MTU Series 8000

“Focus on Technology”
Main Development Targets

• Robust Design Specifically for Marine Applications
• Meet High Power Demand of Fast and High Payload Commercial Ships
• Meet Special Requirements of Military Ships
• Provide High Reliability and Availability With Good Maintainability
Series 8000
Main Development Targets

• Low Life Cycle Costs, I.E. Low Fuel and Lube Oil Consumption
• Meet Current and Future Emission Requirements
• Designed to Fit Stringent Requirements of Catamarans
• Provide Complete Engine System With Minimal Interfaces
Series 8000
Engine Design - Crankcase

• Technical Features:
  – Rigid Design, Nodular Cast Iron
  – Integrated Charge Air Ducting
  – Single Centrally Located Camshaft and Main Oil Channel
  – Hydraulically Tensioned Studs for Securing Main Bearing Caps
  – Large Crankcase Access Holes

• Benefits:
  – Extremely Stiff Crankcase
  – Strong Crankshaft Support
  – No Contact With Cooling Water
  – Main Bearings Replaceable on Site
Series 8000
Key Technologies for Diesel Engines

Injection
Turbocharging
Electronics

Combustion System
Series 8000

Key Technology – Air System

- Four MTU Turbochargers
  - Designed and Manufactured In-house
  - Small Chargers With Low Mass Inertia (Quick Response / Acceleration)
- Single-stage With Charge-air Cooling
- Sequential Turbocharging
  - Load-dependent Switching of Turbochargers
  - Two Base Charges and Two Switchable (Three-stage Switching)
  - Hydraulic Actuation of Compressor and Turbine Flaps
Series 8000
Sequential Turbocharging

Base charger in operation

Charger B1 switched into operation
Benefits

- System Optimized to Meet the Design Targets
- Higher Torque Available Compared to Conventional System Allowing Quicker Acceleration and Maneuvering
- Low Fuel Consumption Even at Part Load (Less Than 200 g/kW-h Down to 25% of Nominal Power)
- Minimized Black and White Smoke Emissions at Part Load
- Proven Technology
- Service and Maintenance From One Source
• **Common Rail Fuel System**
  - Designed and Manufactured In-house
  - New but Proven Technology
  - Continuously Optimized Injection Pressure and Flow Based on Load Demands
  - High Injection Pressure Over Full Operating Speed Range
Series 8000 Common Rail Fuel System

- Engine Management System
- Engine operational parameters
- Common-Rail
- Distributor element
- Accumulator with fuel stop valve
- Injector control
- HP pump control
- Fuel
- Injector
Series 8000

Key Technology – Fuel System

• **Benefits**
  – System Optimized to Meet Design Targets
  – Low Fuel Consumption Over Entire Performance Range
  – Significant Reduction of Black Smoke Emissions at Low Engine Speeds
  – No Mechanical Adjustments Required
  – Provides Capability to Meet Emission Requirements Today and for the Future
  – Proven Technology
  – Service and Maintenance From One Source
Series 8000
Key Technology - Electronics

• Engine Fuel Management System
  – Designed and Manufactured In-house
  – Regulates Engine Speed and Fuel
  – Controls Turbo Switching, Cylinder Cutout, and More
  – Monitors Critical Parameters for Engine Protection and Information Displays
  – Self Diagnostics
Series 8000

Key Technology - Electronics

• Benefits
  – Optimized to Control and Monitor Other Key Technologies for Seamless Interfacing
  – Engine Mounted and Wired
  – Simple Diagnostic Tools
  – Proven Technology
  – Service and Maintenance From One Source
Series 8000
Main Features

- Bore / Stroke 265 mm / 315 mm
- Bank-Configuration 48° V
- Swept volume 17.37 liter / cyl.
- Power range today up to 9 000 kW
- Speed range 380 - 1,150 rpm

- The engine is capable of running without operational restrictions at 9,000 kW
- At 45°C intake air and 32°C sea water, full power is available considering ISO standard tolerances.

- Power unit concept
- Common Rail fuel injection system
- Sequential turbo charging
- Split Circuit Cooling System
- Electronic engine management
Series 8000
Performance and Fuel Consumption

<table>
<thead>
<tr>
<th>Engine power</th>
<th>Fuel cons.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2500 kW / 3350 bhp</td>
<td>605 lit/h (160 gal/h)</td>
</tr>
<tr>
<td>5000 kW / 6700 bhp</td>
<td>1154 lit/h (305 gal/h)</td>
</tr>
<tr>
<td>7500 kW / 10060 bhp</td>
<td>1741 lit/h (460 gal/h)</td>
</tr>
<tr>
<td>9000 kW / 12070 bhp</td>
<td>2119 lit/h (560 gal/h)</td>
</tr>
</tbody>
</table>

Reference conditions:
- Intake air temperature: 25 °C
- Raw water temperature: 25 °C
- IMO-NOX optimized

\[ P_{eff} = 9000 \text{ kW} @ 1150 \text{ rpm} \]
Series 8000
Fast Ferry Performance

- 9,000 kW Can Be Used for Unlimited and Uninterrupted Operation Without Thermal Overload for Yachts or Naval Vessels
- For Fast Ferry Power Is Limited 8,200 kW (90% of 9,000 kW)
  - Service Power Could Be Used for Unlimited and Uninterrupted Operation at 1080 to 1150 RPM
  - No Power Reduction up to 45 °C Air Inlet Temperature
Series 8000 Emissions

- NOx Regulation
  - Marpol 73/78, Annex VI
  - Valid for Engines Above 130 kW Going in Service After January 2st, 2000
  - NOx Limit Curve, Test Cycle ISO 8178-4, E3

![Graph showing NOx emissions for Series 8000 engines. The graph plots NOx limit (g/kWh) against speed (rpm). A trend line indicating the relationship between NOx limit and speed is shown, with a note stating 45 x speed^0.2. A specific point on the graph labeled 8000 M70 indicates 9.84 g/kWh at a certain speed.]
Black Smoke Emission

**20V 8000, M70 on test bed**

1. 22 kW / 380 rpm / 4 Turbochargers
   SZ Bosch: 0.85

![Graph showing power kW vs. speed rpm]

\[ P_{eff} = 8200 \text{ kW} @ 1150 \text{ rpm} \]
Black Smoke Emission

**20V 8000, M70 on test bed**

- 4100 kW / 915/min / 3 Turbochargers
- SZ Bosch: 0.11

\[ P_{\text{eff}} = 8200 \text{ kW} @ 1150 \text{ rpm} \]
Black Smoke Emission

20V 8000, M70 on test bed

6150 kW / 1046/min / 3

4 TC switching

SZ Bosch: transient

$P_{eff} = 8200$ kW @ 1150 rpm
Series 8000 Emissions

Black Smoke Emission

**20V 8000, M70 on test bed**

- 8200 kW / 1150/min / 4 Turbochargers
- SZ Bosch: 0.21

![Graph showing power and speed relationship for 20V 8000 M70 engine.](image)
Series 8000
Serviceability - Power Unit

Power Unit Consists of

1. Cylinder Head
2. Intermediate Cooling Water Housing
3. Cylinder Liner With Anti-Polishing Ring
4. Piston
5. Connecting Rod
Series 8000

Serviceability – Power Unit

- **Power Unit Two Functions**
  - Combustion and Cooling System
    - Liner With Intermediate Cooling Water Housing Bolted Onto Cylinder Head With 24 Bolts
    - Optimizes Liner to Head Sealing
    - Optimum Circularity of Liner
    - Low Wear Piston Rings and Liner
  - Retention System
    - Four Large Bolts Attaches Unit to Crankcase
    - Easy Removal / Installation As Single Unit
• All Main Accessories Are at Front of Engine
  – Easy Servicing of Filters and Pumps
  – Well-accessible Interfaces for Fuel, Raw Water and Fresh Water
  – Minimized Interfaces to Ship Connections (Reduced Complexity of Shipside Installations)
Series 8000
Serviceability - Automatic Lube Oil Filter

- Full Flow Lube Oil Purification With Continuous Back-flushing
- By-pass Filtration Via Centrifugal Filters
- Benefits
  - Defined Filter Fineness Maintained
  - Environmentally Friendly
  - Reduced Maintenance
  - Complete Lube Oil Treatment Integrated at Engine
Series 8000 Monitoring and Control System
Series 8000 Monitoring and Control System
Series 8000 Monitoring and Control System
Series 8000 Monitoring and Control System
Series 8000
First Application in Fast Ferry

The World’s most powerful diesel engine driven Catamaran

„Spit of Ontario“ 86 M, Passengers 774, Cars 238,
4 X MTU 20V 8000, 4 X 8200 Kw, 1150 Rpm, > 45 Knots
Series 8000

Summary of Benefits - Installation

- Reduced Installation Time / Costs Due to Engine Installed Accessories:
- Complete and Fully Tested Diesel Engine System
- Compact Design Suitable for Vessels With Limited Machinery Space
- Several Gearbox Arrangements Are Available
Series 8000

Summary of Benefits - Operation

- Quick Acceleration Behavior With Minimal Black Smoke
- High Torque at Low Speed Provides Excellent Maneuverability
- Unlimited Operation at 9,000 kW for Yacht
- Unlimited Operation at 8,200 kW for Fast Ferry
- Low Emissions
- Minimal Smoke
Series 8000

Summary of Benefits - Operation

• Low Fuel Consumption Over Entire Operating Range
  – ≤ 195 G/kW-h at Maximum Power
  – ≤ 200 G/kW-h Down to 2,500 kW

• Low Lube Oil Consumption
  – Approximately 0.6 G/kW-h, 5 Lit/h

• Reduced Maintenance Work With Long Maintenance Intervals

• Minimized Life Cycle Costs
The Design Has Been Verified by Extensive Testing

New Proven Technologies Have Been Applied

All Targets Such As Performance, Consumption, Emissions Have Been Met

It Is A Robust New Generation Diesel Engine for Marine Applications

Conclusion