



## Tier 4 Aftertreatment for CMI Marine



# Agenda

1. Marine Emission Overview
2. Emissions Technology
3. NOx Reduction Technology
4. Tier3 vs. Tier4 Marine

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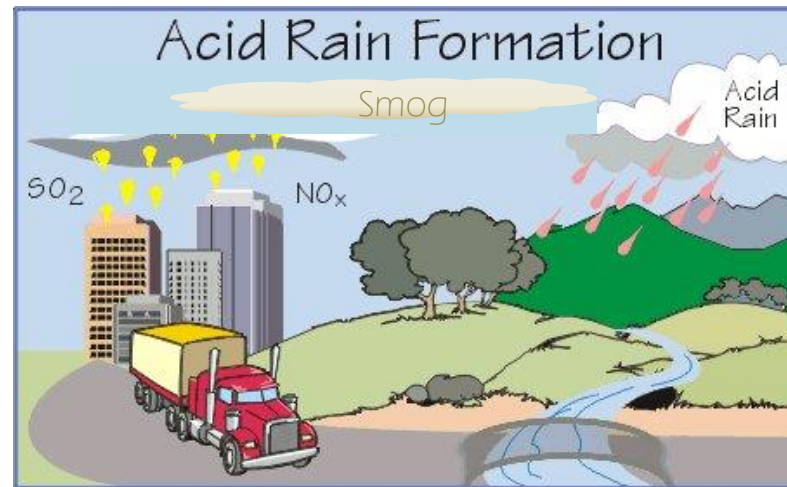
# What drives the need for aftertreatment?

- **Oxides of Nitrogen (NO<sub>x</sub>)**

- Made up of colorless nitric oxide (NO) and reddish-brown, very toxic and reactive nitrogen dioxide (NO<sub>2</sub>)
- Contribute to photochemical smog and acid rain

- **Greenhouse Gas (GHG)**

- Comprised of Carbon Dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), Nitrous Oxide (N<sub>2</sub>O), Fluorinated Gases
- Gases that trap heat in the atmosphere raising temperatures



Original source: epa.gov

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# What are the new Emissions Requirements?

## Tier3

PM: 0.10 g/kW-hr

CO: 5.0 g/kW-hr

NOx +HC 5.6 g/kW-hr

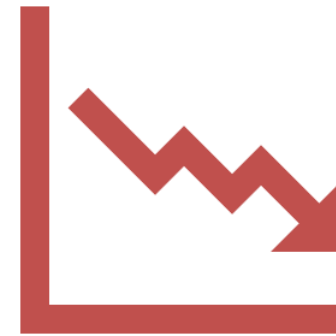
## Tier4

PM: 0.04 g/kW-hr

CO: 5.0 g/kW-hr

NOx: 1.80 g/kW-hr

HC: 0.19 g/kW-hr



Reduction in  
NOx Drives  
the need for  
SCR

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# Meeting Marine HHP Needs with Aftertreatment

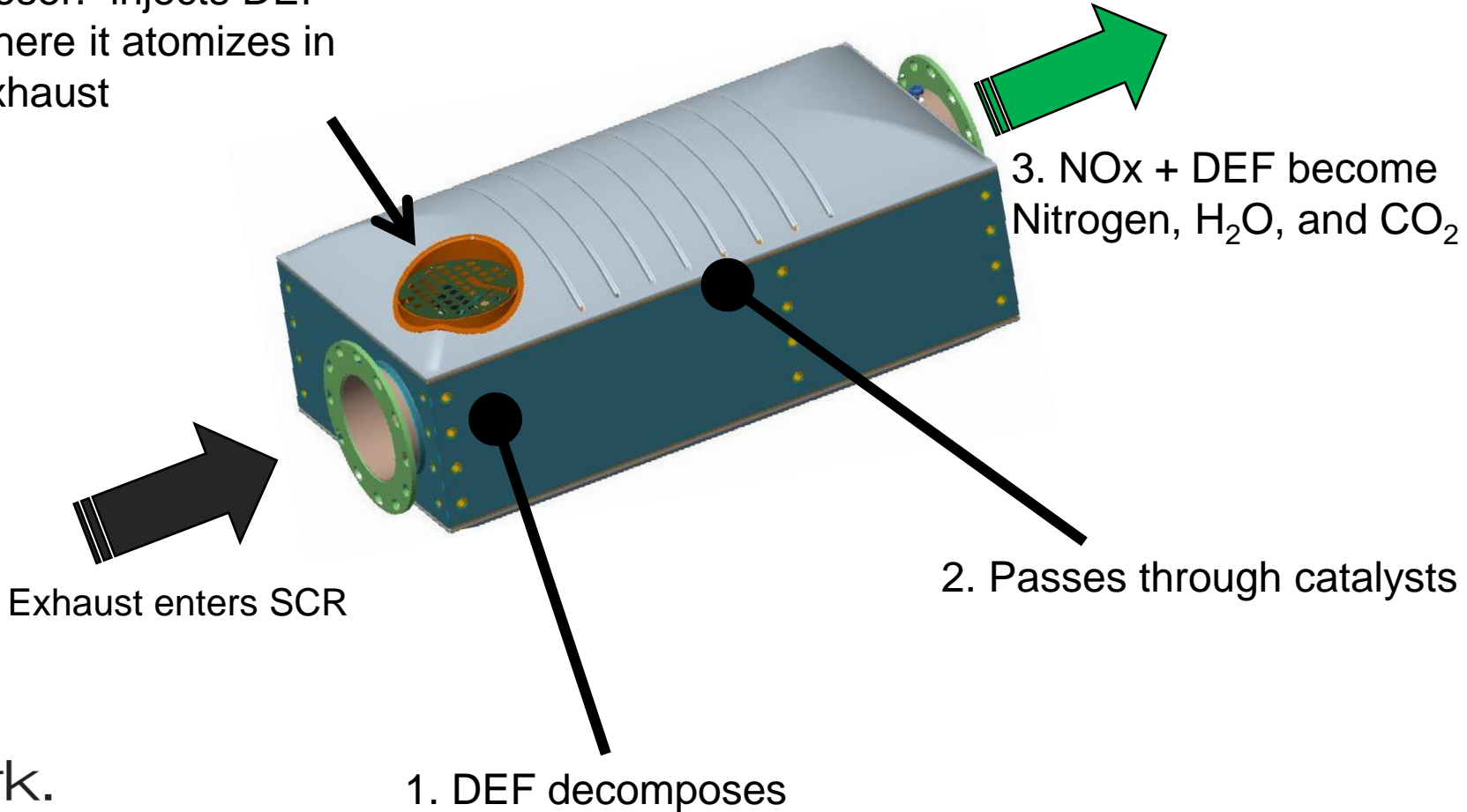
- Leverage Existing Technology (SCR – Selective Catalytic Reduction)
  - SCR technology is not new; proven track record
- Design to Fit HHP Marine Applications
- Plan for Harsh Environments
  - Meeting temperature, environmental and vibration requirements
- Performance Characteristics
  - Aftertreatment design is flow-through with low backpressure
- Robust and Durable
  - Designed for life to overhaul

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# Selective Catalyst Reduction Fundamentals

Doser: injects DEF where it atomizes in exhaust

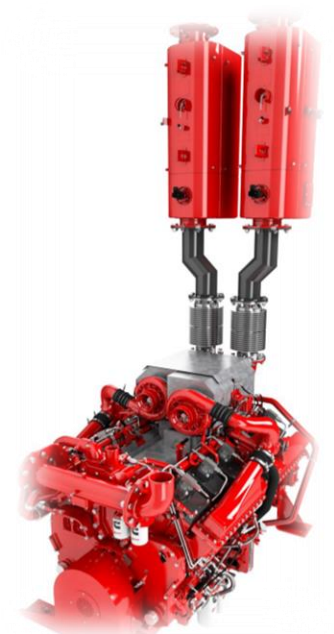
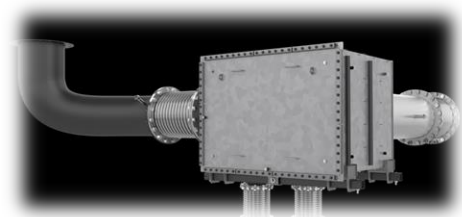


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# CMI Product Lineup for Marine Tier4/IMO III

- IMO III (Non Tier4)
  - QSK60 (2200-2700 HP) – *Propulsion and Auxiliary*
  - QSK50 (1500- 1900 HP) – *Propulsion and Auxiliary*
  - QSK38 (800 – 1400 HP) – *Propulsion and Auxiliary*
  - QSK19 (600-800 HP) – *Propulsion and Auxiliary*
- Tier4 and IMO III
  - QSK60 (2200 – 3000 HP) – *Propulsion and Auxiliary*
  - QSK38 (1000 – 1500 HP) – *Propulsion and Auxiliary*



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*Cummins*  
*Booth - #340*



# Marine Tier3 vs. Tier4 – What to Expect

- Using incorrect fuel or oil will poison catalyst
  - ULSD fuel required (<15 PPM sulfur)
  - CJ-4 oil required (low Phosphorous)
- DEF (Urea) Tanks and injection hardware
- Stainless Exhaust to A/T
- EPA
  - Recordable events documented and reported by Vessel
- System Performance
  - Improved Fuel consumption
  - Better or equal Fluid Consumption
  - Improved Transient Response
- IMO III required for Transient Vessels outside EPA zone – Inland waterway not affected.

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