



CHC Requirements and Technology

Technical Working Group #1, Session 2
April 24, 2024

Amended CHC Regulation Engine and Technology Requirements

- U.S. EPA Tier 3 & Tier 4 certified Clean Air Act compliant engines
- Commercially available CARB Verified Level 3 DPF
- Zero Emission and Advanced Technology (ZEAT)
 - Zero emission technology - battery electric or hydrogen fuel cell
 - Zero emission capable hybrid technology

Requirements for Zero Emission and Advanced Technology (ZEAT)

Marine Technology Type	Vessel Category Requirement	Mandate Phase-In Date
Zero-Emission Capable Hybrid	New and Newly Acquired Excursion Vessels	December 31, 2024
Zero-Emission	New, Newly Acquired and In-Use Short-Run Ferries	December 31, 2025

Tier 3 and Tier 4 In-Use Performance Standards

CARB's new In-Use Performance Standards:

- Below 600 kW: Tier 3 or 4 (if certified) + CARB Verified Level 3 diesel particulate filter (DPF)
- Above 600 kW: Tier 4 + CARB Verified Level 3 DPF
- Most common Tier 3 + DPF performance standard:
4.2 g/bhp-hr NO_x + HC, 0.010 g/bhp-hr PM
- Most common Tier 4 + DPF performance standard:
1.3 g/bhp-hr NO_x, 0.005 g/bhp-hr PM

Technologies Utilized for Controlling Tier 3 Marine Engine NOx and PM Emissions

- Advanced combustion in-cylinder control strategies
- Retarded or delayed fuel injection timing
- High-pressure common rail (HPCR) injection

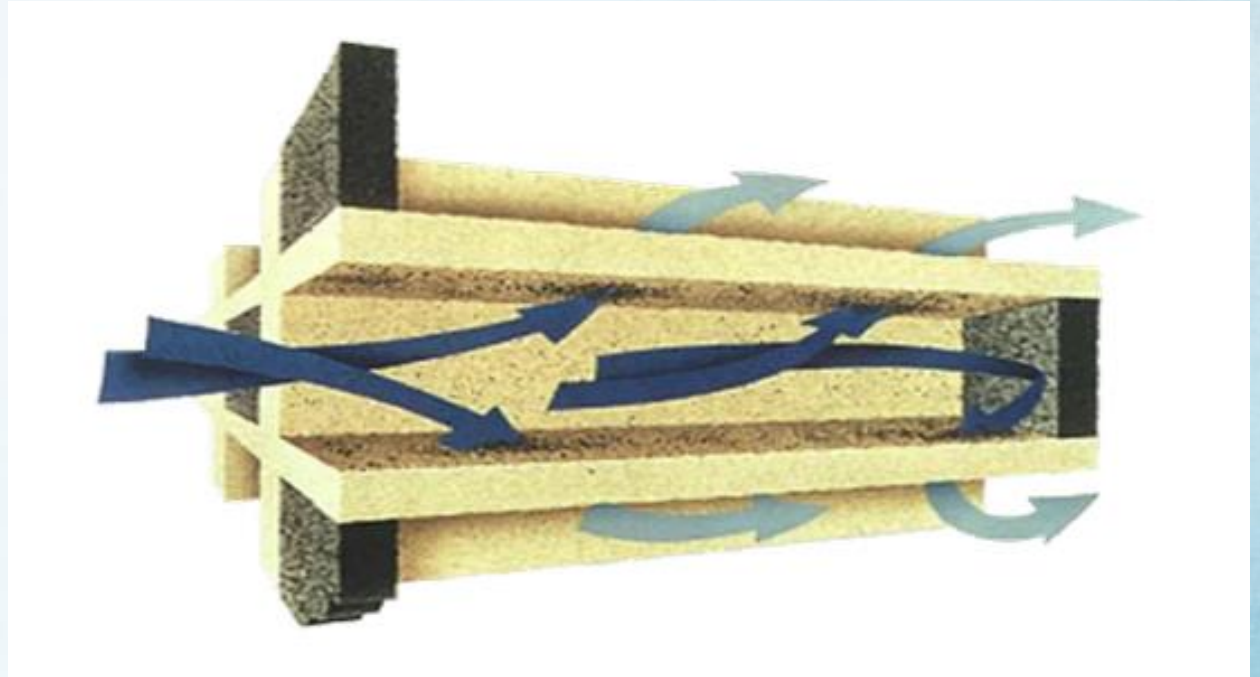
Technologies Utilized for controlling NOx Emissions in Tier 4 Engines

- U.S. EPA-certified Tier 4 marine engines may utilize:
 - Selective Catalytic Reduction (SCR) with urea injection as the reductant to reduce engine-out oxides of nitrogen, NO_x, back to diatomic nitrogen is the most common strategy; or
 - Exhaust Gas Recirculation (EGR) to cool combustion temperatures reducing engine out (NO_x) below applicable U.S. EPA Tier 4 certification standards

Diesel Particulate Filter (DPF)

- DPFs trap diesel Particulate Matter (PM) or soot but allow engine exhaust gases to pass through
- Captured soot may be passively oxidized into ash in the catalyzed DPF substrate during normal engine operation
- Captured soot may be actively oxidized during periodic forced DPF regeneration

Diesel Particulate Filter (DPF)



[Wall-Flow Monoliths
\(dieselnet.com\)](http://dieselnet.com)

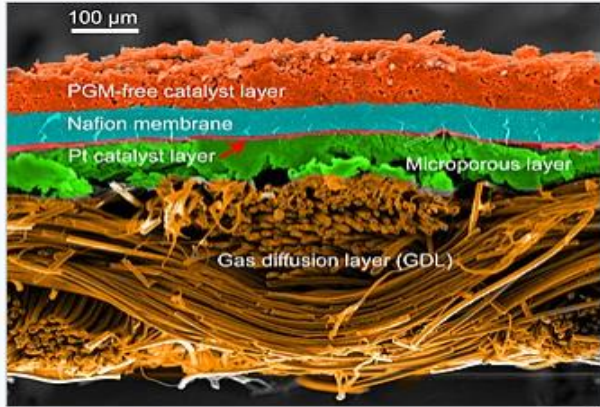
CARB DPF Verification Procedure

- CARB's existing Verification Regulation (13 CCR 2700-2711) specifies requirements for aftermarket DPF verification,
- [CARB's Verification Website,](#)
- To meet CARB's new In-Use Performance Standards for diesel PM, DPF must be a CARB Verified Level 3 DPF capable of reducing diesel PM by 85% or higher

Zero Emission Advanced Technology (ZEAT) Common Technologies

- Battery electric
 - Electric propulsion system
 - Lithium-ion battery technology for onboard Energy Storage Systems (ESS) charged by grid electricity
- Hydrogen fuel cell
 - Electric propulsion system
 - Proton exchange membrane fuel cell (PEMFC) operating on gaseous hydrogen fuel and atmospheric oxygen

PEM Fuel Cell Operation



SEM micrograph of a PEMFC MEA cross-section with a non-precious metal catalyst cathode and Pt/C anode. False colors applied for clarity.^[4]

[Effects of MEA Fabrication and Ionomer Composition on Fuel Cell Performance of PGM-Free ORR Catalyst \(Journal Article\) | OSTI.GOV](#)

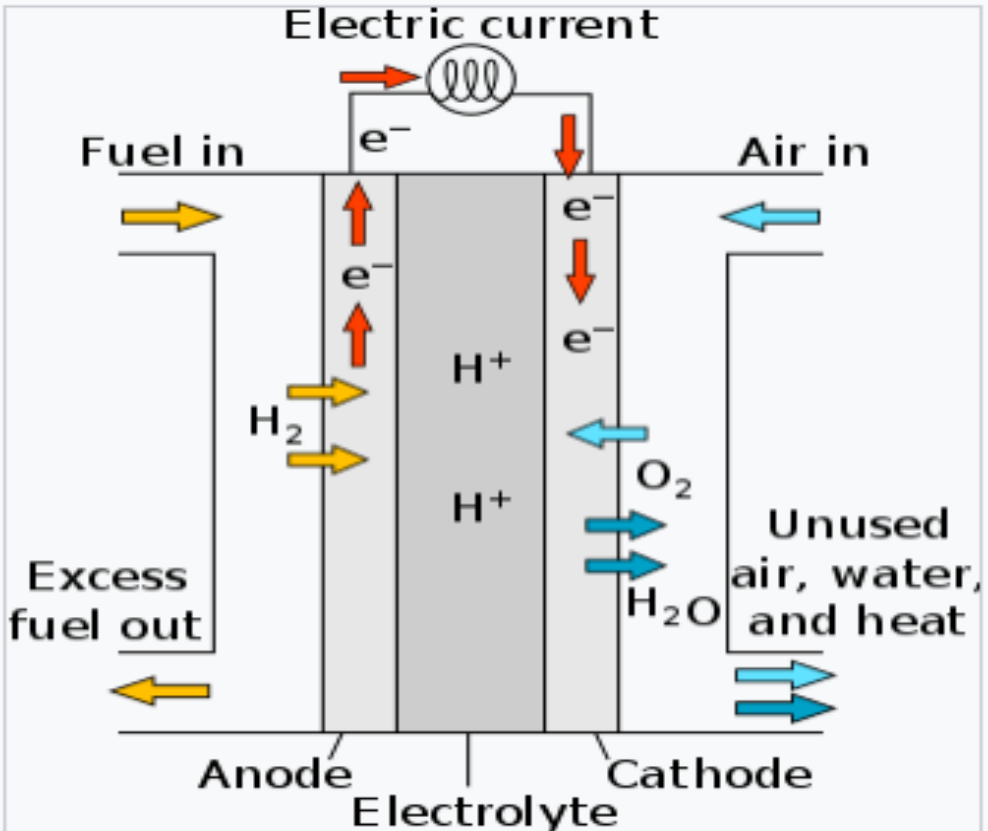


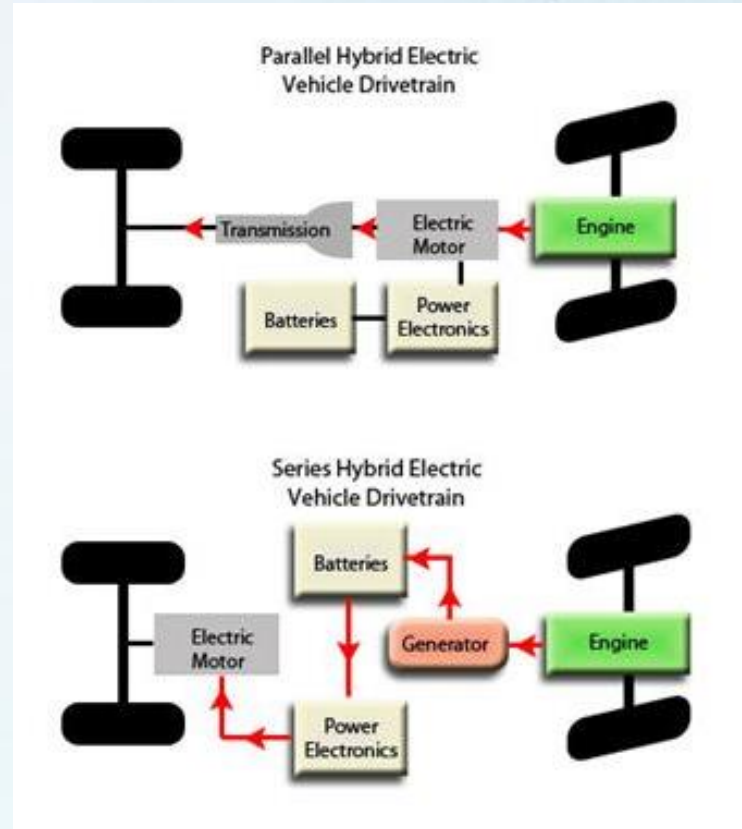
Diagram of a PEM fuel cell

Zero Emission Capable Hybrid

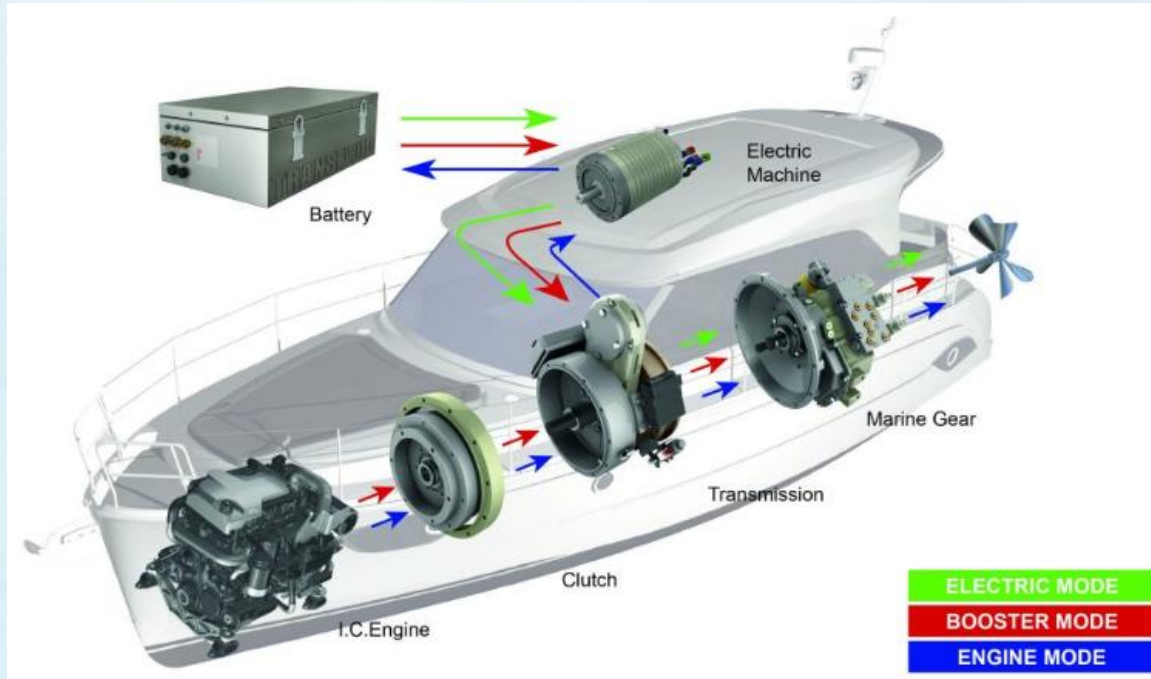
- Definition
 - 30% annual vessel power from zero tailpipe emission power source (when averaged over a calendar year)
- Hybrid Propulsion system
 - Series hybrid
 - Parallel hybrid

Series and Parallel Hybrid Configurations

[Different types of hybrid drive trains | Fuel Cell Electric Buses \(fuelcellbuses.eu\)](http://fuelcellbuses.eu)



Marine Parallel Hybrid Configuration



[Parallel Hybrid System - Bellmarine](#)

Available Tier 3/4 Marine Engines

- US. EPA Marine Engine Certification Database:
 - [Annual Certification Data for Vehicles, Engines, and Equipment | US EPA](#)
- A list of Tier 4 marine engines and marinized Tier 4 engines on CARB's website:
 - [Resources | California Air Resources Board](#)
- Contact dealers or distributors