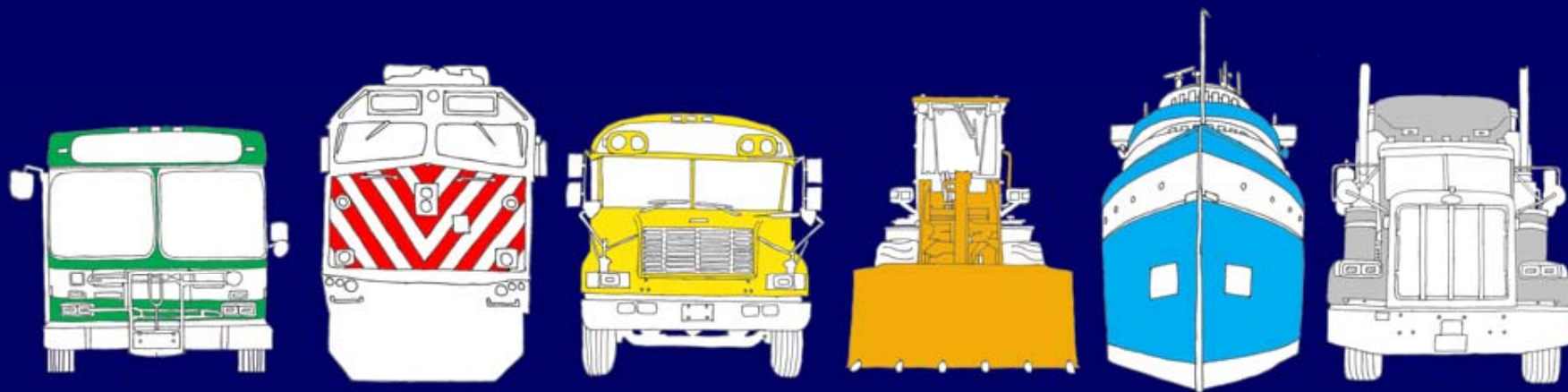


US EPA ARCHIVE DOCUMENT

Midwest Clean Diesel Initiative Presents

Learn More About It:

Marine and Locomotive Repowers



Repowering line-haul/switcher locomotives and heavy-duty marine engines can achieve significant emissions reductions while extending the life of the vehicle

Agenda

- Introduction
- EPA Marine and Locomotive regulations overview (Tony Maietta)
- Locomotive Repowers
 - Cummins
 - Progress Rail
- Marine Repowers
 - EMD
 - Cummins
- Q&A

EPA's Marine & Locomotive Regulations

- Final rule signed March 14, 2008
 - Full phase in by 2017
- Unique remanufacture aspect
 - Durability of equipment
 - Long working life
 - Environmental benefits

Clean Locomotives and Marine Diesels A Comprehensive 3-Part Program

1
standards for
remanufactured
existing engines
starts 2008

2
Tier 3
for newly-built engines
starts 2012
engine-based

[2009 for
marine
<75 kW]

3
Tier 4
for newly-built engines
starts 2014 (marine),
2015 (locomotive)
aftertreatment-based

What the Rule Covers-- Locomotives



Line-Haul
(>2300 hp)



Typically rebuilt
every 5-7 years

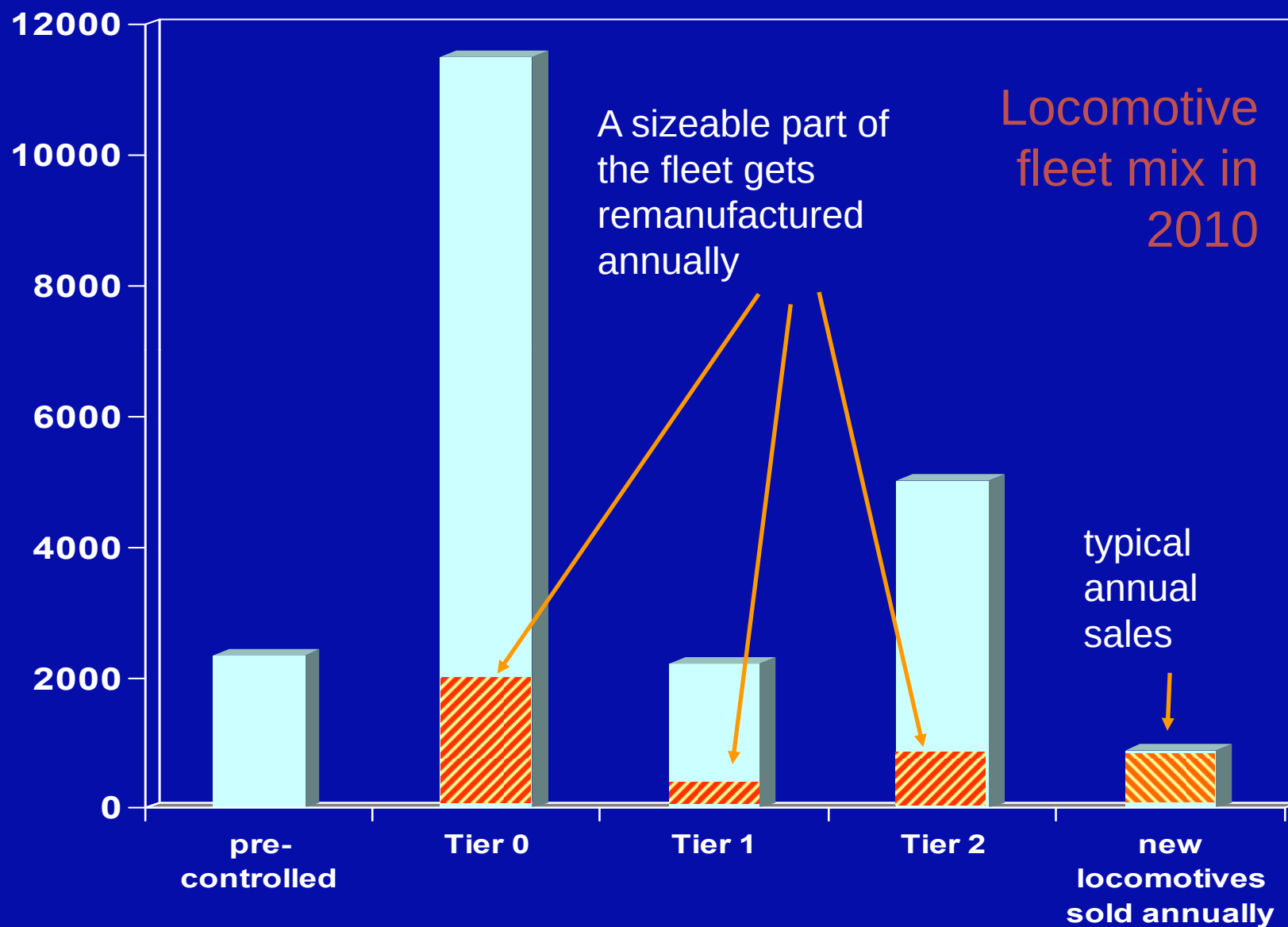


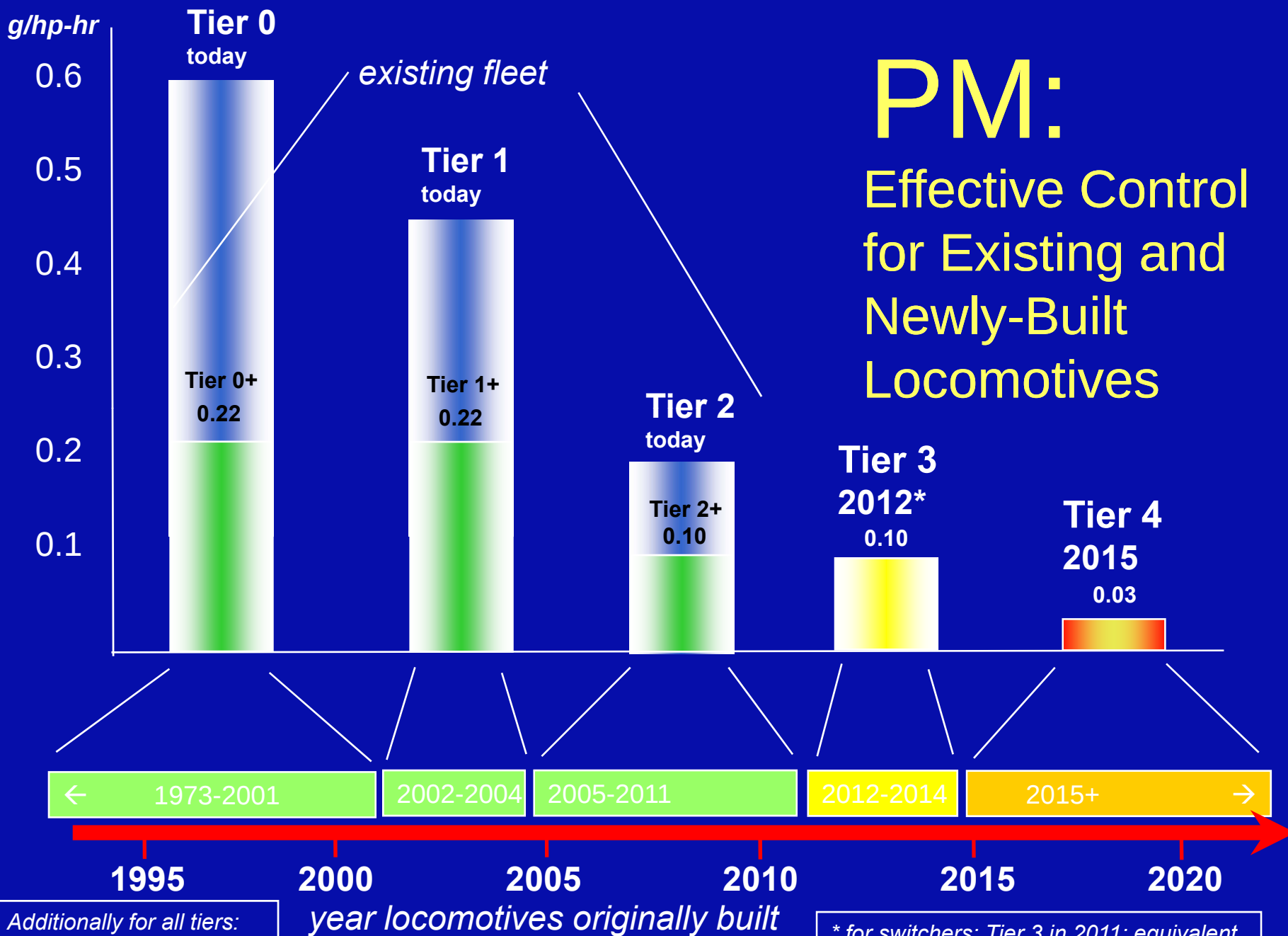
Switch (<2300 hp)

Passenger



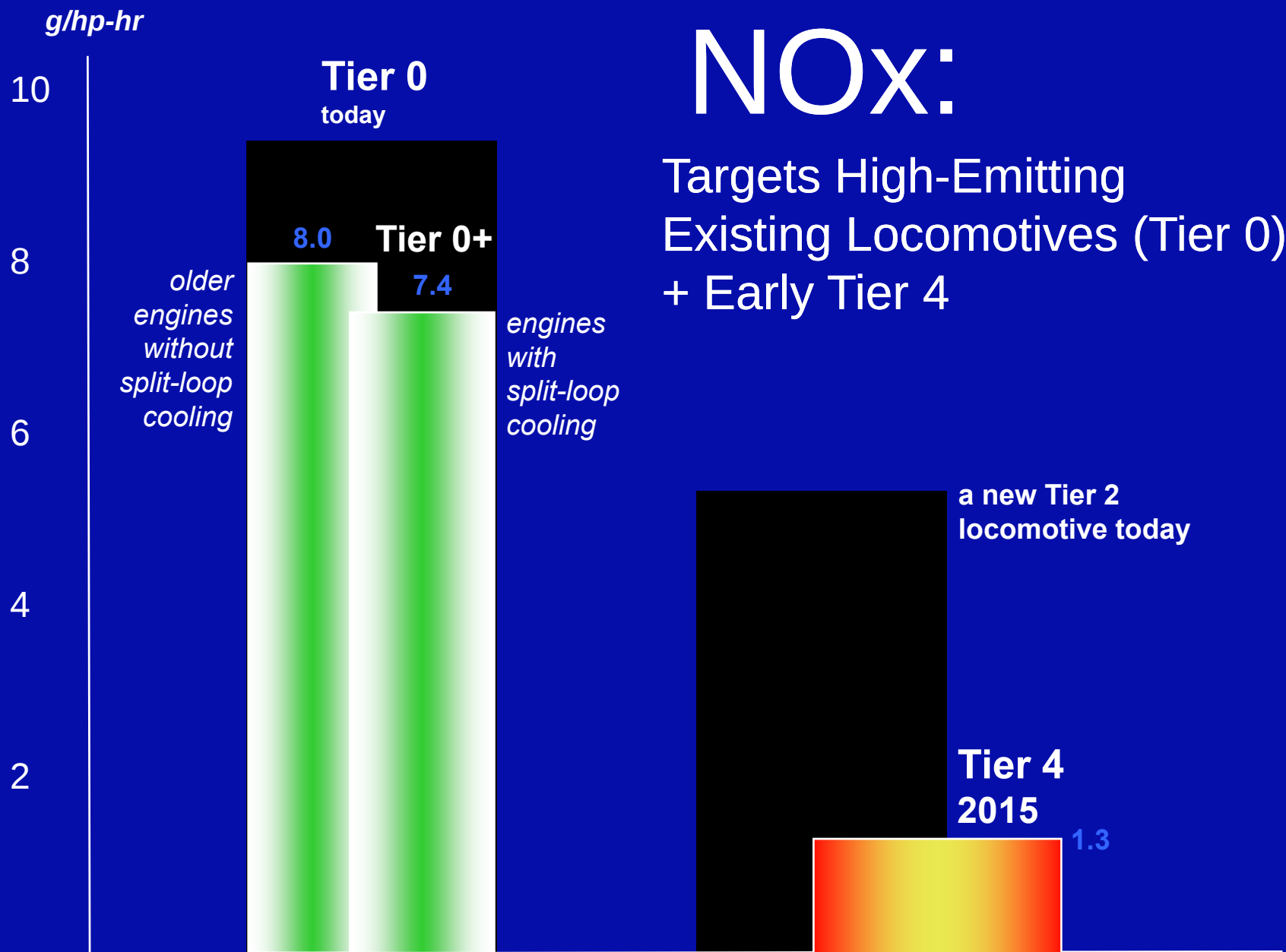
The Significance of Locomotive Remanufacturing





Additionally for all tiers:
Idle emissions controls

* for switchers: Tier 3 in 2011; equivalent₇
standards apply to switchers in all tiers



What the Rule Covers – Marine

Diversity In Vessel Applications Calls for Targeted Diesel Emissions Standards

<75 hp
<10,000/year



gen sets



sailboats

Recreational
~15,000/year

cruisers



yachts



Category 1 Commercial (<7 liter/cylinder)
~15,000/year (about half are aux engines)



workboats



police boats



fishing vessels

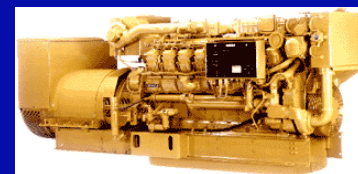
Category 2 (7 to 30 liter/cyl) <300/year



tugboats



ferries



auxiliary power for
ocean-going vessels



Great Lakes freighters

**Category 3
(>30 liter/cyl)**



ocean-going ships

Covered in separate initiative

Diversity In Marine Diesel Engines Calls for Targeted Emissions Standards



Category 1 Commercial
<7 liters/cylinder



Category 2
7–30 liters/cylinder
many derived from locomotive
engines

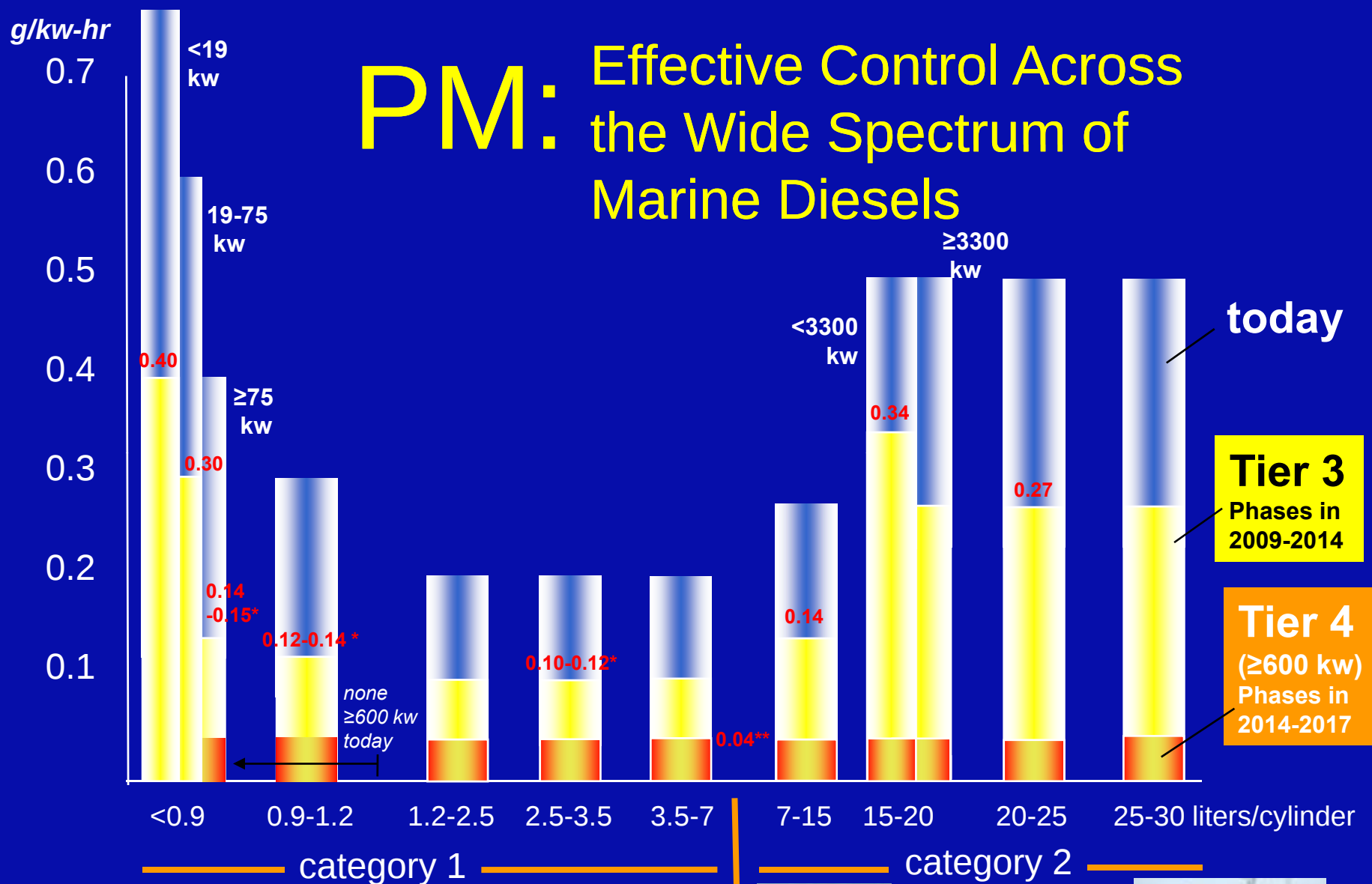


Recreational
high power-to-weight ratios
to enable vessel planing

<75 kW
marinized
nonroad
engines



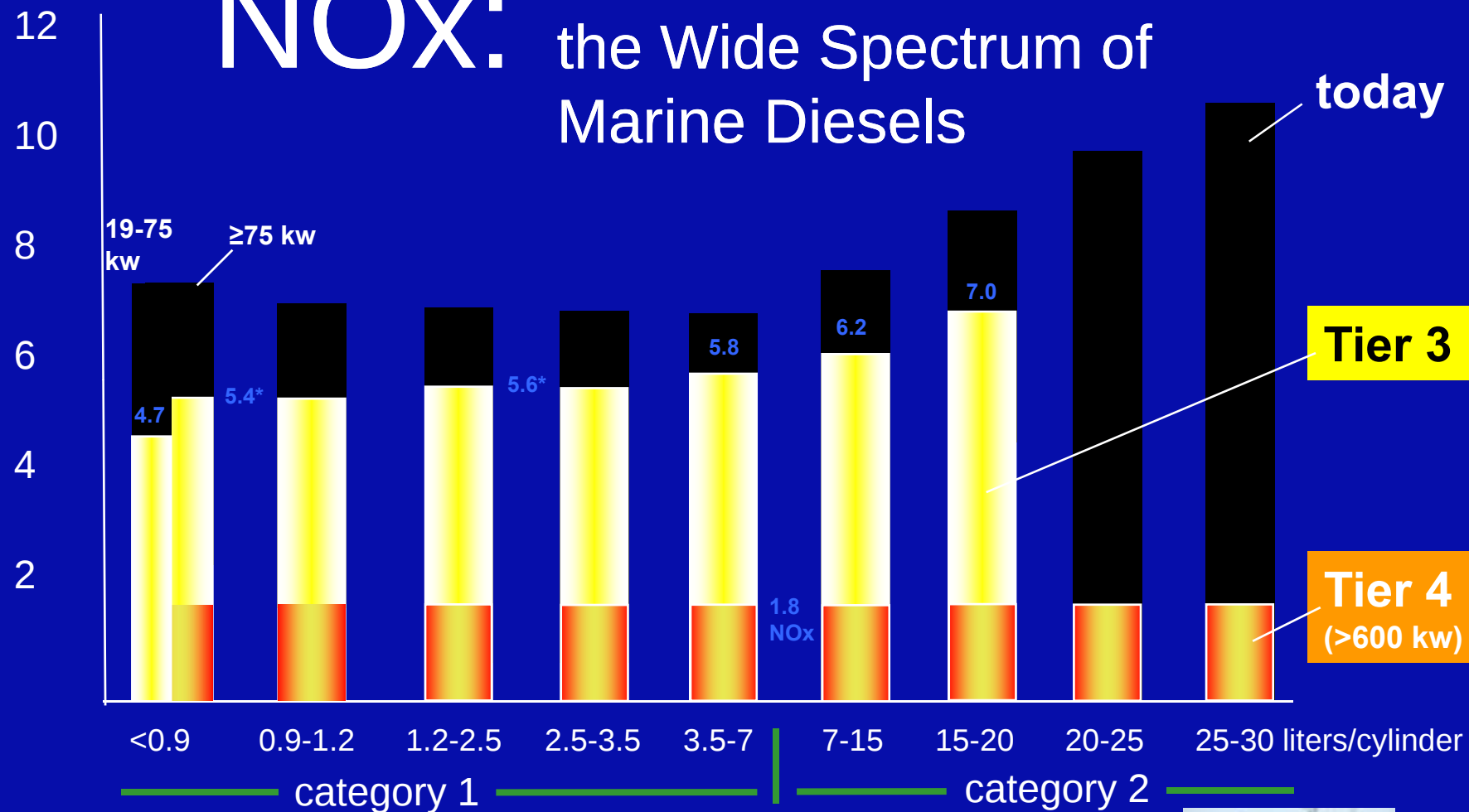
PM: Effective Control Across the Wide Spectrum of Marine Diesels



* higher #s are for hi-power density (≥35 kw/L) engines.
 ** 0.06 for the very largest (>3700 kw) engines.

NO_x+HC
g/kw-hr

NO_x: Effective Control Across the Wide Spectrum of Marine Diesels



Indicated standards are NO_x+HC, except Tier 4 (NO_x).
For ≥2000 kw: no Tier 3 NO_x (early Tier 4 instead).
* 5.8 for hi-power density (≥35 kw/L) engines.

...and for reference:

The New Line-Haul Locomotive Standards (g/bhp-hr)

locomotive group	date	PM		NOx		HC	
		previous standard	new standard	previous standard	new standard	previous standard	new standard
Remanufactured Line-Haul Locomotive Standards							
Remanufactured Tier 0 & 1	2008 as available 2010 required	0.60	0.22	9.5 (Tier 0) 7.4 (Tier 1)	7.4 (8.0 if no SLAC)	1.00 (Tier 0) 0.55 (Tier 1)	0.55 (1.00 if no SLAC)
Remanufactured Tier 2	2008 as available 2013 required	0.20	0.10	5.5	5.5	0.30	0.30
Newly-built Line-Haul Locomotive Standards							
Tier 3	2012	--	0.10	--	5.5	--	0.30
Tier 4	2015	--	0.03	--	1.3	--	0.14

SLAC = separate loop intake air cooling.

Additionally, in all locomotive groups:

Idle emissions control– must equip locomotive with automatic engine stop/start.

HC standards are Total HC, except Tier 4 (NMHC).

Part 92 smoke standards apply if PM FEL >0.05 g/bhp-hr, but are generally waived from testing.

Part 92 CO standards continue to apply (at Tier 2 levels for Tiers 3&4); notch caps also apply.

Must also meet switch-cycle standards of the same tier (of Tier 2 for Tier 3 line-haul locomotive) except for Tier 4.

The New **Switch** Locomotive Standards (g/bhp-hr)

locomotive group	date	PM		NOx		HC	
		previous standard	new standard	previous standard	new standard	previous standard	new standard
Remanufactured Switch Locomotive Standards							
Remanufactured Tier 0	2008 as available 2010 required	0.72	0.26	14.0	11.8	2.10	2.10
Remanufactured Tier 1	2008 as available 2010 required	0.54	0.26	11.0	11.0	1.20	1.20
Remanufactured Tier 2	2008 as available 2013 required	0.24	0.13	8.1	8.1	0.60	0.60
Newly-built Switch Locomotive Standards							
Tier 3	2011	--	0.10	--	5.0	--	0.60
Tier 4	2015	--	0.03	--	1.3	--	0.14

Additionally, in all locomotive groups:

Idle emissions control– must equip locomotive with automatic engine stop/start.

HC standards are Total HC, except Tier 4 (NMHC).

Part 92 smoke standards apply if PM FEL >0.05 g/bhp-hr, but are generally waived from testing.

Part 92 CO standards continue to apply (at Tier 2 levels for Tiers 3&4); notch caps also apply.

Can also use alternative nonroad engine-based program.

EPA's New Marine Diesel Standards (p.1 of 2)

New Marine Diesel Standards: Standard Power Density Commercial

Category 1 <75kW	Displacement L/cyl		Tier 2		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019			
			g/kW-hr	g/hp-hr	g/kW-hr g/hp-hr	g/kW-hr g/hp-hr	g/kW-hr g/hp-hr	g/kW-hr g/hp-hr	g/kW-hr g/hp-hr	g/kW-hr g/hp-hr	g/kW-hr g/hp-hr	g/kW-hr g/hp-hr	g/kW-hr g/hp-hr	g/kW-hr g/hp-hr	g/kW-hr g/hp-hr			
see note 5:	<0.9	PM	0.80	0.60	0.40 0.30	0.40 0.30	0.40 0.30	0.40 0.30	0.40 0.30	0.40 0.30	0.40 0.30	0.40 0.30	0.40 0.30	0.40 0.30	0.40 0.30			
	<19 kW	NOx+HC	7.5	5.6	7.5 5.6	7.5 5.6	7.5 5.6	7.5 5.6	7.5 5.6	7.5 5.6	7.5 5.6	7.5 5.6	7.5 5.6	7.5 5.6	7.5 5.6			
	<0.9	PM	0.6/0.4	0.30/0.45	0.30 0.22	0.30 0.22	0.30 0.22	0.30 0.22	0.30 0.22	0.30 0.22	0.30 0.22	0.30 0.22	0.30 0.22	0.30 0.22	0.30 0.22			
	19 - <75kW	NOx+HC	7.5	5.6	7.5 5.6	7.5 5.6	7.5 5.6	7.5 5.6	7.5 5.6	4.7 3.5	4.7 3.5	4.7 3.5	4.7 3.5	4.7 3.5	4.7 3.5			
Category 1 75-600kW	<0.9	PM	0.40	0.30				0.14 0.10	0.14 0.10	0.14 0.10	0.14 0.10	0.14 0.10	0.14 0.10	0.14 0.10	0.14 0.10			
		NOx+HC	7.5	5.6				5.4 4.0	5.4 4.0	5.4 4.0	5.4 4.0	5.4 4.0	5.4 4.0	5.4 4.0	5.4 4.0			
	0.9 - <1.2	PM	0.30	0.22				0.12 0.09	0.12 0.09	0.12 0.09	0.12 0.09	0.12 0.09	0.12 0.09	0.12 0.09	0.12 0.09			
		NOx+HC	7.2	5.4				5.4 4.0	5.4 4.0	5.4 4.0	5.4 4.0	5.4 4.0	5.4 4.0	5.4 4.0	5.4 4.0			
	1.2 - <2.5	PM	0.20	0.15						0.11 0.08	0.11 0.08	0.11 0.08	0.11 0.08	0.10 0.07	0.10 0.07			
		NOx+HC	7.2	5.4						5.6 4.2	5.6 4.2	5.6 4.2	5.6 4.2	5.6 4.2	5.6 4.2			
2.5 - <3.5	PM	0.20	0.15					0.11 0.08	0.11 0.08	0.11 0.08	0.11 0.08	0.11 0.08	0.11 0.08	0.10 0.07	0.10 0.07			
	NOx+HC	7.2	5.4					5.6 4.2	5.6 4.2	5.6 4.2	5.6 4.2	5.6 4.2	5.6 4.2	5.6 4.2	5.6 4.2			
3.5 - <7.0	PM	0.20/0.27	0.15/0.20				0.11 0.08	0.11 0.08	0.11 0.08	0.11 0.08	0.11 0.08	0.11 0.08	0.11 0.08	0.10 0.07	0.10 0.07			
	NOx+HC	7.2/7.8	5.4/5.8				5.8 4.3	5.8 4.3	5.8 4.3	5.8 4.3	5.8 4.3	5.8 4.3	5.8 4.3	5.8 4.3	5.8 4.3			
Category 1 600-3700 kW	all	PM	Same Tier 2 & 3 standards, displacement categories, and start dates as for 75-600 kW (see note 6)										600 - <1400 kW:		0.04 0.03	0.04 0.03	0.04 0.03	0.04 0.03
		NOx											1.8 1.3	1.8 1.3	1.8 1.3	1.8 1.3		
		PM											1400-2000 kW:		0.04 0.03	0.04 0.03	0.04 0.03	0.04 0.03
NOx	1.8 1.3	1.8 1.3	1.8 1.3	1.8 1.3														
PM	2000-3700 kW (see note 6):		0.04 0.03	0.04 0.03	0.04 0.03	0.04 0.03												
NOx	1.8 1.3	1.8 1.3	1.8 1.3	1.8 1.3														
Category 2 <3700 kW	7.0 - <15.0	PM	0.27	0.20	see note 2:										0.14 0.10	0.14 0.10	0.14 0.10	Tier 4 standards and start dates for 600-3700 kW Category 2 engines are the same as those for Category 1 600-3700 kW (including see note 6)
		NOx+HC	7.8	5.8					6.2 4.6	6.2 4.6	6.2 4.6	6.2 4.6	6.2 4.6	6.2 4.6				
	15.0 - <20.0	PM	0.50	0.37						0.34 0.25	0.34 0.25	0.34 0.25	0.34 0.25					
	<3300kW	NOx+HC	8.7	6.5						7.0 5.2	7.0 5.2	7.0 5.2	7.0 5.2					
	15.0 - <20.0	PM	0.50	0.37						0.27 0.20	0.27 0.20	0.27 0.20	0.27 0.20					
	≥3300kW	NOx+HC	9.8	7.3						8.7 6.5	8.7 6.5	8.7 6.5	8.7 6.5					
20.0 - <25.0	PM	0.50	0.37						0.27 0.20	0.27 0.20	0.27 0.20	0.27 0.20	0.27 0.20	0.27 0.20				
	NOx+HC	9.8	7.3						9.8 7.3	9.8 7.3	9.8 7.3	9.8 7.3	9.8 7.3	9.8 7.3				
25.0 - <30.0	PM	0.50	0.37						0.27 0.20	0.27 0.20	0.27 0.20	0.27 0.20	0.27 0.20	0.27 0.20				
	NOx+HC	11.0	8.2						11.0 8.2	11.0 8.2	11.0 8.2	11.0 8.2	11.0 8.2	11.0 8.2				
>=3700 kW	<15.0	PM	0.27	0.20				see note 2:		0.12 0.09	0.12 0.09	see note 4:		0.06 0.04	0.06 0.04	0.06 0.04	0.06 0.04	
		NOx+HC	7.8	5.8					NOx	1.8 1.3	1.8 1.3	1.8 1.3	1.8 1.3	1.8 1.3	1.8 1.3	1.8 1.3		
	>=15.0	PM	0.50	0.37						0.25 0.19	0.25 0.19	see note 4:		0.06 0.04	0.06 0.04	0.06 0.04	0.06 0.04	
		NOx+HC	same as for <3700 kw						NOx	1.8 1.3	1.8 1.3	1.8 1.3	1.8 1.3	1.8 1.3	1.8 1.3	1.8 1.3		

Notes:

- option for 19-75 kW starting in 2014: 0.20 and 5.8 g/kW-hr (0.15 and 4.3 g/hp-hr) PM and NOx+HC.
- option for C2 >1400kW: Tier 3 in 2012: 0.14/7.8 g/kW-hr PM/NOx+HC; Tier 4 in 2015, including 0.06 PM for >3700kW.
- manufacturer may delay compliance within indicated 2017 compliance model year: to 10/1/2017 for 600-1000 kW
- manufacturer may delay compliance within the indicated 2016 compliance model year: to 12/31/2016
- any <75 kW engines with displacement above 0.9 L/cyl are subject to corresponding 75-600 kW standards
- Tier 3 PM standards/dates apply for 2000-3700 kW, but not Tier 3 NOx+HC (Tier 2 NOx+HC levels apply through 2013)

1st MY for new standards are boxed in red

Tier 2

Tier 3

Tier 4

EPA's New Marine Diesel Standards (p.2 of 2)

New Marine Diesel Standards: High Power Density (≥ 35 kW/L) Commercial & Recreational

Category 1 <75kW	Displacement L/cyl	Tier 2 g/kW-hr g/hp-hr	2009	2010	2011	2012 g/kW-hr g/hp-hr	2013 g/kW-hr g/hp-hr	2014 g/kW-hr g/hp-hr	2015 g/kW-hr g/hp-hr	2016 g/kW-hr g/hp-hr	2017 g/kW-hr g/hp-hr	2018 g/kW-hr g/hp-hr	2019 g/kW-hr g/hp-hr		
	<0.9 PM <19 kW NOx+HC see note 1: <0.9 PM 19 - <75kW NOx+HC	same as for <i>standard</i> power density engines													
Category 1 75-600kW	<0.9 PM NOx+HC	0.40 0.30 7.5 5.6				0.15 0.11 5.8 4.3	0.15 0.11 5.8 4.3	0.15 0.11 5.8 4.3	0.15 0.11 5.8 4.3	0.15 0.11 5.8 4.3	0.15 0.11 5.8 4.3	0.15 0.11 5.8 4.3	0.15 0.11 5.8 4.3		
	0.9 - <1.2 PM NOx+HC	0.30 0.22 7.2 5.4				0.14 0.10 5.8 4.3	0.14 0.10 5.8 4.3	0.14 0.10 5.8 4.3	0.14 0.10 5.8 4.3	0.14 0.10 5.8 4.3	0.14 0.10 5.8 4.3	0.14 0.10 5.8 4.3	0.14 0.10 5.8 4.3		
	1.2 - <2.5 PM NOx+HC	0.20 0.15 7.2 5.4					0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3		
	2.5 - <3.5 PM NOx+HC	0.20 0.15 7.2 5.4				0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3	0.12 0.09 5.8 4.3		
	3.5 - <7.0 PM NOx+HC	0.20/0.27 0.15/0.20 7.2/7.8 5.4/5.8				0.12 0.09 5.4 4.0	0.12 0.09 5.4 4.0	0.12 0.09 5.4 4.0	0.12 0.09 5.4 4.0	0.12 0.09 5.4 4.0	0.12 0.09 5.4 4.0	0.12 0.09 5.4 4.0	0.12 0.09 5.4 4.0		
Category 1 >=600kW	all	Tier 2 and 3 standards and dates are the same as for high power density 75-600 kW engines (except see note 6 on standard power density summary)												Tier 4 standards and dates are the same as for <i>standard</i> power density engines (except no Tier 4 for recreational)	

Notes:

- 1) any <75 kW engines with displacement above 0.9 L/cyl are subject to the corresponding 75-600 kW standards

Tier 2

Tier 3

Tier 4

1st MY for new standards are boxed in red