	0.047	0.038	0.030

LEV III FTP Emission Standards (150,000 Durability)

Emission Category	NMOG+NOx (g/mi)	CO (g/mi)	Formaldehyde (mg/mi)
LEV160	0.160	4.2	4
ULEV125	0.125	2.1	4
ULEV70	0.070	1.7	4
ULEV50	0.050	1.7	4
SULEV30	0.030	1.0	4
SULEV20	0.020	1.0	4

LEV III: Reducing Criteria Emissions

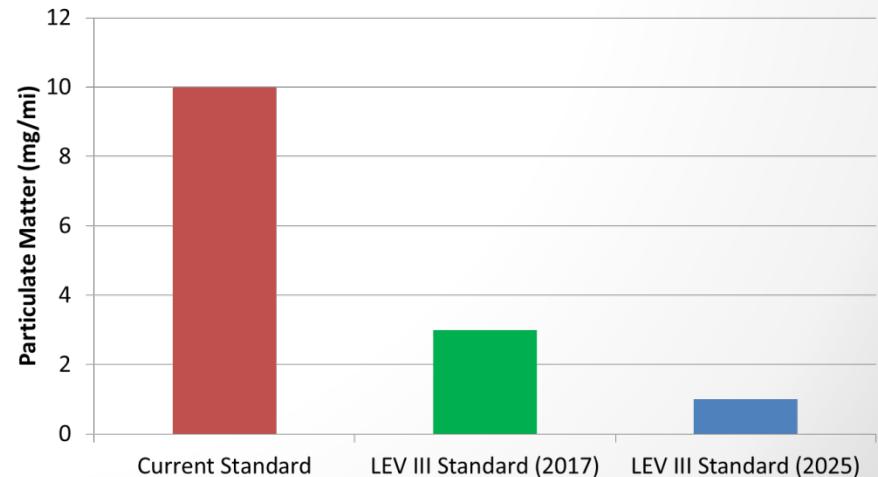
150,000-mile New Vehicle Fleet Average Emissions



75% Reduction in fleet average emissions 2015-2025

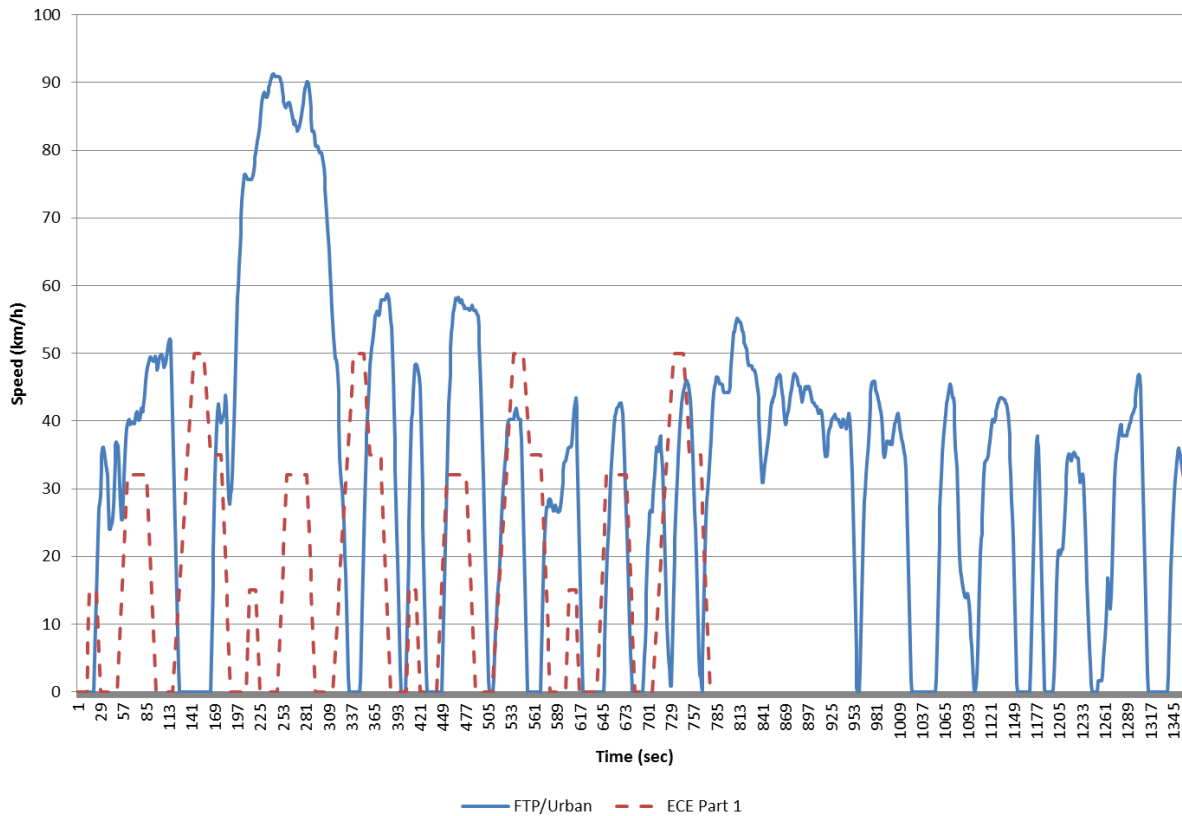
1 mg/mi PM standard in 2025 maintains current PM emission level of well controlled PFI engines

LEV III Particulate Matter Standards



LEV III Structure and Overview: Criteria (Test Cycles - FTP or Urban)

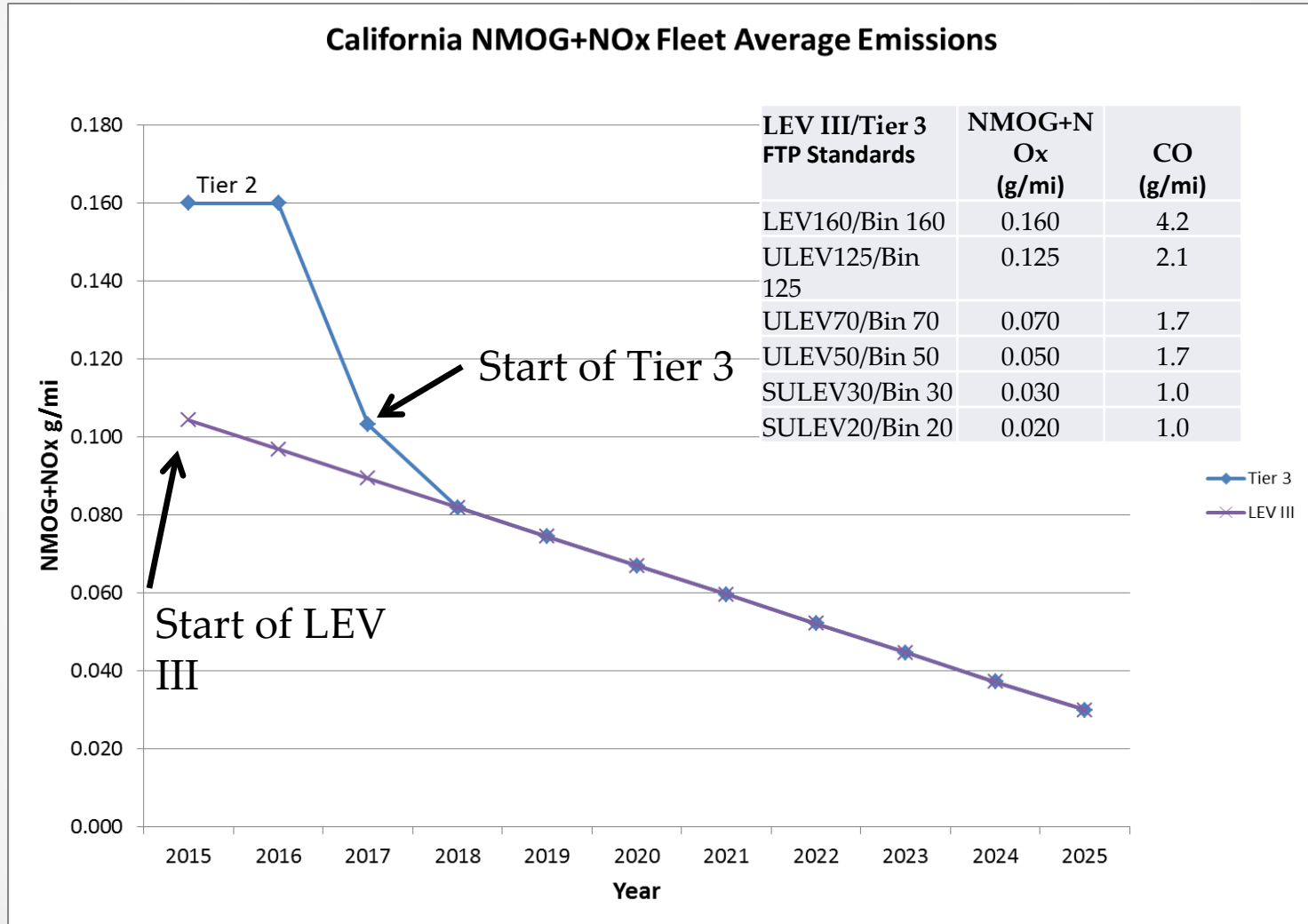
FTP/Urban vs ECE Part 1



FTP 75 (Urban Cycle)
 Duration: 1877 sec
 Distance traveled: 11.04 miles (17.77 km)
 Average speed: 21.2 mph (34.12 km/h)
 Maximum speed: 56.7 mph (91.25 km/h)
 Maximum acceleration : 3.3 mp/h-s (1.5 m/s²)

NEDC
 Duration: 780 sec
 Distance traveled: 2.47 miles (3.98 km)
 Average speed: 11.4 mph (18.35 km/h).
 Maximum speed: 31.1 mph (50 km/h).
 Maximum acceleration: 2.4 mp/h-s (1.1 m/s²)

LEV III Structure and Overview: Criteria (Relation to Tier 3)



LEV III Structure and Overview: Criteria (Fleet Average and Bins for MDV)

- Fleet average
 - Emissions measured on FTP or Urban cycle
 - Declines every year
 - Sales weighted emissions must meet fleet average
 - Fleet average below requirement earns credits
 - Fleet average above requirement accrues debits

FLEET AVERAGE NON-METHANE ORGANIC GAS PLUS OXIDES OF NITROGEN EXHAUST MASS EMISSION REQUIREMENTS FOR MEDIUM-DUTY VEHICLES (150,000 mile Durability Vehicle Basis)		
Model Year	Fleet Average NMOG + NO _x (g/mi)	
	MDVs 8,501 - 10,000 lbs. GVWR	MDVs 10,001-14,000 lbs. GVWR
2016	0.333	0.548
2017	0.310	0.508
2018	0.278	0.451
2019	0.253	0.400
2020	0.228	0.349
2021	0.203	0.298
2022+	0.178	0.247

LEV III Structure and Overview: Criteria

(Fleet Average and Bins for MDV)

- Standards or Bins
 - Individual Test Groups certify to standards
 - Used to comply with fleet average

LEV III Exhaust Mass Emission Standards for New 2015 and Subsequent Model Medium-Duty Vehicles						
Vehicle Type	Durability Vehicle Basis (mi)	Vehicle Emission Category ²	NMOG + Oxides of Nitrogen ⁴ (g/mi)	Carbon Monoxide (g/mi)	Formaldehyde (mg/mi)	Particulates ¹ (g/mi)
MDVs 8501 - 10,000 lbs. GVWR, excluding MDPVs Vehicles in this category are tested at their adjusted loaded vehicle weight	150,000	LEV395	0.395	6.4	6	0.12
		ULEV340	0.340	6.4	6	0.06
		ULEV250	0.250	6.4	6	0.06
		ULEV200	0.200	4.2	6	0.06
		SULEV170	0.170	4.2	6	0.06
		SULEV150	0.150	3.2	6	0.06
MDVs 10,001-14,000 lbs. GVWR Vehicles in this category are tested at their adjusted loaded vehicle weight	150,000	LEV630	0.630	7.3	6	0.12
		ULEV570	0.570	7.3	6	0.06
		ULEV400	0.400	7.3	6	0.06
		ULEV270	0.270	4.2	6	0.06
		SULEV230	0.230	4.2	6	0.06
		SULEV200	0.200	3.7	6	0.06

LEV III Structure and Overview: Criteria (Credits/Debits)

- Credits
 - Expressed in units of NMOG+NO_x g/mi
 - Carry forward 5 years/carry back 3 years
 - Can be banked by manufacture for use in future years
 - Can be traded or sold to other manufacturers

LEV III Structure and Overview: Criteria Credit/Debit Calculation –Example 1

- 2020 NMOG+NOx fleet average requirement – PC/LDT1 0.065 g/mi, LDT2 0.074 g/mi
- Manufacturer fleet – 50% PC/LDT1/50% LDT2

Sample Manufacturer 2020 Fleet Composition				
Category	Emission Category	Number of Vehicles	Sales Weighted Fleet Average Emissions (g/mi)	Credits/Debits (g/mi)
PC/LDT1	LEV160	1,000	0.061	150
	ULEV125	2,500		
	ULEV70	16,500		
	ULEV50	25,000		
	SULEV30	5,000		
	SULEV20	0		
LDT2	LEV160	3,050	0.077	-150
	ULEV125	2,470		
	ULEV70	41,480		
	ULEV50	3,000		
	SULEV30	0		
	SULEV20	0		

In this case, credits earned from PC/LDT1 offset debits accrued from LDT2. The manufacturer earns no credits to carry forward or debits to be offset in future years.

Fleet average emissions calculation:

$$[(\#LEV160 \times 0.160) + (\#ULEV125 \times 0.125) + (\#ULEV70 \times 0.070) + (\#ULEV50 \times 0.050) + (\#SULEV30 \times 0.030) + (\#SULEV20 \times 0.020)] / \text{Total Vehicles}$$

Credit/Debit calculation:
 (Fleet average requirement – Manufacturer fleet average emissions) x Total vehicles

LEV III Structure and Overview: Criteria

Credit/Debit Calculation – Example 2

- Example credit/debit calculation
 - 2020 NMOG+NOx fleet average requirement – PC/LDT1 0.065 g/mi, LDT2 0.074 g/mi
 - Manufacturer fleet -50% PC/LDT1/50% LDT2

Sample Manufacturer 2020 Fleet Composition				
Category	Emission Category	Number of Vehicles	Sales Weighted Fleet Average Emissions (g/mi)	Credits/Debits (g/mi)
PC/LDT1	LEV160	1,000	0.065	0
	ULEV125	1,000		
	ULEV70	28,250		
	ULEV50	19,750		
	SULEV30	0		
	SULEV20	0		
LDT2	LEV160	3,050	0.077	-150
	ULEV125	2,470		
	ULEV70	41,480		
	ULEV50	3,000		
	SULEV30	0		
	SULEV20	0		

In this case, the manufacturer carries forward 150 g/mi NMOG+NOx debits.

If not offset in 2023, manufacturer subject to civil penalties equal to $150/0.070 = 2158$ non-compliant vehicles.

0.070 = 2020 manufacture total fleet average requirement.

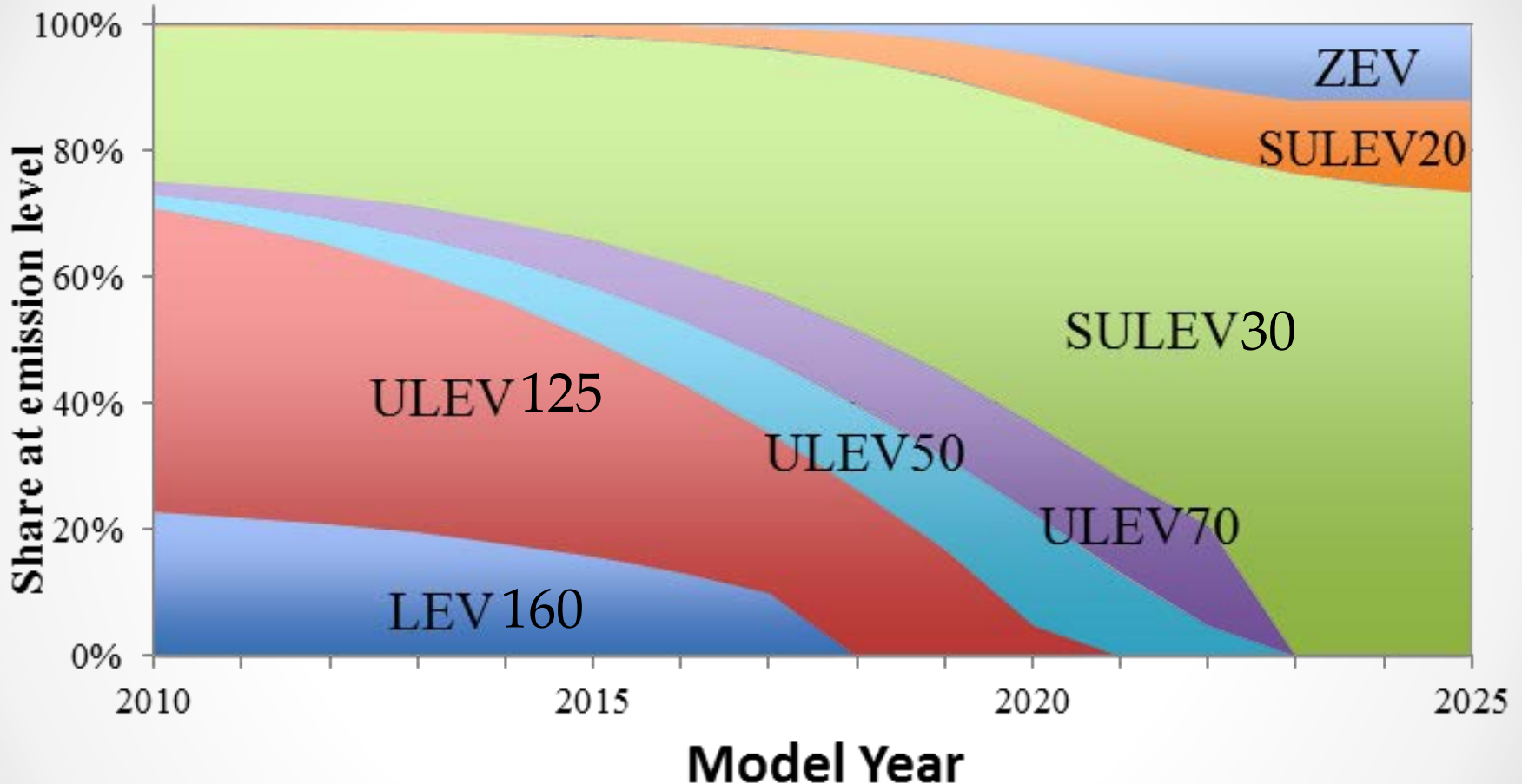
Civil penalty for non-compliant vehicles can be up to \$5,000 per vehicle.

Fleet average emissions calculation:

$$\frac{[(\#LEV160 \times 0.160) + (\#ULEV125 \times 0.125) + (\#ULEV70 \times 0.070) + (\#ULEV50 \times 0.050) + (\#SULEV30 \times 0.030) + (\#SULEV20 \times 0.020)]}{\text{Total Vehicles}}$$

Credit/Debit calculation:
 (Fleet average requirement – Manufacturer fleet average emissions) x Total vehicles

LEV III Structure and Overview: Criteria (Possible Compliance Scenario)



Declining fleet average requirement forces manufacturers to certify an increasing fraction of their vehicles to more stringent emission standards

LEV III Structure and Overview: Criteria (Relation to Tier 3)

- Similarities
 - Same fleet average requirement 2017-2025
 - California phases-in 2015-2025
 - 150,000 mile durability
 - Same emission standards or Bins
 - E10 certification fuel
 - California and federal require E10 certification fuel
 - Reciprocity between California/Federal certification fuel

LEV III Structure and Overview: Criteria (Relation to Tier 3)

- Differences
 - Eight year credit life
 - Could delay meeting federal 0.030 NMOG+NOx fleet average requirement to 2030
 - Certification fuel Reid Vapor Pressure (RVP)
 - California 6.9-7.2 psi; Tier 3 8.7-9.2 psi

LEV III Structure and Overview: Criteria (Technologies and Cost)

Gasoline Passenger Cars and Light-Duty Trucks

Additional Emission Control Technology Requirements												
Technology component	From ULEV125 to SULEV30						From LEV160 to SULEV30					
	PC/LDT1 (No of cylinders)			LDT2 (No of cylinders)			PC/LDT1 (No of cylinders)			LDT2 (No of cylinders)		
	4	6	8	4	6	8	4	6	8	4	6	8
Greater catalyst loading	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Optimized close-coupled catalyst(s)	0%	0%	0%	0%	0%	0%	50%	60%	75%	50%	60%	75%
Secondary air	0%	25%	75%	0%	25%	75%	0%	25%	75%	0%	25%	75%
HC adsorber (active)	0%	0%	0%	0%	0%	15%	0%	0%	0%	0%	0%	15%
Optimized thermal mass manifold	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Low thermal mass turbocharger	0%	0%	0%	0%	0%	15%	0%	0%	0%	0%	0%	15%
Evap equip	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

LEV III Structure and Overview: Criteria (Technologies and Cost)

Gasoline Passenger Cars and Light-Duty Trucks

	Technology Component	From LEV160 to SULEV30					
		PC/LDT1			LDT2		
		4-cyl	6-cyl	8-cyl	4-cyl	6-cyl	8-cyl
Systems with additional technology costs	Greater catalyst loading	\$47	\$62	\$78	\$47	\$62	\$78
	Optimized close-coupled catalyst(s)	\$8	\$19	\$35	\$8	\$19	\$35
	Secondary air	\$0	\$19	\$58	\$0	\$19	\$58
	HC adsorber (active)	\$0	\$0	\$17	\$0	\$0	\$17
	Optimized thermal management	\$6	\$6	\$6	\$6	\$6	\$6
	Low thermal mass turbocharger	\$0	\$0	\$0	\$0	\$0	\$0
	Evap equip	\$13	\$13	\$13	\$13	\$13	\$13
Total incremental cost		\$73	\$119	\$207	\$73	\$119	\$207
Total incremental price		\$87	\$142	\$248	\$87	\$142	\$248

LEV III Structure and Overview: Criteria (Technologies and Cost)

Gasoline Passenger Cars and Light-Duty Trucks

	Technology Component	From ULEV125 to SULEV30					
		PC/LDT1			LDT2		
		4-cyl	6-cyl	8-cyl	4-cyl	6-cyl	8-cyl
Systems with additional technology costs	Greater catalyst loading	\$23	\$31	\$39	\$23	\$31	\$39
	Optimized close-coupled catalyst(s)	\$0	\$0	\$0	\$0	\$0	\$0
	Secondary air	\$0	\$19	\$58	\$0	\$19	\$58
	HC adsorber (active)	\$0	\$0	\$17	\$0	\$0	\$17
	Optimized thermal management	\$6	\$6	\$6	\$6	\$6	\$6
	Low thermal mass turbocharger	\$0	\$0	\$0	\$0	\$0	\$0
	Evap equip	\$13	\$13	\$13	\$13	\$13	\$13
Total incremental cost		\$42	\$69	\$134	\$42	\$69	\$134
Total incremental price		\$50	\$83	\$161	\$50	\$83	\$161

LEV III Structure and Overview: Criteria (Technologies and Cost)

Gasoline Medium-Duty Vehicles

	Technology Component	Cost of Technology Needed	
		8,501-10,000 lbs GVWR	10,001-14,000 lbs GVWR
		8-cylinder	
Systems with additional technology costs	Greater catalyst loading	\$40	\$40
	Optimized close-coupled catalyst(s)	\$0	\$0
	Secondary air	\$0	\$0
	HC adsorber (active)	\$0	\$0
	Optimized thermal management	\$6	\$6
	Low thermal mass turbocharger	\$0	\$0
	Evaporative equipment	\$17	\$17
Total incremental direct cost		\$62	\$62
Total incremental vehicle price		\$75	\$75

LEV III Structure and Overview: Criteria (Technologies and Cost)

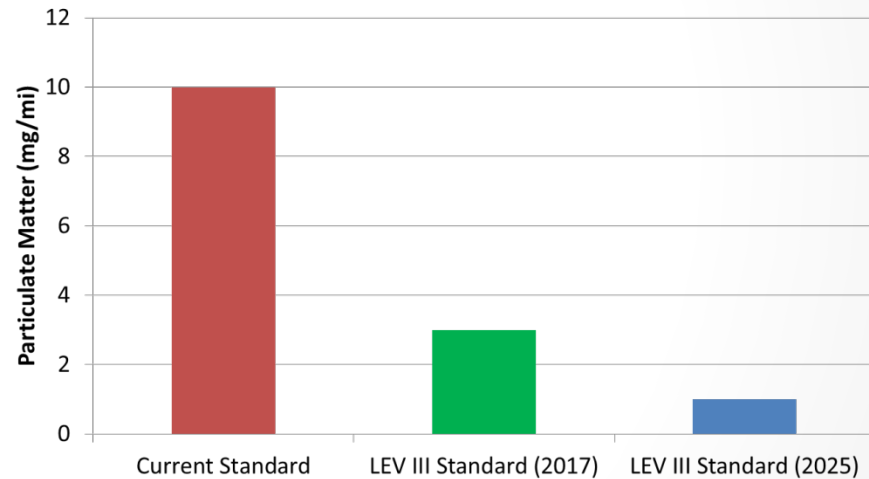
Diesel Medium-Duty Vehicles

	Technology Component	Cost of Technology Needed	
		8,501-10,000 lbs GVWR	10,001-14,000 lbs GVWR
		8-cylinder	
Systems with additional technology costs	Greater catalyst loading	\$0	\$0
	Optimized close-coupled catalyst(s)	\$0	\$0
	Secondary air	\$0	\$0
	HC adsorber (active)	\$0	\$0
	Optimized thermal management	\$6	\$6
	Low thermal mass turbocharger	\$0	\$0
	Evaporative equipment	\$0	\$0
	SCR optimization	\$40	\$40
Total incremental direct cost		\$45	\$45
Total incremental vehicle price		\$54	\$54

LEV III Structure and Overview: Criteria

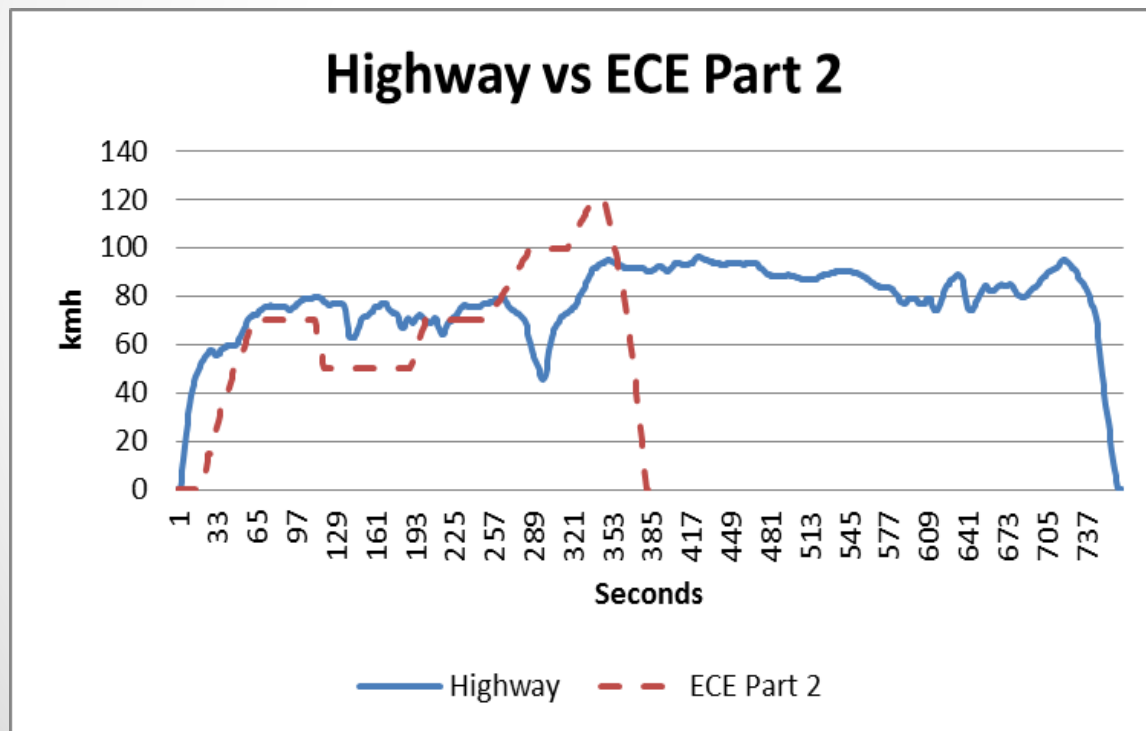
(Particulate Matter Standards)

- Testing showed GDI engines emitted high PM levels relative to current PFI engine technology
- 3 mg/mi phase-in 2017-2021
- 1 mg/mi PM standard phase-in 2025-2028 maintains current PM emission level of well controlled PFI engines
- Board interested in moving up 1 mg/mi standard phase-in earlier
 - Staff to review feasibility of earlier phase-in
- Manufacturers demonstrate compliance by testing 25% of their test groups each year
- Medium-duty vehicles
 - Phase-in 2017-2021
 - 8,501-10,000 lbs GVW – 8 mg/mi
 - 10,001-14,000 lbs GVW – 10 mg/mi



LEV III Structure and Overview: Criteria (Other Provisions)

- Highway Emission Standard
 - Must not exceed FTP NMOG+NOx standard



Highway Cycle

Duration: 765 seconds

Distance: 10.26 miles (16.45 km)

Average speed: 48.3 mph (77.7 km/h)

Maximum speed: 59.9 mph (96.4 km/h)

Maximum acceleration: 3.3 mp/h-s (1.5 m/s²)

ECE Part 2

Duration: 400 seconds

Distance: 4.32 miles (6.95 km)

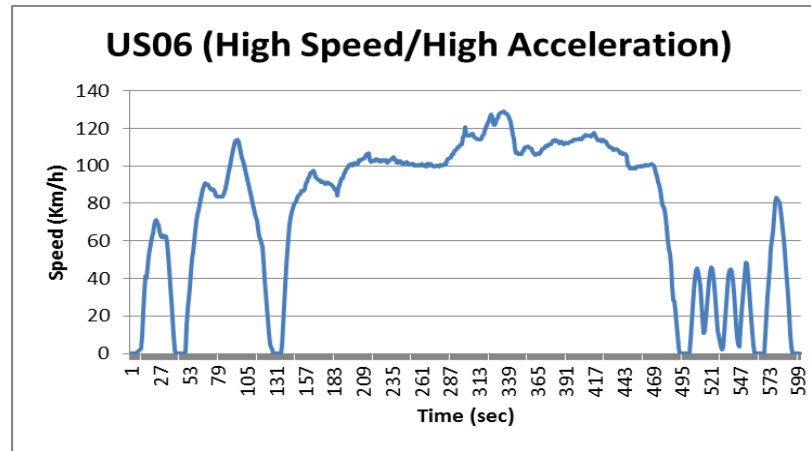
Average speed: 48.3 mph (62.6 km/h)

Maximum speed: 74.6 mph (120 km/h)

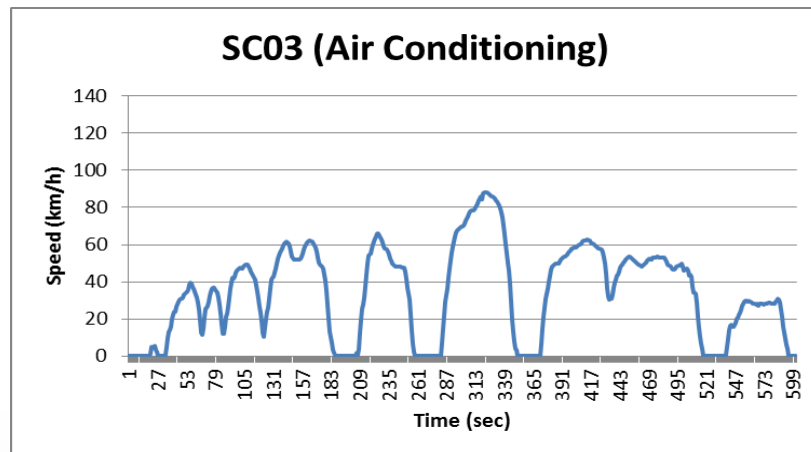
Maximum acceleration: 1.9 mp/h-s (0.85 m/s²)

LEV III Structure and Overview: Criteria (Test Cycles - SFTP)

- Supplemental FTP emission standards (150,000 miles)
- Assures emission control under high speed/high acceleration and air conditioning operation
- Two compliance options
 - Stand alone emission standards
 - Primarily for low volume manufacturers
 - Composite emissions over FTP, US06 and SC03 test cycles
 - Vehicles certified to LEV III FTP requirements must meet LEV III SFTP requirements



High speed/high acceleration
 Duration: 596 seconds
 Distance 8.01 (12.8 km)
 Average speed: 48.4 mph (77.9 km/h)
 Maximum speed: 80.3 mph (129.2 km/h)
 Maximum acceleration: 8.4 mp/h-s (3.8 m/s²)



Duration: 596 seconds
 Distance: 3.6 miles (5.8 km)
 Average speed: 21.6 (34.8 km/h)
 Maximum speed: 54.8 mph (88.2 km/h)
 Maximum acceleration: 5.1 mp/h-s (2.3 m/s²)

LEV III Structure and Overview: Criteria (Other Provisions)

SFTP NMOG+NO_x and CO Stand-Alone Exhaust Emission Standards for 2015 and Subsequent Model LEV III Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles						
<i>Vehicle Type</i>	<i>Durability Vehicle Basis (mi)</i>	<i>Vehicle Emission Category¹</i>	<i>US06 Test (g/mi)</i>		<i>SC03 Test (g/mi)</i>	
			<i>NMOG + NO_x</i>	<i>CO</i>	<i>NMOG + NO_x</i>	<i>CO</i>
All PCs; LDTs 0- 8,500 lbs. GVWR; and MDPVs Vehicles in these categories are tested at their loaded vehicle weight (curb weight plus 300 pounds).	150,000	LEV	0.140	9.6	0.100	3.2
		ULEV	0.120	9.6	0.070	3.2
		SULEV	0.060	9.6	0.020	3.2
		SULEV	0.050	9.6	0.020	3.2

LEV III Structure and Overview: Criteria (Other Provisions)

SFTP NMOG+NOx and CO Composite Emission Standards for 2015 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles (g/mi) ¹											
Model Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025+
All PCs; LDTs 8,500 lbs. GVWR or less; and MDPVs ³	<i>Sales-Weighted Fleet Average NMOG+NOx Composite Exhaust Emission Standards</i>										
	0.140	0.110	0.103	0.097	0.090	0.083	0.077	0.070	0.063	0.057	0.050
Vehicles in this category are tested at their loaded vehicle weight (curb weight plus 300 pounds) except LEV II vehicles, which are subject to the test weights specified in §1960.1(r), title 13, CCR.	<i>CO Composite Exhaust Emission Standard⁷</i>										
	4.2										

$$\text{Composite Emission Value} = 0.28 \times \text{US06} + 0.37 \times \text{SC03} + 0.35 \times \text{FTP}$$

LEV III Structure and Overview: Criteria (Other Provisions)

- 50°F FTP emission standards
 - Assures emission control during low summer morning temperatures on ozone formation days
 - 2 times FTP standard
 - Higher multiples provided for alcohol fueled vehicles
- 20°F FTP CO emission standards

Vehicle Type	Carbon Monoxide
All PCs, LDTs 0-3750 lbs. LVW	10.0
LDTs 3751 lbs. LVW - 8500 lbs. GVW; MDPVs 10,000 lbs. GVW and less	12.5

LEV III Structure and Overview: Criteria

(High Altitude Emission Requirements)

- High altitude means a test condition of 1,620 meters (5,315 feet) \pm 100 meters (328 feet)
- Low altitude FTP emission standards apply at high altitude
- The manufacturer must submit a Statement of Compliance in the application for certification which attests to the fact that they have assured themselves that the engine family does not unnecessarily reduce emission control effectiveness of vehicles operating at high altitude or other conditions not experienced within the US06 (aggressive driving) and SC03 (air conditioning) test cycles.
- In lieu of testing vehicles a manufacturer may provide a statement in its application for certification that, based on the manufacturer's engineering evaluation of appropriate high-altitude emission testing, all light-duty vehicles, light-duty trucks, and complete heavy-duty vehicles comply with the emission standards at high altitude.
- Does not apply to SFTP standards (US06 and SC03)
- Evaporative standards apply at high altitude
- For vehicles that comply with the cold temperature NMHC standards described in §86.1811-10(g) and the CO₂, N₂O, and CH₄ exhaust emission standards described in §86.1818-12, manufacturers must submit an engineering evaluation indicating that common calibration approaches are utilized at high altitudes (except when there are specific high altitude calibration needs to deviate from low altitude emission control practices). Any deviation from low altitude emission control practices must be included in the auxiliary emission control device (AECD) descriptions submitted at certification.

LEV III Structure and Overview: Criteria (Other Provisions)

- Evaporative emission standards
 - Zero fuel evaporative emissions
 - Phase-in from 2015-2022
- Two compliance options
 - Option 1: Whole vehicle plus fuel-only evaporative standards
 - Option 2: Whole vehicle with fleet average compliance and canister bleed test

Evaporative Standard Implementation Schedule

Model year	Minimum percentage of vehicle fleet
2015 to 2017	Average of previous 3 model year PZEVs
2018 to 2019	60
2020 to 2021	80
2022 and subsequent	100

LEV III Structure and Overview: Criteria (Other Provisions)

Option 1: Evaporative Emission Standards

Option 1 evaporative emission standards must be met by all vehicle models

Vehicle type	Hydrocarbon emission standards		
	Running loss (grams per miles)	Three-day diurnal + hot soak, and two-day diurnal + hot soak	
		Whole vehicle (grams per test)	Fuel only (grams per test)
Passenger car	0.05	0.350	0.0
Light-duty truck 6,000 lbs. GVWR and under	0.05	0.500	0.0
Light-duty truck from 6,001-8,500 lbs. GVWR	0.05	0.750	0.0
Medium-duty passenger vehicle	0.05	0.750	0.0
Medium-duty vehicle (8,501-14,000 lbs. GVWR)	0.05	0.750	0.0
Heavy-duty vehicle (over 14,000 lbs. GVWR)	0.05	0.750	0.0

LEV III Structure and Overview: Criteria (Other Provisions)

Option 2 allows manufacturers to demonstrate compliance with the proposed diurnal plus hot soak emission standard through fleet averaging. For example, if a manufacturer's evaporative fleet average certification emission level for a particular emission standard category equals, or is less than, the applicable emission standard, the manufacturer would be in compliance for that given emission standard category. A credit/debit scheme similar to the FTP fleet average requirement is provided. I.e., evaporative credits can be carried forward for five years; debits must be offset within three years.

Option 2: Whole-Vehicle Evaporative Emission Standards with a Fleet Average Option and a Canister Bleed Test Requirement

Vehicle type	Hydrocarbon emission standards		
	Running loss (grams per test)	Highest diurnal plus hot soak (grams per test)	Canister bleed (grams per test)
Passenger car; and Light-duty truck 6,000 lbs. GVWR and under, and 0 – 3,750 lbs. LVW	0.05	0.300	0.020
Light-duty truck 6,000 lbs. GVWR and under, and 3,751 – 5,750 lbs. LVW	0.05	0.400	0.020
Light-duty truck 6,001 - 8,500 lbs. GVWR; and Medium-duty passenger vehicle	0.05	0.500	0.020
Medium-duty vehicles (8,501 – 14,000 lbs. GVWR); and Heavy-duty vehicle (over 14,000 lbs. GVWR)	0.05	0.600	0.030

California ZEV Program

Requires large volume automobile manufacturers to produce zero emitting passenger vehicles



Battery Electric Vehicles (BEV)



Hydrogen Fuel Cell (FCEV)

May substitute some with near-zero emission vehicles



Plug-in Hybrid Electric Vehicles (PHEV)



Conventional Hybrids



Clean Gasoline Vehicles



LEV III Structure and Overview: Criteria (Summary)

- LEV III program drives criteria emissions to near-zero levels by 2025
- The program is structured to assure that vehicle emissions are controlled under all vehicle operating conditions.
 - Assurance provided by multiple test cycles and their applicable emission standards
- Long-term phase-in provides manufactures with certainty re: emission requirements.
- Long lead time and fleet average requirement provide manufacturers with the flexibility to incorporate more effective emission control systems across their product line during the normal roll out new vehicle models

LEV III Structure and Overview

(Criteria and GHG References)

- LEV III*
 - Clean version of regulations
 - http://www.arb.ca.gov/msprog/levprog/test_proc.htm
 - Board hearing documents, including ISOR and FSOR
 - <http://www.arb.ca.gov/regact/2012/leviiighg2012/leviiighg2012.htm>
- Tier 3 criteria and GHG
 - Code of Federal Regulations, Title 40, Part 86 – “Control of Emissions from New and In-Use Highway Vehicles and Engines”
 - http://www.ecfr.gov/cgi-bin/text-idx?SID=6ec7e678d4099b14b25291062fe86dba&tpl=/ecfrbrowse/Title40/40cfr86_main_02.tpl
 - Code of Federal Regulations, Title 40, Part 600 – “Fuel Economy and Greenhouse Gas Exhaust Emissions of Motor Vehicles”
 - http://www.ecfr.gov/cgi-bin/text-idx?SID=5b42e2bc13f79fa352b77cd60ae3ec85&tpl=/ecfrbrowse/Title40/40cfr600_main_02.tpl

*Minor changes to LEV III were adopted October 2014. These have not been approved by the Office of Administrative Law but can be found at:

<http://www.arb.ca.gov/regact/2014/leviii2014/leviii2014.htm>