Emission Standards for Commercial Marine Diesel Engines

Workshop on Maritime Energy and Clean Emissions

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Overview

- International Standards - MARPOL Annex VI
- Federal Standards
  - Category 1 and Category 2 Marine Diesel Engines
  - Category 3 Marine Diesel Engines

3 Categories of Marine Diesel Engines

- Category 1: less than 5 liters/cylinder
  - » kW range 37-560 (50-750 hp)
  - » Similar to engines in construction and farm equipment
- Category 2: 5-30 liters/cylinder
  - » kW range 560-1,120 (750-1,500 hp)
  - » Similar to locomotive engines
- Category 3: more than 30 liters/cylinder
  - » kW range 1,120-75,000+ (1,500-100,000+ hp)
  - » Similar to power plant generators
  - » Primarily used for propulsion on ocean-going vessels
  - » They typically use residual fuel

Emission Standards

- There are two sets of standards that apply to marine diesel engines
  - International Maritime Organization -- Annex VI to the International Convention on the Prevention of Pollution from Ships (MARPOL 73/78)
  - Federal standards promulgated under CAA §213
- Discussions began at about the same time for both -- mid-1990s

MARPOL Annex VI Standards

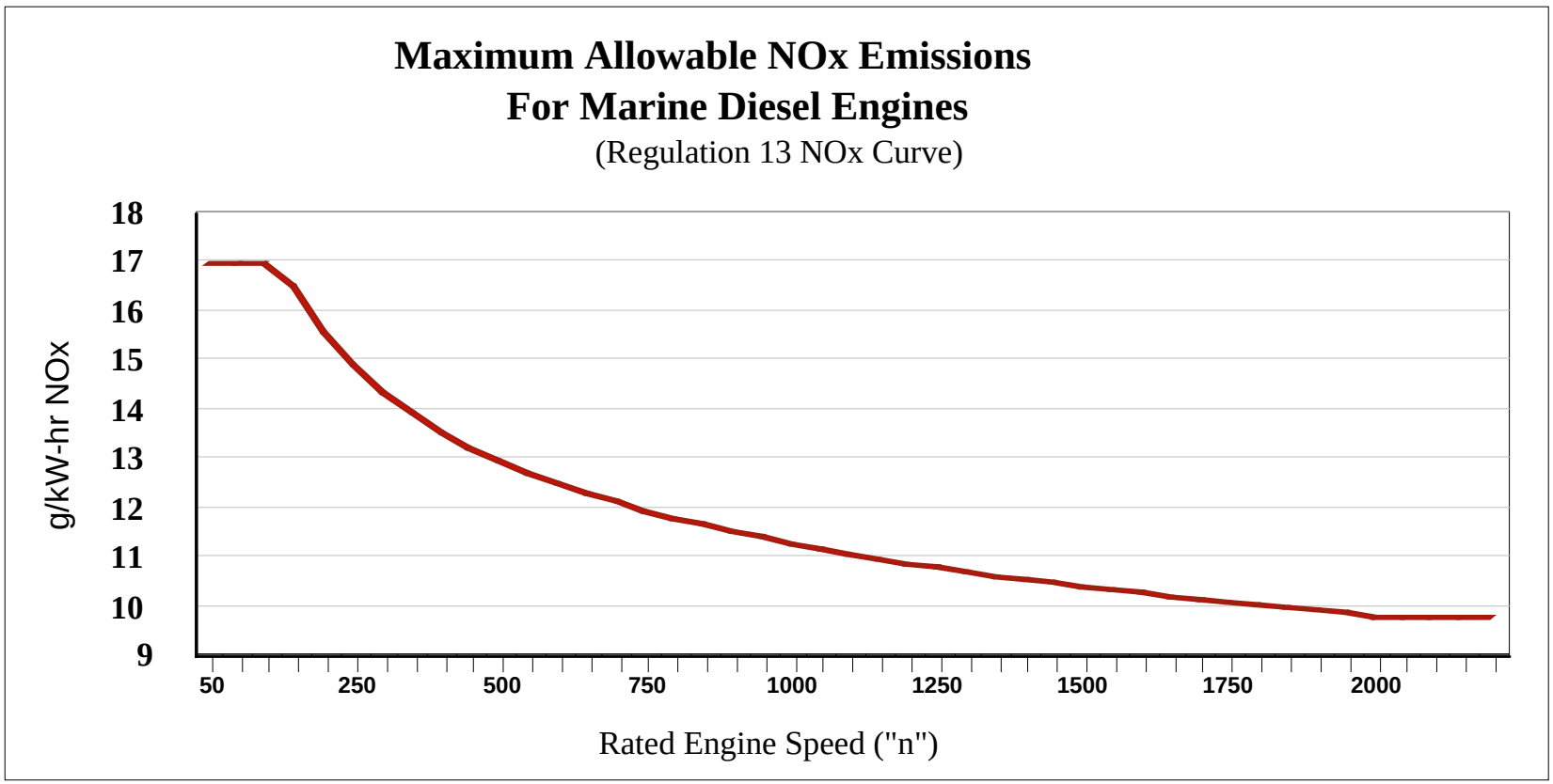
- MARPOL Annex VI was adopted by IMO in 1997 but is not in force
  - Need 15 countries, 50% of world fleet to ratify
  - 4 countries, 14.5%, so far
    - » Sweden, Norway, Singapore, Bahamas, Malawi

Regulation	Topic
12	Ozone depleting substances
13	NOx emissions
14	SOx emissions
15	VOC emissions from tanker refueling
16	Shipboard incineration
17	Reception facilities
18	Fuel quality
19	Platforms and drilling rigs

MARPOL Engine Requirements

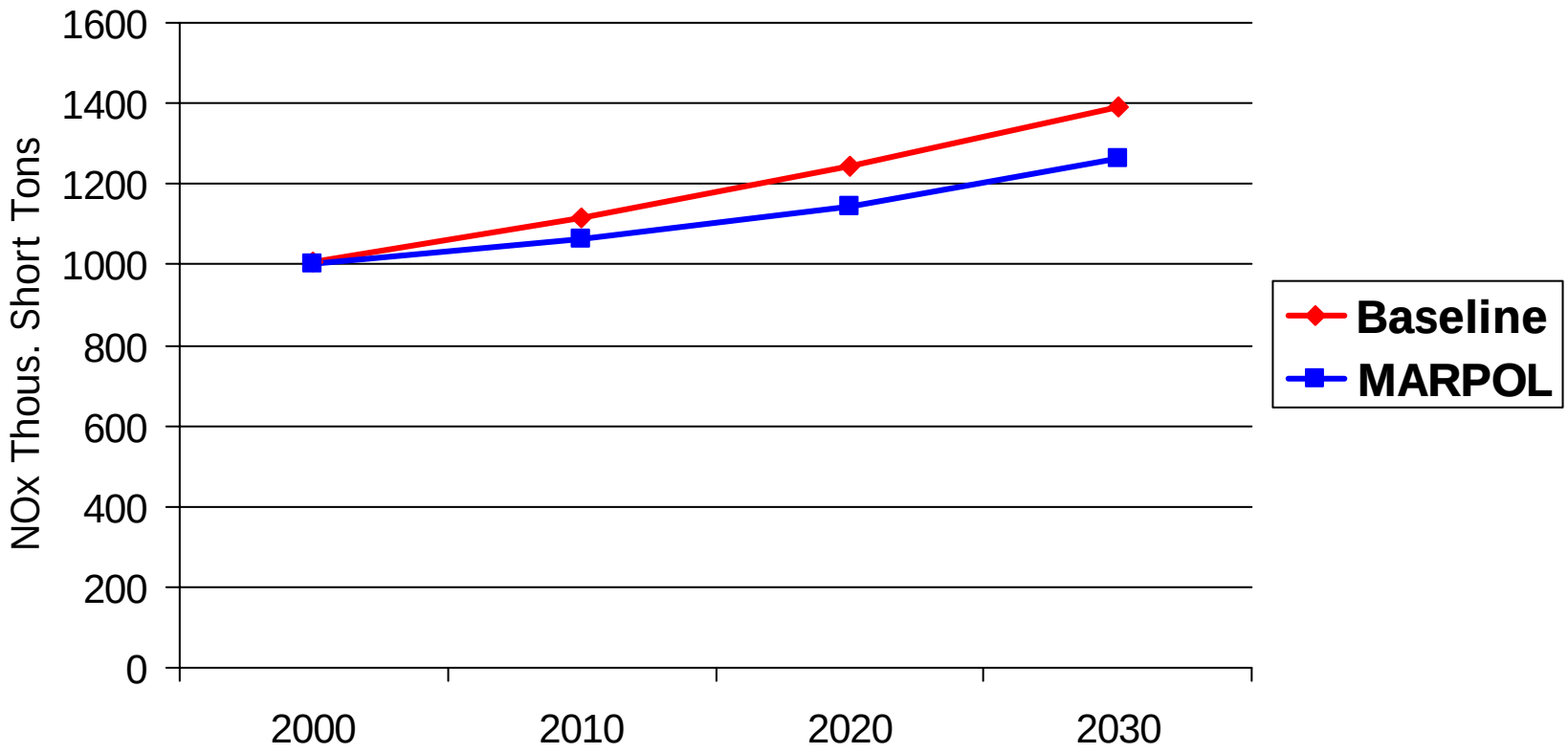
- Annex VI Engine Standards
  - Apply to engines ❍ 130 kW
    - » Installed on a ship constructed on or after 1/1/2000
    - » Undergo a major conversion on or after 1/1/2000
    - » Countries can set different standards for domestic fleet
  - Limits are for NOx only
    - » Based on engine speed
    - » Similar in stringency to Tier 1 nonroad standards
      - ~15% reduction from uncontrolled
      - New engines have largely been in compliance since late 1990s

MARPOL Engine Requirements



MARPOL Engine Requirements

NOx Emissions from All Marine Diesel Engines (within 250 Miles of U.S.)



MARPOL Fuel Requirements

- Very large ocean-going vessels use residual fuel
  - » This fuel has a high sulfur content
  - » World average is approximately 30,000 ppm (3.0%)
  - » Can be up to 45,000 ppm (4.5%)
  - » Most diesel engines operating in the U.S. use nonroad distillate: 2,000 to 3,000 ppm
    - HD2007 requires 15 ppm
  - » can also have high nitrogen content (0.4-0.5%)
- 3 regulations affect marine fuel
  - – SOx Limits (Regulation 14)
  - – Fuel Oil Quality (Regulation 18)
  - – Shipboard Incineration (Regulation 16)

MARPOL Fuel Requirements

- SOx
  - Maximum sulfur content: 45,000 ppm (4.5%)
  - SOx Emission Control Areas
    - » Baltic Sea, North Sea designated
    - » Method for designating other areas specified
      - Can establish these areas for the US as part of the international process
    - » Sulfur content: 15,000 ppm or less
  - Unlike engines, the fuel standards do not apply until the Annex enters into force Sulfur content: 15,000 ppm (1.5%) or less

Federal Marine Diesel < 37 kW

- Small marine diesel engines included in the Nonroad Tier 2 rule
  - » Finalized 10/23/98, 63 FR 56967; 40 CFR Part 90

Final Emission Standards and Dates - Marine Diesel < 37 kW

Engine Power	Tier	Model Year	NMHC + NOx (g/kW-hr)	CO (g/kW-hr)	PM (g/kW-hr)
kW<8	Tier 1	2000	10.5	8.0	1.0
	Tier 2	2005	7.5	8.0	0.80
8≤kW<19	Tier 1	2000	9.5	6.6	0.80
	Tier 2	2005	7.5	6.6	0.80
19≤kW<37	Tier 1	1999	9.5	5.5	0.80
	Tier 2	2004	7.5	5.5	0.60

Federal Marine Diesel: C1 & C2

- Federal standards for commercial marine diesel engines were finalized 12/29/99
  - » 64 FR 73300; 40 CFR Part 94
- Standards are by category
- Cover PM, HC, CO as well as NOx
- Technology similar to nonroad Tier 2 requirements
  - Internal engine design, turbocharging, better engine cooling, electronic Controls
- By 2020, these standards, plus the MARPOL limits, are expected to reduce national NOx levels by 21% and PM levels by 11%

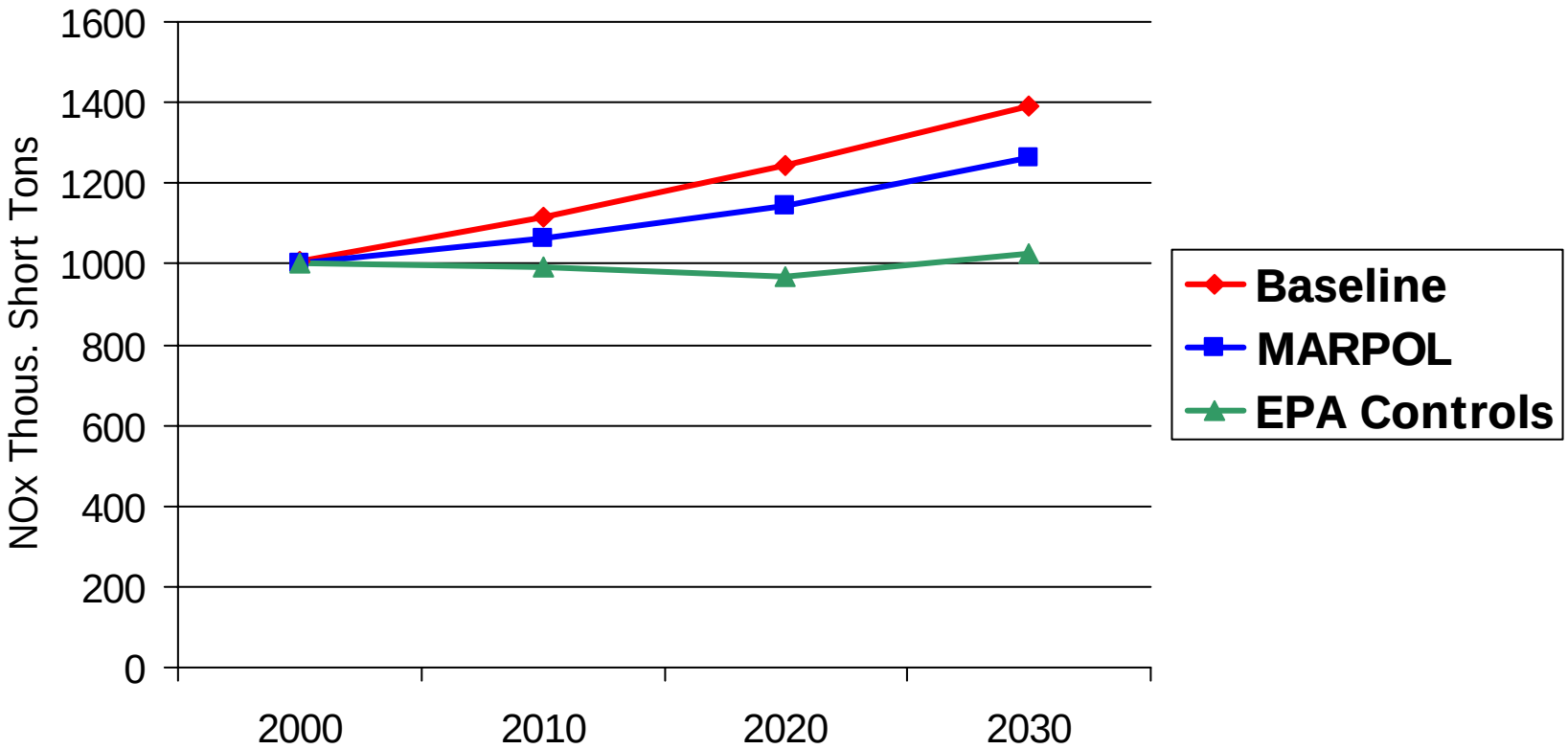
Federal Marine Diesel: C1 & C2

Final Emission Standards and Dates - Commercial Marine Diesel ≥ 37 kW

Category	Displacement (liters/cylinder)	Starting Date	NOx+HC (g/kW-hr)	PM (g/kW-hr)	CO (g/kW-hr)
1	power ≥ 37 kW disp. < 0.9	2005	7.5	0.40	5.0
	0.9 ≤ disp. < 1.2	2004	7.2	0.30	5.0
	1.2 ≤ disp. < 2.5	2004	7.2	0.20	5.0
	2.5 ≤ disp. < 5.0	2007	7.2	0.20	5.0
2	5.0 ≤ disp. < 15	2007	7.8	0.27	5.0
	15 ≤ disp. < 20, and power < 3300 kW	2007	8.7	0.50	5.0
	15 ≤ disp. < 20, and power ≥ 3300 kW	2007	9.8	0.50	5.0
	20 ≤ disp. < 25	2007	9.8	0.50	5.0
	25 ≤ disp. < 30	2007	11.0	0.50	5.0
3	disp. ≥ 30	No standards finalized; MARPOL limits apply			

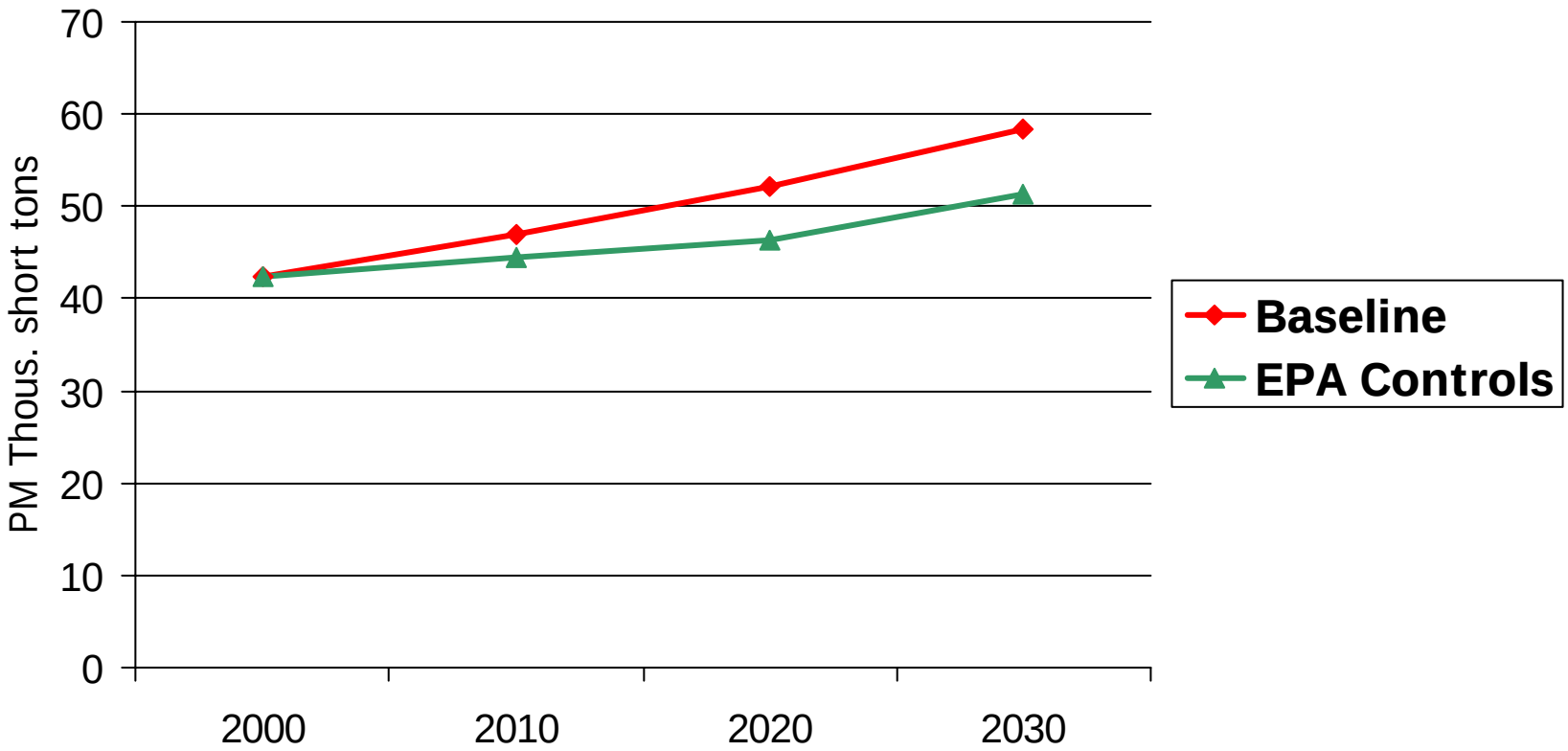
Emission Projections - NOx

U.S. NOx Emissions from Marine Diesel Engines (within 250 Miles of U.S.)



Emission Projections - PM

U.S. PM Emissions from Marine Diesel Engines (within 250 Miles of U.S.)



Federal Marine Diesel: C1 & C2

- Additional provisions - commercial marine ❍ 37 kW
  - MARPOL NOx limits are voluntary until effective dates of national standards
    - » Ships subject to MARPOL inspection requirements should be equipped with MARPOL engines
  - Manufacturers need to show engines comply under real operating conditions (not-to-exceed zone)

C3 Marine Diesel Engine Rule

- We deferred to MARPOL Annex VI standards for Category 3 engines
  - MARPOL standards are voluntary until Annex VI goes into effect (Statements of Voluntary Compliance)
- We were sued and entered into a settlement agreement
  - We will take final action on NOx limits for C3 engines
  - We will ask for comment on applying the NOx limits to foreign flag vessels in U.S. ports
    - » The inventory contribution of these vessels is significant
    - » According to MARAD data, 94% of vessels that entered the U.S. in 1999 were foreign flag vessels
    - » These represent 93% of all vessel entrances

C3 Marine Diesel Engine Rule

- Schedule for C3 marine rulemaking
  - NPRM: 4/30/02
  - FRM: 1/31/02
- We are currently developing this rulemaking
  - New inventory
    - » “Bottom-up” based on emission factors, port activity levels
    - » Nationally, 1-2% of total NOx, but 4%+ in port areas
  - Analysis of application of existing and advanced technologies to these engines

C3 Marine Diesel Engine Rule

- World C3 marine industry is small
  - 1,260 engines manufactured worldwide in 1998
    - » 5 main companies; 1 US manufacturer
  - 1,080 ships built in 1998
    - » Major builders are in Korea, China, Japan
    - » US shipbuilding presence is small - Jones Act vessels Only 19 vessels have been built in the US in the last 10 years
- World fleet of C3 vessels is about 30,000 vessels
  - US fleet is about 450 vessels
  - Turnover for C3 vessels is slow
    - » Average age for world fleet is 29 years

C3 Marine Diesel Engine Rule

- Engine standards under consideration
  - Considering MARPOL
  - Considering other limits as well
- Fuels
  - Concerns with fuel effects on emissions
  - Residual fuel has high sulfur and nitrogen content
    - » affects SOx, PM, and NOx
- We will be asking for comment on whether these standards should apply to foreign flag vessels that use U.S. ports

Emission Standards for Commercial Marine Diesel Engines

Questions?

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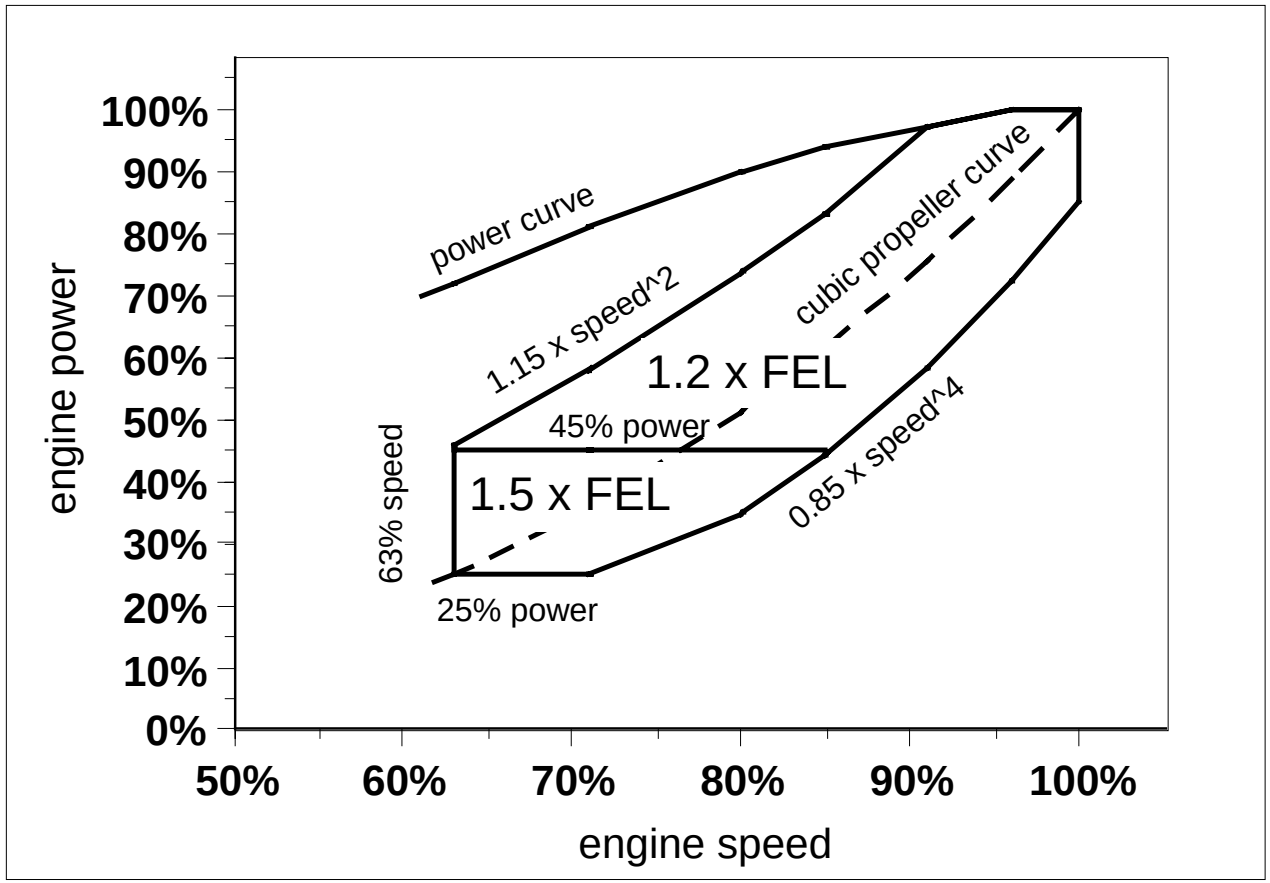
Appendix 1

– Illustration of not-to-exceed zone



Appendix 2

- MARPOL Annex VI Certificates
  - Engine International Air Pollution (EIAPP) Certificate
    - » Issued by US EPA
    - » Due to 1/1/2000 effective date, EPA is already issuing Statements of Voluntary Compliance
    - » Process to exchange for EIAPP later
  - International Air Pollution Prevention (IAPP) Certificate
    - » Issued by Coast Guard
    - » Vessel's engines must comply with Annex VI