MAN Diesel & Turbo is the world’s leading designer and manufacturer of low and medium speed engines – engines from MAN Diesel & Turbo cover an estimated 50% of the power needed for all world trade. We develop two-stroke and four-stroke engines, auxiliary engines, turbochargers and propulsion packages that are manufactured both within the MAN Diesel & Turbo Group and at our licencees.

More than ever before, MAN Diesel & Turbo’s development focus is the environmental performance of our engines. Using our unrivalled grasp of large engine technology, we aim to make our engines progressively cleaner, more powerful and more efficient.

Our absolute commitment to reducing emissions while increasing fuel efficiency and power density starts with our active partnership in the emissions law making process and ends with the delivery of engines that achieve an ideal synthesis of prime mover characteristics.
The changing climate

Time to act

Climate change is a major challenge facing the world today. As a result of the greenhouse effect, caused by emissions of gases such as carbon dioxide (CO₂), average temperatures are climbing. This threatens fragile ecosystems and poses huge risks for agriculture – potentially destabilising the global economy.

In our own interests, and those of future generations, we all share a responsibility to minimise the impact of climate change. This means working proactively to reduce greenhouse gas emissions.

Shipping makes a difference

Although shipping is already the most efficient form of bulk transportation, it plays an important role: increasing globalisation is set to raise the amount of goods travelling by sea. Against this background, the International Maritime Organisation (IMO) has identified potential for improving the efficiency of shipping even further, based on existing technologies such as streamlined engines and improved design.

New standards

After intensive discussions with stakeholders, the IMO has adopted a number of mandatory instruments requiring new ships to meet higher standards of efficiency. These encompass every stage of a ship’s lifecycle, applying to design, operation, maintenance, crew training, upgrades and retrofits.

One of these measures is the Energy Efficiency Design Index (EEDI), which requires new ships to meet a certain level of energy efficiency from the outset. Another mandatory scheme, the Ship Energy Efficiency Management Plan (SEEMP), which governs operations, applies to all ships.

Financial incentives

In addition, market-based measures such as levies or emissions trading may be introduced in the future, creating further incentives for efficient ships. These are currently the subject of discussion at the IMO, although they are proving to be controversial.

EEDI – In a nutshell

The IMO regulations

What is it?

The Energy Efficiency Design Index (EEDI) calculates a vessel’s energy efficiency, based on a complex formula. This takes into account the ship’s emissions, its capacity and speed. The lower a ship’s EEDI, the more efficient it is. Under the regulations, ships are required to meet a minimum energy efficiency requirement – in other words, their EEDI must be equivalent to or less than a threshold value.

Who is affected?

The EEDI does not apply to all ships. Initially, it targets the vessels responsible for the most emissions. In its current form, it applies to new ships of and above 400 GT, where a building contract is placed on or after 1 January 2013. If there is no contract, it applies when keel-laying occurs on or after 1 July 2013. In both cases, delivery must be on or after 1 July 2015. However, nation-states have the right to delay the EEDI’s application by up to four years to ships flying their flag.

Older vessels will only require an EEDI should they undergo a major conversion on or after 1 January 2013.

In addition, EEDI benchmarks will be raised successively – new ships built in 2015, 2020 and 2025 will need to meet even higher standards.

And who is exempt?

Vessels with diesel-electric, gas turbine or hybrid propulsion do not need an EEDI. Currently, RoRo, RoPax, cruise, offshore and other vessels not explicitly mentioned in the regulations are also exempt. However, the IMO has announced its intention of expanding the EEDI to include additional types of ships down the track, based on the results of its experience with the first phase.
**EEDI means efficiency**
Definition & application

**Assumption**
The EEDI assesses the energy consumption of the vessel at normal seafaring conditions, taking into account the energy required for propulsion and the hotel load for the crew. Energy consumed to maintain the cargo and for manoeuvring or ballasting is not considered.

**Required EEDI**
The required EEDI represents a minimum energy efficiency requirement for new ships depending on ship type and size. This begins with a baseline value in 2013 and is raised successively in three steps until 2025. The baseline for the required EEDI is calculated from the EEDI of vessels built after the millennium.

**Formula & Definitions**

**Engine Power (P)**
Individual engine power at 75% Maximum Continuous Rating

**Correction and Adjustment Factors (F)**
Non-dimensional factors that were added to the EEDI equation to account for specific existing or anticipated conditions that would otherwise skew individual ships’ rating

**Specific Fuel Consumption (SFC)**
Fuel use per unit of engine power

**Ship Design Parameters**

**CO2 Emissions (C)**
CO2 emission factor based on type of fuel used by given engine

**Availability factor of individual energy efficiency technologies (+1.0 if readily available)**

**Correction factor for ship specific design elements. E.g. ice-classed ships which require extra weight for thicker hulls**

**Coefficient indicating the decrease in ship speed due to weather and environmental conditions**

**Capacity adjustment factor for any technical/ regulatory limitation on capacity (+1.0 if none)**
Meeting the EEDI requirements with MAN Diesel & Turbo

To comply with the EEDI, ships need to be fitted with efficient, well-designed technology. MAN Diesel & Turbo offers a comprehensive range of solutions, including engines, turbochargers and propellers. Built entirely by MAN Diesel & Turbo, these systems reflect the high quality standards that have made us a world leader.

Highly efficient engines

As gas contains less carbon, running engines on liquid natural gas (LNG) produces far lower emissions. This leads to a significantly reduced EEDI. MAN Diesel & Turbo has recently introduced a range of extremely efficient and versatile dual-fuel engines, suitable for almost all types of shipping. These allow shipowners to benefit from the increasing availability and attractive price of gas, yet offer full fuel flexibility.

Due to reduced carbon factors, the use of LNG by the new 3S/44DF results in approx. 14% lower EEDI.

Multiple combinations

MAN Diesel & Turbo offers a wide range of energy efficiency devices to provide the optimum solution for your vessel. One of the most efficient ways to optimise your vessel is through the use of Kappel propellers in combination with a rudder bulb. Whether your engine is driven by liquid or gaseous fuels, this increases the efficiency of your vessel up to 10%.

Carbon Factors

Due to reduced carbon factors, the use of LNG by the new 3S/44DF results in approx. 14% lower EEDI.

<table>
<thead>
<tr>
<th>CF (t-CO2/t-Fuel)</th>
<th>Diesel/LNG</th>
<th>Light Fuel Oil</th>
<th>Heavy Fuel Oil</th>
<th>Liquefied Petroleum Gas</th>
<th>Liquefied Natural Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>-1.7%</td>
<td>2.0%</td>
<td>-4.6%</td>
<td>-5.5%</td>
<td>-14.2%</td>
</tr>
<tr>
<td>3.1</td>
<td>-1.7%</td>
<td>2.0%</td>
<td>-4.6%</td>
<td>-5.5%</td>
<td>-14.2%</td>
</tr>
<tr>
<td>3.2</td>
<td>-1.7%</td>
<td>2.0%</td>
<td>-4.6%</td>
<td>-5.5%</td>
<td>-14.2%</td>
</tr>
<tr>
<td>3.3</td>
<td>-1.7%</td>
<td>2.0%</td>
<td>-4.6%</td>
<td>-5.5%</td>
<td>-14.2%</td>
</tr>
</tbody>
</table>

Various solutions on the market today – and how they can be combined

Due to reduced carbon factors, the use of LNG by the new 3S/44DF results in approx. 14% lower EEDI.
Waste heat recovery

The more efficient an engine is, the more power it obtains from the same amount of fuel. At MAN Diesel & Turbo, we have the expertise to maximise this output: for example, by making use of the heat given off by the combustion process, which can be recovered from the cooling water and exhaust gases. In fact, up to ten per cent more power can be obtained using an effective waste heat recovery system.

The energy recovered by this system can be used to heat accommodation, fuel and/or cargo, or power a steam turbine and generator.
**Example**

**Attained EEDI vs Required EEDI**

**Container ship**

DWT design draught: 15,375 t  
ME: 11,200 kW (MAN B&W 8L58/64)  
AE: 4 x 1720 kW (MAN 8L21/31)  
Generator efficiency: 93%  
Speed: 19 knots  
Diesel / Gas Oil, ISO 8217, DMC – DMX

**Tanker (2008)**

DWT design draught: 7,900 t  
ME: 3,360 kW (MAN 6L32/44CR)  
AE: 1 x 1,290 kW (MAN 6L21/31)  
Generator efficiency: 93%  
Speed: 13,3 knots  
Diesel / Gas Oil, ISO 8217, DMC – DMX

**Assumptions and considerations:**

- All variations are only done with changing the ME characteristics.

**Sensitivity**

- Attained EEDI: 25,49
- Attained EEDI: 22,29 (with 12V51/60DF)
- Attained EEDI: 18,06 (with engine 8L51/60DF; 9,000 kW and 18 knots)
PrimeServ – peace of mind for life

With more than 150 PrimeServ service stations and service partners worldwide, plus our growing network of PrimeServ Academies, the MAN Diesel & Turbo after-sales organisation is committed to maintaining the most efficient and accessible after-sales organisation in the business.

PrimeServ’s aim is to provide:

- Prompt delivery of high demand OEM spare parts within 24 hours
- Fast, reliable and competent customer support
- Individually tailored O&M contracts
- Ongoing training and qualification of service personnel
- Global service, open 24 hours-a-day, 365 days-a-year
- Diagnosis and troubleshooting with our high performance Online Service
- Retrofitting of the latest MAN Diesel & Turbo engine and turbocharger technologies for improved operating economy and minimised emissions

The PrimeServ offering

Based on almost 110 years of service experience with marine diesel engines, our sophisticated logistics system ensures that all frequently requested spare parts are available worldwide within 24 hours. In addition, MAN Diesel & Turbo Online Service helps to optimise maintenance cycles by the use of remote engine monitoring, diagnostics and calibration. The resulting condition-based maintenance (CBM) promotes high availability, increases operational safety, shortens downtimes and enhances the performance of MAN Diesel & Turbo marine engines.

The bottom line: leaner operating costs and better planning for you.

When service is required, the MAN PrimeServ network responds to organise assistance as fast as possible. This guarantees rapid completion of maintenance work and high availability of MAN Diesel & Turbo engines, GenSets, turbochargers, gears, propellers and marine propulsion packages.

In short: MAN PrimeServ gives you the benefit of our specialist expertise in marine power so that you can concentrate on your own core business.
All data provided in this document is non-binding. This data serves informational purposes only and is especially not guaranteed in any way. Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions. Copyright © MAN Diesel & Turbo.

D2366498EN Printed in Germany GMC-AUG-08122