

Innovative Technology Regulation Public Workshop Concept Paper
California Air Resources Board
March 9, 2015

Background: The South Coast and San Joaquin Valley air basins are the only two areas in the nation in extreme non-attainment of the national ambient air quality standard for ozone. Meeting the federal eight-hour ozone standard will require a 90 percent oxide of nitrogen (NO_x) emission reduction from 2010 levels in the South Coast by 2031, and will also require significant NO_x reductions in the San Joaquin Valley and other California regions. In addition, California Executive Order S-3-05 sets a greenhouse gas (GHG) target of 80 percent reductions from 1990 levels by 2050.¹ To meet these multiple long-term air quality and climate goals, California must accelerate development and deployment of the cleanest feasible technologies for all vehicle and equipment sectors, with broad deployment of zero- and near-zero-emission cars, trucks, and buses.

Certification Requirements

California law requires new motor vehicles and engines to be certified by the California Air Resources Board (ARB) for emission compliance before they are legal for sale, use, or registration in California. New vehicles and engines must certify as follows:

- *Light-duty vehicles* (below 8,501 lbs gross vehicle weight rating (GVWR)) and *medium-duty vehicles* (between 8,501 and 14,000 lbs) certify as complete vehicles, and must comply with new vehicle certification procedures.²
- *Heavy-duty vehicles* (greater than 14,000 lbs) are not required to be ARB-certified as a complete vehicle; instead, an engine must be ARB-certified for use in a heavy-duty vehicle.³

ARB new engine or vehicle certification requirements mandate that manufacturers demonstrate that their new engines or vehicles comply with applicable exhaust and evaporative emissions standards over their useful life, and comply with other requirements, such as labeling and emissions warranty requirements. New vehicle and engine certification requirements include, but are not limited to, the following:

- Demonstrate the new engine/vehicle complies with applicable emission standards when tested in conformity with specified test procedures
- Demonstrate durability for the useful life of the engine or vehicle
- Meet the applicable labeling requirements
- Provide emissions warranty to the ultimate purchaser
- Demonstrate compliance with on-board diagnostics (OBD) system requirements

1 Schwarzenegger, A. (2006) Governor's Executive Order S-3-05.

2 Medium-duty vehicles, under certain circumstances, may opt to meet applicable engine certification requirements in lieu of full vehicle certification.

3 Hybrid heavy-duty vehicles have the option for complete full vehicle certification, utilizing ARB's Heavy-Duty Hybrid-Electric Vehicles Certification Procedures (December, 2013)

Only after a manufacturer obtains a new engine or vehicle certification from ARB can it legally place new engines or vehicles that are covered by that certification into commerce in California.

Aftermarket Conversions

Once ARB has certified a new engine or vehicle, no one may install, sell, offer for sale, or advertise any device, apparatus, or mechanism that alters or modifies the original design or performance of that engine or vehicle emission control system unless that device, apparatus or mechanism has been exempted by ARB. ARB is only authorized to exempt modifications to a certified configuration if it finds the modifications will not reduce the effectiveness of required motor vehicle pollution control devices or cause the emissions from the modified or altered vehicle to exceed applicable emissions standards for the model-year of the vehicle being modified or converted.

ARB's aftermarket conversion approval process is structured to address two specific categories of aftermarket parts: legal add-on or modified parts and catalytic converters. Neither of these processes are tailored to evaluate and potentially approve the transformative truck or bus technologies that California needs to meet its long-term air quality and climate goals.

Technology Verification. ARB does have diesel emission control strategy verification procedures for diesel engine emission reduction technologies, such as diesel particulate filters. *Technology verification* differs from *aftermarket part approval* in that verification must demonstrate that a technology achieves real, durable reductions of particulate matter (PM) and/or NOx emissions from the applicable engine or vehicle, while aftermarket part approval requirements are geared to ensure no emissions increase.⁴ ARB technology verification has also traditionally targeted aftermarket filters, parts, or other technologies that reduce post-combustion tailpipe emissions, rather than technologies that impact how the engine or driveline operate.

Regulatory Objective: ARB's existing certification and OBD requirements provide a critical and effective mechanism for ensuring that a vehicle's expected emission benefits are achieved and maintained. However, ARB's engine and vehicle approval paradigm, geared towards traditional technologies, may deter some manufacturers from developing promising new technologies that are uncertain to achieve market acceptance. The Innovative Technology Regulation is intended to encourage the development and market launch of the next generation of advanced truck and bus technologies California needs to meet its long-term air quality and climate goals, by providing these technologies with near-term, targeted certification flexibility and a discrete aftermarket conversion approval pathway.

⁴ The *Regulation for the Verification Procedure for In-Use Strategies to Control Emissions from Diesel Engines* identifies stringent requirements to ensure real emission reductions are achieved in-use, and an emission control system is durable and compatible with various engines and applications. Technology verification requires robust in-use testing, including after the diesel emission control devices have been in operation for a certain period of time. Annual warranty reporting is also required of each manufacturer, for each of their verified products. For more information, visit: www.arb.ca.gov/diesel/verdev/verdev.htm .

Draft Regulatory Structure

Each manufacturer of an eligible innovative technology would be eligible to sell an initial number of vehicles to launch and demonstrate technology readiness (Tier 1: Demo Approval). Once a manufacturer meets Tier 1 OBD/certification and other requirements, an additional number of vehicles could be sold to encourage and evaluate potential for market acceptance (Tier 2: Pilot Approval). Eligible technologies would no longer be considered innovative and would have to meet full certification/OBD requirements once an industry-wide threshold of units is met. Manufacturer- and industry-wide sales volume thresholds will be determined via a public workgroup process and informed by variables such as: the volumes needed to encourage manufacturer participation, technology maturation, and consumer acceptance; the number of vehicles needed for fleets to evaluate a new truck or bus technology; the typical annual industry engine family sales volume per vehicle vocation; and the extent of flexibility offered per sales tier.

Possible Regulation Applicability for New Engine or Vehicle Certification

An innovative truck or bus technology for the purposes of new engine or vehicle certification may include those transformational zero- and near-zero-emission technologies which California needs to meet its long-term air quality and climate goals, and which have yet to be deployed in significant numbers. This definition includes strategies that enable or provide a technology pathway to zero- and near-zero-emission technologies, such as hybrids, and is dependent upon vehicle class and vocation. For new engine or vehicle certifications, this would include:

- *Class 2b-3 Pick-ups/Vans and Class 4-8 Vocational/Short-Haul Vehicles → Zero-Emission Technologies:*
Achieves zero emissions during typical daily operation or provides a technology bridge to zero emissions. This may include robust hybrids that achieve significant GHG benefit.⁵ Other technologies could be eligible if they can demonstrate they also provide a technology bridge to zero-emission technologies.
- *Class 7/8 Long-Haul Tractors → Zero- and Near-Zero-Emission Technologies:*
Same as above, plus vehicles achieving the optional NOx standard (until/unless the standard becomes mandatory) or a significant GHG benefit.⁵
 - *Technology Diversity Provisions:* Technologies that achieve incremental NOx or GHG benefits would be eligible for more modest, targeted certification flexibility provisions.

The regulation is intended to provide flexibility to technologies that effect the engine or driveline in a meaningful way, and have an impact on the engine or vehicle OBD system. Technologies taking advantage of this regulatory flexibility must be surplus to what is required by California air quality requirements, including all applicable engine or fleet average emission standards.

⁵ ARB staff is considering a 20 percent GHG benefit threshold as a potentially appropriate threshold for defining "significant" GHG benefits for the purposes of this regulation.

Table 1, below, provides a draft list of technologies that may be considered innovative for the purposes obtaining new engine or vehicle certification flexibility. Each vehicle type and technology combination (i.e. each cell) could represent a discrete “innovative technology.” Manufacturers would be eligible for certification/OBD flexibility for an as yet undetermined sales volume for each “innovative technology.”

Table 1: New Engine or Vehicle Certification: Possible Technology Applicability¹

	Hybrid with Significant Zero-Emission Operation	Hybrid with No/Low Zero-Emission Operation	>20% GHG Benefit (Non-Hybrid) ⁶	Alt. NOx Standard ↓50%	Alt. NOx Standard ↓75%	Alt. NOx Standard ↓90%
Class 2b/3	√	√	TBD	TBD	TBD	TBD
Vocational Truck/Bus	√	√	TBD	TBD	TBD	TBD
Class 7/8 Tractors	√	√	√	√	√	√

1 - Other technologies may apply to be defined as innovative based upon their providing a discrete technology bridge to zero-emission operation/technology.

The following three pages include tables summarizing possible ARB approval pathways for innovative new engine or vehicle certification (Table 2), more targeted certification flexibility to encourage technology diversity (Table 3) and innovative aftermarket conversions (Table 4).

⁶ ARB staff is considering a 20 percent GHG benefit threshold as a potentially appropriate threshold for defining “significant” GHG benefits for the purposes of this regulation.

Table 2: Possible New Engine or Vehicle Certification Flexibility Provisions

Tier	Number that can be sold	All Existing Certification Requirements Apply Plus the Following Provisions	Action items to proceed to next tier
1	Demo (Volume tbd)	<ol style="list-style-type: none"> 1. Approved application 2. ARB approves applicant plan and process for independent PEMS or chassis dynamometer emission testing (if technology impacts not quantified by engine dynamometer testing) 3. Report California sales to ARB 4. Labeling requirements 5. Meet basic diagnostic requirements rather than OBD 6. One new innovative technology per model year is exempt from counting as an additional engine family for the purposes of triggering an additional OBD demonstration data set 7. Assigned or carryover deterioration factors may be used 	<ol style="list-style-type: none"> 1. Application to advance to Tier 2 approved. 2. Emissions testing completed, confirms emission benefit.¹ ARB may request manufacturers provide vehicles for independent confirmatory testing.
2	Pilot (Volume tbd)	<ol style="list-style-type: none"> 1. Continue Tier 1 flexibility provisions 2. Basic OBD (i.e., circuit and functional checks) required, may light separate malfunction indicator light (MIL) and use proprietary scan tools. 3. Demonstrate that OBD readiness can be achieved to ensure compatibility with Smog Check or other in-use inspection programs 4. Monitoring frequency evaluation required after vehicles are on the road for one year, but no enforcement action will be taken based on the results 5. Report California sales to ARB. 6. Labeling requirements. <ul style="list-style-type: none"> ➔ Additional vehicles beyond Tier 2 volumes must meet full certification/OBD requirements 	<ol style="list-style-type: none"> 1. Additional vehicles beyond Tier 2 meet full certification/OBD requirements

1 – Required only for technologies for which emissions impacts not quantified by dynamometer testing.

Each technology would no longer be considered innovative after a certain number (tbd) of units is sold in California industry-wide. After this market threshold, manufacturers must meet full certification requirements.

Possible Technology Diversity Provisions:

The regulation would include more modest, targeted flexibility provisions for certification of heavy-duty engine or vehicle technologies which may not be transformative but which provide incremental progress towards zero or near-zero emissions. This could include waste heat recovery, turbo compounding, and other similar technologies.

**Table 3:
Possible Flexibility Provisions for Incremental New Engine or Vehicle Technologies**

Number that can be sold	ARB Certification Flexibility to Encourage Technology Diversity
Pilot Deployment (Volume tbd)	<ol style="list-style-type: none"><li data-bbox="407 541 1373 604">1. Basic diagnostics (i.e., circuit and functional checks) required for the innovative technology<li data-bbox="407 636 1466 737">2. One new innovative technology per model year is exempt from counting as an additional engine family for the purposes of triggering an additional OBD demonstration data set<li data-bbox="407 762 1346 793">3. Greater flexibility to use assigned or carryover deterioration factors

Technology no longer considered innovative after a certain number (tbd) of units sold industry-wide in California. After this market threshold, manufacturers must meet full certification requirements.

Possible Regulation Applicability for Aftermarket Conversions

As mentioned earlier, an innovative truck or bus technology for the purposes of this regulation targets those transformational zero- and near-zero-emission technologies which California needs to meet long-term air quality and climate goals, and which have yet to be deployed in significant numbers. For the purposes of aftermarket conversions, this includes aftermarket technologies that enable a vehicle to provide significant zero-emission operation and robust hybrid technologies, since hybrid technology helps enable development, commercialization, and consumer acceptance of more advanced zero-emission technologies. For the purposes of this regulation, a robust hybrid aftermarket conversion must achieve significant GHG benefit from the base vehicle or chassis.⁷ Other technologies could be eligible for the aftermarket approval pathways defined in this regulation on a case-by-case basis if, like hybrids, they can reasonably be defined as helping accelerate development and market commercialization of zero-emission technologies.

⁷ ARB staff is considering a 20 percent GHG benefit threshold as a potentially appropriate threshold for defining “significant” GHG benefits for the purposes of this regulation.

Table 4: Possible Aftermarket Conversion Flexibility Provisions

Tier	Number sold in CA per Manuf.	Requirements prior to sale in the tier	Action items to proceed to next tier
1	Demo (Volume tbd)	<ol style="list-style-type: none"> 1. Approved application 2. Engineering analysis showing potential for emission reductions, no adverse impact on emissions 3. No false MILs from the base vehicle OBD 4. ARB may require a prototype system be provided for evaluation 5. Installation & System Warranties: 3yr/50K mi 6. Labeling requirements. 7. Report California sales to ARB. 8. ARB approves applicant plan for independent PEMS or chassis dynamometer testing. 	<ol style="list-style-type: none"> 1. Independent emissions testing completed, confirms no emissions increase. ARB may request manufacturers provide vehicles for independent confirmatory testing. 2. Application for Tier 2 approved.
2	Pilot (Volume tbd)	<ol style="list-style-type: none"> 1. No false MILs from base vehicle OBD 2. Basic diagnostics (i.e., circuit and functional checks) required for the innovative technology or system. 3. ARB approval of manufacturer plan/roadmap to meet Tier 3 OBD requirements. 4. Provide in-use duty cycle data for all deployed vehicles to confirm expected in-use emission benefits. 5. Installation & System Warranties: 5yr/75K mi 6. Labeling requirements. 7. Report California sales to ARB. 	<ol style="list-style-type: none"> 1. Manufacturers' in-use duty cycle data for vehicles in Tier 2 confirms/ consistent with identified emission benefits identified from vehicles in Tier 1. 2. ARB may request conversion manufacturers provide vehicles for independent confirmatory testing. 3. Application to Tier 3 approved.

Technology no longer considered innovative after a certain number (tbd) of units sold industry-wide. After this market threshold, manufacturers must meet full aftermarket parts technology approval requirements identified below.

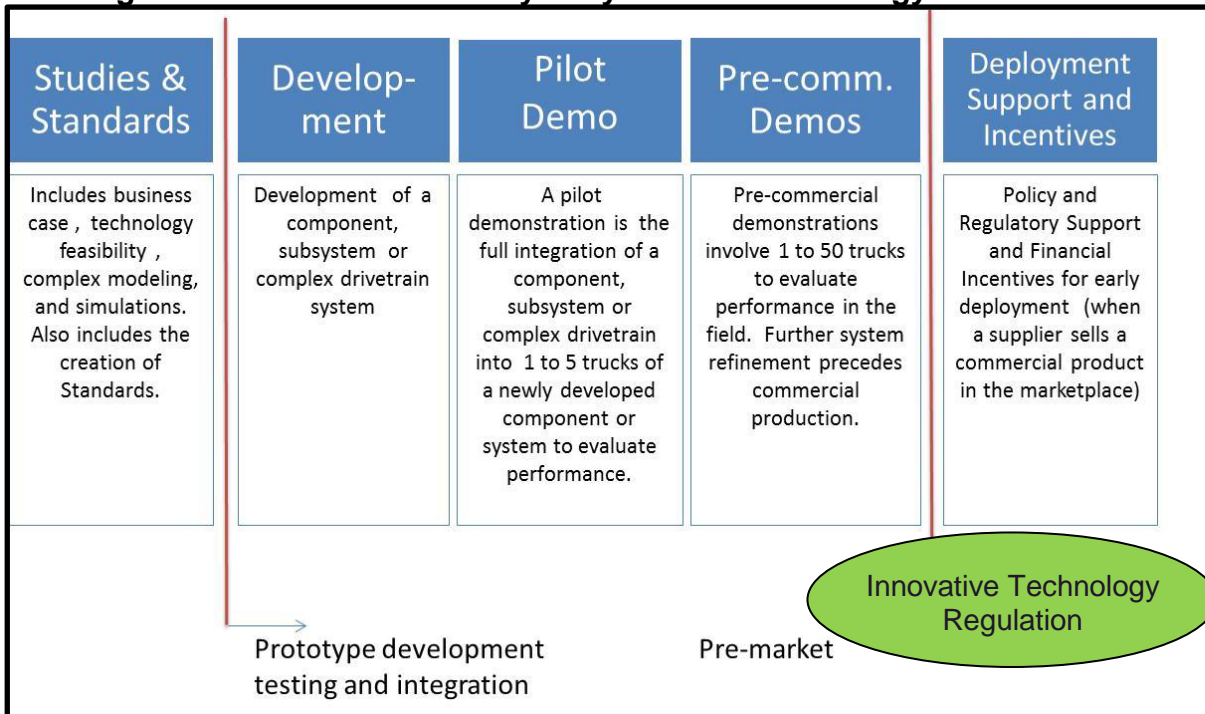
3	Full After-Market Approval	<p>Tier 3 Concept: Base vehicle must be fully OBD compliant and the conversion technology must utilize basic diagnostics. Requirements include:</p> <ol style="list-style-type: none"> 1. Meet requirements identified in Tier 1 and 2 (above) 2. Demonstrate that OBD readiness can be achieved to ensure compatibility with Smog Check or other in-use inspection programs. 3. Show of readiness indicators set and no OBD MIL/DTC during emission tests 4. Full OBD (i.e., circuit and functional checks) required for the full vehicle; must light single MIL and use standardized scan tools. 5. Demonstrate in-use monitoring performance ratio compliance 6. ARB may request durability test data to vehicle useful life
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Applicable Tiers and Sales Volumes

Staff welcomes stakeholder comment regarding what level of manufacturer-specific sales volumes per technology should be associated with each tier identified in Tables 2 and 4, as well as at what industry-wide California sales volume a technology should no longer be considered “innovative”. Maximum allowable sales volume per tier will be informed by variables such as: the volumes needed to encourage manufacturer participation, technology maturation, and consumer acceptance; the number of vehicles needed for fleets to evaluate a new truck or bus technology; the typical annual industry engine family sales volume per vehicle vocation; and the extent of flexibility offered per sales tier.

Figure A (below) describes how advanced medium- and heavy-duty vehicle technology evolves from early development to deployment. This illustrates the role of policy and regulatory support (such as certification flexibility) in helping launch a new technology. Staff envisions the Innovative Technology Regulation certification flexibility could facilitate the final two of the five discrete technology development and deployment steps identified below.

Figure A: Medium- and Heavy-Duty Vehicle Technology Evolution



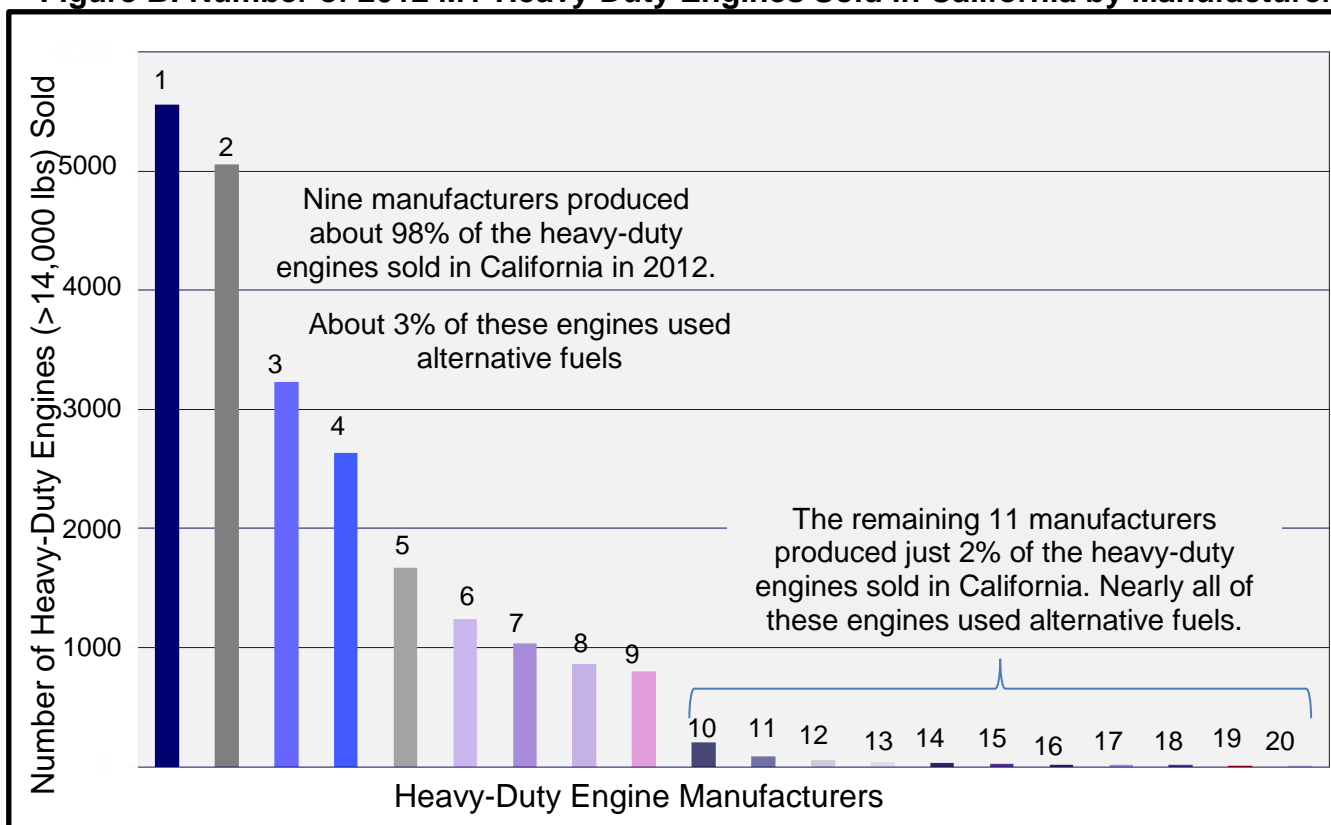
Source: CalHEAT Research and Market Transformation Roadmap for Medium- and Heavy-Duty Trucks; California Hybrid, Efficient, and Advanced Truck Research Center; February 2012

Figure B (below) illustrates the distribution of heavy-duty (>14,000 lbs GVWR) engine sales by the twenty manufacturers that sold 2012 model year (MY) heavy-duty engines in California. This figure provides context regarding the total volume of engines sold in California, the difference in sales volume between the largest and smallest manufacturers, and the role smaller manufacturers play in helping bring newer technologies (in this case, alternative fuel engines) to market. The nine largest manufacturers averaged about 2,500

2012 MY engines sold each, while the eleven smaller manufacturers averaged fewer than fifty engines sold. Only about three percent of the engines sold by the largest manufacturers used alternative fuels, while the vast majority of the eleven smaller manufacturer sales were for alternative fuel engines. This overall trend is similar for previous model years, suggesting that smaller manufacturers may play an important role in introducing newer heavy-duty engine technologies to market.

Engine family data for these manufacturers provides additional useful information. An engine family is a group of engines that shares very similar characteristics, such as manufacturer, displacement, fuel type, emissions control strategy, and other key parameters. A manufacturer must complete ARB certification (including OBD) for each heavy-duty engine family. The nine largest manufacturers in Figure B averaged almost six engine families each (meaning they certified six discrete engines), with an average of about 400 engines sold within each family. The eleven smaller manufacturers averaged just over one engine family each, with about forty engines sold from each engine family. Ideally, the Innovative Technology Regulation should balance the needs of both large and small manufacturers, providing a mechanism that encourages both to bring hybrids and other innovative technologies to market while ramping up their diagnostics capabilities.

Figure B: Number of 2012 MY Heavy-Duty Engines Sold in California by Manufacturer



ARB welcomes public comment on this concept paper and the accompanying workshop presentation. For more information, visit www.arb.ca.gov/msprog/itr/itr.htm or contact Joe Calavita, Staff Air Pollution Specialist at (916) 445-4586 or jcalavit@arb.ca.gov.