

POLICY UPDATE

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California's in-use locomotive regulation

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On April 27, 2023, the California Air Resources Board adopted a regulation aimed at forcing the retirement of older diesel locomotives and increasing the use of zero-emission (ZE) technology.¹ The In-Use Locomotive Regulation is expected to reduce 7,400 tons of particulate matter (PM), 386,300 tons of nitrogen oxides (NO_x), and 21.6 million tons of greenhouse gas (GHG) emissions cumulatively between 2023 and 2050. This is the first regulation in the United States to set zero-emission requirements for locomotives, but California still needs approval from the U.S. Environmental Protection Agency before it can be implemented.

BACKGROUND

In 2022, locomotives in California emitted over 640 tons of fine particles (PM_{2.5}) and almost 30,000 tons of NO_x. Locomotives travel across the state, connecting seaports, railyards, industrial facilities, and other locations close to where people work and live, causing harmful impacts on air quality and public health. Relying almost exclusively on diesel fuel, locomotives were responsible for 10% of NO_x emissions from mobile sources in California in 2020. That share of NO_x emissions is expected to increase to 15% in 2035 because most other transportation sectors have committed to moving toward cleaner engines and zero-emission technology.²

There are several types of locomotive operators in California:

- » Class I railroads are the largest rail companies in the United States. Two freight carriers operating in California, Union Pacific and BNSF Railway Company, meet the

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1 California Air Resources Board, "CARB Passes a New In-Use Locomotive Regulation Estimated to Yield Over \$32 Billion in Health Benefits," April 27, 2023, <https://ww2.arb.ca.gov/news/carb-passes-new-use-locomotive-regulation-estimated-yield-over-32-billion-health-benefits-0>.

2 California Air Resources Board, "CARB's 2022 In-Use Locomotive Emission Inventory: Regulation Proposal and Scenarios," August 2022, <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/locomotive22/appg.pdf>.

Class I definition by having revenue in 2022 of more than \$943.9 million.³ Class I line-haul (greater than 2,300 horsepower) locomotives move freight over long distances throughout the country. Class I switchers are smaller locomotives used by Class I companies to pull freight through railyards or for short distances outside of railyards.

- » Class II railroad companies, often called regional railroads, pull freight over short and medium distances, generally between a small number of states. Class II companies have 2022 revenue between \$42.4 million and \$943.9 million.
- » Class III or short-line railroads pull freight over short distances, typically between a port and a railyard or between a railyard and an industrial client. These rail companies have revenue of less than \$42.4 million.
- » Industrial locomotive operators use switch locomotives (2,300 horsepower or less) to move freight to a main track to be connected to a larger train.
- » Passenger railroads operate over a range of distances, from local commuter routes to cross-country trips.⁴
- » Historic locomotives, kept in their original configuration, are used to help interpret historical experiences and transport passengers for educational purposes.⁵

The federal Clean Air Act preempts or prohibits states from imposing their own, more stringent emission standards on manufacturers of locomotives, including setting standards for new locomotives and locomotive engines. The Environmental Protection Agency (EPA) has the authority at the federal level to set tailpipe and GHG emission standards for new internal combustion engines used in locomotives. Older locomotives with the least-stringent emission limits are classified as Tier 0. New locomotives must meet the more-stringent Tier 4 standards, which were adopted in 2015.

Because the California Air Resources Board (CARB) cannot regulate the manufacturing of locomotive engines, it has instead turned to in-use agreements and regulations targeting how much pollution railroads may emit and what kinds of engines rail companies may use while operating in the state.

Years before adopting the new regulation in April 2023, CARB negotiated two voluntary memorandums of understanding (MOUs) with the state's two Class I freight railroads. Both MOUs were aimed at encouraging the operation of cleaner locomotives in the South Coast Air Basin in the Greater Los Angeles metropolitan area. The first MOU, signed in 1998, set an average NO_x emissions requirement of 5.5 grams-per-brake-horsepower-hour (g/bhp-hour) by 2010.⁶ It included penalties of \$5,000 a day for failing to report annual fleet-average emissions and \$100,000 for each 0.1g/bhp-hour of annual emissions above the NO_x limit (stated as the "liquidated damage" in the MOU). These fleet-average NO_x limits were consistent with the limits set in EPA's Tier 2 and Tier 3 emission standards for new engines.⁷ In 2005, the agency and railroad companies signed a second MOU that required at least 80% use of ultra-low sulfur diesel fuel and visible smoke inspections with a required

3 The Surface Transportation Board adjusts revenue requirements for rail company classifications annually based on inflation. In 2022, the thresholds were more than \$943.9 million for Class I, between \$42.4 million and \$943.9 million for Class II, and less than \$42.4 million for Class III railroad companies.

4 California Air Resources Board, "CARB Fact Sheet: Passenger Locomotive Operators," June 21, 2022, <https://ww2.arb.ca.gov/resources/fact-sheets/carb-fact-sheet-passenger-locomotive-operators>.

5 California Air Resources Board, "CARB Fact Sheet: Historic Locomotive Operators."

6 California Air Resources Board, "Memorandum of Mutual Understandings And Agreements: South Coast Locomotive Fleet Average Emissions Program," July 2, 1998, <https://ww2.arb.ca.gov/sites/default/files/2021-02/1998MOU.pdf>.

7 In 1998 when the MOU was signed, new locomotives needed to meet Tier 1 emission standards nationwide.

repair program for smoke opacity greater than 20%. The MOU also required, starting in 2007, the installation of automatic idle-reduction systems that shut off engines if trains do not move for more than 15 minutes.

Despite these agreements, the locomotive fleet in California remains dominated by old diesel engines. As of 2022, three-quarters of the locomotives used by Class II, Class III, and industrial locomotive operators were pre-Tier 0 (manufactured before 1973), and thus not covered by any EPA emission standards for locomotives.⁸ Even the two Class I railroad companies, which are subject to the MOUs for the Greater Los Angeles area, use mostly older locomotives; about 50% of the Class 1 in-use fleet as of 2021 was made up of pre-Tier 0, Tier 0 (manufactured between 1973 and 2001), and Tier 1 (manufactured between 2002 and 2004) locomotives.⁹ Tier 4 locomotives (manufactured after 2015) made up less than 5% of all locomotives in California in 2020, even though the standard has been in place for almost a decade. CARB's new regulation aims to reduce locomotive emissions from all railroad operators in the state, with the aim of improving public health and air quality, particularly for communities near rail operations.

KEY ELEMENTS OF THE REGULATION

The In-Use Locomotive Regulation targets all locomotives in California with the goal of accelerating the transition to zero-emission operations. The regulation, which includes in-use emissions requirements and mandatory accounts based on annual emissions, encourages railway companies to operate with zero-emission (ZE) locomotives in the states as early as possible. It also covers various flexibilities and includes other supporting elements to enhance the compliance and management of the locomotive fleet used in California.

IN-USE OPERATIONAL REQUIREMENTS

Starting in 2030, locomotives must be less than 23 years old to operate in California. This requirement will gradually ban old diesel locomotives from the state, starting with Tier 0, Tier 1, and some early Tier 2 models that were manufactured before 2007. However, if the locomotive is remanufactured or repowered to meet Tier 4 emission limits or better before 2030, the state will consider the time of remanufacturing as the original build date. Exemptions are granted for low-usage locomotives and locomotives operating only in zero-emission configurations in California.

In addition, zero-emission requirements will phase in starting in 2030. All switch, industrial, and passenger locomotives built after 2030 must operate with zero emissions in California. For Class I companies, line-haul locomotives built after 2035 must operate with zero emissions. The extra 5 years granted for compliance takes into consideration the more powerful engines needed for moving freight long distances.¹⁰ Line-haul locomotives typically have above 4,000 horsepower and an

8 California Air Resources Board, "CARB Fact Sheet: Class II, Class III, and Industrial Locomotive Operators," June 21, 2022, <https://ww2.arb.ca.gov/resources/fact-sheets/carb-fact-sheet-class-ii-class-iii-and-industrial-locomotive-operators>.

9 California Air Resources Board, "Rail Emission Reduction Agreements," accessed July 24, 2023, <https://ww2.arb.ca.gov/resources/documents/rail-emission-reduction-agreements>; California Air Resources Board, "Locomotive Fact Sheets," accessed July 24, 2023, <https://ww2.arb.ca.gov/our-work/programs/reducing-rail-emissions-california/locomotive-fact-sheets>.

10 According to EPA's locomotive duty cycle, the operational duty cycles of line-haul locomotives are characterized by a longer time in higher power settings, while those of switchers and passenger locomotives spend more time in idle or lower power settings.

average fueling range of 800 to 1,200 miles.¹¹ CARB staff will develop technology assessments to gauge market readiness for zero-emission line-haul locomotives and adjust the timeline if needed.

The potential impact of the zero-emission deadlines is likely to be limited, however, by low turnover in the locomotive fleet. Union Pacific and BNSF together added 64 new line-haul locomotives in 2020 to a fleet of about 15,202 diesel locomotives in use in California.¹² Those 64 new units represented less than 1% of the locomotive fleet in 2020. More line-haul locomotives were added earlier in the previous decade, but the annual total of new locomotives never exceeded 5% of the fleet, as shown in Figure 1.

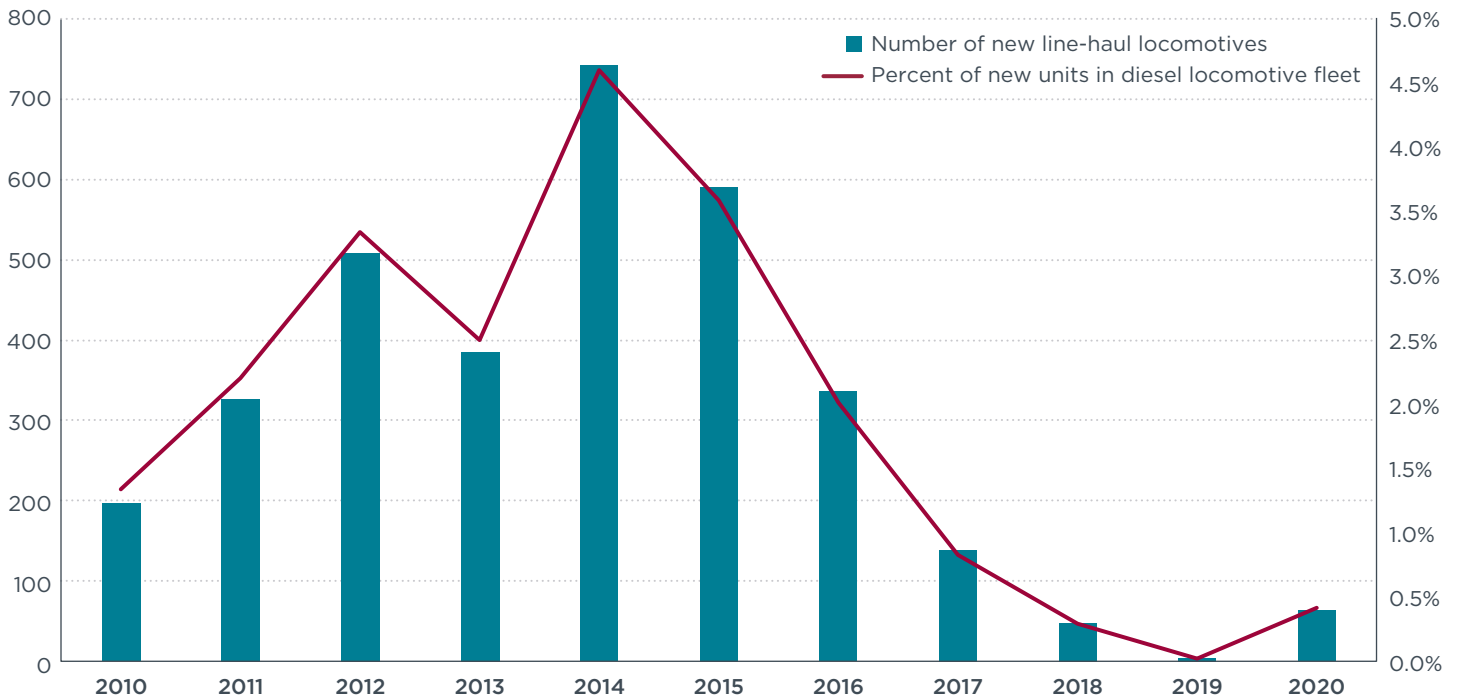


Figure 1. Number of line-haul locomotives in California, 2010–2020, and these acquisitions as a percentage of the statewide diesel fleet. (Data from California Air Resources Board.)

SPENDING ACCOUNTS

To encourage faster deployment of zero-emission trains, California required locomotive operators are required to set up spending accounts by July 1, 2024, and fund these accounts based on how much pollution the operators’ locomotives emit in the state. The annual deposit to an account will be calculated using the PM and NO_x emission rates included in the EPA’s Engine Certification Data for each locomotive, along with information on how much the locomotive was used in California. Usage data is obtained from the MWh (megawatt-hour) meter on most locomotives. CARB also includes in the calculation a weighted factor that increases over time, so that the same amount of pollution will require higher payments in the future. Locomotive

¹¹ California Air Resources Board, “Technology Assessment: Freight Locomotives,” November 2016, https://ww2.arb.ca.gov/sites/default/files/2020-06/final_rail_tech_assessment_11282016%20-%20ADA%2020200117.pdf.

¹² California Air Resources Board, “CARB’s 2022 In-Use Locomotive Emission Inventory: Regulation Proposal and Scenarios,” August 2022, <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/locomotive22/appg.pdf>.

operators may receive credits against the annual account deposit by using ZE locomotives and equipment before 2030.

The funding in the spending account is designated for the purchase, lease, or rental of ZE locomotives, ZE-capable locomotives, and ZE rail equipment, and to repower or upgrade locomotives to have zero emissions or be ZE-capable.¹³ Locomotive operators can use the funding to launch ZE pilot and demonstration projects. Before 2030, the funding can also be used to upgrade locomotives to Tier 4 or cleaner standards.

As the spending account is designed to help locomotive operators set aside money to meet in-use operational requirements, a railway can cash out the funding and close the account if all of its locomotives operated in California are in a ZE configuration. The operator might need to re-open the account if any violation is identified. The account will be audited by the California Department of Finance.

ALTERNATIVE COMPLIANCE PLAN

If approved by CARB, a locomotive operator can adopt an alternative compliance plan to replace the in-use operational requirements, spending account, or both. The plan, to be in force for 5 years, must include strategies for achieving emission-reduction benefits (covering PM, NO_x, and greenhouse gas emissions) that would be equivalent or greater than those achieved through the in-use operational requirements and spending account. An application to use an alternative compliance plan must cover all the locomotives in the operator's fleet; an application fee is charged based on the number of locomotives. All application materials submitted will be shared on CARB's website for public access.

ALTERNATIVE FLEET MILESTONE OPTION

Locomotive operators have another pathway to compliance: until 2047, they can earn credits for operating ZE locomotives or equipment and use those credits to offset the use of old diesel locomotives. Under this approach, operators do not need to comply with the spending account or in-use operational requirements, but they must commit to four milestones:

1. Beginning January 1, 2030, 50% of annual fleet usage in California must be from Tier 4 or cleaner locomotives.
2. Beginning January 1, 2035, 100% of annual fleet usage in California must be from Tier 4 or cleaner locomotives.
3. Beginning January 1, 2042, 50% of annual fleet usage in California must be from ZE locomotives, ZE-capable locomotives, or ZE rail equipment.
4. Beginning January 1, 2047, 100% of annual fleet usage in California must be from ZE locomotives, ZE-capable locomotives, or ZE rail equipment.

Under the offset formula, each megawatt-hour (MWh) of power generated by the engines of ZE locomotives or ZE rail equipment would provide credit for 2 MWh of power generation by Tier 2 or Tier 3 locomotives, 1.5 MWh by a Tier 1 locomotive, 1 MWh by a Tier 0 locomotive, and 0.5 MWh by a pre-Tier 0 locomotive before 2047. The offset credits are mutually exclusive; the operation of one ZE locomotive can be used to offset the operation of only one diesel locomotive.

¹³ ZE capable locomotives are locomotives that can be operated in a ZE configuration or operated on a fuel that produces emissions.

OTHER PROVISIONS

Registration requirements

All operators must register their California locomotives with CARB by July 2024 and report the total MWh of operation for each since the original engine build date. Information about the locomotives and engines will be documented with photographs.

Reporting and recordkeeping requirements

Starting in July 2024, all locomotive operators must submit locomotive emission reports, spending account reports, and in-use operational requirement reports to CARB annually. These reports state how the locomotives used in California comply with the in-use locomotive regulation. For those who applied for exemptions and alternative approaches, separate reports are needed. CARB also requires an annual \$175 payment for each locomotive operated in California. Historic locomotives and ZE locomotives can be exempted from the payment.

Idling Limits

Starting in 2024, locomotive engines cannot idle for more than 30 minutes in California. Locomotive Operators must install Automatic Engine Stop/Start (AESS) systems on locomotives and ensure these systems are working properly.¹⁴ Exemptions are granted for locomotives operated in ZE configurations, for maintenance, and for other reasons.

In addition to the general rules, CARB offers various flexibilities, extensions, and exemptions for locomotive operators to choose the best strategy for complying with the in-use regulation.

Other extensions and exemptions

- » Small businesses with annual gross revenue of less than \$5 million (in 2019 dollars), can apply for a temporary extension of their obligations for the spending account, the in-use operational requirements, or both.
- » Low-use historic locomotives can be exempted from the spending account, the in-use operational requirements, or both.
- » Operators can apply for temporary operating extensions for the purpose of removing a locomotive from California or for maintenance of old diesel locomotives.
- » Compliance extensions may also cover delays in manufacturing or installing compliant equipment or the unavailability of compliant equipment.

COSTS AND BENEFITS

CARB staff estimated that the regulation would cost \$13.8 billion for new equipment and labor cumulatively between now to 2050, but the related health benefits would be more than \$32 billion. Health benefits will exceed the costs of the new equipment as early as 2024. In addition, approximately 3,200 premature deaths, 1,100 hospital admissions, and 1,500 emergency room visits could be avoided, and the cancer risk posed by exposure to air toxins within one mile of locomotive operations would be reduced by more than 90%.

¹⁴ AESS systems automatically shut down engines to reduce idling without the need to have an operator take action.

COMPLEMENTARY FUNDING PROGRAMS

CARB offers grants to help locomotive operators accelerate the adoption of ZE technology. Funding sources include, at the state level, the Carl Moyer Memorial Air Quality Standards Attainment Program, Prop. 1B Goods Movement Emission Reduction Program, VW Mitigation Trust, and the Clean Off-Road Equipment Voucher Incentive Project. The Federal Consolidated Rail Infrastructure and Safety Improvements Program is also a potential source of money for ZE projects.¹⁵

¹⁵ California Air Resources Board, "Incentives for Locomotives," accessed July 24, 2023, <https://ww2.arb.ca.gov/our-work/programs/reducing-rail-emissions-california/incentives-locomotives>.