Long-Stroke Diesel Engines for Maximum Efficiency and High Reliability
M 20 C – The Compact Long-Stroke Diesel Engine with Heavy Fuel Capability

Launched in 1992, the M 20 series set a new milestone in MaK modern long-stroke engine technology. Developed and designed in response to the special requirements of marine applications, the most striking features of this engine are its high reliability and economy. These features help to explain the continued high market demand for the M 20 C as an engine for both marine propulsion and marine generating sets.

The long-stroke design principle is the backbone of an excellent combustion process with low fuel and lube oil consumption, as well low NOx emissions. The M 20 C engine is SOLAS compliant.

Overall, this leads to outstandingly low operating costs and rapid returns on investment. Reliability and ease of maintenance are convincing arguments in favour of the engines of this series.

The M 20 C, the updated version of the highly popular M 20, features a range of benefits for operators and shipyards. These include:

- Turbocharger with improved efficiency
- Exhaust System Cladding for greater simplicity
- Dual Circuit Fresh Water Cooling System for easier installation with higher efficiency thanks to higher cooling water temperatures up to 80 °C

MaK Propulsion Package

Marine Propulsion

On-Board Power
M 20 C – Design Improvement

Latest Modifications + New Customer Benefits
■ Turbocharging System with improved efficiency
■ Exhaust Pipe Design for greater simplicity
■ Exhaust System Cladding small, compact and easy to maintain
■ Dual Circuit Fresh Water Cooling System for easier installation with higher efficiency thanks to higher cooling water temperature up to 90 °C

Latest Modifications + New Customer Benefits
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■ Dual Circuit Fresh Water Cooling System for easier installation with higher efficiency thanks to higher cooling water temperature up to 90 °C

Engine with high safety level
The M 20 C is an engine with a high safety level. This applies not only to those special internal design features which guarantee long component life and high availability but also to safety in the area around the engine. As a result, SOLAS regulations are strictly and consistently observed. Explosion protection cover for the cylinder/crankcase housing and cladding of the complete fuel and exhaust gas system in stainless steel are part of an overall SOLAS safety concept.

HFO/MDO – Long TBO and lifetime
Long maintenance intervals and the life of components are the basis for low operating costs.

Charging system with a high air excess
■ Rapid engine response
■ Low temperature levels on components surrounding the combustion chamber
■ Long turbocharger bearing life
■ Turbocharger casing without water cooling. Safe and reliable. No corrosion.

Engine control stand
■ Reliable engine operation due to direct mounting of the control stand on the engine
■ All control functions arranged directly on the engine

Cylinder head
■ Inherent stability due to nodular cast iron, double bottom construction
■ Intensive cooling of the combustion chamber and exhaust valve seats
■ Increased reliability due to integrated media ducts
■ Easy maintenance thanks to plug-in connections and four hydraulically tightened studs

Cooling water ring
■ Intensive cooling of the cylinder liner where cooling is needed
■ Engine block free from coolant
■ Coolant only circulates around the upper part of the cylinder liner and the cooling water ring

TBO Lifetime

<table>
<thead>
<tr>
<th>Item</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piston crown</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Piston skirt</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Piston ring</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Cylinder head</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Intake valve</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Exhaust valve</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Nozzle element</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Pump element</td>
<td>0,1 – 0,3”</td>
<td>0,1 – 0,3”</td>
</tr>
<tr>
<td>Main bearing</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Big-end bearing</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

*HFO Operation
The above mentioned data are not binding. They only serve as standard values. These standard values can be altered if MaK operating and maintenance specifications are strictly observed. These standard values and any MaK spare parts must be purchased from MaK or an authorized dealer. Please check the specification sheet for actual spare part numbers.

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M 20 C – Complete Diesel Generating Sets on a Common Base Frame

The main features of the diesel generating set are ease of installation, reliable operation, ease of maintenance and easy component accessibility. Its base is the rigid frame which forms a foundation for both the engine and the generating set and includes an integral, large-capacity oil sump and universal fuel supply equipment covering both HFO and MDO operation.

Generation of electricity
In addition to its use as a marine propulsion unit, the M 20 C has a wide range of application providing power for the continuous generation of electricity applications where a high level of reliability is always important. The power range of the M 20 C engine series as a generator unit is from 1,210 to 2,030 kVA.

M 20 C – Design Features

Cylinder liner with anti-wear ring
- Long component life with a piston removal interval of 30,000 h under heavy fuel operation
- Extended lubricating oil change intervals
- Low overall operating costs

Camshaft
- Easy maintenance thanks to simple design
- Integrated non-adjustable cams for injection and valve timing
- Low wear thanks to cam follower lever arm arrangement

Exhaust pipe
- Single pipe exhaust line with modular construction
- Flow optimized pipe design for quick load acceptance
- Simplified maintenance due to clamped connection of individual modules

Engine block
- No cooling water in the engine block
- Firm base for main and camshaft bearings due to inherent rigidity
- Easy access for inspection and maintenance
- Safe mounting of engine on foundation
- Maintenance-friendly

Cylinder liner with anti-wear ring
- Long component life with a piston removal interval of 30,000 h under heavy fuel operation
- Extended lubricating oil change intervals
- Low overall operating costs

Resilient mounting system
Major components:
- Conical rubber elements isolate dynamic engine forces and structure-borne noise. Horizontal, lateral and vertical stoppers are combined to limit engine movement
- Dynamically balanced, highly resilient coupling
- Flexible connections for all media
- Specially designed exhaust gas bellows

Piston
- Robust crown manufactured from forged steel with only two ring grooves
- First ring groove features with hardened surfaces
- Long aluminum skirt for measurable guidance
- Long piston-ring service life
- Low cylinder liner wear

M_20_C_2008.qxd:Layout 1  13.05.2008  8:58 Uhr  Seite 6
M 20 C – Technical Data

Complete engine
The engine is marketed with a standardized range of installed pumps and filters. Interfaces for fuel, lubricating oil and cooling water systems are located at the opposite end to the crankshaft coupling for ease of connection.

PROPULSION

<table>
<thead>
<tr>
<th>Number of cylinders</th>
<th>6, 8, 9</th>
<th>6, 8, 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bore mm</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Stroke mm</td>
<td>300</td>
<td>300</td>
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<tr>
<td>Cylinder rating kW</td>
<td>170</td>
<td>190</td>
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<tr>
<td>Speed rpm</td>
<td>900</td>
<td>1000</td>
</tr>
<tr>
<td>Mean piston speed m/s</td>
<td>9.0</td>
<td>10.0</td>
</tr>
<tr>
<td>BMEP bar</td>
<td>24.1</td>
<td>24.2</td>
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</tbody>
</table>

Engine rating kW

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<tr>
<th>Engine</th>
<th>6 M 20 C</th>
<th>8 M 20 C</th>
<th>9 M 20 C</th>
</tr>
</thead>
<tbody>
<tr>
<td>60Hz</td>
<td>1210</td>
<td>1360</td>
<td>1530</td>
</tr>
<tr>
<td>50Hz</td>
<td>1290</td>
<td>1445</td>
<td>1625</td>
</tr>
<tr>
<td>Generator rating*</td>
<td>1080</td>
<td>1140</td>
<td>1200</td>
</tr>
<tr>
<td>kWe</td>
<td>1210</td>
<td>1360</td>
<td>1530</td>
</tr>
<tr>
<td>kVA</td>
<td>1615</td>
<td>1805</td>
<td>2030</td>
</tr>
</tbody>
</table>

Specific fuel consumption** g/kWh

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<th>9 M 20 C</th>
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<tbody>
<tr>
<td>100%</td>
<td>186</td>
<td>190</td>
<td>189</td>
</tr>
<tr>
<td>85%</td>
<td>190</td>
<td>194</td>
<td>196</td>
</tr>
</tbody>
</table>

Specific lubricating oil consumption

0.6 g/kWh, ±0.3 g/kWh

The engine fulfills the MARPOL 73/78 Annex VI regulations.

* Generator efficiency: 0.95, cos ϕ: 0.8
** LCV = 42,700 kJ/kg, without engine-driven pumps, tolerance 5%

Complete engine
The engine is marketed with a standardized range of installed pumps and filters. Interfaces for fuel, lubricating oil and cooling water systems are located at the opposite end to the crankshaft coupling for ease of connection.

Generating sets
Reliable energy supply
The complete diesel generating set is notable for its ease of installation, reliable operation, ease of maintenance and good component accessibility. The base is formed by the rigid base frame on foundation of the engine and alternator with integrated oil sump, large oil volume and universal equipment for both HFO and MDO operation.

ENGINE

<table>
<thead>
<tr>
<th>Engine</th>
<th>6 M 20 C</th>
<th>8 M 20 C</th>
<th>9 M 20 C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6073</td>
<td>6798</td>
<td>7128</td>
</tr>
<tr>
<td>B</td>
<td>4900</td>
<td>5548</td>
<td>5875</td>
</tr>
<tr>
<td>C</td>
<td>2165</td>
<td>2335</td>
<td>2335</td>
</tr>
<tr>
<td>D</td>
<td>1054</td>
<td>1054</td>
<td>1054</td>
</tr>
<tr>
<td>E</td>
<td>1680</td>
<td>1816</td>
<td>1816</td>
</tr>
<tr>
<td>Weight with flywheel (tons)</td>
<td>11.0</td>
<td>14.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>

GENERATING SET

<table>
<thead>
<tr>
<th>Engine</th>
<th>6 M 20 C</th>
<th>8 M 20 C</th>
<th>9 M 20 C</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>5803</td>
<td>6768</td>
<td>7130</td>
</tr>
<tr>
<td>B</td>
<td>4003</td>
<td>5344</td>
<td>5875</td>
</tr>
<tr>
<td>C</td>
<td>2305</td>
<td>2205</td>
<td>2205</td>
</tr>
<tr>
<td>D</td>
<td>1539</td>
<td>1610</td>
<td>1719</td>
</tr>
<tr>
<td>F</td>
<td>11.0</td>
<td>14.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>
The long-stroke concept for ecological operation

Environmental protection is also becoming increasingly important for seagoing shipping. Caterpillar Motoren recognized this trend in good time and, with the design and development of the modern long-stroke engine concept, created the conditions for engine operation at reduced emission levels. The NO\textsubscript{x} emissions of the M 20 C engine lie well below the International Maritime Organisation’s limiting curve.

M 20 C – MaK Propulsion Package

Complete propulsion systems
The supply of complete propulsion systems is a market requirement which is becoming more and more important. We have wide experience gathered in the design and installation of many successful propulsion plants and from our close cooperation with competent partners.

We offer
- System responsibility and supply from a single source
- Accurately matched interfaces
- Coordinated delivery data control

A complete propulsion system usually consists of:
- MaK main propulsion engine with flexible coupling
- Reduction gearbox with or without installed clutch and gearbox PTO* with shaft generator
- Propeller and shaft installation
- Matched remote control and monitoring equipment
*Power Take Off

M 20 C – Clean Solution

The long-stroke concept for ecological operation

The long-stroke concept for engine operation at reduced emission levels

The following features characterize the concept which ensures, in addition to smooth running, maximum operational reliability and also permits operation on heavy fuel oil up to 150 cSt (50°C):
- Long piston stroke
- Large stroke/bore ratio
- Intensive injection
- Shaped injection curve
- Optimized control times
- High ignition pressure

For MDO operation the engine is also available with less NO\textsubscript{x} emission: Det Norske Veritas DNV “Clean Design” and Federal Ministry of Environment “Blue Angel”.

MARPOL 73/78 Annex VI

DNV Clean Design

▲●▼▲●▼▲●▼
Cat Financial – Our World-Class Financial Support

Global Resource from One Source
When you select Cat Marine Power for your vessel, look to Cat Financial for world-class financial support. With marine lending offices in Europe, Asia and the US supporting Caterpillar’s worldwide marine distribution network, Cat Financial is anchored in your transport. We also have over 20 years of marine lending experience, as we understand your unique commercial marine business needs. Whether you’re in the offshore support, cargo, ship assist, towing, fishing or passenger vessel industry, you can count on Cat Financial for the same high standard you expect from Caterpillar.

www.CAT.com/CatMarineFinance
Visit our web-site or see your local Cat dealer to learn how our marine financing plans and options can help your business succeed.

Integrated Solutions – Customer Support Portfolio

Ocean-Going Vessels
Pleasure Craft
Commercial Vessels

Marine Financing Guidelines
Power: Cat and MaK.
Financial Products: Construction, term and repower financing.
Repayment: Loan terms up to 10 years, with longer amortizations available.
Financial Amount: Up to 80% of your vessel cost.
Rates: Fixed or variable.
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Global Resource from One Source
### One Strong Line of World-Class Diesel Engines

**Perfect Solutions for Main Propulsion and On-Board Power Supply**

The application of engines in main and auxiliary marine power systems varies greatly and extends from high-speed boats and yachts, through tugboats, ferries and cruise liners.

### Caterpillar Marine Power Systems

**Sales and Service Organization**

Caterpillar has combined the sales and service activities and responsibility of their Cat and M&K brand marine engine businesses into Caterpillar Marine Power Systems with headquarters in Hamburg, Germany.

In setting up this worldwide structure, we have concentrated on integrating the Cat and M&K brand groups into a single, united marine team, which utilizes the particular expertise of each group.

Commercial marine engine business is split into three geographic regions: – Europe, Africa, Middle East; – Americas; – Asia-Pacific.

### Caterpillar Marine Power Systems Production Facilities

Some of the most advanced manufacturing concepts are used at Caterpillar locations throughout the world to produce engines in which reliability, economy and performance are second-to-none.

From the production of core components to the assembly of complete engines, quality is always the top priority. Comprehensive, recognized analysis systems, test procedures and measuring methods ensure that quality requirements are met throughout all the individual manufacturing phases. All of our production facilities are certified under ISO 9001, the international benchmark that is helping to set new quality standards worldwide.

---

**Medium-Speed Engines**

<table>
<thead>
<tr>
<th>Model</th>
<th>Power Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>3512</td>
<td>793 - 3,699 kW</td>
</tr>
<tr>
<td>3516</td>
<td>914 - 5,100 kW</td>
</tr>
<tr>
<td>3518</td>
<td>1,186 - 6,000 kW</td>
</tr>
</tbody>
</table>

**High-Speed Engines**

<table>
<thead>
<tr>
<th>Model</th>
<th>Power Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>3508</td>
<td>2,525 - 5,100 kW</td>
</tr>
<tr>
<td>3512</td>
<td>3,699 - 9,000 kW</td>
</tr>
<tr>
<td>3516</td>
<td>5,100 - 9,000 kW</td>
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**Onboard Power Supply**

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<th>Model</th>
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<tbody>
<tr>
<td>W 12</td>
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</tr>
<tr>
<td>W 18</td>
<td>1,900 - 3,250 kW</td>
</tr>
<tr>
<td>W 20</td>
<td>3,250 - 4,500 kW</td>
</tr>
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**Main Propulsion**

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</tr>
<tr>
<td>3520</td>
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