MAN 35/44DF

Dual fuel flexibility

Engineering the Future – since 1758.

MAN Diesel & Turbo


907

MAN Diesel & Turbo

Leading technology - the responsible way

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.

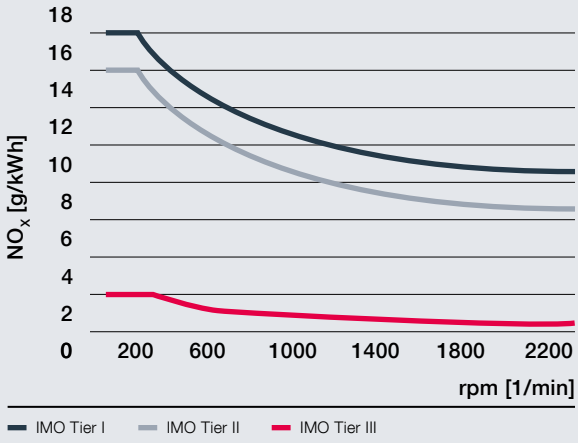
More than ever before, MAN Diesel & Turbo's development focus lies in the environmental performance of our engines. Using our unrivalled grasp of large engine technology, we aim to make our engines progressively cleaner, more powerful and more efficient.

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

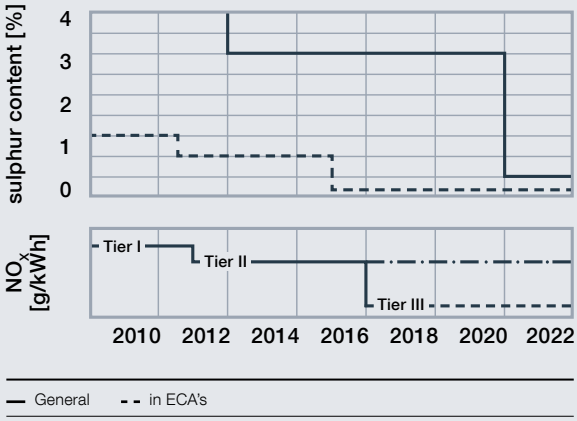
Turning the Tide on Fuels and Emissions

A sea change for marine industries

IMO NO_x limit curves according to engine speed



Implementation schedule



Implementation Schedule SO_x & NO_x limits according to IMO MARPOL 73/78 Annes VI

The shipping industry is facing some pretty tough challenges. In light of rising fuel costs and increasingly strict environmental regulations, engines have to be more efficient and more eco-friendly than ever before. Highly flexible dual fuel engines designed by MAN Diesel & Turbo are up to the task.

Crucial regulations come at a cost

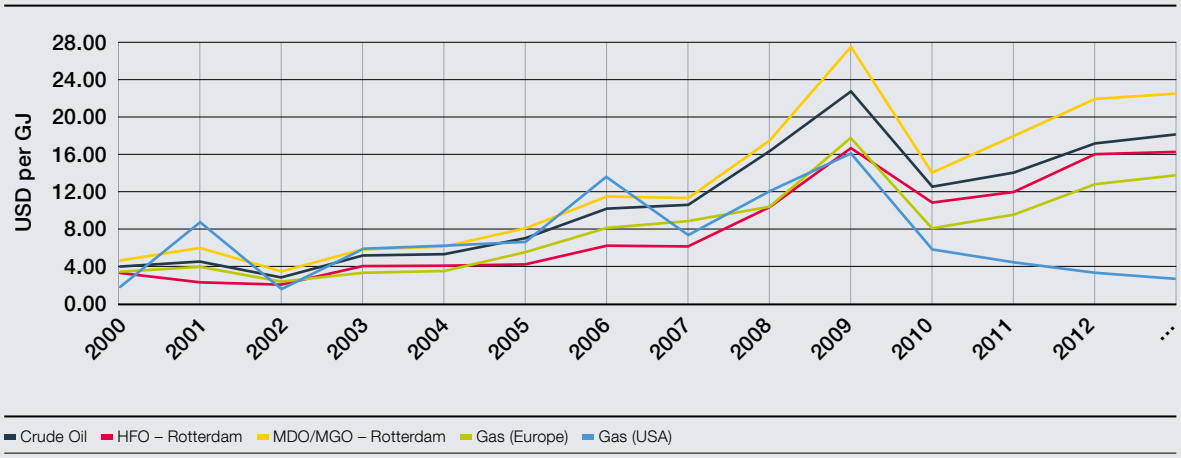
The growing global demand for energy has seen fuel prices skyrocket. At the same time, heightened environmental awareness has led to stricter domestic and international regulations, especially for harbors. The International Maritime Organization (IMO) has responded by imposing tougher thresholds for NO_x and SO_x emissions from marine traffic, and these limits will continue to tighten in the coming years.

This spells a sea change for marine industries. Ship owners, ship builders and classification societies are now actively taking steps to reduce emissions, focusing on measures that prove economically viable for both new and existing vessels. Yet markets are teeming with cutting-edge technologies designed to make ships comply with emissions regulations – there's no one-size-fits-all solution.

Dual fuel: double the options, double the benefits

Dual fuel engines that run on clean-burning liquefied natural gas (LNG) ideally address the pairing of ecology and economy. They not only satisfy all emission requirements when running on gas (including future IMO Tier III regulations), but they also boast low operational

Selected fuels: price development on energy equivalent base



and maintenance costs. Beyond this, dual fuel options offer unrivalled flexibility in engine operation: In the event of a fuel shortage or problems running purely in gas mode, ship operators can simply switch to liquid fuel. Whatever the fuel source, ships can keep moving full steam ahead.

MAN Diesel & Turbo understands that no two ships are identical. Different designs and different missions will take vessels into many different directions on the open sea. Armed with exactly the right experience, we can help ship owners determine the appropriate LNG system for their vessel, guaranteeing the most beneficial solution to meet their unique needs.

Saving costs – and the environment

There are many good reasons to opt for natural gas technology, and there is no better way to save resources. The price differential between liquid and gas fuels is steadily increasing, and this trend isn't expected to stop.

Fuel makes up the largest part of a ship's operating costs, and reducing fuel expenses is the most effective way to keep shipping affordable. Using natural gas as a primary fuel allows ship owners to save fuel costs compared to conventional diesel engines. The savings potential is even greater in terms of total operating costs. The MAN 35/44DF brought to you by MAN Diesel & Turbo was designed to show these savings in action, allowing ship operators to fully harness the complete flexibility of dual fuel technology and achieve optimum use of resources.

Truly Ahead of its Time

Highest power output with lowest emissions

For the shipping industry, the choice of fuel for marine propulsion is becoming increasingly challenging. Highly flexible dual-fuel engines offer an eco-friendly yet cost-effective solution.

Standing the test of time

The MAN 35/44DF is not an ordinary high-performance engine. Incorporating design features taken from the reliable and innovative four-stroke, medium speed MAN 32/44CR Tier II, and gas components taken from the MAN 51/60DF, this powerful engine offers an ideal combination of functions and benefits. Engineering ingenuity was not only channeled into reducing product development time, it has enabled ship owners to tap into component synergies and cut down their operating costs.

This engine's unique design centers around gas operation. Ship operators can switch to gas at any time, at loads between 15% and 100% – with no loss of engine power. The air-gas mixture is ignited with a small amount of liquid fuel injected through a separate pilot fuel system.

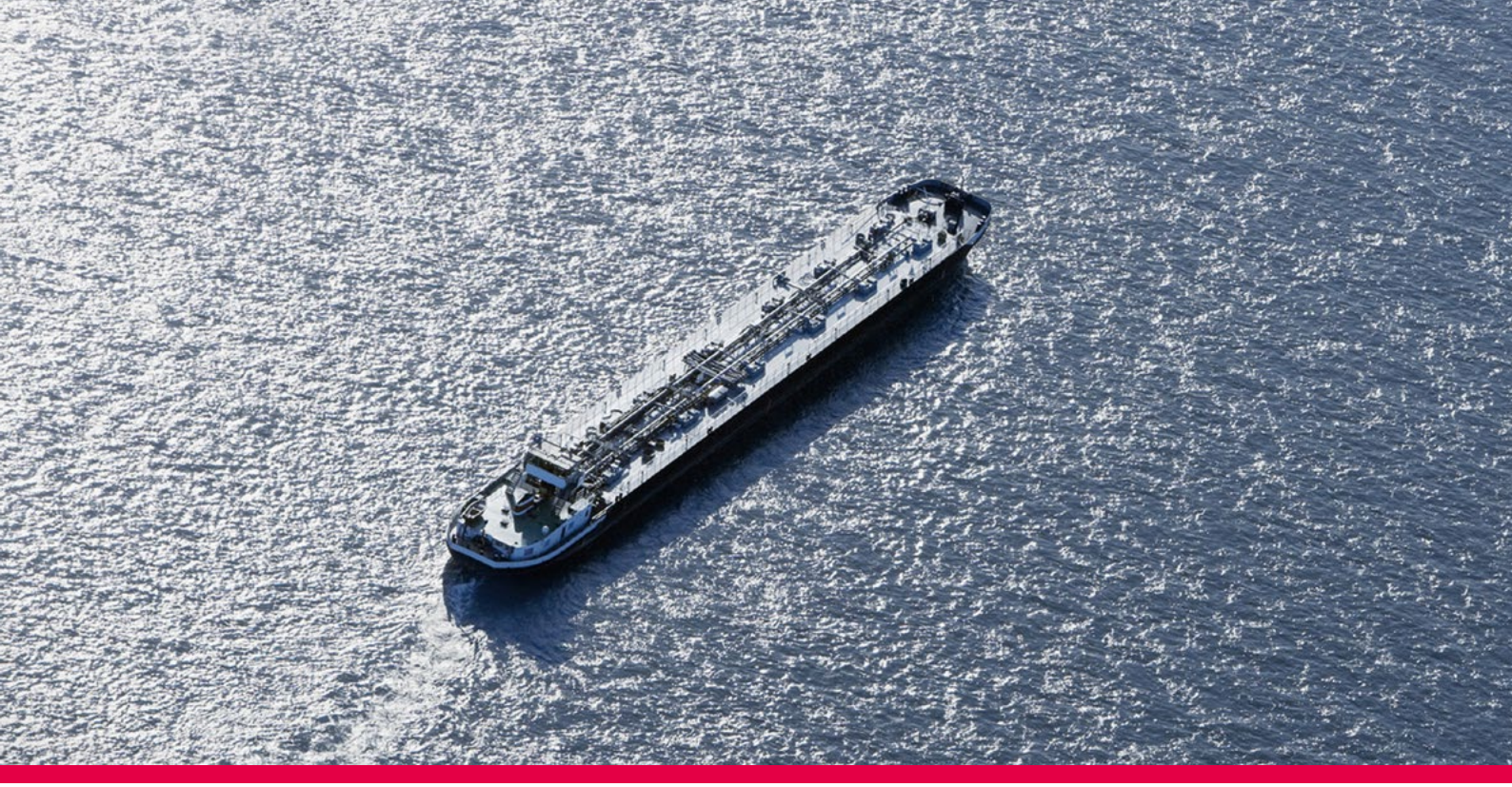
In gas mode, the MAN 35/44DF complies fully with IMO Tier III standards. Compared to liquid fuel operation, in gas mode, CO_2 emissions are lowered by 25% and other emission levels go down by up to 99% – or beyond. The engine uses a separate pilot ignition system based on high-pressure injection technology, an approach which has become well established in our trucking applications. What's more, the engine is also equipped with a fully functional common rail injection system with injection pressures of up to 1,600 bar. In liquid fuel mode, the MAN 35/44DF engine fulfills current emissions regulations under IMO Tier II.

A fully loaded system

The MAN 35/44DF is equipped with the newest generation of MAN Diesel & Turbo's engine management system: $SaCoS_{one}$. It unites all of the functions of modern engine management in one complete system. Thanks to clever system integration on the engine, it forms one unit with the drive assembly. Just some of the benefits that $SaCoS_{one}$ offers:

- Integrated self-diagnostics
- Maximum reliability and availability
- Simple use and diagnostics
- Quickly interchangeable modules (plug-ins)
- Fast, trouble-free maintenance

This state-of-the-art electronic engine management system was developed by MAN Diesel & Turbo to control the additional pilot injection system as well as the gas admission system. Its modular design and mounting on the engine significantly reduce the amount of wiring needed and enable decentralized functions. All modules of the $SaCoS_{one}$ system are completely self-sufficient via a redundant connection, improving availability and communication. All components match ideally to one another and work in harmony for optimal engine efficiency in both engine operating modes.



Safe and sound

The performance of the MAN 35/44DF is perfectly suited to meet the unique applications and requirements of the marine industry. With this in mind, our engineers focused on safety and adherence to all existing classification society regulations, guidelines and standards. Safe operation is not only a key quality criterion at MAN Diesel & Turbo – as a central pillar of our company's philosophy, it has been given the highest priority.

Don't keep pace – stay ahead

With an output of 530kW/cyl, the MAN 35/44DF engine clearly yields the highest power output in its segment. Yet it still meets current IMO Tier II emissions limits in liquid fuel mode. In gas operation, it even meets future IMO Tier III limit restrictions – without the need for additional after-treatment systems. This engine isn't just keeping up with the times, it's staying one step ahead. Perfectly equipped for the future, ship operators can count on tangible and measureable cost savings thanks to more favorable gas fuel prices. They can also count on a higher resale value later down the line.

Many of the components used in the MAN 35/44DF match those of our popular MAN 32/44CR Tier II model. On account of this extensive compatibility, onboard engine maintenance can be carried out quickly and easily. Unrivalled fuel flexibility offers reliable operation on all kinds of marine fuels such as HFO, MDO, MGO – and, of course, LNG. This makes the MAN 35/44DF ideal for ships where a key priority is cleanliness and efficient propulsion – ferries, RoRo vessels, cruise ships, gas tankers, offshore service vessels, even supply and production vessels – there's no end to the marine applications that can benefit from this engine.

The engine can easily be switched from liquid fuel to gas operation and back again. Though this can be done in normal operation, the feature is mostly reserved for use in emergency situations while in gas operation. In such situations, the engine retains its high-quality performance and remains fully compliant with the limits outlined by classification regulations – especially ISO 8528, which specifies the permissible range for speed undershoot at load-dump.

The new MAN 35/44DF marks the next stage of expansion in MAN Diesel & Turbo's dual fuel engines portfolio, perfectly complementing the power range of the MAN 51/60DF. These are engines of today that perfectly meet the economic and environmental demands of tomorrow's shipping industry!

MAN 35/44DF – Made for Marine Applications

The drive for your needs

The MAN 35/44DF was designed as a multi-purpose drive. It has received type approval as a marine main engine and auxiliary engine from all main classification societies.

Marine main engine
(mechanical / dual fuel-electric propulsion drive)

- Bulkers, container vessels and general cargo vessels
- Ferries and cruise liners
- Tankers
- LNG carriers
- Fishing vessels
- Dredgers and tugs
- Others

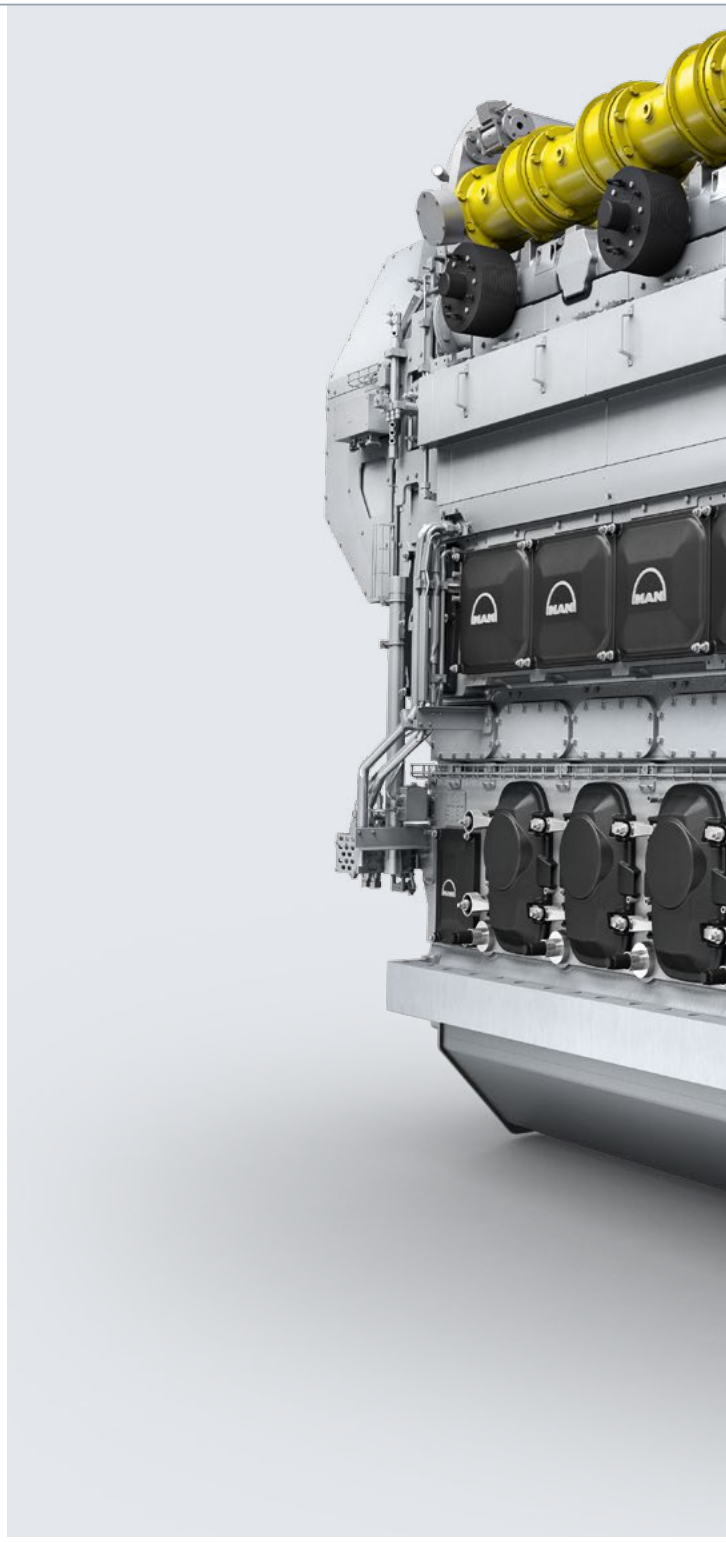
Marine auxiliary engine
(diesel-electric power generation)

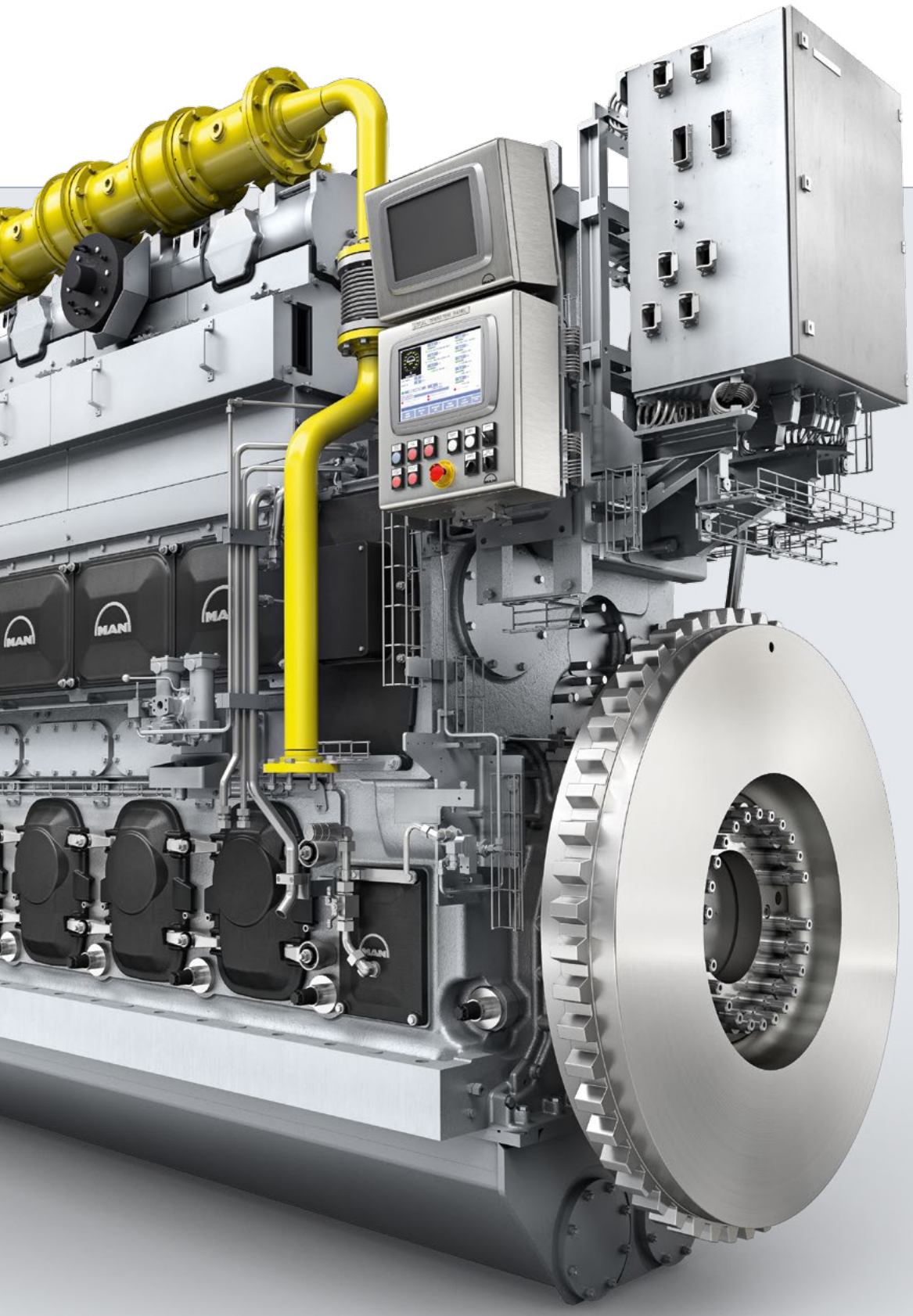
- Auxiliary gensets
- Emergency gensets

Offshore
(mechanical / dual fuel-electric propulsion drive; auxiliary engine)

- Platforms / offshore supply vessels
- Anchor handling tugs
- Drilling ships
- Semi-submersibles
- TLWPs
- FPSOs
- All kinds of service & supply vessels

Due to the wide range of possible applications, all requirements need to be clarified at an early project stage.





MAN 35/44DF Genset
Engine specifications

The new MAN 35/44DF engine can also be implemented as a high-power genset using the latest technologies for clean and efficient on-board power generation. By using a robust and compact design based on previous experience with former generations of the HFO marine genset, using the MAN 35/44DF Genset in combination with our current dual fuel engine program leaves customers comfortable in the knowledge that they are prepared for any future emissions requirements and other legislative developments.

Extremely efficient, fully flexible

The MAN 35/44DF Genset offers fuel flexibility and a compact on-board power generating unit which can be operated with HFO, MDO, and MGO as well as LNG. This genset fulfills future IMO Tier III NO_x limits in gas mode, with best-in-class power output and fuel consumption. Using gas as a fuel provides substantial economic advantages where the fuel cost makes up the largest part of ship operating costs, hence keeping shipping affordable.

Well-known basic design (L32/40, L3244K)

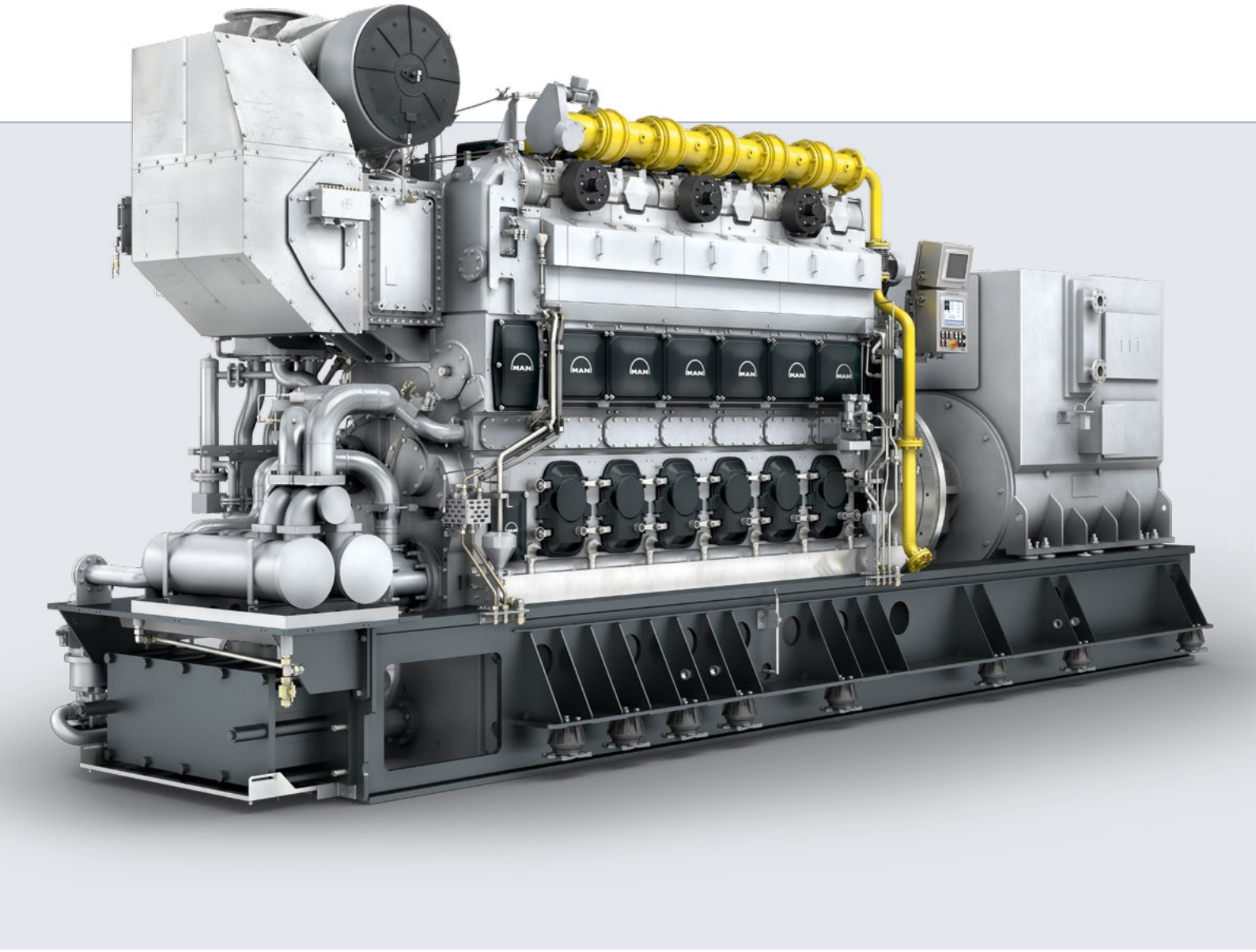
The MAN 35/44DF Genset design relies on one of the most successful and robust high-power gensets available on the marine market. The 32 and 35 bore engine family has been proven to be extraordinary reliable and a treasured choice by customers since its first introduction of a MAN L32/40 Genset in 1996. Meanwhile more than 1,900 gensets have been installed in different applications worldwide.

Compactness and flexibility

Installation is easy, as the engine and the alternator are fitted on a common base frame, and the connection to external systems is trouble-free. This is facilitated by already integrated auxiliary systems attached on the genset, e.g., lube oil system with cooler, filter and integrated service tank in the common base frame. The genset is therefore delivered in a ready-to-start state, speeding up the installation and commissioning process.

Everything from a single source

For LNG carrier propulsion based on dual fuel-electric or ME-GI, the MAN 35/44DF Auxilary Gensets offer alternative power solutions making them the perfect match with requirements.



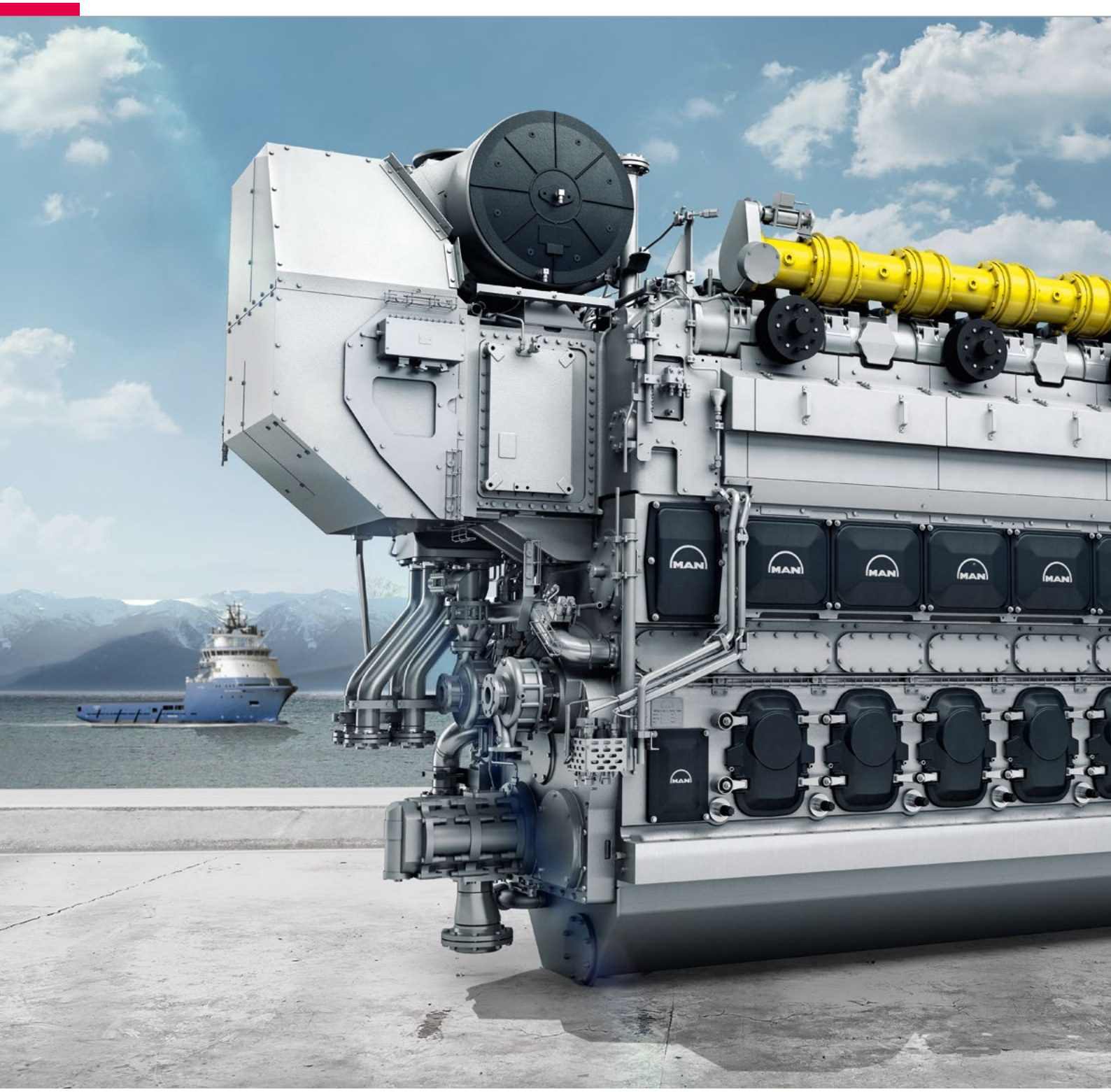
- By using a single source for main and auxilary gensets you benefit from optimized interfaces.
- Due to low pressure gas injection on the MAN 35/44DF, it's possible to burn boil-off gas, which is a smart way of dealing with it.
- Common after-sales support packages are available from MAN PrimeServ.

Safe and solid design

The MAN 35/44DF genset uses core components from the well-known and robust MAN 32/44CR engine, with some elements of the dual fuel technology from other areas of the MAN product portfolio. This reliable technology helps engine owners reduce daily maintenance and maximize TBOs. The MAN 35/44DF has been developed to fulfill prevailing marine requirements and to ensure safe operation independently of the fuel operation mode.

MAN 35/44DF – Prepared for the Future

Benefits at a glance



- Highest power output in its class
- Compliance with IMO Tier II and IMO Tier III standards
- No after-treatment needed to fulfill IMO Tier III in gas mode
- Full fuel flexibility (HFO, MDO, MGO and natural gas)
- Based on established technology
- Upgrade option from the MAN 32/44CR IMO Tier II engine
- Low operating costs
- Low maintenance costs
- Long time between overhauls
- Increased vessel resale value
- Safe engine operation in accordance with standards and regulations

Technical Data
Definitions

Engine data for MAN L35/44DF

General:

- Engine cycle: four-stroke
- Turbocharging system: constant pressure
- No. of cylinders, in-line engine: 6, 7, 8, 9, 10
- Bore: 350 mm
- Stroke: 440 mm
- Displacement per cylinder: 42.3 l

Cylinder output (MCR)

- 530 kW at 750 rpm
- 510 kW at 720* rpm

Power-to-weight ratio (MCR)

- In-line engine: 11.3 - 13.2 kg/kW

Cooling

- Cylinder cooling
- Charge air cooling (two-stage)
- Fuel injector cooling

Starting method

- Air (turbine) starter

MCR = maximum continous rating
* For generator drive only

General performance definition for diesel engines as per ISO 3046-1:2002

ISO reference conditions:

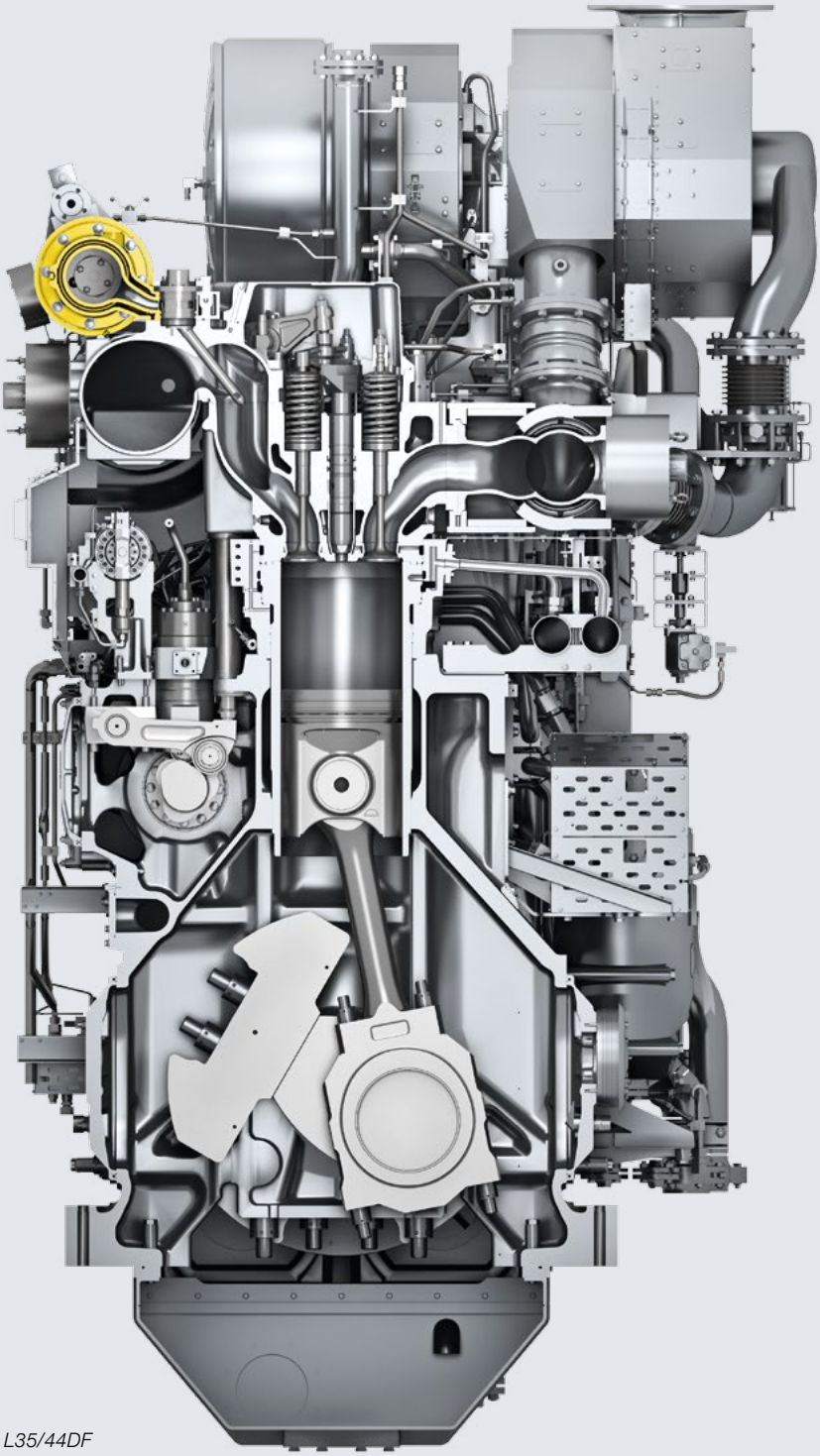
- Air temperature: 298 K (25 °C)
- Air pressure: 1 bar
- Cooling water temperature upstream of charge air cooler: 298 K (25 °C)
- Relative humidity: 30 %

No power reduction required below:

- Air temperature: 318 K (45 °C)
- Air pressure: 1 bar
- Cooling water temperature upstream of charge air cooler: 311 K (38 °C)
- Relative humidity: 50 %

IMO requirements

The engine detailed here complies with IMO Tier II emissions limits.



Cross section of the MAN L35/44DF

Technical Data

Output, dimensions, and weight

MAN L35/44DF

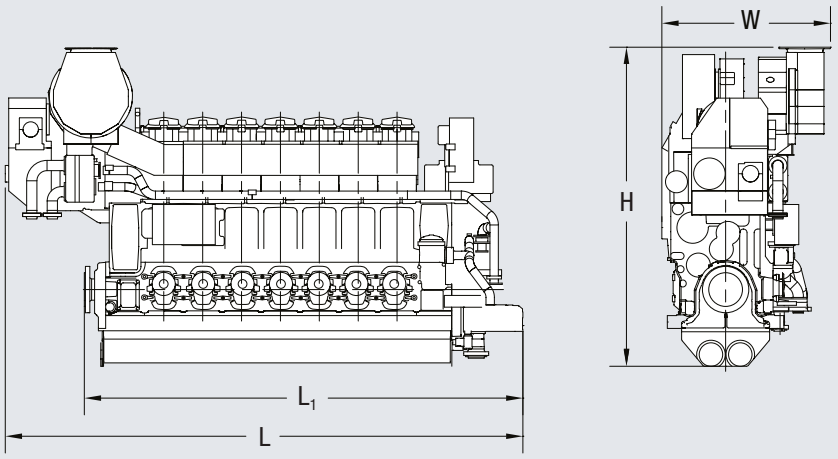
Engine

Bore: 350 mm

Stroke: 440 mm

No. of cylinders:

6, 7, 8, 9, 10



Output

Speed	r/min	750	720
mep	bar	20.0	20.1
		kW	kW
MAN 6L35/44DF		3,180	3,060
MAN 7L35/44DF		3,710	3,570
MAN 8L35/44DF		4,240	4,080
MAN 9L35/44DF		4,770	4,590
MAN 10L35/44DF		5,300	5,100

LHV of fuel gas ≥ 28,000 kJ/Nm^3

(Nm^3 corresponds to one cubic meter of gas at 0 °C and 1.013 bar)

Dimensions

Cyl. No.		6	7	8	9	10
L	mm	6,485	7,015	7,545	8,075	8,605
L_1	mm	5,265	5,877	6,407	6,937	7,556
W	mm	2,539	2,678	2,678	2,678	2,678
H	mm	4,163	4,369	4,369	4,369	4,369
Dry mass*	t	40.5	45.6	50.7	55.0	59.7

* Including built-on lube oil automatic filter, fuel oil filter and electronic equipment

Minimum centerline distance for twin engine installation: 2,500 mm (project-specific requirements can lead to higher values).

Speed 720 r/min for generator drive only

Technical Data

Output, dimensions, and weight

MAN L35/44DF

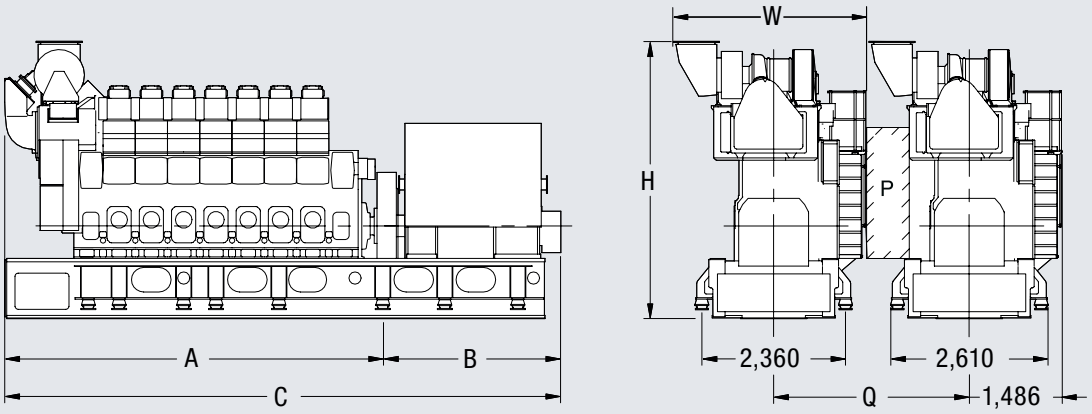
Genset

Bore: 350 mm

Stroke: 440 mm

No. of cylinders:

6, 7, 8, 9, 10



P Free passage between the engines: width 600 mm, height 2,000 mm (project-specific requirements can lead to higher values)

Q Minimum distance between center of engines: 3,400 mm (with gallery)

Output

Speed	r/min		750		720
Frequency	Hz		50		60
		Eng. kW	Gen. kW*	Eng. kW	Gen. kW*
MAN 6L35/44DF		3,180	3,069	3,060	2,953
MAN 7L35/44DF		3,710	3,580	3,570	3,445
MAN 8L35/44DF		4,240	4,092	4,080	3,973
MAN 9L35/44DF		4,770	4,603	4,590	4,429
MAN 10L35/44DF		5,300	5,115	5,100	4,922

* Based on nominal generator efficiencies of 96.5%

Dimensions

Cyl. No.		**6**	**7**	**8**	**9**	**10**
A	mm	6,270	6,900	7,480	8,110	8,690
B*	mm	3,900	4,100	4,400	4,600	4,800
C*	mm	10,170	11,000	11,880	12,710	13,490
W	mm	2,958	3,108	3,108	3,108	3,108
H	mm	4,631	4,867	4,867	4,867	4,867
Dry mass*	t	83	92	101	108	115

* Depending on alternator applied

World-Class Service

Marine propulsion, gensets, and stationary plants

The PrimeServ offering

The MAN Diesel & Turbo Group offers worldwide, round-the-clock service, 365 days a year. In addition to MAN Diesel & Turbo's service headquarters in Augsburg, Copenhagen, Frederikshavn, Saint-Nazaire, Hamburg and Stockport, service centers on all continents provide comprehensive and continuous support.

MAN Diesel & Turbo engines are renowned for their quality and durability. We are a global organization with a strong local presence, delivering exceptional field service management, tailor-made solutions, and first-class technical support.

PrimeServ provides advice and assistance to customers throughout the product life cycle, from delivery to resale. With our far-reaching network of service centers, we respond rapidly to customer needs. Furthermore, we offer outstanding service and unrivalled technical expertise. Plus, we only use genuine spare parts – safeguarding the longevity of your engine.

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 operators and maintenance staff
- Global service, 24 hours a day, 365 days a year
- Diagnosis and troubleshooting with our high-performance Online Service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