

Certification Flexibility for Innovative
Heavy-Duty Engine and Vehicle Technology and
Certification and Installation Procedures for
Medium- and Heavy-Duty Vehicle Hybrid
Conversion Systems
(Innovative Technology Regulation)

Public Workshop
September 28, 2015
El Monte, CA

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY



Air Resources Board

Agenda

- Background and Overview
- Optional Low NOx Heavy-Duty Engines
- Hybrid Heavy-Duty Engines and Vehicles
- Possible Technology Diversity Provisions
- Hybrid Conversion Systems
- Potential Economic Impacts
- Next Steps

Potential Innovative Technology Regulation (ITR)

Objectives

California's Long-Term and Air Quality Challenges

- California needs additional NO_x and GHG reductions beyond what can be achieved by existing technologies
 - Significant NO_x reduction needed by 2031 to attain 8-hour ozone standard in South Coast
 - 40% GHG reduction by 2030, 80% by 2050
- Accelerated, broad deployment of innovative, new zero- and near-zero emission technologies needed

Innovative Technology Rulemaking

Certification: Existing certification/on-board diagnostics requirements geared towards traditional technologies

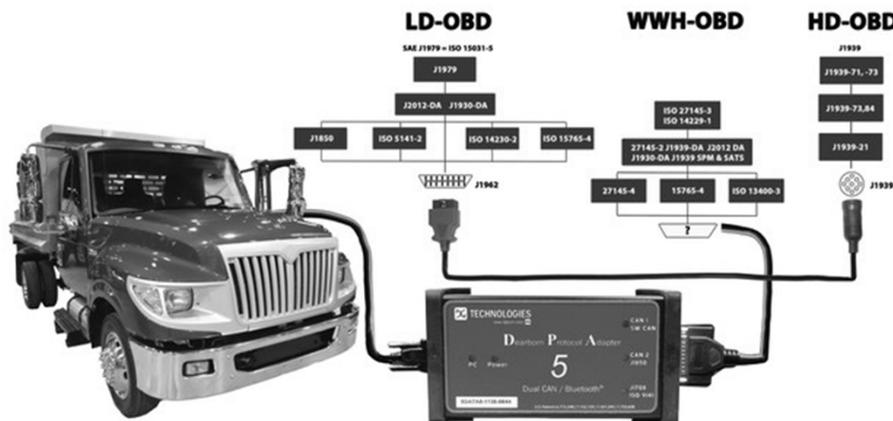
- May pose challenge for emerging new engine and vehicle technologies

Aftermarket Conversions: ARB certification procedures do not exist specifically for aftermarket hybrid conversions

- Case-by-case consideration based upon 1990 regulation

On-Board Diagnostics (OBD)

- OBD is an important emission control system that is critical to achieving California's air quality goals
- OBD Systems Required on All Vehicles
 - *Light- and medium-duty* → 1996+ model years (MYs)
 - *Heavy-duty (14,000+ lbs GVWR)* → Gasoline and Diesel: 2013+ MY
→ Alt. Fuel: 2018+ MY



Innovative Technology Regulation Objectives

- √ Provide new engine OBD/certification flexibility and hybrid conversion system certification pathway to accelerate market launch of needed truck and bus technologies, while maintaining ability to ensure anticipated air quality benefits



Innovative Technology Regulation

Potential Technologies

- New Heavy-Duty Engines and Vehicles
 - New engines meeting California's optional low-NOx standards
 - New hybrid engines and vehicles
 - Other new, innovative engine or vehicle technologies with CO₂ or NOx emission benefit (Technology Diversity Element)
- Medium-Duty Hybrid Vehicles (tbd)
- Medium- and Heavy-Duty Vehicle Hybrid Conversion Systems

Innovative Technology Regulation

Potential Conceptual Framework

- Encourage early technology deployment with targeted certification flexibility
 - Tier 1: Initial market volumes = greatest certification flexibility
 - Tier 2: Diagnostics and other requirements ramp up as market matures
 - Beyond Tier 2: Full certification/OBD requirements apply
- Each manufacturer could progress through Tier 1 → Tier 2 → full certification as market matures
- Each new technology's ITR flexibility would sunset 4 to 6 years after its "market launch"

DRAFT
For Workshop Discussion
Purposes Only

New Heavy-Duty Engine Certification

Possible ITR General Requirements

New Engine Certification

Possible General Requirements

- Participating manufacturers submit ITR Compliance Plan each MY, demonstrating for each engine family:
 - Surplus emission reductions
 - No OBD backsliding
 - Anticipated California sales volume
 - Meet applicable labeling requirements and other criteria
- ARB approval of the MY Compliance Plan enables engine family certification with applicable ITR flexibility
- Manufacturer's end-of-MY report demonstrates compliance with annual sales allowance

DRAFT
For Workshop Discussion
Purposes Only

Innovative Technology Regulation

Heavy-Duty Engines Meeting the Optional Low-NO_x Standard

Six Possible Optional Low-NOx Engine Technology Categories

Heavy-Duty Engine Type	NOx Certification Level (g/bhp-hr)		
	0.10	0.05	0.02
Compression Ignition	√	√	√
Otto Cycle	√	√	√

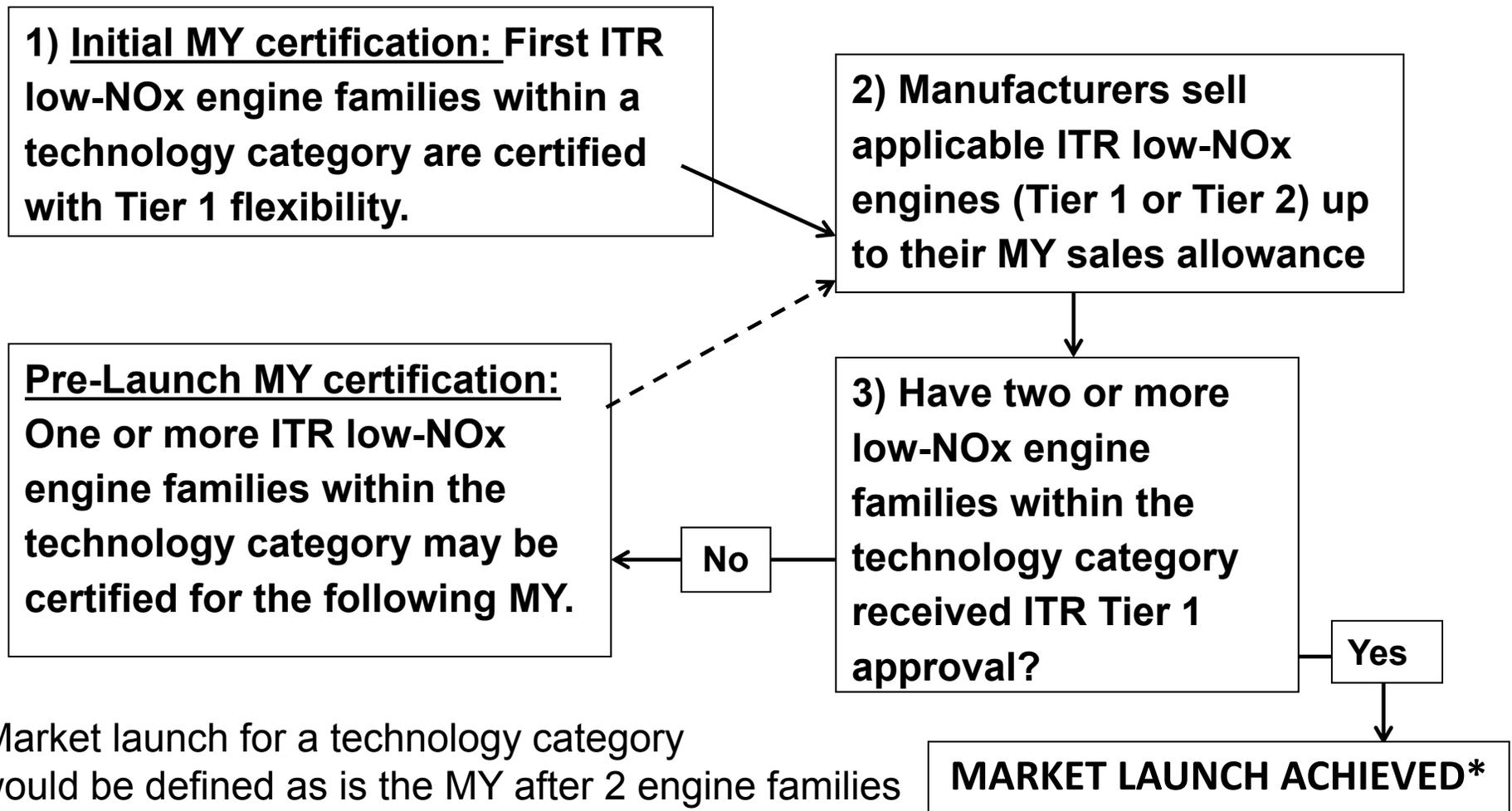
Possible California Sales Allowance

(sum within all low-NOx technology categories receiving ITR flexibility per MY)

- 10% of average annual sales volume or 200 engines, whichever is greater.
- Average annual sales volume = annual average of total California heavy-duty engine sales over the three most recent MYs, not including the immediately preceding MY (e.g., for MY 2017, average based on MYs 2013, 2014, and 2015).

Possible ITR Process for Low NOx Engines

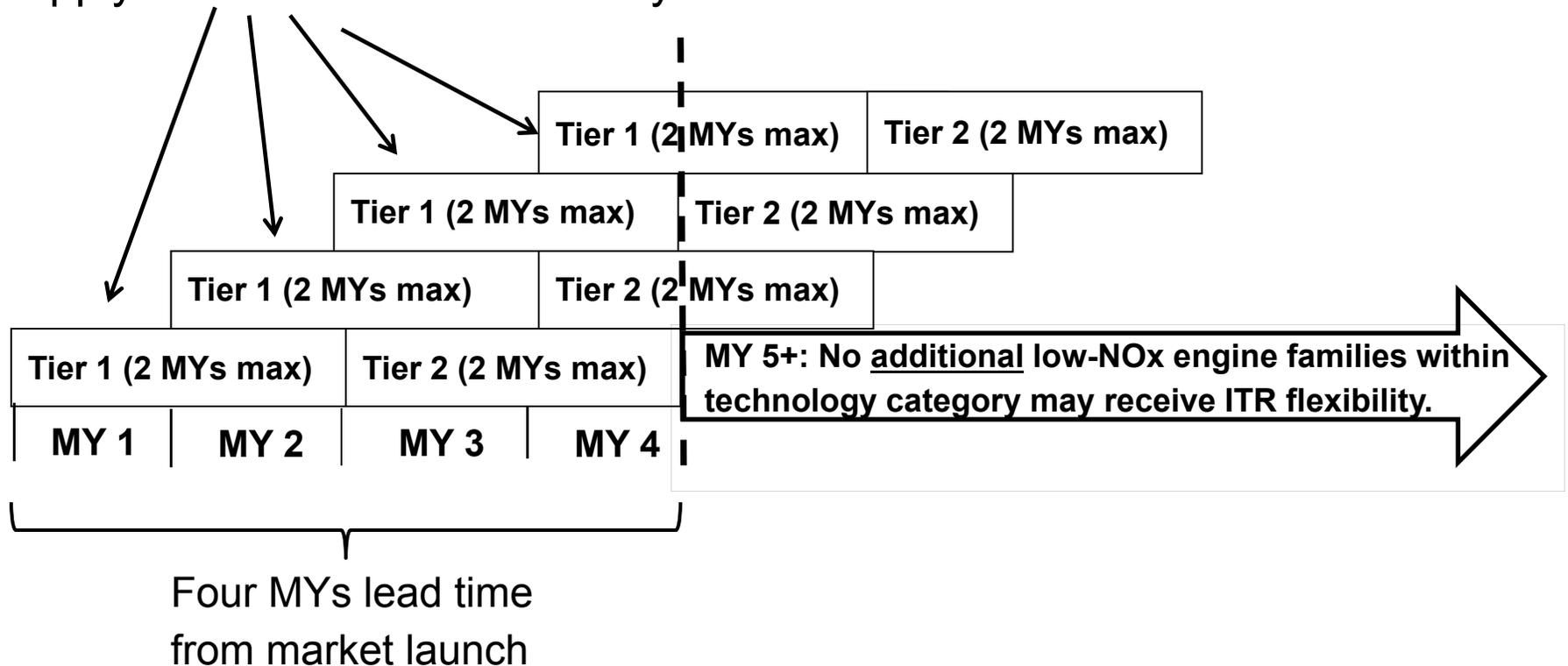
Potential Pre-Market Launch Period



* Market launch for a technology category would be defined as is the MY after 2 engine families within that technology category are Tier 1 approved.

Possible ITR Process for Low NOx Engines Subsequent to Market Launch

Any low-NOx engine family that is first certified within 4 MYs of market launch would be eligible to apply for 4 MYs of ITR flexibility.



Low-NOx Heavy-Duty Engines

Possible Tier 1 Requirements

Existing Certification Requirements Apply
Plus the Following Flexibility Provisions:

1. OBD Emission Test Data Sets: One engine family may be excluded from section 1971.1(i)(2.2.3) calculation
2. In-Use Monitoring Performance Ratio (IUMPR) for evaluation purposes only
3. 1065-certified cells not required for OBD purposes
4. Forgo fines pursuant to 1971.1(k)(3) for up to five deficiencies related to low-NOx engine
5. Allow use of assigned deterioration factors (DFs)

This is a straw man proposal to generate stakeholder feedback

Low-NOx Heavy-Duty Engines

Possible Tier 2 Requirements

Existing Certification Requirements Apply
Plus the Following Flexibility Provisions:

1. OBD Emission Test Data Sets: One engine family may be excluded from section 1971.1(i)(2.2.3) calculation
2. IUMPR for evaluation purposes only
3. Forgo fines pursuant to 1971.1(k)(3) for up to three deficiencies related to low-NOx engine

This is a straw man proposal to generate stakeholder feedback

DRAFT
For Workshop Discussion
Purposes Only

Innovative Technology Regulation

Heavy-Duty Hybrid Engines and Vehicles

Possible Hybrid Technology Categories and Associated Tier 1/Demonstration Volumes¹

Vehicle Type	Hybrid with <35 Miles All-Electric Range	Hybrid with 35+ Miles All-Electric Range
Class 2b/3 Pickup or Van	TBD	TBD
Class 4 – 8 Vocational Vehicle	100	200
Class 8 Urban Bus	TBD	100
Class 8 Tractor (non-vocational)	50	100

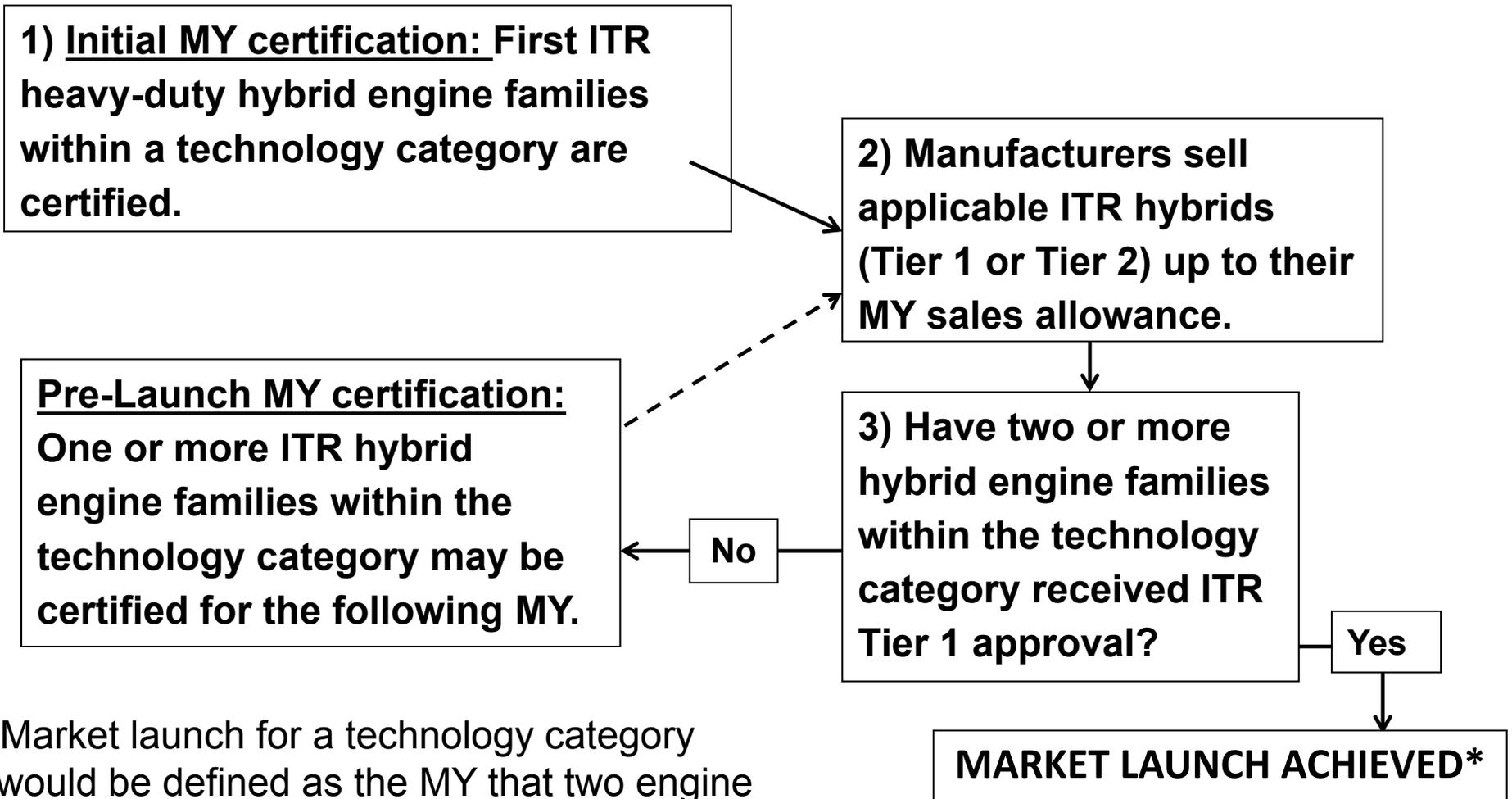
1 – Demonstration Volumes would be cumulative (i.e., not per model year), per engine manufacturer.

Possible ITR Engine California Sales Allowance

- Hybrids in Demo/Tier 1: Subject to sales allowances shown above.
- Sum of hybrids in all tiers and technology categories:
10% of average annual sales volume or 200 engines, whichever is greater.
- Hybrid + Optional Low NOx Engines: 12.5% of average annual sales volume or 250 engines, whichever is greater.

Possible ITR Process for Heavy-Duty Hybrids

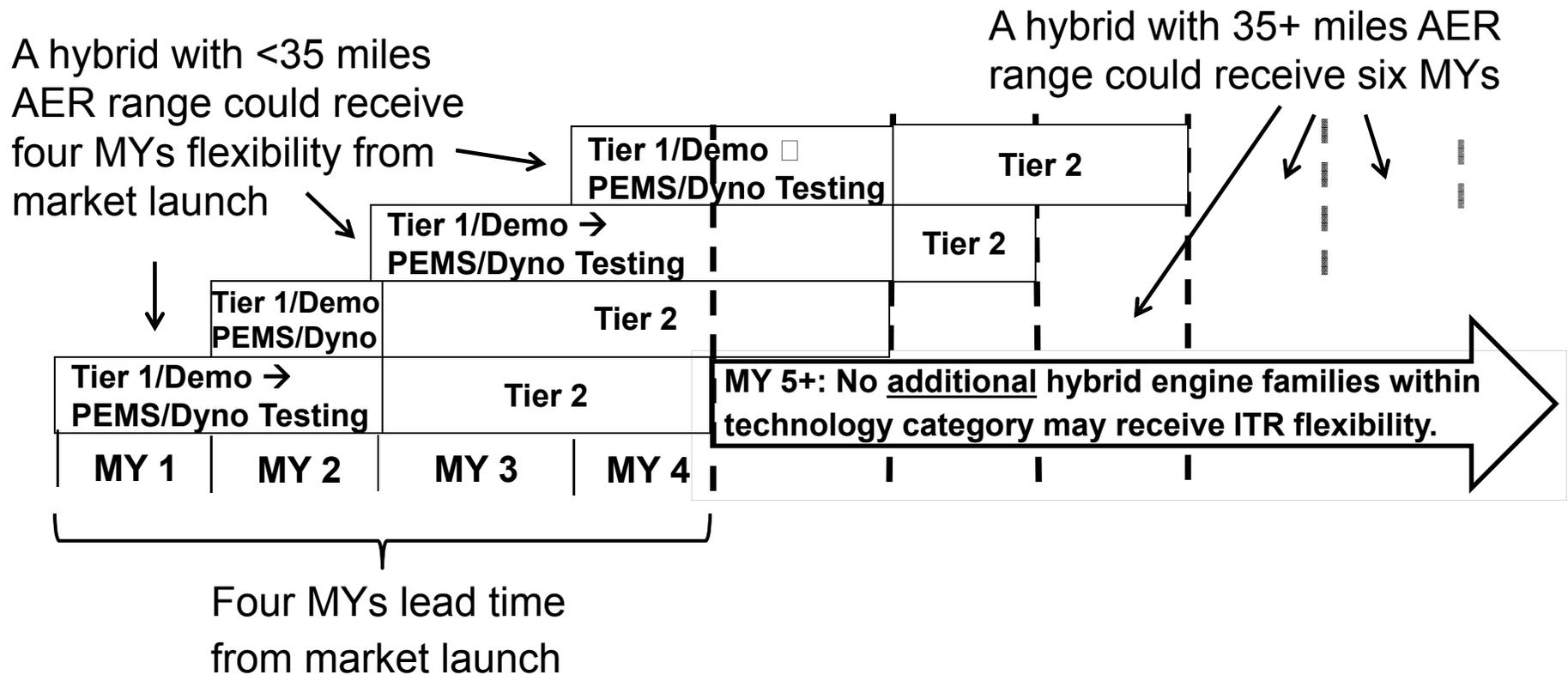
Potential Pre-Market Launch Period



* Market launch for a technology category would be defined as the MY that two engine families within that technology category are Tier 1 approved.

Possible ITR Process for Low NOx Engines Subsequent to Market Launch

All heavy-duty hybrid engine families that are first certified within four MYs of market launch would be eligible to apply for four to six MYs of ITR flexibility.



Hybrid Heavy-Duty Engines

Possible Tier 1 Requirements

Existing Certification Requirements Apply
Plus the Following Flexibility Provisions:

1. EMD+ rather than heavy-duty OBD requirements
2. Allow use of assigned deterioration factors (DFs)

Additional Tier 1 Eligibility Requirements

1. Agree to collect and share with ARB upon request required engine parameter and vehicle telematics data
2. Submit an approvable plan for chassis dynamometer or in-use PEMS testing (as required to proceed to Tier 2)

This is a straw man proposal to generate stakeholder feedback

Hybrid Heavy-Duty Engines

Proceeding from Tier 1 to Tier 2

Must demonstrate no increase in any criteria pollutant via vehicle A to B emission testing

- Chassis dynamometer
 - Based upon *Heavy-Duty Hybrid-Electric Vehicle Certification Procedures* (Dec. 2013)
 - Staff evaluating alternatives: Use of SAE J2711 protocols?
 - Include more vocation-specific duty cycles
- PEMS testing
 - Staff welcomes input regarding development of possible heavy-duty hybrid PEMS testing criteria
- Drivetrain testing (similar to Phase 1 GHG)
 - Staff welcomes stakeholder comment regarding appropriateness of these procedures for ITR

Hybrid Heavy-Duty Engines

Possible Tier 2 Requirements

Existing Certification Requirements Apply
Plus the Following Flexibility Provisions:

1. Basic OBD: Circuit and functionality checks required, may light separate MIL and use proprietary scan tools
2. Demonstrate OBD readiness
3. OBD Emission Test Data Sets: One engine family may be excluded from section 1971.1(i)(2.2.3) calculation
4. IUMPR for evaluation purposes only
5. Allow use of assigned DFs

This is a straw man proposal to generate stakeholder feedback

Hybrid Medium-Duty Vehicles

8,501 – 14,000 lbs. GVWR

- Should ITR address Class 2b/3 hybrid vehicles?
- Stakeholder feedback needed regarding:
 - What, if any, certification or OBD challenges do hybrid medium-duty vehicle manufacturers face?
 - How might the ITR help accelerate market launch of vertically-integrated hybrid medium-duty vehicles?
 - Other reasons ITR is needed to enable market launch of robust, medium-duty hybrids

DRAFT
For Workshop Discussion
Purposes Only

Innovative Technology Regulation

Possible Technology Diversity Element

Possible Technology Diversity Element Overview

- More modest, targeted flexibility for other innovative heavy-duty engine technologies
- Potential eligibility criteria
 - Engine or driveline technology with ability to achieve CO₂ or NOx reductions
 - Not previously commercialized in medium- or heavy-duty vehicle
 - Presents significant certification or OBD challenge

Possible Technology Diversity Element Potential Eligibility Categories

Existing Engine Architecture

- Examples might include: advanced engine transmission, engine downsizing, engine down-speeding, advanced waste heat recovery, cylinder deactivation, or predictive cruise technology

Novel Heavy-Duty Vehicle Propulsion Technology

- Examples might include: opposition piston engine, free piston engine, camless engine, or microturbine

Possible Technology Diversity Element

Existing Engine Architecture

Potential Certification Flexibility

- One MY of the Tier 1 and one MY of Tier 2 flexibility similar to that afforded low NOx engines, maximum 200 engines per manufacturer per MY

Potential Sunset Provisions

- The technology (from any manufacturer) would be ineligible for ITR flexibility if first ARB-certified more than four MYs subsequent to market launch

This is a straw man proposal to generate stakeholder feedback. Staff is also evaluating other potential strategies and encourages stakeholder feedback regarding other approaches to enable evaluation and certification of promising new technologies.

Possible Technology Diversity Element

Novel Heavy-Duty Vehicle Propulsion Technology

Potential Certification Flexibility

- Two MY of the Tier 1 and two MY of Tier 2 flexibility similar to that afforded hybrid engines, maximum 200 engines per manufacturer per MY

Potential Sunset Provisions

- The technology (from any manufacturer) would be ineligible for ITR flexibility if first ARB-certified more than four MYs subsequent to market launch

This is a straw man proposal to generate stakeholder feedback. Staff is also evaluating other potential strategies and encourages stakeholder feedback regarding other approaches to enable evaluation and certification of promising new technologies.

Off-Road Engines in HD Hybrids

- Must demonstrate no emissions increase relative to applicable on-road base vehicle
- Potential eligibility criteria
 - 56kW or greater engine
 - Steady state operation, engine does not directly propel vehicle
 - Installed on vehicle with 35+ miles zero-emission range
 - Engine meets most stringent NOx emission standard and 0.01 g/bhp-hr PM standard
 - If diesel engine, equipped with certified DPF calibrated for steady state operation
- Also consider light-duty or stationary engines?

Innovative Technology Regulation

September 28, 2015 Public Workshop

10 minute break

For online access and to submit comments or questions,
please register at:

<https://attendee.gotowebinar.com/register/8994048364784771073>

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY



Air Resources Board

Aftermarket Conversion Systems

Background

Aftermarket Conversions

Background

- California certification requirements ensure new engines and vehicles meet expected emission limits when new and in-use
- Anti-tampering requirements prohibit modification of a certified vehicle or engine without an aftermarket exemption
 - Must demonstrate no emission increase from original vehicle or engine design and no adverse impact to emission controls and OBD

Aftermarket Conversions

Existing Provisions

ARB has adopted aftermarket part certification requirements for two specific technologies

- Hybrid to Plug-In Hybrid Conversion Procedures
- Alt Fuel Conversion Procedures
 - Include more strict emission testing and other criteria for certifying the alt fuel conversion achieves an emission benefit in-use

Innovative Technology Regulation

*Possible Medium- and Heavy-Duty
Vehicle Hybrid Conversion System
Certification Requirements*

Hybrid Conversion Systems

Possible Conceptual Framework

- Defines ARB approval pathway for truck and bus hybrid aftermarket conversions
- Requirements could increase within CA sales volumes
 - Tier 1/Demo: Basic requirements facilitate tech launch
 - Emission testing required prior to Tier 2
 - Must demonstrate no criteria pollutant increase
 - If CO₂ benefit > 20%, ARB Executive Order identifies CO₂ benefit upon manufacturer request; must retest to demonstrate durability within two years
 - Tier 2/Pilot: OBD and other requirements ramp up
 - Tier 3: Full aftermarket certification requirements

Six Possible Hybrid Conversion System Technology Categories and Tier 1 and 2 Sales Allowances¹

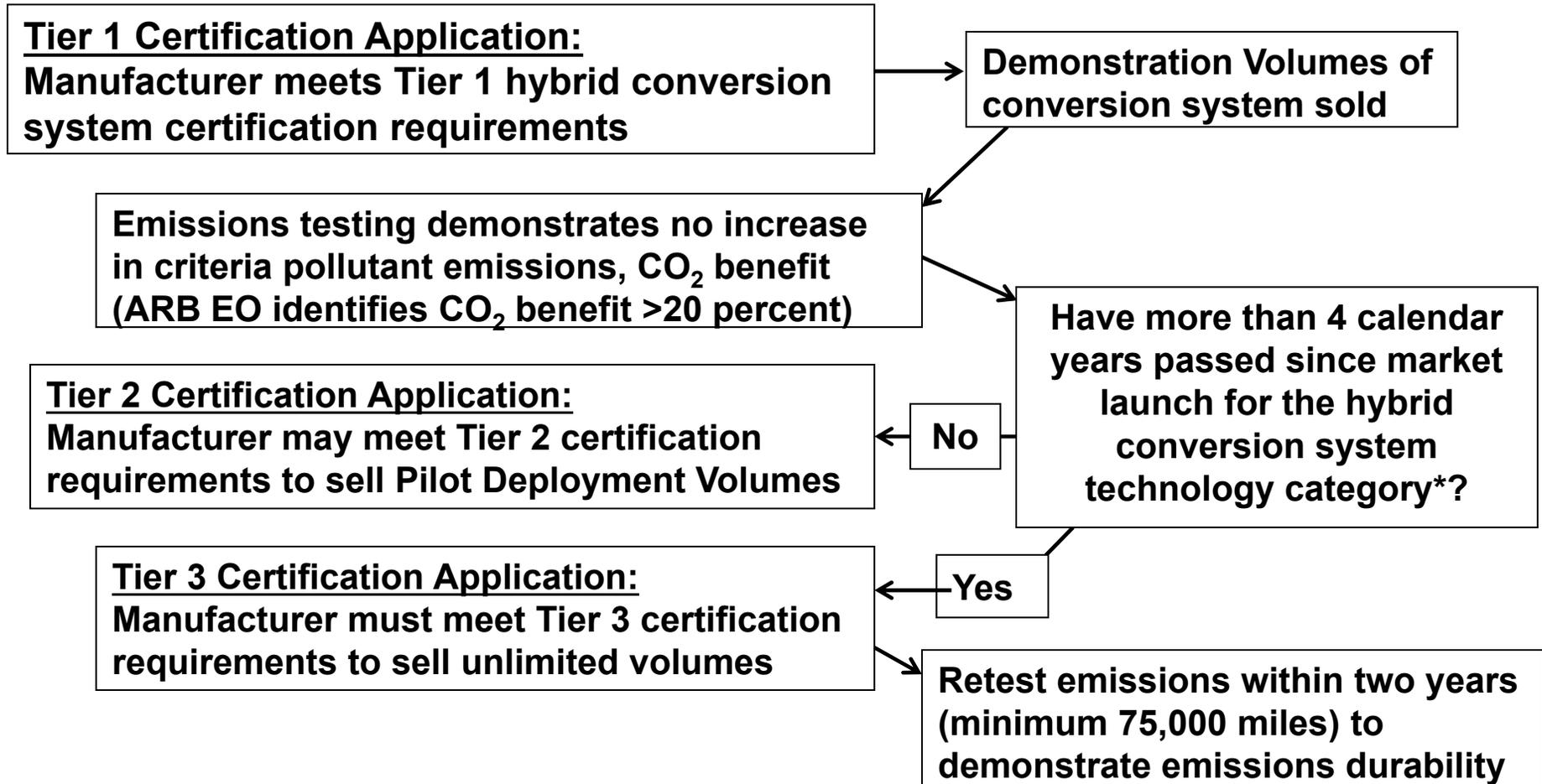
Vehicle Type	Hybrid with <35 Miles All-Electric Range		Hybrid with 35+ Miles All Electric Range	
	Tier 1/ Demo Volume	Tier 2/ Pilot Volume	Tier 1/ Demo Volume	Tier 2/ Pilot Volume
Class 2b or 3 Vehicle	10	500	25	1,000
Class 4-8 Vocational Vehicle	10	500	25	1,000
Class 8 Tractor (non-vocational)	10	500	25	1,000

1 – Volumes would be cumulative (i.e., not per model year).

Possible Eligibility Criteria: The maximum power available from the hybrid's rechargeable energy storage system during a standard ten second pulse power or equivalent test would have to be:

- at least 10 percent of the vehicle's total traction power for a vehicle that has a GVWR of between 8,501 and 14,000 lbs; and
- at least 15 percent of the vehicle's total traction power for a vehicle that has a GVWR of more than 14,000 lbs

Possible ITR Process for Hybrid Conversion Systems



* Market launch for a technology category would be defined as the calendar year after 2 conversion systems within that category receive Tier 1 certification.

Aftermarket Conversions

Possible Tier 1 Requirements

- Meet minimum criteria for energy storage, potential CO₂ benefit
- Commit to and submit plan for emission testing
- Demonstrate evaporative emissions meet base vehicle standard
- On-Board Diagnostics
 - Do not disable base vehicle OBD
 - No false MIL from base vehicle
 - IUMPR data within 12 months, no enforcement

This is a straw man proposal to generate stakeholder feedback

Hybrid Conversion Systems

Proceeding from Tier 1 to Tier 2

Must demonstrate no increase in any criteria pollutant

- Chassis dynamometer
 - Based upon *Heavy-Duty Hybrid-Electric Vehicle Certification Procedures* (Dec. 2013)
 - Staff evaluating alternatives: Use of SAE J2711 protocols?
 - Include more vocation-specific duty cycles
- PEMS testing
 - Staff welcomes input regarding development of possible heavy-duty hybrid PEMS testing criteria
- Drivetrain testing
 - Could be modeled after US EPA Phase 1 GHG procedures

Aftermarket Conversions

Possible Tier 2 Requirements

Tier 2 flexibility would sunset four years after technology category market launch. After that, the conversion system would proceed directly from Tier 1 → Tier 3

- Continue to meet Tier 1 OBD requirements
- Monitors originally calibrated to an emission threshold must detect total lack of function
- Demonstrate readiness in-use
(non-representative conditions okay)
- Additional IUMPR data may be required
(no enforcement)
- Approved plan to meet Tier 3 OBD requirements

This is a straw man proposal to generate stakeholder feedback

Aftermarket Conversions

Possible Tier 3: Full Certification

- Base vehicle fully OBD compliant and basic diagnostics for conversion technology
 - Full OBD for base vehicle
 - Light single MIL
 - Use standardized scan tools
 - Comprehensive component monitoring for hybrid conversion system
 - IUMPR meets requirements of CCR, section 1968.2 or 1971.1

This is a straw man proposal to generate stakeholder feedback

Aftermarket Conversions

Potential Warranty & Reporting Requirements

Conversion System Approval Level	Hybrid Conversion System Minimum Product and Installation Warranty Period
Tier 1	3 years or 50,000 miles, whichever comes first ¹
Tier 2 or Tier 3 (no CO₂ emission benefit)	5 years or 60,000 miles, whichever comes first ¹
Tier 3 (for defined CO₂ emission benefit)	7 years or 75,000 miles, whichever comes first ²

1 – Hybrid conversion systems with ePTO may include a 3,000 hour warranty period.

2 – Hybrid conversion systems with ePTO may include a 4,200 hour warranty period.

- Possible installation and installation warranty requirements
- May require reporting of warranty claims exceeding one percent
- Possible conversion system recall criteria

Potential Economic Impacts

- For what technology are you most interested in ITR flexibility?
- Are your customers requesting these technologies now? Do you anticipate high demand?
- When is the earliest you might consider certifying an ITR technology?
- What would be the most cost-prohibitive part(s) of this regulation?

Please provide feedback at:
www.surveymonkey.com/r/J5N3VWP

Next Steps

Ongoing

- Continue individual stakeholders meetings

Late 2015 (dates tbd)

- Additional Public Work Group meeting(s)

Early 2016

Proposed Regulation released for
45-Day Public Comment Period

Spring 2016

- Board Consideration of Proposed Regulation
- If adopted, ARB to request early effective date

Contacts

Innovative Technology Rulemaking

Joe Calavita, Lead Staff
Tel. 916-445-4586
jcalavit@arb.ca.gov

David Chen, Manager
Tel. 626-350-6579
David.Chen@arb.ca.gov

www.arb.ca.gov/msprog/itr/itr.htm

Aftermarket Conversions

Tony Martino, Manager
Tel. 626-575-6848
Antonio.Martino@
arb.ca.gov

[www.arb.ca.gov/msprog/
aftermkt/aftermkt.htm](http://www.arb.ca.gov/msprog/aftermkt/aftermkt.htm)

Certification

Kim Pryor, Manager
Tel. 626-575-6640
kpryor@arb.ca.gov

[www.arb.ca.gov/msprog/
onroad/cert/cert.php](http://www.arb.ca.gov/msprog/onroad/cert/cert.php)

On-Board Diagnostics

Leela Rao, Manager
Tel. 626-350-6469
lrao@arb.ca.gov

[www.arb.ca.gov/msprog/
obdprog/obdprog.htm](http://www.arb.ca.gov/msprog/obdprog/obdprog.htm)

Innovative Technology Regulation

September 28, 2015 Public Workshop

For online access and to submit comments or questions,
please register at:

<https://attendee.gotowebinar.com/register/8994048364784771073>