Commercial Harbor Craft
2024 Biennial Report

Assessment of Commercial Availability and Implementation Status for the Amended Commercial Harbor Craft Regulation

Table of Contents

Executive Summary

This 2024 Biennial Report provides updates on the status of technology for reducing emissions from Commercial Harbor Craft (CHC) and on the status of implementation of the amended CHC Regulation,[1] which was adopted by the California Air Resources Board (CARB) in March 2022 through Resolution 22-6.[2] Resolution 22-6 directed the Executive Officer to establish a technical working group to assess the commercial availability of lower-emitting combustion engines and zero-emission technology for all categories of harbor craft and to report back to the Board by December 31, 2024, and biennially until 2032. The Board also directed staff to report back on the status of implementation.[3]

Summary of Findings: The amended CHC Regulation requires engines on most CHC vessels to meet performance standards equivalent to a U.S. EPA Tier 4 engine plus a Diesel Particulate Filter (DPF). The Regulation also includes Zero Emission and Advanced Technology (ZEAT) requirements for short run ferries and excursion vessels.

In January 2025, EPA granted a partial authorization of the CHC Regulation. The partial authorization covered most components of the Regulation. [4] The two components that EPA did not take action on were 1) zero-emission requirements for in-use short run ferries; and 2) performance standards for in-use engines and vessels that would apply after the expiration of feasibility extensions.

However, the findings of this Biennial Report show that availability and feasibility of technology to reduce emissions from CHC is continuing to improve. Zero emission technology for short run ferries is available today. Several ferry operators in California had already been awarded incentive funding to transition their vessels to zero-emission at the time EPA issued the partial authorization, and these operators are still actively working toward this transition despite EPA's non-action in this area. Tier 4 engines are commercially available with over 100 already operating on CHC in California. DPFs are available on some U.S. EPA-certified Tier 4 engines and retrofit DPFs are undergoing CARB verification. The variety of Tier 4 engine models has increased since 2021, improving feasibility of Tier 4 repowers.

Overall, zero-emission technologies are rapidly developing, and zero-emission vessels are being deployed in California, including in vessel categories where the CHC Regulation does

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[1] California Code of Regulations title 17, section 93118.5, *Commercial Harbor Craft Regulation*.

[2] Resolution 22-6: Proposed Amendments to the Commercial Harbor Craft Regulation, March 24, 2022, *RESO 22-6 FIN CHC 2nd Hearing (ca.gov)*.

[3] Videoconference Meeting State of California Air Resources Board, pages 144 and 156, March 24, 2022, *22-03-24 - CARB MEETING.*

[4] Federal Register, Vol. 90, No. 6, Friday, January 10, 2025. *2025-00465.pdf*.

not require zero-emission, and worldwide. Feasibility for zero-emission vessels is still case-by-case for most vessel operations but is improving as technology progresses.

Staff Recommendation: Based on the information received to date through the technical working group process and through implementation of the amended CHC Regulation, staff does not recommend any changes to the Regulation at this time.

Staff recognizes that industry is facing challenges in complying with the amended CHC Regulation. However, staff believes the concerns identified so far can be resolved within the current Regulation. Operators are using compliance extensions where appropriate, such as for supply chain delays, feasibility, and equipment availability. The vast majority of the CHC Regulation is covered by EPA's authorization, and staff recently posted a factsheet[5] to answer questions related to the implementation and enforcement of the areas EPA did not take action on. Factsheets are also available to explain key aspects of the CHC Regulation,[6] and staff frequently communicate with stakeholders and hold meetings as needed to explain requirements and help regulated parties identify compliance pathways.

Moving forward, staff will continue to work with vessel and facility operators, the U.S. Coast Guard, technology developers, advocacy groups, and all other stakeholders. As directed by Resolution 22-6, staff plans to hold technical working groups biennially through 2032.

[5] CHC Factsheet: EPA Partial Authorization of Commercial Harbor Craft Regulation, July 28, 2025, *CHC Factsheet: EPA Partial Authorization of Commercial Harbor Craft Regulation July 28th, 2025*.

[6] Commercial Harbor Craft Factsheets, *Commercial Harbor Craft Factsheets | California Air Resources Board*.

Chapter 1 - Introduction

Purpose of the December 2024 Biennial Report

This report provides an assessment of commercial availability of technology and implementation status for the amended Commercial Harbor Craft Regulation[7] ("Amended CHC Regulation" or "Regulation"), which was approved for adoption by the California Air Resources Board (CARB) in March 2022 via Resolution 22-6.[8] This report includes a high-level summary of the following:

- Summary of the Technical Working Group meetings CARB staff conducted in 2024 in accordance with the Board's direction in Resolution 22-6
- Review of implementation status of the amended CHC Regulation and stakeholder outreach conducted since the amended Regulation was adopted by the Board in 2022
- Assessment of commercial availability of cleaner combustion technologies including Tier 4 engines and aftertreatment, feasibility of installations, and U.S. Coast Guard processes for installations
- Assessment of commercial availability of zero-emission and advanced technologies
- Staff's conclusions and recommendations

While this report was initially developed to meet the Resolution 22-6 direction for staff to report back to the Board by December 31, 2024, the release of this report was delayed until late 2025. Therefore, staff have made an effort to update key information through the date of release, as applicable.

Background and Context

Commercial Harbor Craft ("CHC" or "harbor craft") are a vital part of California's economy and are essential for moving cargo and providing services to Ocean-Going Vessels (OGV) and various seaports, harbors, and marinas throughout California. While these vessels are reliable and operationally efficient, many of them are powered by and utilize diesel engines that emit significant amounts of air pollutants, including diesel particulate matter (DPM), fine particulate matter (PM2.5), oxides of nitrogen (NOx), oxides of sulfur (SOx), reactive organic gases (ROG), and greenhouse gases (GHG). Coastal areas throughout the State continue to be impacted by emissions generated from more than 3,000 CHC operating near California seaports and marine terminals.[9] Emission reductions are necessary from CHC to help

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[7] California Code of Regulations (CCR) title 17, section 93118.5, and title 13, section 2299.5, *Final Regulation Order (ca.gov)*. December 30, 2022.

[8] Resolution 22-6: Proposed Amendments to the Commercial Harbor Craft Regulation, *RESO 22-6 FIN CHC 2nd Hearing (ca.gov)*. March 24 2022.

[9] Initial Public Hearing to Consider the Proposed Amendments to the Commercial Harbor Craft Regulation, Staff Report: Initial Statement of Reasons, p. I-1, *02. CHC ISOR (ca.gov)*. September 21, 2021.

California's air basins meet the National Ambient Air Quality Standards (NAAQS) as required by the Federal Clean Air Act,[10] and to reduce exposure to toxic air contaminants, especially in port communities that are severely impacted by air pollution as required under Assembly Bill (AB) 617.[11]

Overview of Commercial Harbor Craft (CHC) Regulation

The amended CHC Regulation was originally adopted in 2008 and amended in 2010 to reduce diesel particulate matter (PM) and criteria pollutant emissions from diesel-powered engines on commercial harbor craft vessels. The regulation primarily established an in-use (existing) engine requirement, mandating that engines on specified in-use harbor craft meet Tier 2 or Tier 3 emission standards. The emission reduction requirements applied only to certain vessel categories, including ferries, excursion vessels, tugboats (including ocean-going tugs), towboats, push boats, crew and supply vessels, barge and dredge vessels. The compliance dates ranged from 2009 to 2022, depending on the engine model year, annual hours of operation, and homeport location. The regulation also required that any new ferry with a capacity of 75 or more passengers must operate using Best Available Control Technology, and required all CHC to use CARB diesel fuel.

A scoping study presented to the Board in 2018 found that in 2016, CHC remained a top 3 source of diesel PM pollution in communities near the Ports of Los Angeles and Long Beach and would contribute an even greater proportion of diesel PM emissions by 2023.[12] Therefore, the CHC Regulation was amended in 2022 to achieve further emission reductions. The amendments expanded the applicability of the Regulation to include more vessel categories, require cleaner engine upgrades, aftertreatment installations and zero-emission and advanced technology where feasible.

The key provisions of the amended CHC Regulation include:

- All CHC are required to use renewable diesel fuel (R99) as of January 1, 2023.
- New, newly acquired and in-use short-run ferries are required to be zero-emission by December 31, 2025.
- New and newly acquired excursion vessels are required to be zero-emission capable hybrid beginning December 31, 2024.

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[10] 2022 State Strategy for the State Implementation Plan, *2022 State SIP Strategy (ca.gov)*. September 22, 2022.

[11] Assembly Bill No. 617, CHAPTER 136, *Bill Text - AB-617 Nonvehicular air pollution: criteria air pollutants and toxic air contaminants.* July 26, 2017.

[12] State of California Air Resources Board, Proposed Amendments to the Regulation to Reduce Emissions from Diesel Engines on Commercial Harbor Craft Operated within California Waters and 24 Nautical Miles of the California Baseline, Standardized Regulatory Impact Assessment (SRIA), page 15, *Appendix C-1: Standardized Regulatory Impact Assessment (SRIA)*. September 21, 2021.

- Engines on regulated in-use vessels must meet performance standards equivalent to the cleanest available engine, which is either Tier 3 or Tier 4 depending on engine power rating, plus a diesel particulate filter (DPF) when commercially available.
- Compliance dates for engines meeting performance standards range from 2024 to 2031 depending on the engine model year; older, higher-polluting engines are required to upgrade earlier.
- The performance standards in the amended CHC Regulation apply to vessel categories that were previously exempt from in-use engine requirements, including sportfishing or commercial passenger fishing vessels (CPFVs), tank barges, pilot vessels, research vessels, and workboats.
- Vessel owners/operators or facility owners/operators may apply for compliance extensions (E1-E5) for various circumstances that may prevent them demonstrating compliance with applicable requirements by the compliance deadlines. These compliance extensions include infrastructure delays (E1), equipment unavailability (E2), need for vessel replacement and financial difficulty (E3), Tier 3 or cleaner engines by December 31, 2024 in CPFV (E3), diesel particulate filter (DPF) infeasibility and limited annual operation hours (E4), and manufacturing delays or overlapping compliance dates (E5).
- Pre-Tier 1 and Tier 1 engines on commercial fishing vessels are required to be upgraded to Tier 3 engines in 2030–2032, depending on the engine model year.
- Beginning on January 1, 2024, main engines or auxiliary engines with a power rating of 99 kilowatts (kW) or less are not allowed to idle more than 15 minutes when docked.
- Facility owners and operators with more than 50 annual vessel visits were required to provide land-side shore power infrastructure for engines under 99 kW by January 1, 2024.
- All CHCs engines are required to meet opacity limits, and the first biennial opacity testing reports were due by March 31, 2024.
- Other requirements include a compliance pathway for low-use vessels, alternative emissions control options, annual reporting and recordkeeping, labeling requirements, and compliance fees for vessel owners or operators.

The amended CHC Regulation was approved by the Office of Administrative Law (OAL) on December 30, 2022 and went into effect on January 1, 2023. By 2035, the amended CHC Regulation is expected to result in an 89% reduction of diesel particulate matter and a 52% reduction in nitrogen oxides from regulated CHC. The amended Regulation will also reduce the cancer risk to over 22 million residents who live near the coast and up to 50 miles inland.

Rulemaking Process and Board Direction

CARB staff began rulemaking efforts for the CHC Regulation amendments in 2018. As described in the Initial Statement of Reasons, prior to its publishing in September 2021,

CARB staff conducted more than 400 meetings[13] with members of impacted communities, environmental justice advocates, public agencies at federal, state, and local levels, and industry stakeholders (including vessel operators, seaports, marine terminals, industry associations, as well as manufacturers of emission control and ZEAT systems).[14] The format of these conversations included agency working groups, public workshops, community meetings, and meetings with individual stakeholders.[15]

CARB's Board considered the CHC Regulation amendments at two separate Board meetings, held on November 19, 2021, and March 24, 2022. At the initial hearing on November 19, 2021, Board members directed staff to continue outreach on funding opportunities, streamline compliance extension process, regularly evaluate the status of zero-emission and cleaner combustion technology, and evaluate opportunity for contingency measures supporting State Implementation Plans.[16] To respond to the Board's direction, CARB staff carefully reviewed the public comments, followed up with stakeholders who submitted information into the rulemaking record, and hosted a public webinar on January 12, 2022, to receive input on staff's proposed response to Board direction.

On March 24, 2022, during the second Board meeting, the Board adopted Resolution 22-6,[17] which provided several directives for the Executive Officer, including the directive to establish a technical working group to assess the commercial availability of lower-emitting combustion engines and zero-emission technology for all categories of harbor craft, and using input from this technical working group and other data provided by industry, report back to the Board by December 31, 2024 and biennially through 2032.

Resolution 22-6 also directed staff to make modifications to the regulatory language to include an additional extension pathway option through 2034 for CPFVs that have replaced engines to meet Tier 3 or newer standards by the end of 2024, to conduct a midterm review on CPFV requirements by 2028, and to incorporate additional flexibility in the regulatory provisions that establish compliance extensions to qualifying applicants. In response to the direction in Resolution 22-6, CARB staff released modifications to the regulation language, which was noticed to the public in a 15-day notice package on May 19, 2022.[18]

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[13] Videoconference Meeting State of California Air Resources Board, page 252, *Transcript* , November 19, 2021.

[14] List of Public Workshops, Meetings, and Phone Calls, page F-1, *Appendix F: List of Public Workshops, Meetings, and Phone Calls*, September 21, 2021.

[15] Staff Report: Initial Statement of Reasons, Chapter XII, *Initial Statement of Reasons*. September 21, 2021.

[16] Videoconference Meeting State of California Air Resources Board, page 411-414, *Transcript* , November 19, 2021.

[17] Proposed Amendments to the Commercial Harbor Craft Regulation, Resolution 22-6, *RESO 22-6 FIN CHC 2nd Hearing (ca.gov)*. March 24, 2022.

[18] Notice of Public Availability of Modified Text and Availability of Additional Documents and Information, *Notice of Public Availability of Modified Text and Availability of Additional Documents and Information for the Proposed Amendments to the Commercial Harbor Craft Regulation*. May 19, 2022.

U.S. EPA Authorization

CARB submitted a request to the U.S. Environmental Protection Agency (EPA) on January 31, 2023 for authorization of the CHC Regulation pursuant to section 209(e) of the Clean Air Act. On January 10, 2025, the U.S. Environmental Protection Agency (EPA) granted a partial authorization of the Regulation. [19] The partial authorization covered most components of the Regulation. The two components that EPA did not take action on were 1) Zero-Emission and Advanced Technology (ZEAT) requirements for in-use short run ferries; and 2) emission standards for in-use engines and vessels (excluding commercial fishing vessels) that would apply after the expiration of feasibility extensions, specifically extension E3.

On July 28, 2025, CARB posted a factsheet describing the partial authorization and impacts on implementation of the Regulation.[20] As described in the factsheet, CARB is implementing and enforcing the parts of the Regulation covered by the partial authorization. CARB is not enforcing the two components of the Regulation that EPA did not take action on.

Technical Working Group and Biennial Reports

As stated above, Resolution 22-6 included a directive to establish a Technical Working Group to assess the commercial availability of lower-emitting combustion engines and zero-emission technology for all categories of harbor craft, and using input from this technical working group and other data provided by industry, report back to the Board by December 31, 2024. The Board members, through their discussion during the March 24, 2022 Board hearing, also directed staff to include implementation review in the biennial report, and to report on the economic barriers and technical barriers to adopting cleaner vessels with the goal of ultimately achieving zero emissions.[21]

The Technical Working Group consisted of a series of virtual workshops, beginning with the first held on April 24, 2024, followed by additional sessions on May 29, 2024 and August 7, 2024. The workshop series was open to all members of the public and included presentations and panel discussions that provided information and perspectives from a wide range of stakeholders including vessel owners and operators, industry associations, environmental and community-based organizations, technology developers, engine and aftertreatment manufacturers, academic institutions, government agencies, and members of the public. Further details about the Technical Working Group are provided in Chapter 2.

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[19] Federal Register, Vol. 90, No. 6, Friday, January 10, 2025. *2025-00465.pdf*.

[20] CHC Factsheet: EPA Partial Authorization of Commercial Harbor Craft Regulation, July 28, 2025, *CHC Factsheet: EPA Partial Authorization of Commercial Harbor Craft Regulation July 28th, 2025*.

[21] Videoconference Meeting State of California Air Resources Board (Transcript), pp 154-155, *22-03-24 - CARB MEETING*. March 24, 2022.

Resources Used in Developing this Report

In preparation to draft this Report, starting in the Fall of 2023 and through 2024, CARB staff contracted with California State University, Sacramento (CSUS) to facilitate the Technical Working Group workshops, invited members of the public and industry stakeholders to participate in the workshops, and continued to conduct outreach and solicit feedback through implementation of the Regulation. As directed by Resolution 22-6, CARB staff prepared this report using input from the Technical Working Group and other data gathered, including:

- *Commercial Harbor Craft Technology Assessment – Review of Tier 4 Engine Technology and Zero Emission Technology*[22] - CARB-commissioned report by the University of California Irvine, discussed further below in Chapter 1 and in Chapters 4 and 5
- *Feasibility Study for Selected Vessel Categories*[23] - CARB-commissioned report by American Bureau of Shipping, discussed further below in Chapter 1 and in Chapter 4
- Stakeholder comments and staff observations regarding implementation of the Regulation, discussed further in Chapter 3
- Status updates from CARB incentive programs funding CHC projects, discussed further in Chapter 3
- Market research conducted by CARB staff regarding commercial availability of Tier 4 engines, discussed further in Chapter 4
- Status updates from CARB staff implementing CARB's Verification Procedure,[24] discussed further in Chapter 4

[22] Commercial Harbor Craft Technology Assessment – Review of Tier 4 Engine Technology and Zero Emission Technology, *UC Irvine - Commercial Harbor Craft (CHC) Technology and Assessment Review of Tier 4 Engine Technology and Zero-emission Technology*. October 4 2024.

[23] Feasibility Study for Selected Vessel Categories report, *ABS Feasibility Review - CARB Task 2 Report Rev 4 12.13.2024 Updated.pdf*, December 12, 2024.

[24] Webpage: Verification Procedure for In-Use Strategies to Control Emissions from Diesel Engines, *Verification Procedure for In-Use Strategies to Control Emissions from Diesel Engines | California Air Resources Board*.

Chapter 2 – Technical Working Group

This chapter describes the Technical Working Group (TWG) CARB staff established in 2024 to fulfill the Board's direction in Resolution 22-6[25] to assess the commercial availability of lower-emitting combustion engines and zero-emission technology for all categories of commercial harbor craft (CHC).

Workshop Structure and Format

CARB staff structured this initial TWG as a series of three virtual workshops. The workshops were open to the public and designed to gather input from various stakeholders, including vessel owners and operators, technology developers, environmental organizations, academic institutions, and government agencies, to inform this biennial report. This was the first TWG series held to fulfill the Board's direction, and additional TWGs will be held no less than biennially through 2032.

Technical Working Group Webpage

Prior to the first workshop in April 2024, CARB staff published a webpage[26] to publicly post the TWG charter and workshop materials. This webpage was updated with agendas, presentations, registration information and pre-survey links prior to each workshop, and recordings were posted following each workshop. All TWG materials are posted on this webpage.

Facilitation by California State University, Sacramento (CSUS)

CARB staff contracted with CSUS to deliver impartial, third-party facilitation services for the 2024 TWG workshops. In addition to serving as the facilitator on all three workshops, CSUS staff assisted CARB staff in preparing a charter and a facilitation plan to guide the TWG workshop process. CSUS also compiled factual reports containing outreach and engagement metrics, a pre-workshop survey report, and provided CARB with the recordings from each workshop that are posted on the TWG webpage. The workshop metrics are discussed further at the end of this chapter.

Workshop Participants and Their Roles

The TWG was composed of attendees, presenters, panelists and CARB staff. Each workshop was structured to include formal presentations, panel discussions, and question-and-answer sessions. Presenters shared essential information regarding community impacts, technological progress and processes, and amended CHC Regulation implementation with

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[25] Resolution 22-6: Proposed Amendments to the Commercial Harbor Craft Regulation, *RESO 22-6 FIN CHC 2nd Hearing (ca.gov)*. March 24, 2022.

[26] California Air Resources Board. "Technical Working Group." *Commercial Harbor Craft*, *Technical Working Group | California Air Resources Board*. 2024.

the attendees, and panelists delivered real-world insights on implementation progress. This workshop structure facilitated open conversations on the challenges and opportunities of adopting cleaner combustion and zero emission technologies.

Panel Structure

Each workshop consisted of initial presentations followed by a panel discussion. Each panel consisted of four panelists and a moderator and was designed to facilitate meaningful discussions directly tied to the content of the preceding presentations. CARB staff provided tailored prompts for each panelist, allowing time for each panelist to make introductory remarks, respond to their prompt, and provide additional remarks as desired. Question-and-answer sessions were held following each panel discussion and were open to all attendees.

Summary of Technical Workshops

Workshop 1 – April 24, 2024

The first workshop, held virtually on April 24, 2024, provided attendees with a regulatory and technical overview led by CARB staff and a panel discussion on community impacts moderated by Pacific Environment. The presentations by CARB staff included an overview of the amended CHC Regulation and high-level information regarding vessel technology to provide an informational foundation for the rest of the workshops. The panel discussion featured panelists from the Coalition for Clean Air, Sunflower Alliance, and Earthjustice. The conversation with environmental and community groups addressed the public health impacts of pollution from sources including CHC on communities near ports and terminals, emphasizing the Regulation's potential to reduce emissions in frontline communities.

Workshop 2 – May 29, 2024

The second workshop, held virtually on May 29, 2024, featured two presentations from the University of California, Irvine (UCI). The first presentation focused on technological advancements and commercial availability of Tier 4 engines, exhaust aftertreatment technologies, and alternative fuels. The second presentation focused on the current commercial operational readiness of Zero Emission and Advanced Technology (ZEAT), providing a comprehensive overview of ZEAT vessels in operation or in the design phase globally and in California, as well as infrastructure requirements such as grid capacity and charging systems. This information was pivotal in highlighting both the potential and the challenges of deploying ZEAT solutions across California's maritime industry. UCI's findings on Tier 4 engine and aftertreatment availability are further discussed in Chapter 4 of this report, and alternative fuels and ZEAT technology are further discussed in Chapter 5.

An industry expert panel followed UCI's presentations, where panelists shared their experiences with ZEAT project development and discussed implementation-related obstacles, particularly infrastructure challenges. They emphasized the importance of reverse-engineering in addressing infrastructure deficiencies early in the planning process.

Representatives from Aurora Marine Design, ZeroMar (formerly Green Yachts), Red and White Fleet, and AmNav Maritime served as panelists for this session.

Workshop 3 – August 7, 2024

Workshop 3, held virtually on August 7, 2024, included a presentation by the United States Coast Guard (USCG) District 11 on design change review protocols, including policy considerations for Tier 4 engine repowers,[27] retrofits[28] with diesel particulate filters (DPFs), and the integration of zero-emission technologies in new vessel construction. USCG's presentation focused on their processes for reviewing and approving vessel projects and helped to clarify their distinct roles and responsibilities in the regulatory framework.

Two panels were held during the third workshop, bringing together industry leaders to provide their experiences and perspectives on implementation of the amended CHC Regulation and Tier 4 repowers. During these discussions, panelists described their experiences and challenges faced when transitioning to cleaner technology. Sause Bros., Baydelta Maritime, Island Packers, Port of San Diego, Aurora Marine Design, Foss Maritime, and Crowley Maritime participated in these panels. Vessel and facility operator concerns regarding CHC Regulation implementation are discussed further in Chapter 3 of this report.

Outreach and Engagement

Gov Delivery Notifications

CARB staff sent out two Gov Delivery[29] notifications prior to each workshop. The first was a "save the date" notification sent approximately one month before each workshop. The second notification provided registration instructions and was sent approximately two weeks before each workshop. These Gov Delivery notifications were distributed to several subscriber lists including Commercial Harbor Craft Regulatory Activities, Freight Transport and Toxics Environmental Justice, Environmental Justice Stakeholders, and Community Air, and Tribal Relations. The goal was to ensure the workshop announcements reached a diverse group of stakeholders that included the broader community in addition to industry members. The Gov Delivery notifications were disseminated in both English and Spanish to maximize accessibility.

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[27] "Repower" is defined on page 24 of the CHC Regulation in California Code of Regulations (CCR) title 17, section 93118.5 subsection (d), *Final Regulation Order (ca.gov)*.

[28] "Retrofit" is defined on page 24 of the CHC Regulation in California Code of Regulations (CCR) title 17, section 93118.5 subsection (d), *Final Regulation Order (ca.gov)*.

[29] California Air Resources Board. "Subscribe." *Commercial Harbor Craft*, *California Air Resources Board (govdelivery.com)*

Other Stakeholder Engagement Prior to Workshops

CARB staff actively engaged with Community-Based Organizations (CBOs), Non-Governmental Organizations (NGOs), frontline community representatives, and industry stakeholders to facilitate their involvement as panelists in the TWG workshops. Outreach efforts were conducted through multiple channels, including formal invitation letters to key stakeholders, direct outreach by CARB staff, and collaboration with environmental organizations. CARB coordinated with stakeholders through emails and follow-up meetings to incorporate their feedback into the workshop planning process.

Frequent outreach via Gov Delivery notifications and direct email invitations ensured robust representation, with many stakeholders expressing their interest in participating through the Commercial Harbor Craft (CHC) email inbox.

Workshop Metrics

Pre-Workshop Survey Metrics

CARB contracted California State University, Sacramento (CSUS) to provide metrics from a pre-workshop survey and attendance data. The goal was to understand participant backgrounds, help CARB learn what attendees hoped to gain from the workshops, and assess overall engagement. The survey was made available via QR code on the CHC Program webpage with open access from April 20, 2024 to August 8, 2024. According to the metrics provided by CSUS, 104 participants accessed the survey and 34 completed it. [30]

Workshop Attendance Metrics

As discussed above, CARB staff used Gov Delivery to access multiple subscriber lists to notify potential attendees about the workshops. These notifications reached an average of 13,096 subscribers with a 94% delivery success rate. The average attendance per workshop was 150 attendees.

Public Comment Period

During the third TWG workshop, CARB staff invited workshop attendees to submit comments regarding the implementation of the amended CHC Regulation and the technical workshops. Submissions were encouraged through August 31, 2024. CARB staff received one comment letter, from the Western States Petroleum Association (WSPA).[31]

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[30] California Air Resources Board. "CHC TWG Pre-workshop survey." *CHC TWG Pre-Workshop Survey.pdf*. 2025.

[31] California Air Resources Board." WSPA comment letter." *WSPA Comment Letter*. 2024.

Chapter 3 – Stakeholder Outreach and CHC Regulation Implementation Status

Purpose of Chapter 3

Chapter 3 provides an update on the outreach efforts and industry meetings conducted by CARB staff since the amended CHC Regulation was adopted in late 2022. Chapter 3 also provides a status on implementation progress made during the first two years of implementing the amended Regulation, and summarizes concerns brought to staff's attention by regulated industry and other stakeholders.

CARB Meetings with U.S. Coast Guard and Regulated Industry

As noted in Chapter 1, CARB staff held over 400 meetings with stakeholders during the rulemaking process. During the nearly two years since implementation of the amended Regulation began, CARB staff have continued to engage with stakeholders, including regulated vessel and facility operators, their industry associations, environmental organizations, equipment manufacturers, and the U.S. Coast Guard. These engagements are in addition to the Technical Working Group process described in Chapter 2. The following are some of the key efforts CARB staff have undertaken to communicate with stakeholders regarding the amended CHC Regulation.

Monthly Meetings with U.S. Coast Guard

Since December 2022, CARB staff have held monthly meetings with the U.S. Coast Guard (USCG) District 11. These meetings have focused on topics related to the implementation of the amended CHC Regulation. A key topic of discussion has been to address safety concerns raised by USCG and vessel operators regarding the installation of Diesel Particulate Filters (DPFs) on both new and in-use harbor craft, particularly in relation to the unique operational environments of harbor craft. CARB staff's collaboration with USCG on the topic of DPF safety led CARB to issue Executive Order DE-24-003 [32] on September 12, 2024 providing a process for DPFs on harbor craft to include safety systems, also known as bypass or override systems, under specified conditions.[33] The monthly meetings have also served as a platform to discuss regulatory issues or operational challenges vessel operators have encountered.

In addition to the monthly implementation meetings, CARB staff attended USCG's Towing Vessel Outreach Day event in Benicia, California on February 29, 2024 to learn more about USCG regulations for periodic towing vessel and hull inspection requirements and the

[32] Executive Order DE-24-003, CARB Executive Orders for Verified Diesel Emission Control Strategies with Safety Systems for Engines on Commercial Harbor Craft, *Executive Order for Bypass Systems on VDECS for CHC - Final.pdf*, September 12, 2024.

[33] Executive Order *DE-24-003* is discussed further in this chapter under "DPF Safety."

inspection compliance pathways and resources available to operators. CARB staff also attended a training conducted by Zero Emission Industries at USCG District 11's facility on Yerba Buena Island, in San Francisco, California on March 12, 2024 to learn about marine hydrogen technologies, regulations, and industry standards for hydrogen safety.

Meetings with American Waterways Operators (AWO) and Vessel Operators on Funding Programs

CARB staff held two virtual meetings with the American Waterways Operators (AWO), the main industry association for tugboats and towing vessels, in April 2023. On April 5, 2023, staff from CARB's Advanced Technology Demonstration and Pilot Projects Program (now called the Sustainable Heavy-Duty Initiatives for Future Technology Program, or SHIFT) met with AWO to provide information on how to apply for available funding, in anticipation of the solicitation that was subsequently released on July 14, 2023.[34] On April 20, 2023, CARB staff from the Carl Moyer Program, VW Mitigation Trust, Clean Off-Road Equipment (CORE) Program, and the Advanced Technology Demonstration and Pilot Projects Program met with AWO, presented information on their respective programs, and answered stakeholder questions primarily about how to apply for funding. During the April 20, 2023 meeting, CARB staff also answered questions related to implementation and extensions in the Regulation. In addition to the above meetings, staff from CARB's incentive programs have held numerous meetings and communicated extensively with individual vessel operators to provide guidance on applying for funding for CHC vessel projects. Information on CHC projects awarded funding is provided further below in this chapter.

Meeting with San Francisco Bar Pilots

On February 27, 2024, CARB staff held a remote meeting with the San Francisco Bar Pilots (SFBP). In the meeting, SFBP described their concerns regarding their ability to meet their earliest compliance deadline of December 31, 2024 for two in-use vessels. However, they are in the process of designing new-build vessels due to some of the fleet nearing the end of their useful life. SFBP stated a critical concern is whether they will be able to obtain funding for the new-build vessels. While legislation was passed in 2022 and 2024 to allow SFBP to raise pilotage fees specifically to cover costs of obtaining new pilot boats to comply with state regulations,[35] SFBP stated they would need time to collect enough fees to cover the new vessel costs and would potentially need loans to initially cover costs of new vessels. CARB staff recommended SFBP apply for a combination of available extensions to address the new-build timeline as well as the new-build affordability if they are unable to obtain funding. In December 2024, CARB approved the extension applications submitted by SFBP.

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[34] Grant Solicitation for the Advanced Technology Demonstration and Pilot Program, Gov Delivery, *Grant Solicitation for the Advanced Technology Demonstration and Pilot Projects (govdelivery.com)*, July 14, 2023.

[35] Webpage *Bill Text - AB-2056 Bar pilots: pilotage rates.* Assembly Bill 2056 (Statutes of 2022) and Senate Bill 295 (Statutes of 2024) *California-2023-SB295-Chaptered*

Meeting with Western States Petroleum Association

On May 14, 2024, CARB staff held a remote meeting with the Western States Petroleum Association (WSPA) and representatives from several WSPA member companies for the purpose of clarifying requirements of the amended CHC Regulation for marine oil terminal facility operators. The concerns raised by WSPA and its members are described further below in this chapter under "Implementation Concerns."

Statewide Outreach by CARB Enforcement

Since late 2023, CARB Enforcement staff have assisted CHC implementation through in-person outreach conducted statewide, from Crescent City to San Diego, and inland. This outreach has primarily taken the form of scheduled meetings and door-to-door contacts with facilities, operators, and organizations at all levels, including local, state, and federal public institutions and non-profits, but with a specific focus on connecting with regulated stakeholders in private industry.

CARB Enforcement staff's outreach has been comprised of three distinct efforts. First, Enforcement staff have met with 144 specific parties for education and information exchange regarding the new CHC Regulation requirements. Second, Enforcement staff have made 96 contacts with marine fuel providers to examine California's at-the-pump supply of renewable diesel (R99) for marine vessels. And third, Enforcement staff have met with 10 California ports to establish improved communications on CHC Regulation-related topics. CARB Enforcement's outreach efforts are ongoing.

Other Methods of Outreach

To ensure effective communication and engagement with stakeholders on regulatory matters, CARB staff utilizes a variety of outreach methods. These tools are designed to help stakeholders to understand the regulation, for CARB staff to share updates, and provide resources in a clear and accessible manner. Below are the key methods employed in staff's outreach strategy.

Commercial Harbor Craft Inbox

The Commercial Harbor Craft (CHC) inbox[36] is a dedicated email system where industry, community members, and other interested parties can submit inquiries, applications, reports, provide feedback or request information. The CHC inbox is monitored daily by CARB staff to ensure timely responses and address needs efficiently.

Gov Delivery Notification

Gov Delivery[37] is the email subscription service CARB utilizes to send out important updates and announcements to a broad audience. Subscribers receive timely notifications on CHC

[36] The CHC Inbox can be reached at *harborcraft@arb.ca.gov*

[37] California Air Resources Board, Email Updates, *Gov Delivery subscription*

program topics, such as public meetings and workshop invitations, program and implementation updates. The subscription list for the CHC Regulation currently has approximately 7,000 subscribers.

Factsheets and Other Resources

CARB staff have developed more than 15 factsheets that are posted on the CHC Program webpage[38] to clearly communicate key provisions of the Regulation. While not a substitute for the Regulation itself, the factsheets serve to clarify complex issues and serve as quick reference guides for the Regulation's requirements. In addition to factsheets, the CHC program website[39] provides various other resources, including reporting templates, application templates, meetings and workshop materials, regulatory documents, Technical Working Group materials, documents related to USCG coordination, a list of reported vessels, a list of commercially available Tier 4 engine models, and a list of certified opacity testing vendors.

Implementation Status

U.S. EPA Partial Authorization Received On January 10, 2025

CARB submitted an authorization request to U.S. EPA pursuant to section 209(e) of the Clean Air Act on January 31, 2023, and received a partial authorization on January 10, 2025.[40] EPA held a virtual hearing on June 1, 2023, and a written comment period was opened from June 1, 2023 to July 1, 2023 to provide interested parties the opportunity to present testimony and comments concerning the CHC Regulation amendments.[41] The lapse in time from CARB's authorization request to EPA's action significantly hindered the effective implementation of the amended Regulation through early 2025. In July 2025, CARB completed its evaluation of the partial authorization on CHC Regulation implementation and posted a factsheet on the CHC Program webpage.[42] As described in the factsheet, EPA authorized all components of the regulation except Zero Emission and Advanced Technology (ZEAT) requirements for in-use short run ferries and emission standards for in-use engines and vessels (excluding commercial fishing vessels) that would apply after the expiration of feasibility extensions, specifically extension E3. CARB's factsheet describes the impacts of the partial authorization on implementation of the components of the Regulation that EPA did not take action on. CHC Program staff are

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[38] California Air Resources Board, *Commercial Harbor Craft Factsheets*

[39] California Air Resources Board, *Commercial Harbor Craft*

[40] Federal Register, Vol. 90, No. 6, Friday, January 10, 2025. *2025-00465.pdf*

[41] United States Environmental Protection Agency, Public Hearing Information for Authorization Request for California's Commercial Harbor Craft Regulation, *Public Hearing Information for Authorization Request for California's Commercial Harbor Craft Regulation | US EPA*

[42] California Air Resources Board, CHC Factsheet: EPA Partial Authorization of Commercial Harbor Craft Regulation, *CHC Factsheet: EPA Partial Authorization of Commercial Harbor Craft Regulation July 28th, 2025*

available to discuss questions from regulated entities on how the partial authorization impacts their compliance responsibilities.[43]

Reporting and Compliance Fees

CHC Reporting Database

The amended Regulation adopted in 2022 contains expanded reporting requirements compared to the previous Regulation. The previous Regulation only required periodic reporting after certain actions were taken, such as an engine repower or vessel sale. The amended Regulation requires annual reporting, which helps CARB keep accurate information regarding in-use engines, vessels, and uptake of zero-emission technologies. This information is critical to effective implementation and enforcement of the Regulation.

Number of Reports Received in 2023 and 2024

The amended CHC Regulation requires all vessel owners or operators to submit a complete report annually for all harbor craft vessels in their California fleet by March 31 of each year beginning January 1, 2023. This represents a change from the original CHC Regulation, which required operators to submit a one-time report and required updates only for specified circumstances, such as after an engine was repowered.

CARB received approximately 250 reports representing about 860 vessels reported from vessel owners and operators in 2023, 220 reports representing about 640 vessels reported in 2024, and 188 reports representing about 870 vessels reported in 2025. This reflects an estimated 17%, 15%, and 13% reporting rate by number of companies and 34%, 26%, and 34% reporting rate by number of vessels for 2023, 2024, and 2025, respectively. The actual reporting rates are likely lower still, because the above percentages are based on the number of harbor craft companies (1,470) and individual vessels (2,500) that had been reported under the previous CHC Regulation by the end of 2022, and assumes those numbers represent 100% compliance.

CARB staff believe that multiple factors including the lack of EPA authorization (prior to January 10, 2025) and a lack of awareness of the new requirement to report annually are hindering compliance with the reporting provisions of the Regulation. CARB is attempting to increase awareness of the requirements through outreach efforts, which were previously discussed in this chapter under "Statewide Outreach by CARB Enforcement" and "Other Methods of Outreach." As of September 2025, CARB is conducting direct outreach to vessel operators that have not yet submitted reports.

[43] CHC Program staff can be reached at *harborcraft@arb.ca.gov*.

Fee Collection

The amended CHC Regulation established compliance fee requirements, mandating fees to cover CARB's costs of implementing the CHC Regulation. Fees are based on the number of vessels and main engines in each fleet for all vessel categories except commercial fishing.

Extensions and Other Compliance Pathways

Compliance Extensions, Low Use, and ZEAT

The amended CHC Regulation provides several compliance extensions for various circumstances that may prevent regulated parties from demonstrating compliance with applicable requirements by the deadlines in the Regulation.[44] The compliance extensions E1-E5 provide compliance deadline flexibility in the following situations:

- Delays for shore power and ZEAT infrastructure (E1)
- Lack of available technology (E2)
- Technology infeasibility and financial hardship (E3)
- Tier 3 or cleaner engines by Dec. 31, 2024 in Commercial Passenger Fishing Vessels (CPFV) (E3)
- Diesel particulate filter (DPF) infeasibility and limited annual operation hours (E4)
- Manufacturing delays or overlapping compliance dates (E5)

From January 1, 2023 through September 2025, CARB has received a total of 175 applications for compliance extensions. These include 21 applications for extension E1, 12 applications for extension E2, 3 applications for extension E3 for non-CPFV, 77 applications for extension 3 for CPFV, and 62 applications for extension E5. Additionally, CARB has received 35 low-use applications, 12 zero-emission and advanced technology (ZEAT) applications, and 20 applications for other specific requirements, such as the shore power infrastructure exemption available to facilities receiving fewer than 50 CHC vessel visits per year.

To support CARB's evaluation of feasibility-related extension requests, CARB has contracted with the American Bureau of Shipping (ABS) to perform reviews of non-CPFV E3 feasibility studies conducted by third-party naval architects. These reviews ensure that each E3 extension request is thoroughly assessed for technical feasibility and meets the applicable requirements. As of mid-2025, ABS has completed evaluation of two feasibility studies for CARB and is in the process of evaluating two more.

Alternative Compliance Pathways

The amended CHC Regulation provides an alternative option to comply with the regulatory requirements. This pathway provides flexibility by allowing an alternative control of

[44] California Code of Regulations (CCR) title 17, section 93118.5, and title 13, section 2299.5, *Final Regulation Order (ca.gov)*, subsection (e)(12)(E) Compliance Extensions, p. 80-89, December 30, 2022.

emissions (ACE) compliance strategy,[45] provided vessel owners or operators can demonstrate that the alternative strategy, on a fleetwide basis, will achieve diesel particulate matter (PM) and oxides of nitrogen (NOx) emission reductions equal to or greater than those required by direct compliance with the Regulation, cumulatively from January 1, 2023 through December 31, 2034. Since January 1, 2023, CARB has received two ACE applications. One was undergoing staff review as of September 2025 and will be publicly posted for comment pursuant to the requirements of the Regulation once CARB determines the application is complete. The second ACE application was submitted by the Water Emergency Transportation Authority (WETA), which is the operator of the San Francisco Bay Ferry. WETA's ACE plan received CARB approval on March 6, 2025.[46] Under the ACE plan, WETA plans to convert four of its 17 existing vessels to full battery-electric propulsion, replace four vessels with new build vessels (two ZEAT and two with Tier 4 engines that include DPFs), and build three additional new zero emission short run ferries.[47]

Renewable Diesel (R99) Availability

The amended CHC Regulation requires that all CHC operating in California operate on renewable diesel fuel (R99) as of January 1, 2023. R99 is a drop-in fuel that meets the same specifications as petroleum diesel fuel.[48] During the rulemaking process, CARB received several comments regarding concerns about the availability and reliability of R99 products, with requests to extend the fuel requirement until January 1, 2024. CARB staff responded to these comments in the Final Statement of Reasons (FSOR) published July 21, 2022, which stated that discussions with renewable diesel producers indicated there would be sufficient renewable diesel to accommodate the anticipated demand, especially with large oil companies transitioning their refineries to produce solely renewable diesel.[49] However, vessel operators continued to express concerns about R99 availability into late 2022. In response, CARB staff reached out to several R99 producers and compiled a fact sheet listing companies that had confirmed they were selling R99 for use in marine vessels.[50] In 2022, R99 producers told CARB staff that both foreign and domestic R99 production capacity would be ramping up throughout 2023 and would reach full capacity in early 2024. As of late 2024, CARB staff were aware of multiple renewable diesel producers producing and distributing renewable diesel in California, including the following entities:

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[45] California Code of Regulations (CCR) title 17, section 93118.5, and title 13, section 2299.5, *Final Regulation Order (ca.gov)*, subsection *(f) Alternative Control of Emissions (ACE)*, page 94, December 30, 2022.

[46] CARB Final Action, letter to Seamus Murphy, WETA Executive Director, March 6, 2025, *FAB25-020 - Final Action on WETA ACE Plan.pdf*.

[47] CARB Proposed Action, letter to Seamus Murphy, WETA Executive Director, January 17, 2025, *FAB24-173 - CARB Proposed Action on WETA ACE Plan.pdf*.

[48] CARB, CHC Factsheet: Renewable Diesel (R100 or R99), *CHC Factsheet: Renewable Diesel (R100 or R99) | California Air Resources Board*, December 20, 2022.

[49] CARB, page 327 and page 331, Final Statement of Reasons, *Final Statement of Reasons (FSOR)*, July 21, 2022

[50] CARB, CHC Factsheet: Renewable Diesel (R100 or R99), *CHC Factsheet: Renewable Diesel (R100 or R99) | California Air Resources Board*, December 20, 2022

- Phillips 66[51] stated on April 1, 2024 that it was producing 30,000 barrels per day of renewable diesel (about 460 million gallons annually) at its Bay Area Rodeo facility and was on track to increase renewable diesel fuel production in early-mid 2024 to roughly 800 million gallons annually.
- NESTE, in a joint venture with Marathon Petroleum[52]in Martinez, California, was projected in August 2023 to have 730 million gallons of annual production capacity in Martinez by the end of 2023.
- NESTE, producing 3.3 million tons[53] (nearly 1 billion gallons) annually as of late 2023, had expanded its distribution footprint in both Northern and Southern California in partnerships with NuStar[54] and Vopak[55], respectively.

The above numbers show that the volume of renewable diesel being produced in California vastly exceeds the estimated annual use of 55 million gallons[56] for commercial harbor craft in California.

CARB Enforcement staff have also assessed R99 availability as part of their statewide outreach. Of 96 CHC fueling stations visited statewide in 2023 – 2024, approximately half confirmed they offer R99 for marine vessels. Spatially, R99 providers were identified in all coastal regions including the North Coast of California, Bay Area, Central Coast, Los Angeles and San Diego, as well as within inland waterways.

CARB Enforcement staff observed that both fuel distributors and end users were frequently unaware that biodiesel and renewable diesel are distinctively separate fuel products, leading to a common misconception that CARB is requiring vessels to use biodiesel. In many cases, CARB Enforcement staff found that fuel suppliers had switched from providing petroleum diesel to providing R99 without the fuel dock distributors or vessel operators realizing the change.

Opacity Testing

The amended CHC Regulation requires biennial opacity testing of main engines beginning in 2024. To assist vessel owners and operators in meeting the requirements, CARB staff contracted with California Council on Diesel Education and Technology (CCDET)[57] to

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[51] Phillips 66, News Releases, *Phillips 66 Announces Major Milestone in Production of Renewable Diesel* , April 1, 2024.

[52] Francis Stokes, *Marathon: Phase II of Martinez Conversion on Track to be completed by 2023*, August 4, 2023.

[53] Neste, *How are renewable fuels produced?* 12/7/2023 updated 10/30/2024

[54] Nustar, *Neste, NuStar expand renewable fuel hub in Northern California*, April 13, 2021.

[55] Neste Corporation, News, *Neste expands its renewable fuels supply capabilities in Southern California*, September 27, 2023.

[56] Staff Report: Initial Statement of Reasons, p. III-18, *02. CHC ISOR*, September 21, 2021.

[57]California Council on Diesel Education and Technology, *California Council on Diesel Education and Technology (CCDET) | California Air Resources Board*

develop and conduct a CCDET IV CHC Opacity Testing Certification Course.[58] Under this contract, CCDET conducted 18 certification courses at various CCDET campus locations throughout California during 2023 and six more during early 2024 at no cost to registered attendees. Over 175 CHC operators and individuals from third-party opacity testing vendors obtained certification to perform opacity testing on vessels.

To further assist industry, CARB staff posted a factsheet and guidance documents to summarize and clarify the opacity testing requirements[59] and a list of CCDET IV-certified CHC opacity testing vendors offering commercial CHC opacity testing services.[60] CARB staff have also worked with industry to address specific challenges with opacity testing, such as testing procedures for marine engines in vessels having wet exhaust systems.

Coordination with Funding Programs

CARB and other funding sources,[61] such as federal agencies, offer several funding opportunities to assist vessel owners or operators in meeting the requirements of the amended Regulation. These funding programs are designed to ease the financial burden of compliance by supporting the adoption of cleaner technologies and incentivize earlier upgrades to gain additional emissions reductions prior to compliance dates. CARB staff implementing the CHC Regulation have worked alongside staff implementing CARB funding programs to ensure funding program guidelines are in alignment with regulatory requirements, or provide additional emissions reductions where required, and recipients of incentive funding are in compliance with CARB regulations to maintain the integrity of the programs. The key CARB funding programs that have supported CHC projects are described below.

Clean Transportation Incentives: Sustainable Heavy-Duty Initiatives for Future Technology (SHIFT)

CARB offers the Sustainable Heavy-Duty Initiatives for Future Technology (SHIFT), formerly called the Advanced Technology Demonstration and Pilot Projects[62] funding program, that is designed to accelerate the introduction of advanced technologies into California by pushing technology advancement toward commercialization. During the 2022 – 2023 funding cycle, several harbor craft projects were awarded funding,[63] including

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[58] California Council on Diesel Education and Technology, Class Schedule, *Class Schedule | California Council on Diesel Education and Technology (CCDET)*

[59] CARB, Opacity Testing Factsheet, *Commercial Harbor Craft Factsheets*

[60] CARB, Commercial Harbor Craft Resources, California Air Resources Board (CARB) List of CCDET IV-Certified Opacity Testing Vendors for Commercial Harbor Craft (CHC), *CCDET IV Opacity Smoke Tester Vendor List* (Updated 11/4/2024).

[61] CARB, CHC Factsheet: Funding Programs, *Funding Factsheet*, September 27, 2023.

[62] CARB, Sustainable Heavy-Duty Initiatives for Future Technology, *Sustainable Heavy-Duty Initiatives for Future Technology*

[63] California Energy Commission/California Air Resources Board Advanced Technology Demonstration and Pilot Projects, Notice of Proposed Awards, March 29, 2024. *ATDPP_NOPA_Results_Table2024-03-29.xlsx (live.com)*

zero-emission, zero-emission capable hybrid and Tier 4 projects in the vessel categories of tugboat, commercial fishing, excursion, ferry and charging infrastructure, using funds allocated by the Board and $60 million in funds appropriated by California's Legislature through Assembly Bill (AB) 179[64] specifically for compliance with the amended CHC Regulation.

Carl Moyer Memorial Air Quality Standards Attainment Program

The Carl Moyer Program[65] provides grant funding for cleaner-than-required engines and equipment, either cleaner technology than required, and/or earlier than required by Regulations. As of 2021, The Carl Moyer Program had funded more than 2,200 marine vessel projects totaling over $175 million in awarded funding in California since the program's inception in 1998.[66] The majority of funded engine replacements have been on commercial fishing or charter fishing (referred to in the Regulation as CPFV), however nearly all categories of harbor craft have been funded including over 100 projects each in the tugboat, ferry/excursion, and workboat categories.[67] Since the amended CHC Regulation went into effect on January 1, 2023, the Carl Moyer Program has funded 28 projects in the commercial passenger fishing, commercial fishing, ferry/excursion and workboat categories.

Community Air Protection Incentives

Since 2017, the California Legislature has budgeted $1.4 billion to support Assembly Bill (AB) 617 with incentives administered by local air districts in partnership with communities. The Community Air Protection Incentives Program (CAP Incentives Program)[68] puts advanced technologies to work for cleaner air in the California communities that are most heavily impacted by disproportionate levels of air pollution. Since the amended CHC Regulation went into effect on January 1, 2023, the CAP Incentive Program has funded 6 projects in the commercial passenger fishing, commercial fishing, ferry/excursion, and workboat categories.

Volkswagen Environmental Mitigation Trust

The Volkswagen (VW) Environmental Mitigation Trust[69] provides about $423 million for California to mitigate the excess oxides of nitrogen (NO_X) emissions caused by VW's use of illegal emissions testing defeat devices in certain VW diesel vehicles. Since the amended CHC Regulation went into effect on January 1, 2023, the VW mitigation program has

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[64] Assembly Bill 179 (Ting, Chapter 249, Budget Act of 2022) *Bill Text: CA AB179 | 2021-2022 | Regular Session | Chaptered | LegiScan*.

[65] CARB, Carl Moyer Memorial Air Quality Standards Attainment Program, *Carl Moyer Memorial Air Quality Standards Attainment Program*

[66] 2021 Carl Moyer Program Statistics, Table 2, p. 6. Corrected 10/04/2023, *2021 Carl Moyer Program Statistics*

[67] 2021 Carl Moyer Program Statistics, Table 6, p. 12. Corrected 10/04/2023, *2021 Carl Moyer Program Statistics*

[68] CARB, *Community Air Protection Incentives | California Air Resources Board*

[69] CARB, Volkswagen Environmental Mitigation Trust Program, *Volkswagen Environmental Mitigation Trust*

contracted six vessel repower projects. In total since 2020, 11 vessel projects totaling nearly $40 million in funds had been awarded as of late 2024 in the categories of zero-emission freight and marine and combustion freight and marine.[70] The zero-emission projects include one tug and four ferries, and the cleaner combustion projects include six tugboat repowers.

Clean Off-Road Equipment Voucher Incentive Project

The Clean Off-Road Equipment Voucher Incentive Project (CORE)[71] is an incentive program intended to encourage California companies to purchase or lease currently commercialized zero-emission off-road equipment by providing a streamlined voucher process to offset the higher cost of such technologies. Since the amended CHC Regulation went into effect on January 1, 2023, the CORE program has issued 36 active vouchers, totaling approximately $12 million for CHC.

Implementation Concerns

Funding

Despite the success of available incentive funding programs, securing adequate funding remains a concern for many vessel owners or operators, who have stated they need financial assistance to upgrade to cleaner engines or adopt advanced technologies and to install the infrastructure necessary for zero-emission and advanced technology (ZEAT) projects. However, some operators may not qualify for available funding due to eligibility restrictions within the funding programs, including matching fund requirements, inadequate surplus emission reductions for programs that either require a minimum surplus of emission reductions or calculate funding based on emission reductions achieved, and the need for upfront capital for reimbursement programs.

Tier 4 Engine Repower and DPF Retrofit Feasibility

The amended CHC Regulation's performance standards are equivalent to a Tier 4 engine (Tier 3 if it is the cleanest available under 600 kilowatts (kW)) plus a CARB-verified Level 3 DPF, when they become commercially available.[72] Installation of Tier 4 engines[73] plus retrofit DPFs into existing vessels can be difficult due to space and weight constraints and impact on vessel stability. This issue was raised by industry throughout the rulemaking[74] and continues to be a key concern. As described in Chapter 2, the Technical Working Group meeting held on August 7, 2024 included a panel discussion on Tier 4 repowers. Meeting attendees and panelists reiterated that the feasibility of installing Tier 4 engines and DPF

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[70] *California VW Mitigation Trust*, Last Accessed November, 2024.

[71] CARB, Clean Off-Road Equipment Voucher Incentive Project, *Clean Off-Road Equipment Voucher Incentive Project (CORE)*

[72] Commercial availability of DPFs is further discussed in Chapter 4.

[73] Most Tier 4 engines are equipped with Selective Catalytic Reduction (SCR) aftertreatment to reduce NOx, which requires additional space for the SCR and Diesel Exhaust Fluid (DEF) storage.

[74] Page 74, Comment 2602.2, *Final Statement of Reasons (FSOR)* July 21, 2022.

exhaust aftertreatment retrofits into existing vessel designs remains a challenge. However, the E3 feasibility extension is available for situations where fitment into existing vessels is not feasible and the operator cannot afford a vessel replacement.

DPF Safety

The issue of DPF safety was raised during the rulemaking,[75] and continues to be raised by regulated industry. There are currently millions of DPFs installed and successfully reducing particulate matter emitted from engines on a variety of on-road and off-road equipment. As described further in Chapter 4, DPFs for marine vessels are currently undergoing CARB verification, and over 9,000 hours of DPF operation have been accumulated on marine vessels operating in California with no documented safety incidents attributed to the DPF. However, the potential for DPF failure modes that could cause a loss of propulsion power and reduce vessel maneuverability has continued to be a concern of vessel operators and USCG, and USCG regulations point to the need to maintain a minimum level of vessel propulsion in the event of a component failure or malfunction.[76] To address this concern, CARB issued Executive Order DE-24-003[77] on September 12, 2024 to specify a process for allowing an OEM-integrated and monitored bypass system on CARB-verified DPFs, which would allow for continued operation of an engine if the DPF were to malfunction. This solution addresses safety concerns while maintaining the public health benefits of the DPF requirement in the amended CHC Regulation.

Other Concerns Regarding Tier 4 Engine Installations

In addition to Tier 4 engine and DPF installation feasibility and safety, other concerns were raised by industry during the Technical Working Group meetings, including:

- Increased engine compartment temperatures from Tier 4 engine SCR aftertreatment and DPF aftertreatment can negatively impact crew comfort.
- Increased auxiliary engine power may be needed to support DPF regeneration.
- There is a potential for increase in low frequency engine noise in installations where a muffler is removed to fit a DPF within an existing vessel structure.
- Vessel hull reconfigurations to accommodate Tier 4 engines and DPFs in existing vessel designs could exceed vessel regulatory class tonnage limits putting certain vessels into different regulatory classes. Vessels could then be subject to additional USCG and International Maritime Organization (IMO) safety of life at sea (SOLAS) regulatory oversight and requirements. According to one line-towing tugboat fleet operator, this would negatively impact economic viability of continued operation in California.

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[75] Page 19, Master Response 1: Safety of New Requirements, *Response to Comments on the Draft Environmental Analysis*, March 14, 2022.

[76] CARB, USCG Coordination, *CARB letter to USCG dated November 13, 2023*

[77] CARB, USCG Coordination, *CARB Executive Order for Bypass Systems on VDECS for CHC signed September 12, 2024* .

Electrical Grid Infrastructure for ZEAT Vessels

During the Technical Working Group meetings, stakeholders described a lack of available grid infrastructure and grid power to support electric ZEAT vessel operation in their specific locations. Additionally, stakeholders cited cost and complexity of environmental studies, engineering costs, construction permitting costs, high construction costs, high costs for shore-side battery energy storage system components, and high costs for ZEAT charging equipment as challenges to implementing ZEAT projects. The Regulation contains an extension for infrastructure delays, which is available for up to two years, and is applicable to ZEAT infrastructure delays in addition to shore power delays.

CARB-Verified Level 3 Marine DPFs

DPFs are currently undergoing CARB verification but Level 3 marine CARB-verified DPFs are not yet commercially available for CHC engines.[78] Once CARB-verified Level 3 marine DPFs become commercially available, they will be mandatory for compatible engines on both in-use and newly built vessels unless the engine already meets the amended CHC Regulation performance standards in its EPA-certified configuration. The Executive Order for a CARB-verified DPF will contain a list of the engine models that are compatible with the DPF. Major engine OEMs are now certifying Tier 4 engines with built-in DPFs, which meet the performance standards of the amended CHC Regulation without retrofit aftertreatment. These developments are discussed in greater detail in Chapter 4. In cases where retrofit DPFs and engines with OEM DPFs are not yet available, vessel operators can apply for a compliance extension that is renewable until the equipment becomes available.

Shore Power at Marine Oil Terminals for ATBs

Since January 1, 2024, the Regulation has required vessels operating auxiliary generators under 99 kW to plug into shore power while docked. In late 2023, several marine oil terminal operators began telling CARB staff that they had only recently become aware of the CHC shore power requirement and were not ready to comply with it. The companies have stated their biggest challenge is compliance for articulated tug barges (ATBs), which are vessel combinations composed of an ocean-going tug and a petrochemical tank barge. ATB's dock inside electrically classified areas (ECAs) due to their petroleum cargoes, which presents unique safety considerations.

CARB staff first presented the regulatory concept of shore power requirements for CHC at its December 2018 workshops.[79] CARB staff conducted a survey of vessel operators during the rulemaking which indicated that shore power was already in widespread use for CHC,[80]

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[78] The status of commercial availability of DPFs is discussed further in Chapter 4.

[79] CARB, CHC December 2018 Workshop Materials, *Public Workshop to Discuss Additional Requirements for the Commercial Harbor Craft (CHC) Regulation*, December, 2018.

[80] page E-116, Overview of Current Industry Practices, *Appendix E: Technical Support Document and Assessment of Marine Emission Control Strategies, Zero-Emission, and Advanced Technologies*, September 21, 2021

and subsequently presented the shore power concept in more detail in March 2020.[81] CARB did not receive any comments during the rulemaking from the marine oil terminal operators. However, CARB did receive many comments and active engagement throughout the rulemaking from the ATB vessel operators the marine oil terminals contract with.[82]

In the May 14, 2024 meeting with CARB, WSPA members told CARB staff that they had been unaware of the CHC shore power requirement until recently. The members stated that no certified components are commercially available to provide the lower voltage shore power that ATBs would require in the ECAs, that work was already being done on higher voltage technological solutions and associated certifications for ocean-going vessel shore power connections, but that more time would be needed to develop and certify lower voltage CHC shore power components for ECA shore power connections.

The amended CHC Regulation includes an extension that provides up to two additional years for facilities actively working to install shore power infrastructure for CHC. As of early 2025, staff were working individually with several terminal operators who have applied for infrastructure extensions to clarify the pathway and timeline for compliance.

As of early 2025, CARB staff were also aware of one terminal operator that has completed installation of shore power infrastructure for harbor tugs in response to the CHC Regulation requirements. Multiple other terminal operators have demonstrated to CARB that they are actively working toward installing shore power for auxiliary generators under 99 kW on ATBs. Documentation provided to CARB included identification of equipment that would be used in the installation and a tentative timeline for installation targeting commissioning of the system in 2027. Another terminal operator had already installed a shore power system for auxiliary generators under 99 kW on ATBs and was working with their CHC partners to ensure on-vessel systems had compatible hardware and appropriate safeguards to connect. Another terminal operator indicated to CARB staff that the timeline for development of shore power for auxiliary generators under 99 kW on ATBs is likely six years, at minimum, due to the time needed for prototyping equipment, procurement and manufacturing, and CEQA permitting. Terminal operators have also stated concerns regarding which entity would assume responsibility and liability for transfer of shore power equipment between the vessel and terminal. The CHC Regulation does not specify which entity is responsible for the transfer of shore power equipment between the vessel and terminal, therefore responsibility would be negotiated between the respective entities.

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[81] CARB, CHC Webinar Presentation - March 2020, *WEBINAR: Overview of Proposed Concepts for Amendments to the Commercial Harbor Craft Regulation*, March 5, 2020.

[82] CARB, Public Hearing to Consider the Proposed Amendments to the Commercial Harbor Craft Regulation, *Final Statement of Reasons for Rulemaking, Including Summary of Comments and Agency Response*, July 21, 2022.

Inclusion of Articulated Tug Barges in the Amended CHC Regulation - 2023 Petition

CARB staff continue to hear concerns from the ATB industry regarding their inclusion in the CHC Regulation. On June 30, 2023, CARB received a petition from Holland & Knight, LLP, on behalf of Crowley Maritime Corporation, requesting CARB to exempt larger ATBs from the CHC Regulation, and instead subject ATBs to the provisions of the Control Measure for Ocean-Going Vessels At Berth (At Berth Regulation).[83]

CARB denied the petition on the basis described in its September 5, 2023 response.[84] The ATB industry has made recommendations to CARB to regulate ocean-going tugboats and ATBs under the At Berth Regulation instead of the CHC Regulation during the initial CHC Regulation rulemaking action in 2007, the 2020 At Berth Regulation, and the 2022 CHC Regulation amendments. Generally, CARB has found that ATBs have physical and operational characteristics that align more closely with other definitions of CHC than with ocean-going tanker vessels, and the inclusion of ATBs in the CHC Regulation ensures that all ocean-going tugs and all barges, whether part of ATBs or line towed by other ocean-going tugs, are subject to the same requirements.[85]

It is also important to note that the scope of the At Berth Regulation's requirements is more limited than the requirements under the CHC Regulation, therefore, fewer emission reductions would be achieved if ATBs were regulated under the At Berth Regulation. As Crowley stated in their petition, their ATBs were developed and designed specifically for West Coast operations and weather conditions.[86] Also, as noted in CARB's petition response and further described in Chapter 4 of this report, technologies to reduce emissions from engines on ATBs are commercially available today.[87]

Confusion Regarding Facility Requirements and Responsibility for CHC Shore Power Infrastructure

As stated above, since January 1, 2024, the Regulation has required vessels operating auxiliary generators under 99 kW to plug into shore power while docked. This requirement applies only to vessels visiting facilities where shore power is available. Facilities that receive

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[83] Petition to Amend Regulations Regarding Commercial Harbor Craft and Ocean-Going Vessels At Berth, *2023 Petition | California Air Resources Board.* June 30, 2023.

[84] CARB Response to Petition Seeking Amendment of California's Regulations Regarding Commercial Harbor Craft and Ocean-Going Vessels At Berth, *CARB Response to Petition Seeking Amendment of California's Regulations for Commercial Harbor Craft and Ocean-Going Vessels At Berth*, September 5, 2023.

[85] CARB, Final Statement of Reasons, Proposed Control Measure for Ocean-Going Vessels At Berth (2020), at pp. 61 – 62. *At Berth Final Statement of Reasons (ca.gov)*.

[86] Petition, Exhibit A, p. 4 and Exhibit E, p. 4. *2023 Petition | California Air Resources Board.* June 30, 2023.

[87] CARB Response to Petition Seeking Amendment of California's Regulations Regarding Commercial Harbor Craft and Ocean-Going Vessels At Berth, p. 19. *CARB Response to Petition Seeking Amendment of California's Regulations for Commercial Harbor Craft and Ocean-Going Vessels At Berth*. September 5, 2023.

50 or more CHC vessel visits per year are required to install shore power. However, CARB staff observed during the Technical Working Group meetings, and other meetings with industry, that some facility operators and their respective industry organizations are unclear on how to determine when they must install 99 kW shore power infrastructure. CARB staff have communicated individually with facility operators to clarify the requirements and held a meeting with Pacific Merchant Shipping Association (PMSA) at their request on September 9, 2024, to provide clarification on the requirements for facility operators.

CARB staff understands that the confusion is arising because of some overlap in the Regulation language between the facility operator shore power infrastructure requirements[88] and the engine idling limits for vessel operators.[89] CARB staff have recommended to both facility operators and vessel operators that they communicate with each other to determine shore power needs and responsibility. It is imperative that the facility operators understand their vessel operators' shore power needs to determine whether the facilities are required to install it, based on the annual number of vessel visits by vessels that require shore power to meet the Regulation's idling limits.

Written Comments Received from Technical Working Group

CARB staff invited stakeholders and all interested parties to submit their feedback and comments on the Technical Working Group by August 31, 2024.

CARB staff received one comment letter, from WSPA.[90] In its email transmitting the letter, WSPA stated:

> *We appreciate the focus on technology adoption and implementation. We urge CARB to allocate more time on the discussion of the safety and feasibility challenges of facilities implementing the shore power requirement at marine oil terminals or facilities and vessels with classified areas such as hazardous zones. Based on our discussion this afternoon, there appear to be quite a few challenges to continue to work through.*

WSPA's comment letter reiterates concerns that members have conveyed regarding the status of technology and safety concerns associated with shore power in electrically classified areas and asks CARB to "consider the safety and feasibility challenges of harbor craft involved in transporting and transferring flammable petroleum products attempting to implement shore power while alongside marine oil terminals. WSPA specifically requests discussions to:

> "(1) establish a clear understanding of applicability;
> (2) define limitations in infrastructure options;
> (3) consider a reasonable implementation timeline;

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[88] Subsection (i), page 101, *Final Regulation Order: title 13, section 2299.5 and title 17, section 93118.5*
[89] Subsection (h), page 100, *Final Regulation Order: title 13, section 2299.5 and title 17, section 93118.5*
[90] California Air Resources Board." WSPA comment letter." *WSPA Comment Letter*. 2024.

(4) address the shore power requirement in a manner consistent with the ongoing CARB At Berth Regulation process."

WSPA's letter further requests that:

- "CARB provide insight as to how CARB and the USCG are jointly considering safety and operational feasibility of the proposed marine oil terminal electrification requirements."
- "CARB provide feedback on the electrification readiness of petrochemical tank barges or tugs operating throughout the state of California and shore power infrastructure installation readiness for petrochemical tank barges or tugs that would operate in an electrically classified or hazardous area."
- "Insights from CARB that have been provided through the recent vessel reporting."
- "CARB verify that ABS (Preliminary HAZID for Emission Control Barge) and UC Irvine are performing feasibility studies in support of this rulemaking. If so, [WSPA] further request[s] that CARB advise stakeholders as to how these studies will be utilized and whether they will be available for public review and comment prior to finalization."
- "CARB provide any pertinent risk assessment work that has been conducted for vessels undergoing DPF retrofits, as well as any comparative evaluation of DPF installation in new builds versus retrofits."

CARB's Response:

The issue of shore power at marine oil terminals is discussed earlier in this chapter under "Shore Power at Marine Oil Terminals." As described in Chapter 3, CARB meets monthly with the USCG regarding implementation of the CHC Regulation, including safety and operational concerns. Staff is aware that USCG requires compliance with all applicable National Fire Protection Association (NFPA) and other standards that would apply to a terminal's shore power installation. As stated in subsection (b)(5) of the CHC Regulation, the CHC Regulation does not amend, repeal, modify, or change USCG regulations.

The CHC Regulation was approved by CARB's Board on March 24, 2022 and approved by California's Office of Administrative Law on December 30, 2022 following a five-year rulemaking process. CARB does not have the authority to change the existing requirements or implementation timeline without undertaking a new rulemaking. However, CARB is aware that terminal operators are undertaking feasibility studies, mapping out compliance timelines, and installing equipment. Staff are working with these companies through the extension processes provided in the Regulation, and are committed to working with regulated entities case-by-case to address individual circumstances and identify available compliance pathways.

Staff assumes that "insights from CARB that have been provided through the recent vessel reporting" refers to the infrastructure extension (E1) applications CARB has received, which is discussed earlier in this chapter. Unlike the Control Measure for Ocean-Going Vessels At Berth, the CHC Regulation does not require reporting of individual vessel visits.

The ABS report identified in WSPA's comment letter is related to capture and control barges used to control emissions from tanker vessels at berth, and is not pertinent to the CHC Regulation. However, CARB did contract with ABS to conduct a feasibility study for specific categories of CHC, which is further described in Chapter 1 in the section "Resources Used in Developing this Report."

DPFs undergo rigorous evaluation and testing through CARB's Verification Procedure prior to becoming CARB-verified. The topic of DPF safety is discussed earlier in this chapter under "DPF Safety."

Chapter 4 – Commercial Availability of Tier 4 Engines and Cleaner Combustion Technologies

Purpose of Chapter 4

Chapter 4 provides an update on the commercial availability of Tier 4 diesel engines, exhaust aftertreatment technologies, and how advancements in commercial availability have improved technological feasibility to meet the amended CHC Regulation's Tier 4 + DPF Performance Standards[91] in existing vessel designs. Chapter 4 also discusses recent Tier 4 + DPF feasibility analyses and USCG processes for reviewing CHC vessel design changes and inspecting and certifying equipment installations.

Update on Tier 4 Engine Availability and Cleaner Combustion Technologies

Assessment of Tier 4 Engine Commercial Availability

Tier 4 engines are commercially available for most CHC marine engine power subcategories over 600 kilowatts (kW). U.S. EPA sets Tier 4 standards for marine engines rated 600 kW and higher. For marine engines below 600 kW, the strictest U.S. EPA standards are Tier 3. However, some marine engines rated below 600 kW have been certified to U.S. EPA Tier 4 standards. Tier 4 marine engine options below 600 kW are also increasing due to commercialization of marinized Tier 4 Final non-road engines.[92] CARB staff initially published a list of commercially available Tier 4 marine engines in 2021 as part

[91] California Air Resources Board. "*Final Regulation Order Commercial Harbor Craft Regulation*." *California Code of Regulations*, Title 13 section 2299.5 and title 17 section 93118.5, December 30, 2022, Tables 11-13 on pp. 62 – 66.

[92] U.S. EPA allows U.S. EPA-certified land-based on and off-road engines to be marinized for use in marine applications following guidelines outlined in 40 CFR 1042.605, which is incorporated by reference into the CHC Regulation.

of the CHC Rulemaking in the Initial Statement of Reasons (ISOR) Appendix E.[93] CARB staff subsequently published a list of commercially available Tier 4 marine and marinized Tier 4 Final engines on the CHC Program webpage and continue to update the list periodically.[94] As of the most recent update to the list in August 2025, CARB staff have identified 32 Tier 4 engine models including multiple recently certified Tier 4 marine engines and Tier 4 Final marinized non-road engines that were not commercially available in 2021 when the rulemaking staff report was published. As of February 2024, staff was aware of 111 Tier 4 engines operating on CHC in California.[95]

Commercial Availability of U.S. EPA-Certified Tier 4 Marine Engines

New Tier 4 marine engines are available with OEM-integrated exhaust aftertreatment that meets the Tier 4 plus DPF performance standards in the amended CHC Regulation without retrofit aftertreatment. MAN Diesel has certified a new engine family with three models including full original equipment manufacturer (OEM)-integrated exhaust aftertreatment including diesel oxidation catalyst (DOC), diesel particulate filter (DPF), and selective catalytic reduction (SCR), which are installed on the engines in their U.S. EPA-certified configuration. The engines in this family meet the amended CHC Regulation's Tier 4 Plus DPF Performance Standards for diesel PM of 0.005 grams per brake-horsepower-hour (g/bhp-hr) without any retrofit aftertreatment.[96]

Additional Tier 4 marine engines with OEM DPFs are entering the U.S. market. Caterpillar is currently pursuing U.S. EPA Tier 4 Marine certification for two engine products that contain OEM-integrated DPF exhaust aftertreatment systems. The products were initially developed and commercialized for the European Union Stage V Inland Waterway Regulation, which imposed a new particle number standard for diesel PM on marine engines rated 300 kW or higher.[97] Caterpillar expects these products to obtain U.S. EPA

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[93] "*Technical Support Document and Assessment of Marine Emission Control Strategies, Zero-Emission, and Advanced Technologies for Commercial Harbor Craft*." *Proposed Amendments to the Commercial Harbor Craft Regulation*, 21 Sept. 2021, p. E-40.

[94] *California Air Resources Board (CARB) Listing of Certified Tier 4 Marine Engines and Marinized Tier 4 Final Non-Road Engines, by California Air Resources Board (CARB*), report, 10 Oct. 2024, pp. 1–6.

[95] Commercial Harbor Craft (CHC) Vessel and Engine Information Reported to CARB, last updated February 7, 2024, *CHC Vessel and Engine Data as Reported to CARB | California Air Resources Board*.

[96] Se, Man Truck &. Bus. "MAN Engines Fulfills Strict California Air Resources Board CHC Emissions Requirements." *MAN Engines Fulfills Strict California Air Resources Board CHC Emissions Requirements*, 25 Apr. 2024.

[97] Regulation (EU) 2016/1628 of the European Parliament and of the Council of 14 September 2016 on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery,*Regulation - 2016/1628 - EN - EUR-Lex.* Europa.eu, 2016. Accessed 16 Dec. 2025.

Tier 4 marine certification in 2025.[98] It is currently unknown if these engines will meet Tier 4 + DPF performance standards in the amended CHC Regulation.

New compact Tier 4 marine engines with SCR are commercially available. Yanmar and Mitsubishi offer U.S. EPA-certified Tier 4 marine engines with OEM-integrated SCR. Both engines would meet the amended CHC Regulation Tier 4 plus DPF performance standards if retrofit with a CARB-verified Level 3 marine DPF system, when available. The Yanmar SCR system provides a relatively compact lightweight arrangement with different inlet/outlet flow configurations available to improve installation feasibility in existing CHC vessel designs.[99]

Commercial Availability of U.S. EPA-Certified Tier 4 Final Non-Road Marinized Engines

Marinized Tier 4 Final non-road engines are commercially available for use on CHC. Three marinized Tier 4 Final non-road engine models from M&H Engines are commercially available for smaller engines from 55-317 kW,[100] with plans to expand availability up to 750 kW.[101] Additionally, the three commercially available M&H engine models are CARB-certified to Tier 4 Final off-road emission standards[102] and meet the amended CHC Regulation's Tier 4 Plus DPF Performance Standards.

Assessment of New Cleaner Combustion Technologies

New types of exhaust aftertreatment technology are being developed and becoming commercially available for marine engines. Most U.S. EPA-certified Tier 4 marine engines and Tier 4 Final non-road engines are utilizing existing exhaust aftertreatment technologies such as DOC, DPF, SCR, or exhaust gas recirculation (EGR), which have been utilized in the non-road and on-road sectors for decades and have gradually transferred over into the marine sector. In addition to advancements in the integration of existing on-road and non-road technologies into certified Tier 4 marine and Tier 4 Final non-road marinized

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[98] T.J. Tarabulski (Caterpillar) email dated January 25, 2024, to CARB CHC Program staff, Andrew Damiano, stating CAT is expecting to complete U.S. EPA Tier 4 Marine Certification of CAT's 3512E marine propulsion engine with a DPF clean emissions module by the end of 2024.

[99] Teixeira, Rodrigo and Mitsubishi Turbocharger and Engine America. "Mitsubishi Introduces New Marine Propulsion Engine." *Mitsubishi Turbocharger and Engine America*, by Mitsubishi Turbocharger and Engine America and Mitsubishi Heavy Industries Engine Turbocharger, LTD, 1 Sept. 2020, *"Yanmar Adds New 12AYEM Engine to Heavy-Duty Marine Propulsion Line."* The Maritime Executive, 30 Oct. 2024, Accessed October 30, 2024.

[100] "Home - M&H Engineering." *M&H Engineering*, 24 May 2024, *marineandhazardousengines.com.* Accessed October 30, 2024.

[101] Barry McCooey (M&H Engines) email dated December 20, 2022, to CARB CHC Program staff, Andrew Damiano, discussing development and marinization of M&H's 14-liter and 18-liter engines to provide coverage of power subcategories up to 750 kW.

[102] CARB Executive Orders U-R-004-0577 and U-R-004-0676 for M&H Engines in the OEM John Deere off-road Tier 4 Final configuration, *Executive Order: 2019 JOHN DEERE POWER SYSTEMS OFCI U-R-004-0577*, *Executive Order: 2022 John Deere Power Systems OFCI U-R-004-0631-1*, *Executive Order: 2024 Deere Company OFCI U-R-004-0676*.

engines, staff have identified one significant development in commercially available marine engine exhaust aftertreatment technology, the use of retrofit wet electro-static precipitation technology (WESP).

WESP technology was originally developed and utilized to reduce PM emissions in stationary applications such as blast furnace or power plant operations[103] and is now gradually becoming commercially available for marine engine applications of 1,000 kW or 1 megawatt (MW) and higher. WESP technology was noted by UCI in their report (discussed below in this chapter) and CARB staff further discussed this technology with one OEM that has recently commercialized it in the marine sector, Wartsila.[104] Wartsila's marine WESP systems are commercially available for larger engines ranging from 1 to 11 MW and can reduce diesel PM by more than 90%.[105] This range currently limits feasibility of installing WESP equipment on many CHCs, although the commercially available 1, 2 and 4 MW systems from Wartsila could potentially be used on some larger CHCs operating in California such as towing vessels including articulated tug barge (ATB) tugs and barges, some large dredge vessels, large offshore supply vessels, and some ferries, if and when the systems undergo CARB verification. As of September 2025, Wartsila has not yet submitted an application for CARB verification of its WESP systems.

Potential challenges of utilizing WESP technology include size and weight of the systems, specific maintenance protocols such as disposal of captured soot and scrubber plant water, and potential safety concerns that would have to be addressed if using the system on petrochemical tank barges. Operationally, WESP systems are pass-through aftertreatment systems that do not have a filter substrate like a DPF. Therefore, WESP systems have little to no effectiveness on controlling PM emissions if the WESP system is not activated during engine operation. Therefore, effective regulation of this technology would require operating and reporting protocols similar to those that will be required for CARB-verified marine DPFs.[106]

CARB Verified Level 3 Marine DPF – Commercial Availability Status Update

Retrofit DPFs are undergoing CARB verification. CHC engines not equipped with OEM-integrated exhaust aftertreatment to meet the Tier 3 plus DPF and Tier 4 plus DPF Performance Standards in CARB's amended CHC Regulation will need to be retrofit with a CARB-verified Level 3 marine DPF (or other CARB-verified technology that similarly reduces

[103] Ag, Andritz. *Wet Electrostatic Precipitator (WESP).*

[104] In-person meeting between CARB CHC Program staff and Mr. Dave Adams of Wartsila at CalEPA Headquarters, October 3, 2024, to discuss Wartsila's WESP technology and CHC Regulation applicability.

[105] Presentation provided by Wartsila to CARB staff during an in-person meeting on October 10, 2024, *Wartsila PM Filter System (WESP),* Slide 15.

[106] California Air Resources Board. *Executive Order DE-24-003*. September 12, 2024,

PM emissions), when commercially available. CARB's Verification Procedure[107] requires aftertreatment manufacturers to demonstrate their DPF devices meet emission reduction requirements, safe operation, and durable in-field performance for over one thousand hours of operation. Level 3 means that the DPF reduces engine-out diesel PM emissions by 85% or greater, or to less than 0.01 g/bhp-hr. CARB's Verification Procedure has been used since 2002 to verify emission control devices for engines on a variety of on-road and off-road equipment, and CARB-verified DPFs have successfully and safely controlled emissions on millions of engines.

Verifications are currently in process for marine DPF products; however, no CARB Verified Level 3 Marine DPFs are commercially available at the time of this report's publication. CARB staff anticipates the products undergoing verification may be completed in 2026, depending on how much progress applicants make with the Verification Procedure applications and testing underway.

UCI Report on Commercial Availability of Tier 4 Diesel Engines, DPFs, and Cleaner Combustion Technology

In support of the Board's direction to staff in Resolution 22-6,[108] to evaluate commercial availability of technologies, CARB contracted with University of California, Irvine (UCI) in 2023 and 2024 to provide a comprehensive update of commercial availability for cleaner combustion and zero emission technology for all categories of harbor craft.[109] For combustion technologies this included a market survey of commercially available Tier 4 marine engines, marinized non-road or off-road Tier 4 Final engine products, DPFs, and other emerging exhaust aftertreatment technologies. Similar to the results of CARB staff's analysis of commercially available engines, UCI found that the number of commercially available Tier 4 marine or Tier 4 Final marinized engines continues to increase in 2024.

UCI's report discussed the WESP exhaust aftertreatment technology to reduce PM emissions.[110] UCI's report provides an overview of the technology, and notes multiple companies (other than Wartsila) that have developed the technology for use on ocean-going vessels, including one company that is also developing more compact systems that would be better suited to CHC if its PM collection performance can be improved to meet CARB's Level 3 verification requirements to reduce PM by 85% or greater. Overall, the WESP technology is making market penetration into the marine sector for larger ocean-going vessels due to their relatively large component sizes. However, as discussed

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[107] *Verification Procedure for In-Use Strategies to Control Emissions From Diesel Engines | California Air Resources Board.*

[108] *California Air Resources Board, Proposed Amendments to the Commercial Harbor Craft Regulation. Resolution 22-6. 24 Mar. 2022*, Accessed October 30, 2024.

[109] McDonell, Vincent, et al. *Commercial Harbor Craft Technology Assessment - Review of Tier 4 Engine Technology and Zero Emission Technology*, October 4, 2024, *UCI CARB CHC Report 100622024*, Accessed 4 Dec. 2024.

[110] Ibid, pages 46-47.

above, there is potential for WESP technology to be used on some larger CHC and for smaller WESP systems to eventually become commercially available.

American Bureau of Shipping (ABS) 2024 Tier 4 Repower and DPF Feasibility Study

A CARB-commissioned study by ABS on select vessels showed there are feasible options for repowering the vessels with Tier 4 engines and DPFs. ABS recently completed a Tier 4 engine repower and retrofit DPF feasibility study[111] that evaluated four CHC vessel types: an articulated tug-barge (ATB) combination (including separate analyses of both the ATB tug and ATB barge vessels), a 149-passenger catamaran fast ferry, and a line-towing tugboat. These vessel types were selected for evaluation because three of them (ATB tug, fast ferry, and line-towing tugboat) were not previously evaluated in CARB's CHC Tier 4 Feasibility Study,[112] which was completed by California State University Maritime Academy (Cal Maritime) in 2019. An ATB barge was evaluated in the 2019 study, but was a different model than the one studied by ABS.

ABS evaluated each vessel in two steps. First, ABS identified commercially available Tier 4 engine options that were suitable for meeting the vessel's power requirements, then analyzed the feasibility of each engine option for fitment on the vessel and impact on vessel stability. Second, if a suitable Tier 4 engine was found to have feasible fitment and impact on stability, ABS evaluated the installation of a retrofit DPF[113]on the engine for fitment, effect on engine backpressure, and the DPF's added impact on vessel stability. There are currently no CARB-verified DPFs available, therefore a DPF manufacturer currently undergoing CARB verification was selected for this study. For each of the four vessel types evaluated, at least one technologically feasible Tier 4 main propulsion engine and DPF solution was identified.[114]

Although technologically feasible solutions were identified, operators participating in the study indicated some of the vessels evaluated would require substantial and expensive reconfiguration to accommodate Tier 4 engines and DPFs. One operator stated their vessel would lose some passenger carrying capacity to carry the added weight of Tier 4 engines and DPFs. Another operator stated their vessels would be subject to additional United States Coast Guard (USCG) regulations in the modified Tier 4 plus DPF configuration and

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[111] American Bureau of Shipping. "Feasibility Study for Selected Vessel Categories." *Commercial Harbor Craft - California Air Resources Board*, Dec. 2024, *Vessel Feasibility Review and Consultation for the California Commercial Harbor Craft Regulation*, Accessed January 7, 2025.

[112] *Technical Reports | California Air Resources Board.* Accessed October 30, 2024.

[113] As of this report publication, no CARB-verified Level 3 Marine DPFs are commercially available. In its study, ABS obtained technical specifications from DPF manufacturer, Rypos, to use in evaluating feasibility of DPFs on vessels.

[114] American Bureau of Shipping. "Feasibility Study for Selected Vessel Categories." *Commercial Harbor Craft - California Air Resources Board*, Dec. 2024, *Vessel Feasibility Review and Consultation for the California Commercial Harbor Craft Regulation*, pages 4-5, Accessed January 7, 2025.

could then be required to operate within a different USCG regulatory framework that could negatively impact economic viability.[115]

U.S. Coast Guard (USCG) Processes for Tier 4 Engine and DPF Installations

Installation of commercially available Tier 4 engines and exhaust aftertreatment equipment such as DPFs on USCG-inspected CHC vessels requires a design change review process with USCG. This process is a requirement to obtain USCG approval to install new engines and equipment in existing vessels, and prior to constructing new vessels. After the equipment is installed, the installation must undergo inspection by USCG officers for certification of proper installation according to applicable vessel design standards. USCG representatives presented information on their processes and requirements at CARB's August 7, 2024, Technical Working Group workshop.[116]

CARB staff have observed a common misconception among regulated industry that USCG certifies components such as engines and exhaust aftertreatment such as DPFs and SCR systems. USCG does not certify engines or exhaust aftertreatment components but can approve proposed vessel design changes to install such equipment and can certify the installation of U.S. EPA or CARB-certified engines and DPFs on a case-by-case basis, provided the equipment is installed according to all federal design standards[117] applicable to each CHC.

USCG's August 7, 2024 presentation provided procedural clarifications on how to initiate and complete the design change review process required for Tier 4 engine and DPF installations in CHCs. Design change applications must be submitted to the USCG Marine Safety Center (MSC), reviewed by MSC, and revised if necessary. Once proposed design changes to install DPFs are approved by MSC, DPF installations are inspected, and if approved, certificated at the local USCG Sector level on a per case basis. Certification requires that the DPF is installed according to all applicable 46 CFR Subchapter design standards and that the DPF, in the installed configuration, will not cause engine exhaust backpressure to exceed the maximum allowable limit specified by the applicable engine OEM.

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[115] American Bureau of Shipping. "Feasibility Study for Selected Vessel Categories." *Commercial Harbor Craft - California Air Resources Board*, Dec. 2024, *Vessel Feasibility Review and Consultation for the California Commercial Harbor Craft Regulation*, pages 6-7, Accessed January 7, 2025.

[116] Mike Boyes and Eleventh Coast Guard District Inspections and Investigations Branch (DPI), *U.S. Coast Guard Vessel Plan Review: Vessel Repowers, Retrofits, And Novel Designs.* August 7, 2024,

[117] *46 CFR Chapter I - Coast Guard, Department of Homeland Security*. Accessed October 30, 2024.

Conclusion

Analysis of commercially available engines conducted by CARB staff and contractors demonstrate that Tier 4 engines are commercially available, and commercial availability of Tier 4 engines continued to improve in 2024, including some engine models with integrated DPFs. To date, CARB staff have identified 32 models of commercially available Tier 4 engines and expect this number to continue increasing. CARB staff anticipate CARB-Verified Level 3 Marine DPFs may become commercially available as early as 2026, and WESP technology could be used to reduce PM emissions on some CHC engines if the technology becomes CARB-verified. The amended CHC Regulation provides an extension for operators to defer compliance until engines with OEM-integrated DPFs, retrofit CARB-verified Level 3 DPFs, or other CARB-verified Level 3 emission control technologies are commercially available for their vessel. As demonstrated by the ABS study, the increase in commercially available Tier 4 engine options points to improved feasibility of Tier 4 engine installations and potential DPF retrofits in in-use vessels.

CARB staff expect additional advancements in Tier 4 Final offroad engine marinization, certification of Tier 4 engines with integrated aftertreatment, and completion of CARB verifications of DPFs and potentially other diesel PM aftertreatment technologies will continue to provide regulated CHC vessel owners and operators with additional technological solutions and options for regulation compliance in 2025 and beyond into the 2030s.

Chapter 5 – Assessment of Commercial Availability of Zero Emission and Advanced Technologies

Purpose of Chapter 5

Chapter 5 provides an update on commercial availability of Zero Emission and Advanced Technologies (ZEAT)[118]for CHC vessels, including alternative fuels. Topics discussed include vessels with new ZEAT mandates under the amended CHC Regulation and technological strategies utilized by operators of these vessels for CHC Regulation compliance. Chapter 5 also provides a brief overview of some in-use ZEAT vessels operating in California and discusses opportunities for further deployment of ZEAT technologies into additional CHC vessel categories beyond those required by the amended CHC Regulation to adopt ZEAT.

Information Used in Assessment of Commercial Availability of ZEAT

Chapter 5 incorporates information from CARB's Technical Working Group conducted in accordance with Resolution 22-6 and technical reports commissioned by CARB. In 2023, CARB contracted with the University of California, Irvine (UCI) to assess commercial availability of Tier 4 engines and commercial availability and operational feasibility of ZEAT technologies for CHC applications.[119] In their final report, UCI also provided a global assessment of ZEAT CHC vessels and corresponding shoreside infrastructure, as well as alternative fuels and applicability of ZEAT into additional CHC operating sectors in California.

CHC ZEAT Vessels and Assessment of CHC ZEAT Projects Underway

This section describes several CHC ZEAT in-use vessels currently operating in California and ZEAT vessel projects underway as of mid-2025.

ZEAT Vessels Currently Operating in California

ZEAT CHC vessels currently operating in California include:

- *Sea Change* ferry[120] – Switch Maritime's hydrogen fuel cell vessel, operated a six-month demonstration in 2024 on a short run ferry route along the Embarcadero in

[118] Zero emission advanced technology (ZEAT) is defined in subsection (d) Definitions, of the *CHC Regulation*, on pages 33-34.

[119]McDonell, Vincent, et al. *Commercial Harbor Craft Technology Assessment - Review of Tier 4 Engine Technology and Zero Emission Technology*, October 4, 2024, *UCI CARB CHC Report 100622024*, Accessed 4 Dec. 2024.

[120]Sea Change Hydrogen Ferry Demonstration Project, *Sea Change Hydrogen Ferry Demonstration Project - San Francisco Bay Ferry*.

San Francisco between Pier 41 and the San Francisco Ferry Building. This vessel was operated by Blue and Gold Fleet, as a sub-operator for the San Francisco Bay Ferry, Water Emergency Transit Authority (WETA).

- *e-Wolf* harbor/ship-assist tug[121] – Crowley Marine's battery-electric zero-emission capable plug-in hybrid vessel, operating in San Diego, California.
- *Enhydra* excursion vessel[122] – Red and White Fleet's zero-emission capable plug-in hybrid vessel operating in San Francisco, California.
- *Sand Piper* dredge[123] – City of Santa Barbara zero emission electric harbor dredge powered by a high-voltage cable to grid power on shore.
- *Islander, Alcatraz Clipper, and Alcatraz Flyer*[124] – Alcatraz Cruises hybrid passenger ferries servicing National Park Service route to Alcatraz Island in San Francisco Bay.
- *HDEV*[125] - battery electric service vessel operated by the Newport Beach Harbor Department.

ZEAT Vessel Projects Currently Under Development in California

The amended CHC Regulation requires new and in-use short run ferries to be zero-emission by the end of 2025 and new-build excursion vessels to be zero-emission starting at the end of 2024. Although EPA did not take action on the ZEAT requirements for in-use short run ferries, the partial authorization does cover ZEAT requirements for new short run ferries and excursion vessels.

The ZEAT mandates in the CHC Regulation are in alignment with the Governor's Executive Order N-79-20[126] to achieve 100% zero-emission from off-road vehicles and equipment operations where feasible by 2035. Several short run ferry operators are currently working towards compliance with the zero-emission requirements as well as adopting ZEAT where not required, including the following:

- WETA short-run 150-passenger ZEAT ferries – WETA is constructing three new battery-electric ZEAT short run ferries to operate on routes in San Francisco Bay expected in early 2027.[127]

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[121] McDonell, Vincent, et al. *Commercial Harbor Craft Technology Assessment - Review of Tier 4 Engine Technology and Zero Emission Technology*, October 4, 2024, page 53 *UCI CARB CHC Report 100622024*, Accessed 10 Dec. 2025.

[122] Ibid, pages 54-55.

[123] Ibid, pages 55-56.

[124] "*Alcatraz Cruises (Official Provider) - Alcatraz City Cruises.*" *City Experiences™*, 1 Nov. 2024. Last accessed November 3, 2024.

[125] *Licas, Eric. "Newport Beach confronts boating emissions with nation's first EV service vessel and public charging station" LA Times, August 31, 2024, Newport Beach gets nation's first EV service vessel - Los Angeles Times*. Last accessed November 8, 2024.

[126] NEWSOM, GAVIN. "*EXECUTIVE ORDER N-79-20.*" *STATE OF CALIFORNIA*, 2020. Last accessed November 5, 2024.

[127] *SF Bay Ferry's Rapid Electric Emission Free (REEF) Ferry Program - San Francisco Bay Ferry*. Last accessed September 17, 2025.

- *Angel Island* short run ferry[128] – Angel Island-Tiburon Ferry is planning to retrofit their short run ferry vessel providing service from Tiburon to Angel Island in San Francisco Bay to zero-emission utilizing battery electric propulsion.
- Balboa Island Ferry short-run ferry project – Balboa Island Ferry in Newport Beach plans to build three zero-emission battery electric ferries to replace the three diesel vessels providing vehicle and passenger ferry service between Balboa Island and the Balboa Peninsula in Newport Beach.[129]

Several new-build and retrofit ZEAT CHC projects outside of CARB's mandated ZEAT vessel types are also under development:

- WETA's Transition to Zero-Emission Ferries – WETA plans to electrify four 400-passenger mid-Bay route diesel-powered ferries currently operating in San Francisco Bay to full zero emission plug-in vessels with no onboard diesel engines. Additionally, Nichols Brothers Boat Builders was awarded a contract to design and build two 400-passenger electric ferries in April 2025.[130]
- *Gold Rush* – a commercial passenger fishing vessel operating in the Bay Area was awarded CARB Advanced Technology Demonstration and Pilot Project funding to retrofit to a zero-emission capable plug-in hybrid fishing vessel.[131]
- Bay Area Zero Emission (BAZE) Tugboat Project was awarded CARB Advanced Technology Demonstration and Pilot Project funding for Port of Oakland and Bay Area tugboat operator, AMNAV, to construct and operate a zero-emission harbor tugboat.[132]

Two new-build ZEAT hybrid excursion vessel projects have also been awarded funding and are under development to comply with the amended CHC Regulation requirements for new or newly acquired excursion vessels:

- Monterey Bay Air Resources District (MBARD) was awarded CARB Advanced Technology Demonstration and Pilot Project funding to construct a zero-emission

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[128] McDonell, Vincent, et al. *Commercial Harbor Craft Technology Assessment - Review of Tier 4 Engine Technology and Zero Emission Technology*, October 4, 2024, page 50, *UCI CARB CHC Report 100622024*, Accessed 4 Dec. 2024.

[129] *Ceja, Miranda. "Balboa Island Ferry Gets $7.9M Grant to Continue Operations." Newport Beach-Corona Del Mar, CA Patch, 18 Mar. 2024.* Last Accessed November 5, 2024.

[130] *NBBB AWARDED CONTRACT TO DESIGN AND BUILD TWO STATE-OF-THE-ART ELECTRIC FERRIES FOR SAN FRANCISCO BAY FERRY | Nichols Brothers Boat Builders | Nichols Brothers Boat Builders*. Last accessed September 17, 2025.

[131] California Energy Commission/California Air Resources Board Advanced Technology Demonstration and Pilot Projects, Notice of Proposed Awards, March 29, 2024. *ATDPP_NOPA_Results_Table2024-03-29.xlsx (live.com).* Last Accessed November 5, 2024.

[132] Oakland Seaport. "*Zero Emissions Future Seaport - Oakland Seaport*." *Oakland Seaport*, 10 July 2024. Last accessed November 4, 2024.

capable hybrid whale watching excursion vessel, which will be operated by Monterey Bay Eco Tours (MBET).[133]

- Harbor Breeze Cruises in Long Beach was awarded CARB Advanced Technology Demonstration and Pilot Project funding to construct a zero-emission capable hybrid whale watching excursion vessel as part of the Los Angeles Marine Emission Reduction (LA-MER) Project.[134]

Opportunities to Deploy ZEAT Into Additional CHC Operating Sectors in California

Based on review of ZEAT CHC projects outside California in the U.S. and globally, UCI's 2024 report found there is potential operational feasibility for ZEAT to be adopted in additional CHC operating sectors on a per-case basis, particularly in the following categories:[135]

- Line tender tugs (or similar), select ship-assist tugs with shorter routes, regular operating locations with proximity to sufficient levels of grid power, and variable duty cycles that would allow sufficient battery charging time between jobs.
- Pilot vessels, crew vessels, and workboats operating on shorter routes, with regular operating locations close to sufficient levels of grid power, and variable duty cycles that would allow sufficient battery charging time between jobs.
- Small harbor dredges operating close to shore with access to electrical grid infrastructure that can support powering the operation with a shore power cord.
- Some small or near-shore commercial fishing boats or commercial passenger fishing vessels that can undergo design changes to accommodate zero emission equipment installations and operate with a reduced or limited operating radius to maintain proximity to charging infrastructure.

Alternative Fuels

Alternative fuels are being increasingly utilized in the marine sector, primarily on ocean-going vessels (OGV). However, there is some opportunity for alternative fuels to be used on CHC in the future, including the following fuels.

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[133] District, Monterey Bay Unified Air Pollution Control. *Building Monterey Bay's First Hybrid-Electric Whale Watching Vessel Project*. 9 May 2024. Last Accessed November 4, 2024.

[134] California Energy Commission/California Air Resources Board Advanced Technology Demonstration and Pilot Projects, Notice of Proposed Awards, March 29, 2024. *ATDPP_NOPA_Results_Table2024-03-29.xlsx (live.com).* Last Accessed November 15, 2024.

[135] McDonell, Vincent, et al. *Commercial Harbor Craft Technology Assessment- Review of Tier 4 Engine Technology and Zero Emission Technology*, October 4, 2024, *UCI CARB CHC Report 100622024*, pages 75-81, Accessed 4 Dec. 2024.

Liquified Natural Gas (LNG)

LNG is currently widely used in ground-based transportation fleets and has been used in OGVs since 2003. UCI's report notes there are currently approximately 469[136] LNG vessels operating globally, including some larger ferries and tugs, however less than five percent are operating in the United States, and none are currently operating in California. [137]

Benefits of LNG include reduced CO_2 emissions and criteria pollutant emissions compared to petroleum distillate fuels. However, formaldehyde emissions and methane slip emissions (unburned methane, a greenhouse gas) well above the limit in the amended CHC Regulation have been observed on in-use CHC using LNG dual-fuel engines.[138] Formaldehyde is a toxic air contaminant and methane slip would lower the CO_2 benefit of LNG, therefore emission control strategies would be needed to minimize both pollutants. Most LNG is currently fossil-based, however, as part of California's greenhouse gas emission reduction goals, California has passed legislation to offer incentives for production of renewable natural gas as a substitute for fossil natural gas.[139]

LNG fuel is cryogenic and requires complex expensive insulated storage tanks which reduce feasibility in most current in-use CHC vessel designs. The energy density of LNG is significantly less than renewable diesel, so LNG requires significantly larger tank volume to store the same energy, which impacts vessel operating range and endurance capability.[140] UCI's report notes that dual-fuel combustion strategies utilizing LNG with pilot oil injection in diesel-cycle engine designs requires additional onboard tankage volume for the diesel pilot oil. Therefore, most CHC vessels utilizing LNG fuels in the future would likely be new-build vessels designed to accommodate LNG fuel.

Federal regulations do not currently include USCG design standards for CHC to operate with LNG. However, USCG has indicated that the design basis agreement (DBA) process could be a pathway for operators and vessel designers to incorporate LNG design standards certified in OGV or other industrial sectors into some CHC designs.[141]

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[136] The vessel counts are from UCI's report. UCI's report, *Commercial Harbor Craft Technology Assessment- Review of Tier 4 Engine Technology and Zero Emission Technology,* which cites the Det Norske Veritas (DNV), Alternative Fuels Insight (AFI) Database for the counts of alternative fueled vessels.

[137] McDonell, Vincent, et al. *Commercial Harbor Craft Technology Assessment - Review of Tier 4 Engine Technology and Zero Emission Technology*, October 4, 2024, *UCI CARB CHC Report 100622024*, pages 15-16, Accessed 4 Dec. 2024.

[138] Johnson, Kent, et al. *Local Air Benefits by Switching from Diesel Fuel to LNG on a Marine Vessel Prepared for California Air Resources Board CARB*. March 2020, pp. 26-27. Last accessed 16 Dec. 2025.

[139] Verdant Associates, *Renewable Natural Gas in California, Characteristics, Potential, and Incentives: 2023 Update*, *RNG in California Update August 2023 LCFS Thru End of 2022*, page 6. Accessed January 14, 2025.

[140] *Proposed Amendments to the Commercial Harbor Craft Regulation, Appendix E*, 21 Sept. 2021. Last accessed November 4, 2024.

[141] Boyes, Mike and Eleventh Coast Guard District Inspections and Investigations Branch (DPI). *U.S. Coast Guard Vessel Plan Review: Vessel Repowers, Retrofits, And Novel Designs*. 2024, *Coast Guard Presentation for TWG Workshop 3.pdf (ca.gov)* Last accessed November 4, 2024.

Alcohols (Methanol, Ethanol, Butanol)

CARB staff are not aware of any CHCs currently operating on alcohol fuels in California. However, UCI's report notes there are approximately 29 methanol-fueled vessels (including CHC and OGV) in-use globally, including a ferry and a tug in current operation, and 10 methanol CHC projects underway globally.[142]

While many of the alternative liquid alcohol fuels can provide cleaner combustion than diesel fuel, current marine engine combustion strategies for these fuels would utilize dual-fuel combustion with diesel pilot fuel on a compression ignition cycle. Meeting the amended CHC Regulation's performance standards for PM emissions on engines using diesel pilot fuel with alternative fuels may require CARB-verified Level 3 diesel particulate filters (DPFs), depending on the ratio of diesel pilot fuel to alternative fuel. However, there is a current lack of renewable production pathways, production volume, distribution and bunkering networks for marine alcohol fuels in California combined with a lack of USCG operating protocols and design standards for onboard storage and distribution systems in CHCs, which limits applicability in CHC at this time. Alcohol fuels have significantly lower flashpoints than distillate or hydrotreated renewable diesel fuels, which could present an onboard ignition hazard. USCG would need to revisit vessel design standards for alcohol fuel storage and distribution systems and develop new operational requirements for certain CHCs to operate on alcohol fuels.

Ammonia

UCI's report did not identify any ammonia vessels (CHC nor OGV) currently in operation. However, there are approximately 11 ammonia vessels currently on order globally, including at least one tugboat scheduled for operation in 2024, and 10 ammonia CHC projects currently underway globally in the feasibility or demonstration phase. The majority of these projects are dual fuel engines, which could operate on diesel fuel or ammonia, however three of the listed projects are ammonia fuel cell.[143]

Ammonia has many uses in other U.S. industries such as agriculture or refrigeration, therefore there is infrastructure in place for ammonia production, storage, and distribution. This presents a significant advantage compared with other alternative fuels that currently lack such infrastructure.[144] However, ammonia fuel has numerous health and safety concerns related to on-board storage and distribution that are not currently addressed in USCG regulations.

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[142] McDonell, Vincent, et al. *Commercial Harbor Craft Technology Assessment - Review of Tier 4 Engine Technology and Zero Emission Technology*, October 4, 2024, *UCI CARB CHC Report 100622024*, pages 16-17, Accessed 4 Dec. 2024.

[143] McDonell, Vincent, et al. *Commercial Harbor Craft Technology Assessment - Review of Tier 4 Engine Technology and Zero Emission Technology*, October 4, 2024, *UCI CARB CHC Report 100622024*, page 18, Accessed 4 Dec. 2024.

[144] Ibid, page 18.

Hydrogen

Growth in the CHC hydrogen vessel market appears to be increasing. As noted earlier in this chapter, the *Sea Change* hydrogen fuel cell ferry recently began operating in California. UCI identified four vessels that are currently operating on hydrogen globally, including a large ferry in Norway and a tug operating in Europe. 44 additional hydrogen vessel projects are planned, including 25 CHC.[145]

Hydrogen fuel can be utilized both as a combustion fuel in reciprocating or turbine engines or in fuel cells. UCI noted that most hydrogen currently utilized in technology demonstration projects in California is currently produced from steam reformation of natural gas.[146] California's focus on reducing GHG emissions, which includes achieving carbon neutrality by 2045, is providing momentum for production of cleaner hydrogen from renewable pathways that can provide fueling for hydrogen CHC. Despite the current reliance on hydrogen produced from fossil fuels, it is expected that renewable hydrogen, including production from electrolysis using renewable electricity, will become more widely available and will experience reductions in cost. UCI noted one major step towards developing a renewable hydrogen economy in California is the award of a U.S. Department of Energy (DOE)-funded hydrogen hub in California under the Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES). Under the ARCHES initiative, projects are planned at the Ports of Los Angeles/Long Beach and Oakland.[147]

As demonstrated by the deployment of the *Sea Change*, hydrogen-fueled vessels are operationally feasible on a per-case basis. Logistical and regulatory challenges associated with use in CHC applications include the planning required for shore-side hydrogen fueling and bunkering processes, which must be conducted in specific locations away from critical infrastructure, and fueling process protocols which require approval from authorities having jurisdiction over the specified site.

On the vessel side there are currently no existing USCG design standards for building CHCs with hydrogen power. This necessitates more complex vessel-side design review processes completed on a per-case basis with the USCG Marine Safety Center for project design proposals or design change approvals and certification. However, staff expects that the complexity and timeline of review processes for hydrogen vessel projects will be reduced as more hydrogen vessels become operational.

Electricity

Battery-electric technology is the predominant ZEAT strategy currently utilized for amended CHC Regulation compliance in California, and electric vessels comprise the majority of ZEAT

[145] Ibid, pages 17-18.
[146] Ibid, page 17
[147] Ibid, page 67

vessels currently in operation globally. There are approximately 879 electric vessels in operation worldwide, 94% of which are operating outside of the U.S.[148]

Despite their increasing numbers, ZEAT CHC projects still face technological challenges including the space requirements on the vessel, weight of the equipment, limited energy density, and recharging times.[149] Therefore, battery electric operation is currently optimal for vessels traveling shorter routes close to sufficient electrical infrastructure. However, battery technology and energy density of marine battery energy storage systems are expected to advance,[150] which will expand feasibility of battery electric power for vessels with longer operating routes and higher power requirements.

To date, USCG has reviewed, approved, and certificated more electric ZEAT CHC projects than other ZE technologies or vessels operating with novel alternative fuels. The design change review process for electrification retrofits or new-build projects can now utilize existing USCG engineering policy letter, CG-ENG-02-19, for installations of lithium battery energy storage systems and other electric propulsion components.[151] This significantly reduces the time required to obtain USCG approvals for electric CHC projects to commence or be inspected and certificated when complete compared to hydrogen or other novel liquid or gaseous fuels.

USCG Processes and Pathways for ZEAT CHC Projects

During CARB's third Technical Working Group workshop on August 7, 2024, USCG District 11 staff provided a presentation[152] with USCG MSC officers present to answer technical questions. USCG's presentation clarified the requirements and processes for CHC operators to incorporate ZEAT technologies into in-use or new USCG-inspected vessels. The design basis agreement (DBA) process outlined in USCG's presentation is an approval pathway through which an operator may propose to use novel technologies in a vessel design change. For example, in a vessel class having no applicable design standards for the proposed technology, the operator may request USCG approval to utilize other applicable standards from different USCG-regulated vessel classes or other operating sectors such as on-road that do have approved standards for the technology.

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[148] Ibid, page16

[149] Ibid, pages 15-16

[150] Royal Society of Chemistry, Recent Developments in Energy Storage Systems for Marine Environment, September 29, 2021, *Recent developments in energy storage systems for marine environment (rsc.org)*. Last accessed November 12, 2024.

[151] USCG, U.S. Department of Homeland Security, Design Guidance for Lithium-Ion Battery Installations Onboard Commercial Vessels, October 2, 2019, *Microsoft Word - ENG Policy Ltr_02-19 Li-Ion Battery Policy_Signed (uscg.mil)*. Last accessed November 5, 2024.

[152] Boyes, Mike and Eleventh Coast Guard District Inspections and Investigations Branch (DPI). *U.S. Coast Guard Vessel Plan Review: Vessel Repowers, Retrofits, And Novel Designs*. 2024, *Coast Guard Presentation for TWG Workshop 3.pdf (ca.gov)* Last accessed November 4, 2024.

Conclusion

Advancements in marine ZEAT technologies in the past three years have provided more CARB-regulated vessel owners and operators with operationally feasible technologies to comply with the new CHC ZEAT mandates in the amended CHC Regulation. Additionally, CARB staff observe some operators are developing ZEAT projects that go beyond CARB's current mandates for short-run ferries to be zero emission by December 31, 2025 and for new or newly acquired excursion vessels to be zero-emission capable hybrid after December 31, 2024.

However, some CHC operating sectors still face technological challenges with electric ZEAT CHC projects. While marine grade battery technology is improving with respect to energy storage capacity (battery energy density), feasibility is still limited for CHC operations with longer operating routes and locations in remote areas away from sufficient grid power or infrastructure. There are also financial challenges due to higher capital costs of ZEAT vessel retrofit or construction and cost of required charging infrastructure projects. Incentive programs are available and are providing funding to advance the adoption of ZEAT vessels, as discussed in Chapter 3. Alternative-fueled vessels may face more complex design review processes with USCG, and fueling protocols required with hydrogen may restrict locations and times when/where refueling may occur. Similar restrictions could apply to other alternative fuels such as alcohols, LNG, or ammonia, which will need to be addressed as these technologies are adopted in California.

The proliferation of zero-emission vessel projects both in California and worldwide shows that under the right conditions, zero-emission vessel operations are currently possible across a variety of sectors. Overall, CARB staff concur with UCI's conclusions that when considering vessel design, route and energy analysis, and requisite shoreside infrastructure, significant opportunities do exist to expand CHC ZEAT requirements to new operating sectors in the future, and staff expect the adoption of ZEAT vessels will continue to increase as technology advances.

Chapter 6 – Conclusions and Recommendations

This chapter summarizes implementation progress, provides key conclusions and recommendations to CARB's Board, and describes plans for future efforts by CARB staff to continue outreach and collaboration and to provide future updates to the Board on the status of zero-emission and cleaner combustion technology and implementation progress of the Commercial Harbor Craft (CHC) Regulation.

Summary of Implementation Progress

Since the amended CHC Regulation went into effect on January 1, 2023, CARB staff has primarily focused on building internal processes to facilitate implementation and fostering collaborative relationships with vessel and facility operators, technology developers, environmental organizations, the United States Coast Guard (USCG), and other stakeholders. Through these relationships, CARB staff has worked to address implementation-related concerns including diesel particulate filter (DPF) safety and availability, and continues to work with regulated entities to identify compliance pathways and process extension requests.

As of 2025, CARB staff are actively promoting awareness and understanding of the Regulation through statewide in-person outreach. Factsheets published by CARB staff have helped to simplify understanding of the Regulation's requirements. Vessel and facility operators are making progress toward compliance, as demonstrated through annual reports, Zero Emission and Advanced Technology (ZEAT) applications, and vessel repower and replacement projects including those funded by CARB incentive programs.

The 2024 Technical Working Group (TWG) workshop series successfully brought together various stakeholders to discuss the continued need for emission reductions, the advancement of technology and challenges associated with technology adoption, Regulation implementation experiences, and USCG's processes for reviewing and approving vessel design changes or equipment installations. The majority of concerns raised through the TWG process were consistent with those raised during the rulemaking process, such as the technological and cost-related challenges of Tier 4 vessel repowers, cost and infrastructure challenges of zero-emission projects, and incentive funding availability. A more recently raised concern is the ability of marine oil terminals to comply with facility shore power requirements for CHC, and CARB staff are actively working with terminal operators to identify compliance pathways.

Additionally, CARB incentive programs have awarded funding to several zero-emission vessel projects, and these programs are working to advance technology forward and incentivize upgrades in advance of requirements. Recent awardees of CARB funding include at least three operators of in-use short run ferries.

Key Conclusions and Recommendations

While CARB staff notes there are challenges facing the CHC industry in complying with the Regulation, CARB staff believe that current compliance challenges are manageable within the existing regulatory structure and do not recommend amending the Regulation at this time.

Substantial progress has been made in technology availability. As of August 2025, there are at least 32 Tier 4 marine or marinized nonroad engine models commercially available for use on CHC, including several that were not available when CARB staff evaluated available engine models in the rulemaking Staff Report[153] in 2021. Zero-emission and advanced technologies are making advancements. Despite EPA's inaction on the Regulation's ZEAT requirements for in-use short run ferries, several zero-emission ferry projects are underway in California. For most vessel categories feasibility is still primarily dependent on an individual vessel's operational characteristics and availability of infrastructure, however examples of ZEAT vessels now exist across several vessel categories, including those not required by the CHC Regulation to adopt ZEAT technology.

The increased availability of U.S. EPA-certified Tier 4 marine engines, anticipated commercial availability of CARB-verified Level 3 marine DPFs in 2026, and the increasing number of CHC projects under development to utilize ZEAT technologies in additional CHC operating sectors beyond those mandated by CARB at this time suggests that the pace of development is likely to support the established regulatory timeline, with CARB staff observing that overall, the implementation timeline remains attainable.

Future Efforts

CARB staff will continue to maintain open communication with all stakeholders, including continuing monthly meetings with USCG, and will offer ongoing assistance to vessel and facility operators to identify compliance pathways, answer questions, and process extension requests. CARB staff will also continue to communicate with technology developers to remain up-to-date on technology development, and to keep the resources on the CHC Program webpage current such as the Tier 4 engine list.[154] Coordination with funding programs will also remain a priority to support industry's efforts to comply with the Regulation, attain additional emission reductions, and promote technology advancement. Additionally, as directed under Resolution 22-6, CARB staff plans to hold additional technical working groups biennially and report back to the Board again by the end of 2026, and conduct a Midterm Review focused on Commercial Passenger Fishing Vessel (CPFV) no later than 2028.

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[153] *Staff Report: Initial Statement of Reasons, Appendix E Technical Support Document*, pp. E-39-40, September 21, 2021, *Appendix E Technical Support Document Assessment of Marine Emission Control Strategies, Zero-Emission, and Advanced Technologies for Commercial Harbor Craft*.

[154] *Certified Tier 4 Marine Engines*. Last updated October 10, 2024, *Resources | California Air Resources Board*.

Acronyms and Abbreviations

AB	Assembly Bill
ABS	American Bureau of Shipping
ACE	Alternative Control of Emissions
AmNav	American Navigation Maritime Corporation
ARCHES	Alliance for Renewable Clean Hydrogen Energy Systems
ASTM	American Society for Testing and Materials
ATB	Articulate Tug Barge
AWO	American Waterways Operators
BAZE	Bay Area Zero Emission
CAP	Community Air Protection
CARB	California Air Resources Board
CBO	Community-Based Organization
CCDET	California Council on Diesel Education and Technology
CEQA	California Environmental Quality Act
CHC	Commercial Harbor Craft
CO_2	Carbon Dioxide
CORE	Clean Off-Road Equipment
CPFV	Commercial Passenger Fishing Vessels
CSUS	California State University, Sacramento
DBA	Design Basis Agreement
DOC	Diesel Oxidation Catalyst
DOE	U.S. Department of Energy
DPF	Diesel Particulate Filter
DPM	Diesel Particulate Matter
ECA	Electrically Classified Area
EGR	Exhaust Gas Recirculation
EPA	U.S. Environmental Protection Agency

FSOR	Final Statement of Reasons
GHG	Greenhouse Gas
IMO	International Maritime Organization
ISOR	Initial Statement of Reasons
LA-MER	Los Angeles Marine Emission Reduction
LNG	Liquified Natural Gas
MBARD	Monterey Bay Air Resources District
MBET	Monterey Bay Eco Tours
MSC	United States Coast Guard Marine Safety Center
NAAQS	National Ambient Air Quality Standards
NGO	Non-Governmental Organizations
NOx	Oxides of Nitrogen
OAL	Office of Administrative Law
OEM	Original Equipment Manufacturer
OGV	Ocean-Going Vessel
PEMS	Portable Emissions Measurement System
PM	Particulate Matter
PMSA	Pacific Merchant Shipping Association
ROG	Reactive Organic Gases
SCR	Selective Catalytic Reduction
SFBP	San Francisco Bar Pilots
SOLAS	Safety of Life at Sea
SOx	Oxides of Sulfur
TWG	Technical Working Group
UCI	University of California, Irvine
USCG	United States Coast Guard
VW	Volkswagen
WESP	Wet Electro-Static Precipitation Technology
WETA	Water Emergency Transit Authority

WSPA	Western States Petroleum Association
ZE	Zero Emission
ZEAT	Zero Emission and Advanced Technology