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MTU Detroit Diesel Australia  
Mineral Drilling Association of Australia.

Symposium      Bunker Bay  
May 5th-8th 2009

*Tier 2 Emissions*

*Presenter: Mark Anderson*

# Contents

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What are Tier II emission standards?

What it means to the drilling industry?

Clean v Green.

What is going to change and when?

What does the future look like?



# Tier II

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New emission standards driven from the US since 1999.

Aim to reduce NOx and particulate levels from off highway engines, excluding marine, locomotives, underground equipment, and engines under 50cc.

Applies to equipment built between 1999-2006 depending on category.

Currently Tier II does not apply in Australia however heavy vehicles now have to conform to ADR80-2.



# Clean v Green.

## Clean

NO<sub>x</sub> – Nitrogen Oxides

PM – Particulate Matter

HC – Hydro Carbons

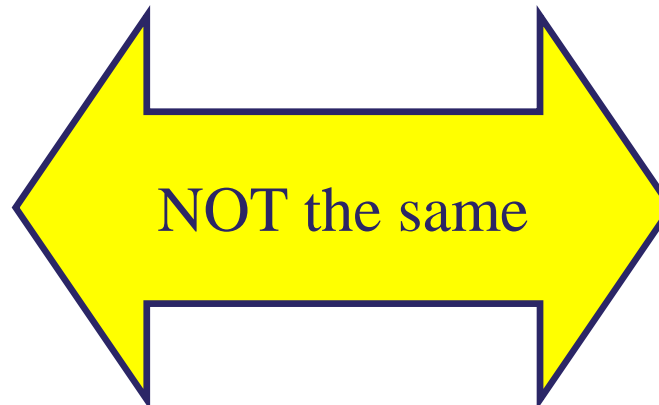
CO – Carbon Monoxide

## Green

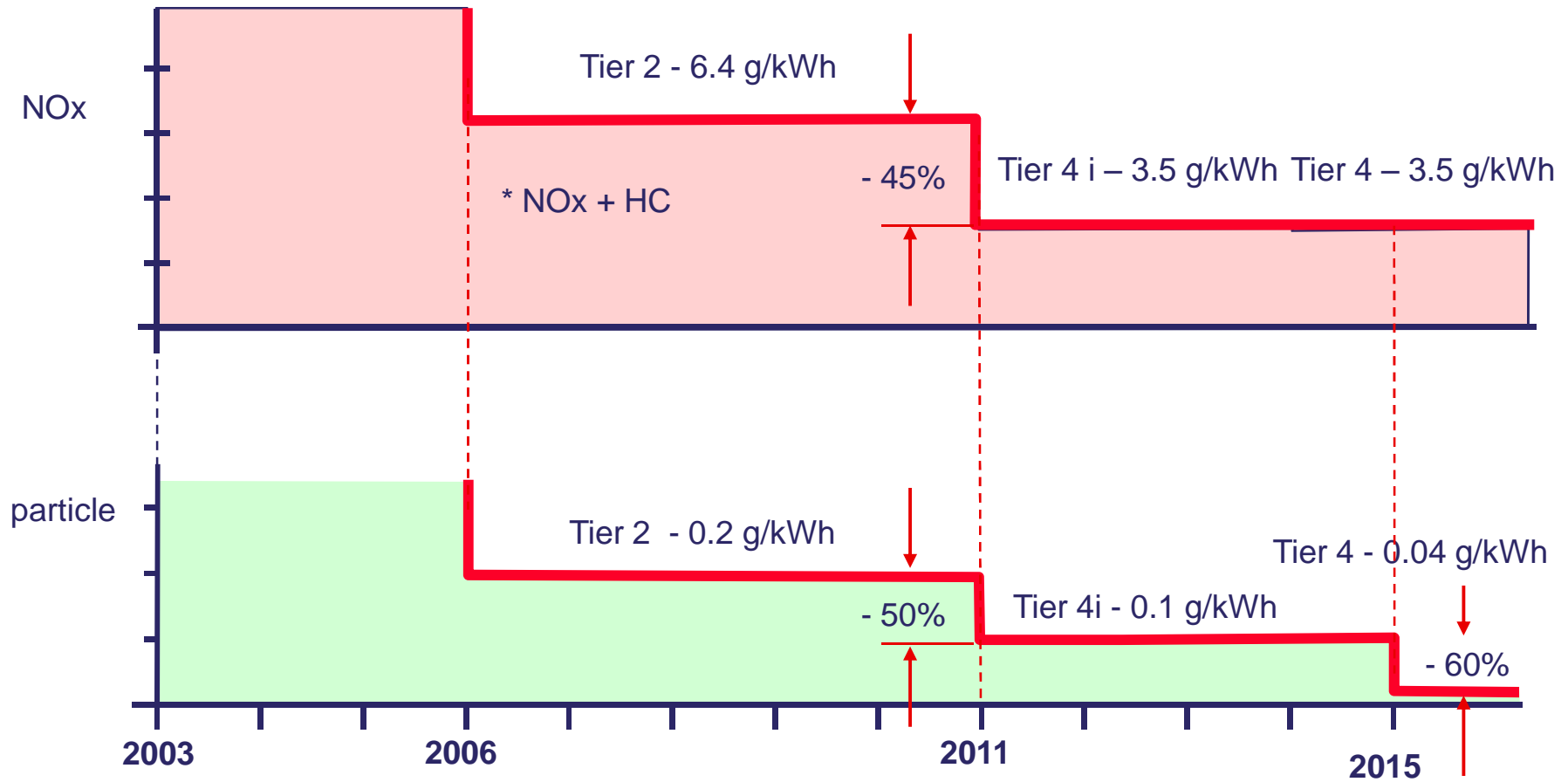
CO<sub>2</sub> – Carbon Dioxide

CH<sub>4</sub> – Methane /  
Natural Gas

N<sub>2</sub>O – Nitrous Oxide



# Emission Legislation (> 560 kW)



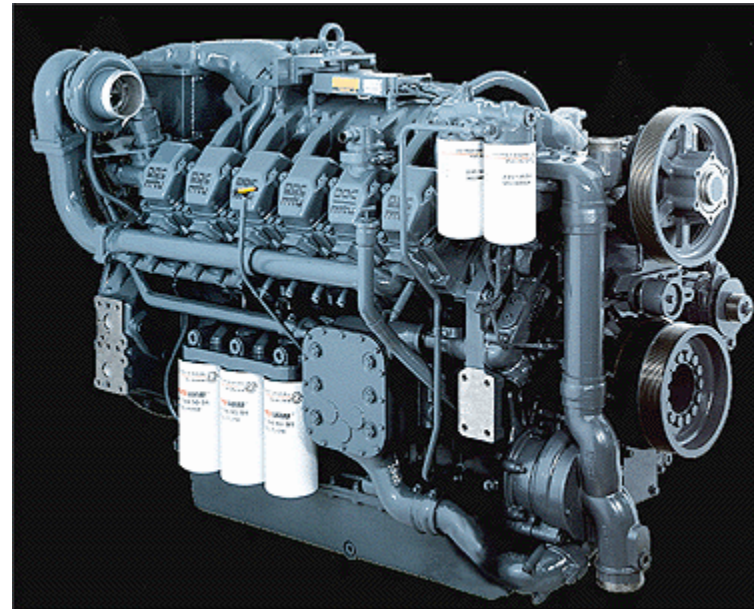
- EPA: no Tier 3
- Africa, Asia, Australia, Europe and South America: **no limits decided yet**



# Series 2000 History

## Series 2000 Tier I

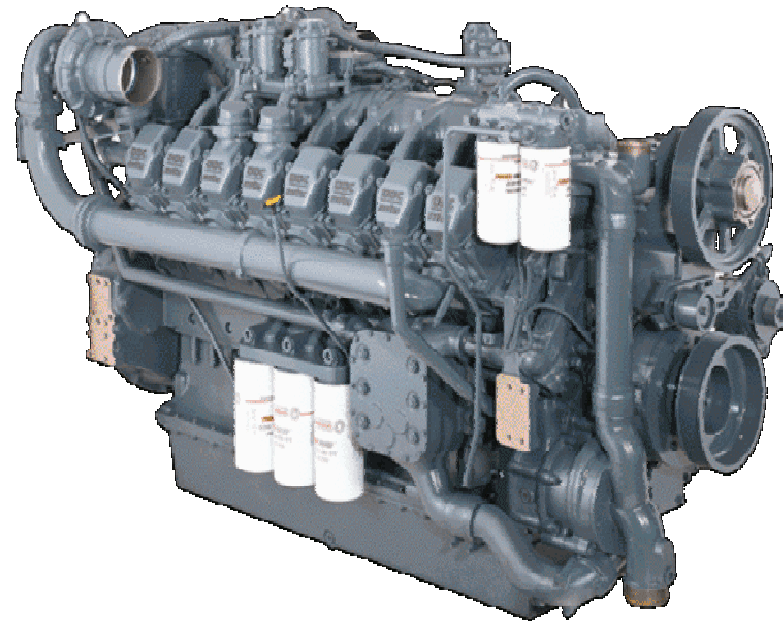
- July 1997 – Market Introduction
- Replaced Series 92
- Developed and Manufactured jointly between MTU Friedrichshafen & Detroit Diesel Corp
- 8/12/16V Engine Family
- Power Range: 605 hp – 1340 hp
- JWAC/SCCC Cooling System
- DDEC engine control system
- EPA Tier I (released 2000)



# Series 2000 Development

## Series 2000 Tier II

- January 2006 - Market introduction of the new improved 8K40 model
- Designed by MTU-Friedrichshafen to meet emission regulation EPA Tier II
- Manufactured in Detroit, Michigan
- 12/16V Engine Family
- Power Range 760 hp – 1205 hp
- SCCC only



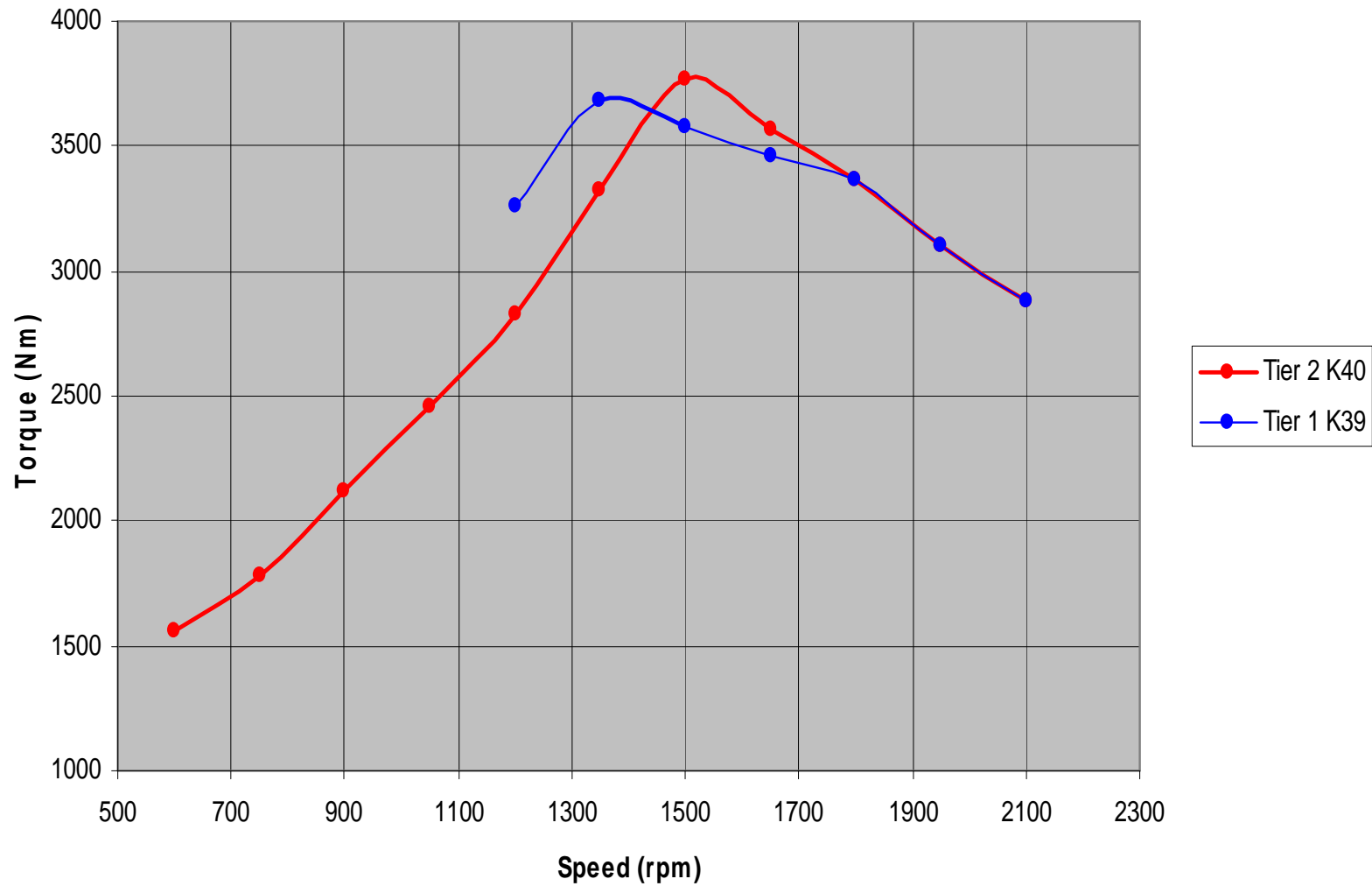
# Tier II - Upgrades

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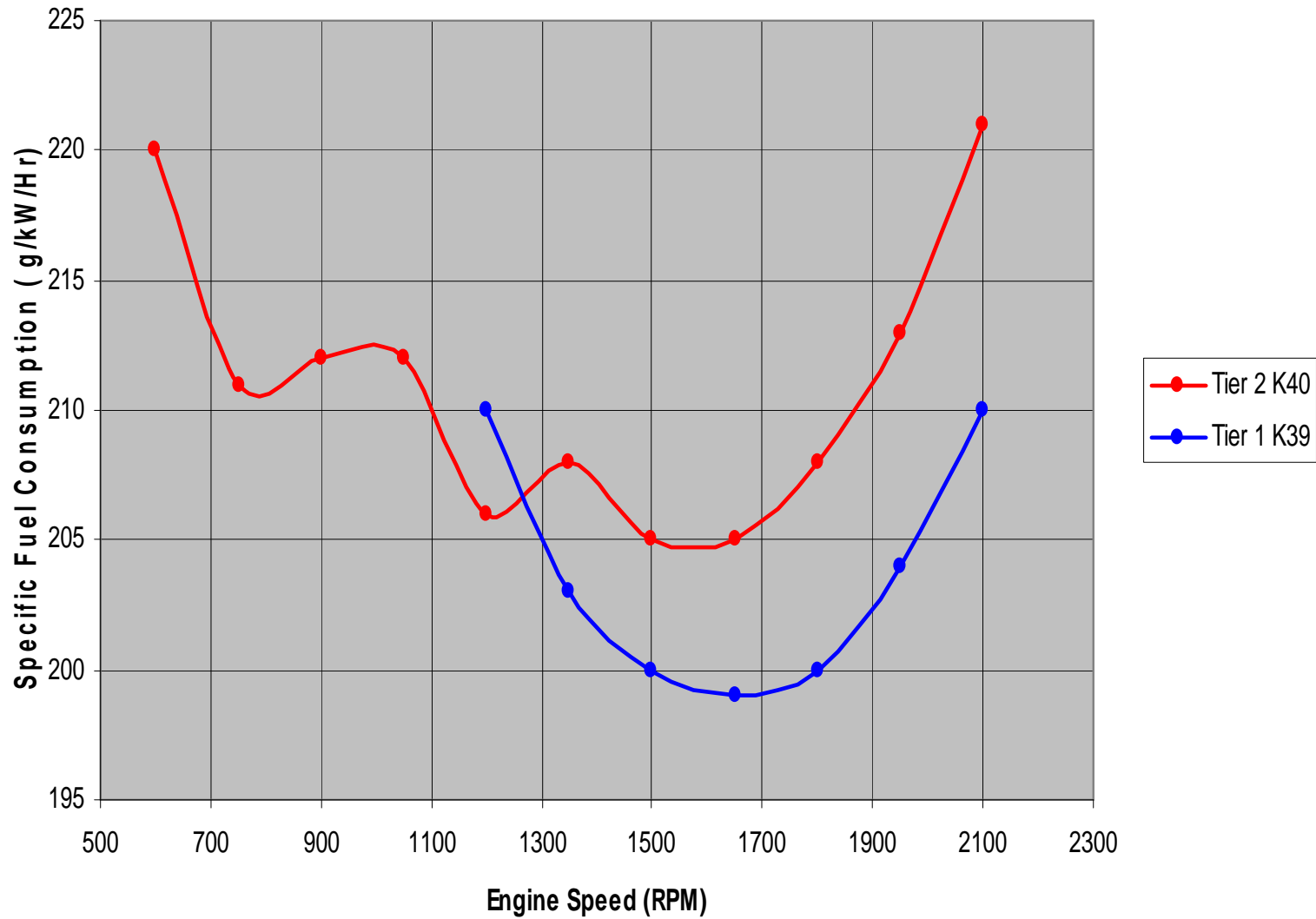
- **Optimized Combustion**
- **Camshaft**
- **Turbocharger**
- **Edge Filter System**
- **Accumulator EUP**
- **Carbon Scraper Piston and Cylinder Liner**
- **Exhaust Manifold Bolts**
- **New Trunnion Mount**
- **Oil Cooler**



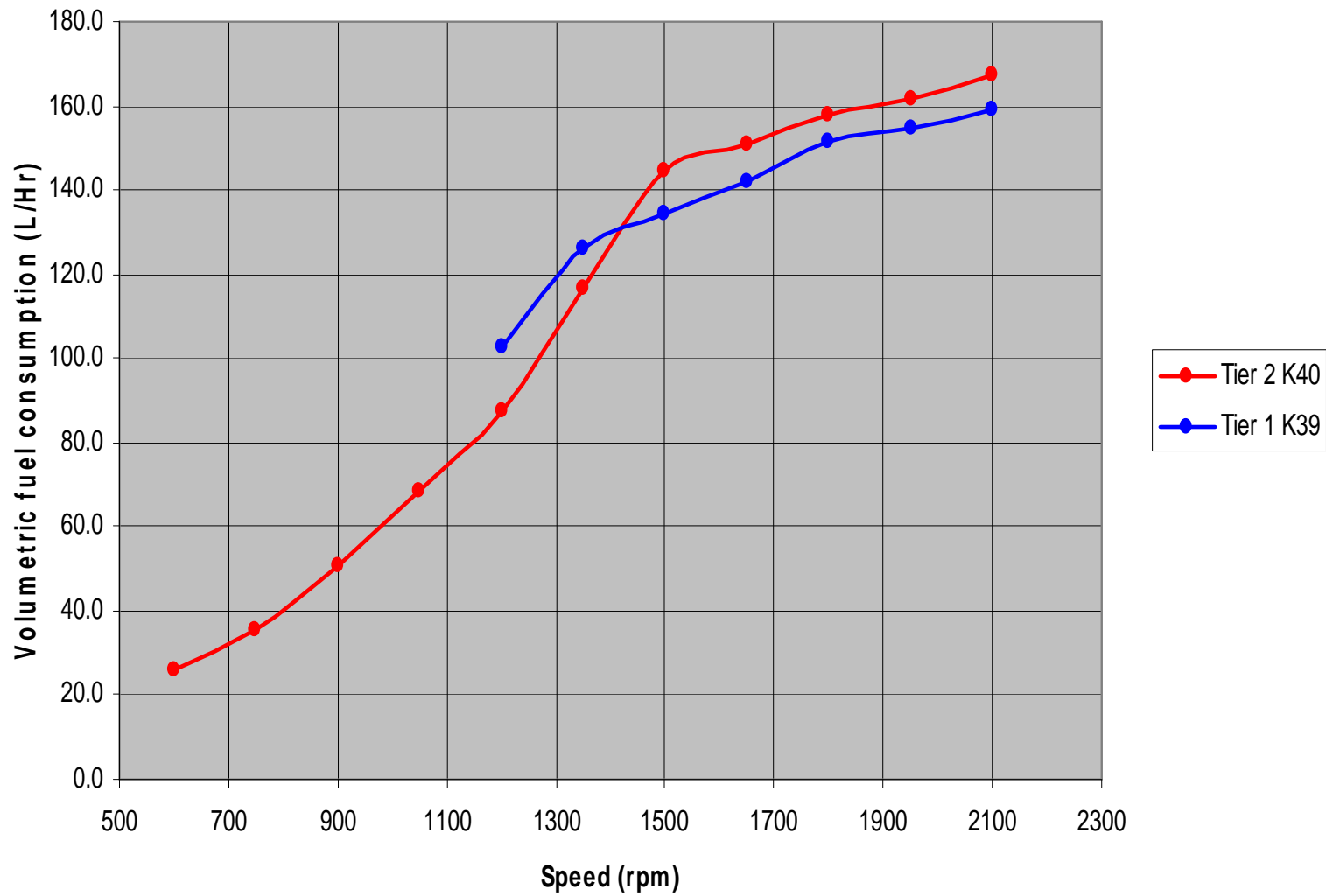
# Torque Comparison – Tier I vs Tier II



# Fuel Consumption – g/KWHr



# Fuel consumption – lt/hr



# Tier II Upgrade Comparison

Characteristic	Tier 1	Tier 2	Effect
Turbo	GT50X (A/R 1.34)	GT5002X (A/R 1.34)	Exhaust flow and temp are higher for Tier II
Total Coolant Capacity	76ltrs	66ltrs	
Coolant Flow rate	1109L/min	633L/min	
Oil pressure	862kPa	690kPa	Reduce parasitic loss
Intake Manifold Pressure	203kPa	310kPa	Boost Pressure is higher
Friction Power	120kW	107kW	Less engine friction (accessories)
Heat Rejection to coolant	270kW	300kW	+ 11% at Peak Power
Heat Rejection to CAC	166kW	180kW	+ 8% at Peak Power
Altitude Capability	4250m	3450m	Reduced for emission reasons

**Note: Engine major components are the same.**



# Future Challenges

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- Meet future emission requirements with minimum effect on OEM-equipment.
- Economic fuel consumption while meeting latest emission legislation.
- Fulfills latest market expectations.
- Further improve cost of ownership.
- Together with the Series 1600 and 4000 create a “one stop shopping” opportunity for customers.
- Utilize next generation of electronic engine management (ADEC).

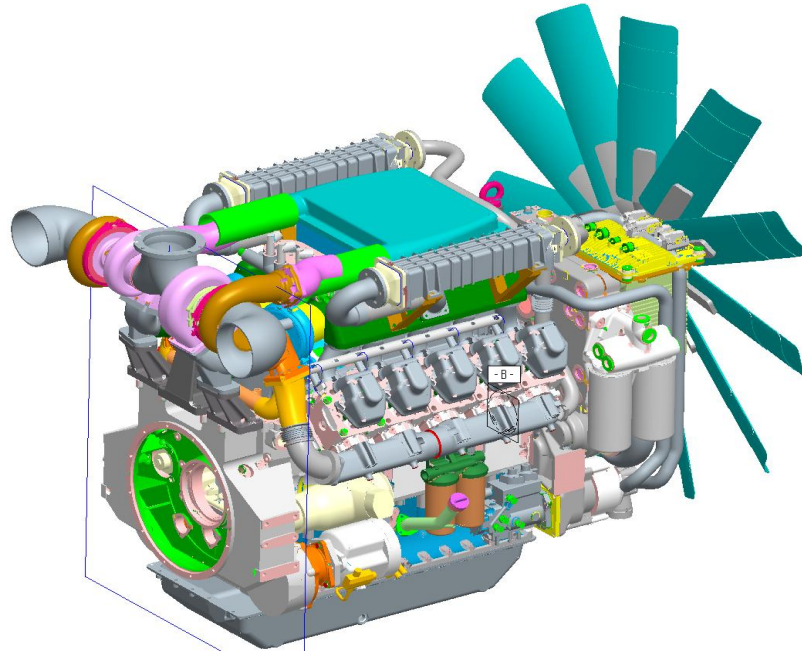


# Series 2000 BETA

As a result of the future emission challenges MTU commenced the BETA project.

**BETA** is the internal project name for the successor engine of the Series 2000 Tier 2. This engine has to meet the EPA emission requirements:

**Tier 4i in 2011**  
**Tier 4 in 2015**



# Series 2000 BETA

## Technical data:

Series 2000 C& I		
	BETA	8K40
Displacement per cylinder	2,23 l	1,99 l
Stroke / Bore	156 / 135 mm	150 / 130 mm
Max. engine brake power	73 kW / cyl.	63 kW / cyl.
Nominal engine speed	2100 rpm	2100 rpm



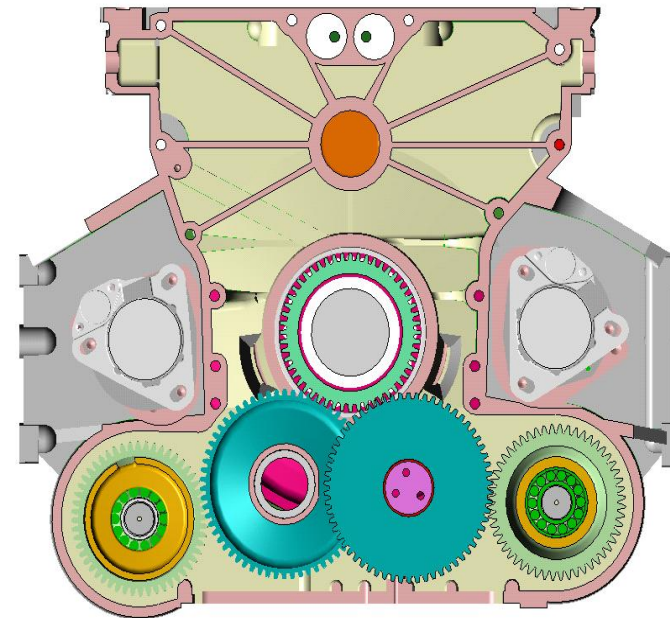
# Series 2000 BETA

## BETA Tier 4i features:

- Common rail injection system
- Two BOSCH CPN 5.2 injection pumps
- 2-stage turbocharging and cooled EGR
- SCCC cooling system
- Mounting point as current 8K40 model
- HT – Coolant temperature  $\geq$  100 °C
- No external exhaust gas aftertreatment

## Optional:

- Powerful PTOs: 2x 400 Nm + 1x 100 Nm
- Air compressor up to 1000 l/min, 8 bar
- (New) trunnion design



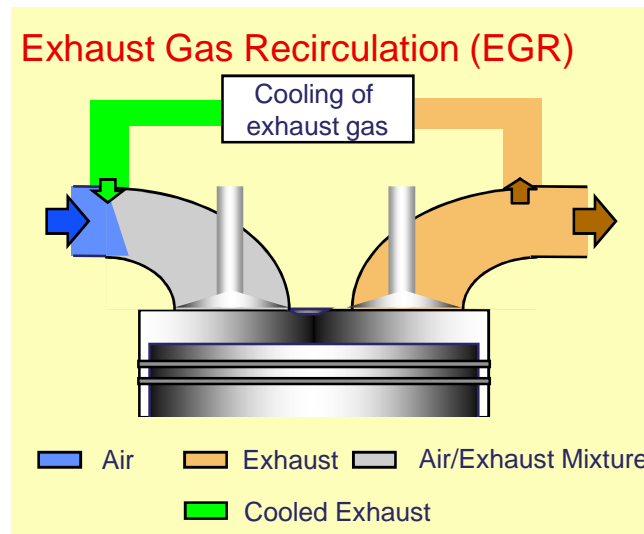
# Series 2000 BETA

## Exhaust Gas Aftertreatment Technology - Industrial

	EPA Tier 4i	EPA Tier 4
	2011	2015
Ratings 560 - 900 kW	EGR*	EGR + DPF*
Ratings above 900 kW		

\*EGR – **Exhaust Gas Recirculation**

\*DPF – **Diesel Particle Filter**



# Series 2000 BETA

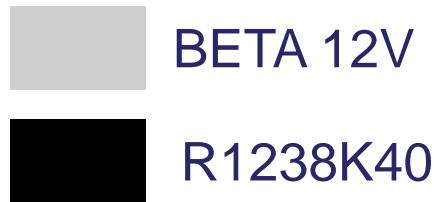
## Rated Power Tier4i / Tier4 - Industrial

Engine config	Appl. Code	Beta	8K40
10V2000	5A	n/a	n/a
	5B	n/a	n/a
	5C	750 kW @ 2100 rpm	n/a
12V2000	5A	561 kW @ 1800 rpm	567 kW @ 2100 rpm
	5B	783 kW @ 2100 rpm	675 kW @ 2100 rpm
	5C	n/a	750 kW @ 2100 rpm
16V2000	5A	671 kW @ 1800 rpm	783 kW @ 2100 rpm
	5B	970 kW @ 2100 rpm	899 kW @ 2100 rpm
	5C	n/a	n/a



# Series 2000 BETA

## Comparison (front view) - BETA 12V vs. R1238K40



# Series 2000 BETA

## Comparison (side view) - BETA 12V vs. R1238K40



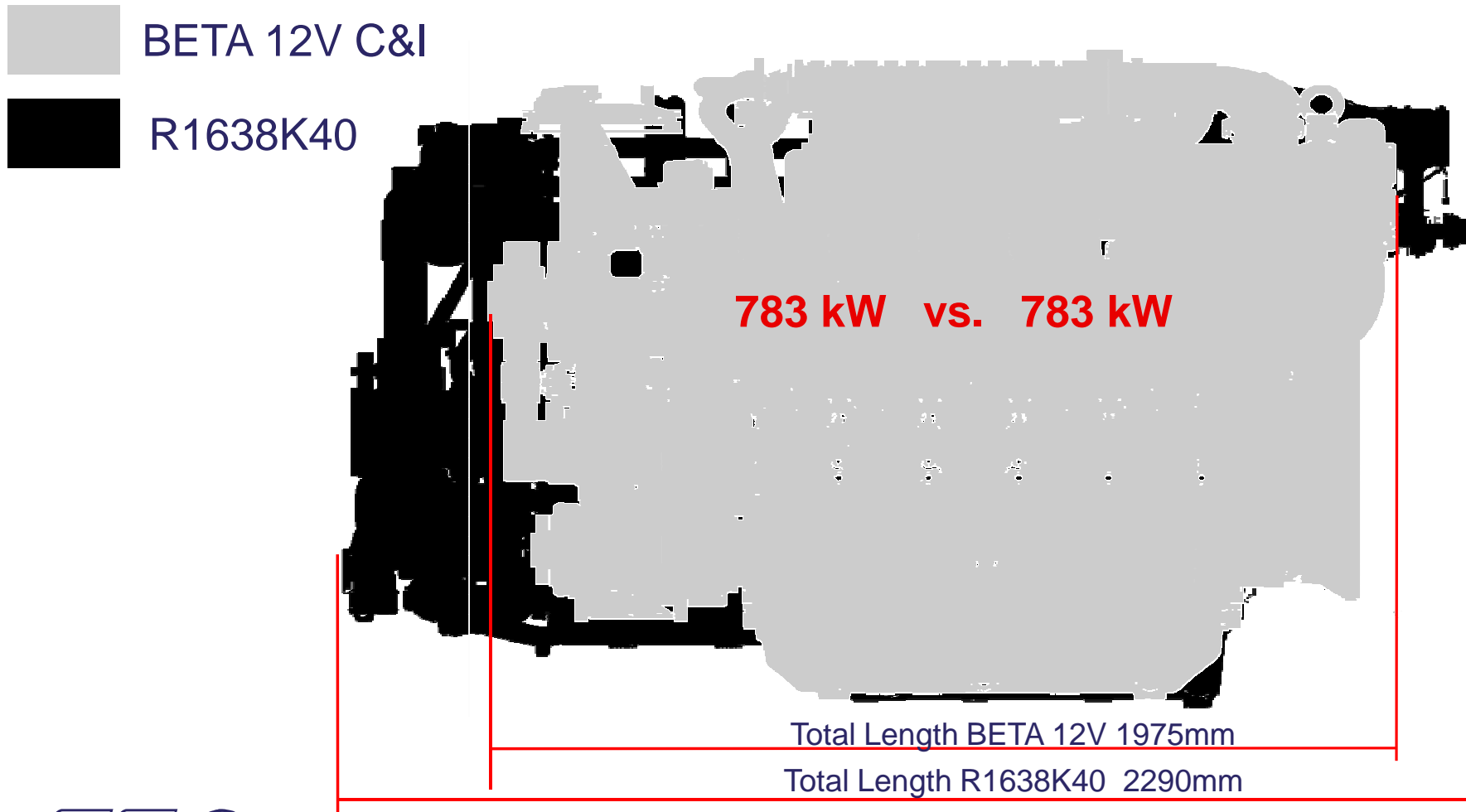
Total Length 1975mm  
(BETA & 8K40)



# Development of Industrial Engines to Meet Future Challenges

## 3. Series 2000 -BETA-

Comparison (side view) - BETA 12V vs. R1638K40





## EPA Tier 4 for OEMs & Engine Manufacturers:

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- Only a combination of engine and aftertreatment systems will meet Tier 4 emission requirements.
- The combined system must be certified as a unit.
- Certified aftertreatment systems can not be altered with out losing emission certification.
- Tier4i and Tier4 engine configuration intended to be identical so that there are no changes in engine installation.
- Close cooperation with the OEM to find an installation solution for the whole package.



# Summary – Tier I vs Tier II

- Same major component hardware
- Same footprint
- Reduced emissions = 😊 clients
- Marginal increase in heat rejection in High & Low Temp cooling circuits
- Marginal increase in fuel consumption
- Field proven technology
- Minimal impact on cost of ownership
  
- **For Drill Rig owner & manufacturers – minimal impact**

