L21/31-VBS
IMO Tier II – Propulsion package
The Genuine Propulsion Package
All from the navigator’s finger tips to the propeller tips

The Genuine Propulsion Package is characterized by all core elements of the package – such as main engine, reduction gearbox, shaftline, propeller and control system – being designed, optimised, commissioned and tested by one organization for integration into tailored propulsion solutions.

And most important – for the benefit of shipowners and operators – The Genuine Propulsion Package is also serviced by that same organization throughout the ship’s operating life.

Yard benefits

- Pre-project plant conception, power and speed prognosis and estimation of propulsion package parameters with a high degree of system accuracy
- Layout of auxiliary systems and package engineering based on integrated overall propulsion expertise
- Propulsion equipment interfaces and integration matters are solved at an early stage
- Torsional vibration calculations and special ice class requirements are dealt with in standard quotations
- A competent contract partner during projecting, planning, purchasing, installation and commissioning of the propulsion equipment
- Thorough handling of engine, gearbox, propeller and control systems leads to minimal shipyard work on a reduced number of connecting points
- One package of documentation providing information on foundations, piping, electrical wiring, auxiliary systems, and covering onboard interfaces and alignment of the entire power train
- One team of commissioning engineers responsible for the entire propulsion package during start-up and sea trials
- Reduced shipyard responsibility and administration, reduced installation work and installation costs.
MAN Diesel & Turbo is the world’s leading designer and manufacturer of low and medium speed engines – an estimated 50% of the world marine trade is powered by engines from MAN Diesel & Turbo.

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 licensees.

The foundation of MAN Diesel & Turbo’s success in all applications, marine or stationary, is our unparalleled understanding of large engine technology. A vital part of our leadership stems from a firm belief in the ‘total systems approach’ to engine building based on the identification of core competences and the pursuit of excellence in these areas.
Propulsion package example:
MAN 6L21/31 Propulsion Engine
MAN Alpha AMG11EV Gearbox
MAN Alpha VBS740 CP Propeller
Alphatronic 2000 Propulsion Controls

Reduced operational costs
Reduced installation costs
Single point of contact
- to one responsible organisation
Owner benefits

- Optimal operating economy is ensured thanks to the optimised layout of engine, reduction gearbox, propeller, remote control and safety system
- Operating reliability, durability and predictable service intervals are assured by a tailored package
- One organization supplying, testing and commissioning the package, together with the subsequent lifetime accumulation of performance and operating experience for the propulsion components
- One package of service documentation, maintenance programmes and spare parts catalogues for the propulsion equipment – as the basis for efficient service routines and identification of parts
- MAN PrimeServ Academies offering complete propulsion system instruction and training for engineers, operators and service staff
- One service organization addressing all propulsion plant support requirements, either directly or via the worldwide network of MAN PrimeServ representatives, authorized workshops and service centres
- One service package contract or support agreement available for all propulsion equipment.

Pioneers and package traditions

MAN traditions are the bedrock of its excellence in integrated propulsion packages. The first propulsion package was developed as early as 1902, based on a 4 HP Alpha vertical four-stroke hot-bulb engine, a mechanical clutch coupling and a two-bladed mechanically controlled pitch propeller.
The L21/31 engine is the ideal power source in the 1,290-1,935 kW output range for small to medium-sized tankers, cargo vessels, ferries, RO-RO vessels, coasters, large fishing vessels, tugs, workboats and supply vessels.

The design criteria for the engine are:
- Reliability in operation
- Long periods between overhauls
- No unscheduled maintenance and repair work
- Unrestricted Heavy Fuel Oil operation
- Low fuel and lube oil consumption – while fulfilling legal emission limits
- Easy maintenance and operational friendliness
- Good part load behaviour
- Compact engine design
- Easy installation, rigid or resiliently seated.

New standards
- are introduced with the following features:
  - Modularized unit concept with a reduced number of components
  - Front-end box and aft-end box
  - Marine head connecting rod
  - Crossflow cylinder head design
  - Pipeless engine layout
  - No cooling water in the engine frame
  - Separate camshafts - one for injection pumps and one for the valve gear
  - Encapsulated engine - special noise dampening covers.

A unique cylinder unit concept:
- Quick and easy 'pit-stop' replacement is possible
- Easy withdrawal of the complete cylinder unit including cylinder head, liner, piston, connecting rod and fuel injection valve
- Overhaul intervals of 20,000-25,000 hours
- Exchange service and overhaul contracts are available.
Cylinder head – high, stiff and stable

A unique casting of nodular cast iron with:
- Integrated cylinder segment of the charge air receiver (with quick-release sleeve coupling)
- Integrated cylinder segment of the cooling water belt (with quick-release sleeve couplings)
- Integrated exhaust gas outlet collar connection to the exhaust gas receiver (with quick-release clamp ring)
- Integrated mountings for the rocker arm shaft and rocker arms.

Marine head

The solidly designed marine head and connecting rod offers the stiffness and high safety margin that ensures an ideal housing for a good and stable long term bearing condition.

The characteristics are:
- Optimal flow of forces and equal bearing loads
- No opening of bearing for piston withdrawal
- Easy use of hydraulic tools
- Low lifting height at overhaul
- Good access.
MAN L21/31 Engine
Optimal propulsion economy

Purpose-designed front-end box
A propulsion-optimised engineering element ensuring:
- Minimal foundation and installation work for auxiliary equipment
- Very short overall installation length
- Cooling water pipe connections optimally positioned on the sides of the box
- Integrated support bearing for optional 100% Power Take-Off
- All lube oil equipment in a safe, closed circuit
- Automatic full-flow lube oil filter – efficient cleaning – maximum safety – and no disposal problems with used filter cartridges
- Service friendliness and easy maintenance by simple plug-out/plug-in actions.

Efficient fuel equipment
The fuel injection system, one of the most important elements for efficient combustion, minimal consumption and smoke emission, is characterized by:
- High injection pressure and good atomisation for optimal charge air mixture – even at part load
- High pressure connections with ample stiffness for safety against vibrations and leakages
- Robust slide connections between injection pumps for easy assembly/disassembly.
**Turbocharger system**

Constant pressure turbocharging ensures the best efficiency for all cylinder versions. The system is based on:

- An uncooled turbocharger with isolated turbine inlet and outlet housing
- A lube oil system integrated with the engine lube oil system
- A charge air by-pass arrangement for higher charge air pressure at part load operation.
- An optional waste gate arrangement for special propulsion plants requiring special performance optimisation.

Integrated charge air receiver segments with quick-release sleeve couplings
MAN Alpha Reduction Gear
Proven and flexible power transmission

In the four-stroke power train the robustly designed MAN Alpha reduction gearboxes efficiently handle power for both propulsion, auxiliary systems and electricity demands.

**Reduction gear features**
- Compact design contributing to a short installation length of the complete propulsion package
- Cast housing with stiff support of bearings for maintaining an accurate tooth contact and well-dimensioned foundation for taking up the propeller thrust
- Helical gear wheels of special alloy steel, case hardened and ground to secure high strength and low noise levels
- Use of robust pressure-lubricated slide bearings for long reliable operating life
- Optional hydraulic actuated friction clutch of the multiple disc type with sintered plates. Optimised clutch-in time to ensure smooth engagement of propeller
- Thrust bearing with tilting pads designed with considerable safety margins
- Common oil system for propeller servo, gearbox clutch control and lubrication using one forced-driven built-on pump for all systems
- No separate oil tank, pumps or control systems are needed for controlling the propeller pitch
- Built-on oil cooler and high pressure full-flow filters
- Flexible Power Take-Off and Power Take-In/PTH solutions available up to the 1500/2000 kW range.
**PTO package expertise**

Shaft alternator operation and Power Take-Off flexibility is a prime feature. A long pedigree underwrites MAN's experience in the fields of tailored layout, installation and operation of PTO-driven alternators.

**PTI/PTH propulsion redundancy**

MAN Diesel & Turbo offers various simple and cost-effective Auxiliary Propulsion Systems with ample redundancy for a “take home” mode in the event of a main engine shutdown. Alternatively, a “take away” function of the system can be deployed during the loading and discharge of critical cargoes, allowing immobilization of the main engine for service inspection and eliminating the need for a standby tug.
Optimal design and layout of propellers are the prime targets for the ship’s overall propulsion efficiency. Full knowledge of the entire power train is one of our most important core competencies. Full knowledge of diesel engines, such as their load characteristics, operating economy, long term performance, manoeuvring and acceleration characteristics, combined with wide package expertise embracing the fields of:

- Hydrodynamics
- Mechanics
- Hydraulics
- Electronics

- and all their interfaces ensure the optimal design of propeller and control systems.

**Company experience**

Today’s MAN Alpha VBS-type propeller design is based on experience accumulated from the design and production of more than 7000 propellers.

**CP Propeller features:**

- Reliable design using few and robust components of high strength material
- Dimensioning of the propeller based on a pyramidal structure with increasing strength from blade towards shafting
- Intensive use of Finite Element calculations, Computed Fluid Dynamics and service experience exploited to ensure that the components meet the requirement of ample safety from not only the hydrodynamic loads but also from impact with debris and ice
- Hydraulic servo motor placed in the propeller hub for precise pitch setting, with a large servo motor piston resulting in low operating pressure for pitch setting
- Reliable and well-proven blade foot seals.
Propeller blades
Designing propellers has always been a challenge due to the complexity of all the factors involved. These factors are not only related to the propeller itself but also to the ship’s hull profile and its operating profile.

The blade design main objectives are to obtain as high a propeller efficiency as possible and to suppress the cavitation and noise to an acceptable level.

Design parameters
The propeller blades are designed and optimised on the basis of the following parameters:
- Blade area
- Blade shape
- Skew angle
- Pitch distribution
- Profile section
- Rake.

Hydrodynamic design analysis based on CFD
SaCoSone PROPULSION is the safety, control and monitoring system for MAN small bore diesel engines type L21/31 and L27/38. All engine mounted sensors and actuators are connected to the system and controlled by the engine attached SaCoSone PROPULSION.

Optionally, the gear box and the propeller control and monitoring can be totally integrated in the system. This means the entire propulsion plant can be operated locally from one position as required by classification societies.

SaCoSone PROPULSION can thus control and monitor all engine, gear and propeller functions, including clutch and pitch operations. Pre-alarms, system-alarms, safety actions, operating values and status information is visualised on the dual redundant display modules in the Local Operator Panel.

**Fit for the future**
SaCoSone is the result of far more than 15 years of MAN Diesel & Turbo experience in the field of engine control software and electronics. SaCoSone is built on a combination of established, well-structured software and modern embedded micro controller-based hardware. The software has been proven extensively on standardised PLC-technology. The new hardware is designed for very harsh environments and is based on standard components used by the automotive industry in their millions. With SaCoSone, MAN Diesel & Turbo engines are well-prepared for the future.

**Functions**
SaCoSone combines all functions in a single package:
- Safety system
- Engine control
- Clutch control
- Pitch control
- Alarm system
- Engine media control
- Speed governing
- Solenoid valve actuation
- Auxiliary control
- Engine operating history data
- Ship alarm system interface
- Remote access interface for online services
- Human machine interface.
SaCoSone is designed as a modular system and can be used with conventional engines as well as on engines with electronically controlled fuel injection. It is flexible and, due to its wide range of interfaces, can be integrated into all modern automation environments.

SaCoSone is completely mounted on engine and gear. The new design includes an economic new cabling concept and terminates at a modern TFT touch screen operating panel.

**Features**

SaCoSone offers a wide range of benefits:
- Integrated self-diagnostics
- Sensor monitoring
- Integrated data security
- High reliability and availability
- Guaranteed long-term spare parts supply
- Ease of operation and maintenance
- Reduced cabling
- Plug-in replaceability
- Standardised interfaces
- Complete control system, factory pre-tested.
Manoeuvrability and overall economy
The Alphatronic Propulsion Control System plays a key role in the optimising function of the entire propulsion plant. The control system not only optimises the function of the propeller but also the engine functioning - as well as securing the vessel’s manoeuvrability and best overall economy with respect to engine dynamics, fuel oil consumption and propeller efficiency.

Versatile functions
The computer-controlled system contains functions for:
- Machinery control of engine start/stop, engine load limits and possible gear clutches
- Thrust control with optimisation of propeller pitch and shaft speed
- Selection of combinator, constant speed or separate thrust mode is possible. The rates of changes are controlled to ensure smooth manoeuvres and avoidance of propeller cavitation
- Transfer of Responsibility between the local control stand, engine control room and control locations on the bridge is incorporated in the system.

Main Bridge Control Station
For remote control a minimum of one control station located on the bridge is required. This control station will incorporate three modules:

Propulsion control panel
- with push buttons and indicators for machinery control and a display with information on condition of operation and status of system parameters. Flexible multi-functional ‘soft-key’ buttons may be programmed for individual purposes, e.g. clutch in/out control for additional PTOs.

Propeller monitoring panel
- with back-up instruments for propeller pitch and shaft speed.

Thrust control panel
- with control lever for thrust control, an emergency stop button and push buttons for transfer of control between bridge control stations. An independent telegraph for communication between bridge and engine room can be incorporated in the Thrust Control Panel.
Engine load control functions:
- Automatic overload protection
- Running up load programme
- Charge air controlled torque limitation
- Automatic load reduction and slow down
- Engineer-controlled limitation of engine load.

Electric shaft system
To ensure bumpless transfer of manoeuvre responsibility between the control stations on the bridge, an electric shaft system is incorporated for automatic synchronization of control levers.

Control station in engine room
A propulsion control station for the engine control room can be incorporated in the system. A thrust control panel with a single control lever is standard, but separate levers for control of engine speed and propeller pitch are optional.
The MAN Diesel & Turbo supply is not limited to the own-designed elements in the propulsion package. Other propulsors, gearboxes or propulsion equipment are often integrated in package solutions.

**Packages can include:**
- Other propulsors such as Fixed Pitch Propellers, Azimuth Thrusters, Z-drive and Voith-Schneider propellers
- Dynamic Positioning and Control systems with joystick arrangements
- Hybrid and multi-engine combination systems with several operating modes, including semi-diesel electric drive.

**Perfect engine characteristics**
Heavy-duty propulsion and manoeuvring power is the core of the L21/31’s performance characteristics:
- Good performance over the entire load range
- Quick acceleration
- Immediate load response
- Smokeless at idling, part load and full load
- Optimized for high-torque layout
- Low NO\textsubscript{x} emissions
- Low fuel oil consumption.
Voith-Schneider installation

Twin engine – twin in/single out installation

Thruster installation
A ‘Green’ Approach
to propulsion power

The design of the L21/31 has been performed with careful attention to its impact on the surroundings. Some key points are:

**Exhaust gas**
A minimum of visible smoke during acceleration and at any load point. Exhaust gas emissions below the IMO Tier II NO\textsubscript{x} limits.

**Noise emission**
Special noise dampening engine covers are applied.

**Vibration**
Well balanced engine with low vibration levels transmitted to foundation, ship structure and accommodation – even when rigidly seated.

**Waste**
No disposal or chemical waste problems with used lube oil filter cartridges – thanks to the self-cleaning automatic full-flow lube oil filter. Easy handling and no disposal costs.

**Fuel oil**
Minimal fuel oil consumption within legal emission limits for reduced operating costs.

**Lube oil**
Low and stable lube oil consumption is another important cost factor.

**Heat emission**
High engine efficiency, low heat emissions with good possibility to exploit surplus heat in auxiliary systems.

**Man and machine**
Operator safety and handling friendliness due to extensive use of ergonomically correct solutions related to lifting gear, hydraulic tools, flanges and couplings.
L21/31-VBS Propulsion Package
Main data and standard package examples

Bore: 210 mm, Stroke: 310 mm

<table>
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<th>6</th>
<th>7</th>
<th>8</th>
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<td>H (mm)</td>
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<td>3,267</td>
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<tr>
<td>W (mm)</td>
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<td>Dry mass (t)</td>
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<td>17.5</td>
<td>19.0</td>
<td>20.5</td>
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Minimum centreline distance for twin engine installation: 2,400 mm.

Specific Fuel Oil Consumption (SFOC) to ISO conditions

- MCR 100% 195 g/kWh
- 85% 192 g/kWh

Specific lube oil consumption: 0.8 g/kWh

Engine type specific reference charge air temperature before cylinder 40 °C

Speed r/min 1000

mep bar 24.0

kW

Bore: 210 mm, Stroke: 310 mm

<table>
<thead>
<tr>
<th>Cyl. No.</th>
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<th>8</th>
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<tbody>
<tr>
<td>Prop. speed r/min</td>
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<td>900</td>
<td>1,000</td>
<td>1,100</td>
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<tr>
<td>D (mm)</td>
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<td>VBS (mm)</td>
<td>550</td>
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<td>Q (mm)</td>
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<tr>
<td>R (mm)</td>
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<td>Wmin (mm)</td>
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<td>K (mm)</td>
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<td>Gear mass (t)</td>
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</table>

* S₁ and propeller mass are based on 4,000 mm propeller shaft and 2,000 mm stem tube for 21/31, 27/38 and 6,000 mm propeller shaft and 3,000 mm stem tube for the other types.
Service Excellence
During the entire life cycle

A service package second to none
The unique “all under one roof” philosophy is particularly beneficial to the owner and operator during the service life of the package.
The Genuine Package is covered entirely – from one source - in all service matters such as:
- Advisory service
- Performance control
- Diagnosis and analysis
- Parts Supply

MAN power - at your service
Specialists in the individual elements of The Genuine Package provide direct back-up, contributing to a professional life-cycle service support programme for engines, reduction gears, CP propellers and controls. Efficient implementation of service and repair actions is secured by a trained team of travelling propulsion package specialists – backed by the very large worldwide after-sales service network of MAN PrimeServ outlets, service centres, authorized repair shops, local spare parts stocks and service agents.

One phone call - and you have got it all!
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