Propeller layout and engine matching with margins

The combination of speed and power obtained for the design condition of the ship may be called the propeller design point (PD). PD is placed on the light running propeller curve, in Fig. 2.01.01.

Some shipyards, and/or propeller manufacturers occasionally use an alternative propeller design point (PD’) for the propeller design. To reflect average conditions at sea, PD’ incorporates all or part of the so-called sea margin described later.

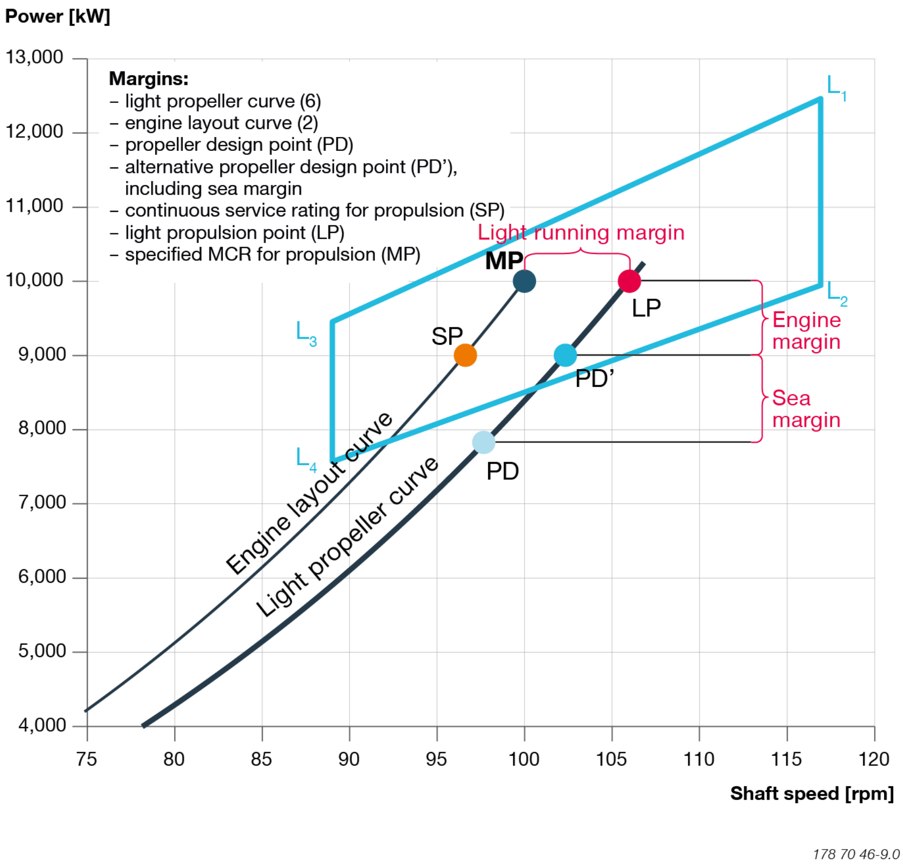

Fig. 2.01.01: Light propeller curve with margins added to establish the specified MCR for propulsion (MP) within a layout area for a specific engine

The service propulsion point (SP) on the engine layout curve is obtained by adding the sea margin, and the light running margin to the propeller design point (PD).

The specified MCR for propulsion, attained by including all margins described in the following sections, must be placed within the layout area. See the later section "Engine layout limitations" for further information.

Sea margin

As the sea is rarely completely calm and a wind often blows, the ship will experience increased resistance from wind and waves in average conditions. When determining the necessary engine power it is normal practice to add a power margin, the so-called sea margin. The sea margin ensures that the ship can maintain the design speed in average conditions at sea.

Traditionally, the sea margin has been approximately 15% of the power required to achieve the design speed with a clean hull in calm weather (PD). As ship design speeds reduce, it can be necessary to increase the sea margin since the resistance experienced by the ship is not reduced. If allowed by the EEDI regulation, it can be sensible to use a larger margin for ships often operating in heavy weather.

Engine margin

Often an engine owner will not permit 100% utilisation of engine power for normal operation due to the increase of the fuel consumption and the reduction of the power reserve. Therefore an engine margin of 10 to 15% is included to operate the engine at 90 or 85% load at the service propulsion point. Higher margins have been experienced for specific trades or reasons. If allowed by the EEDI regulation, a high engine margin is typically preferred for ships in scheduled traffic to make it possible to catch up with delays.

The engine margin can be increased for ships with a shaft generator, see the later section 2.03.

Light running margin

When the ship has sailed for some time, the hull and propeller becomes fouled. This will increase the hull resistance, and reduce the ship speed unless the engine delivers more power to the propeller to maintain the speed. As a result, the propeller will require more torque and the engine will be heavier loaded and heavy running (HR), which requires an increased torque from the engine.

When determining the necessary engine layout speed, the influence of a heavy running propeller and operation with increased vessel resistance must be considered. Therefore it is recommended to use a heavier propeller curve for the layout of the engine. The propeller curve for clean hull, and calm weather may then represent a "light running" (LR) propeller, whereas the engine layout curve represents a propeller curve in heavy weather, or with heavy fouling.

Everllence recommends using a light running margin (LRM) of normally 4.0–7.0%, however, for special cases up to 10%. It means that for a given engine power, the light running propeller rpm is 4.0–10.0% higher than the rpm given on the engine layout curve. Or, conversely, the engine is specified to a speed 4.0–7.0% lower than given on the design light propeller curve.

The point attained in the engine layout diagram, after shifting the propeller curve (containing the sea and engine margins) by the light running margin, is termed the “specified MCR for propulsion” point (MP).

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The high end of the range (7–10%) is primarily intended for vessels often operating in adverse conditions with a heavy running propeller. Low-powered EEDI ships such as tankers, and bulkers with blunt bows may also experience an operational benefit from a relatively high light-running margin.

Vessels with shaft generators, or vessels with high ice classes can also benefit from a light running margin in the high range, or in special cases even beyond 10%. It makes it possible to keep the shaft generator and power take-off (PTO) in operation for longer periods at sea. See the later guidance on PTO layout limits.

The SMCR values of engine power (SMCRpower) and speed (SMCRspeed) when including the margins can be calculated using equations 2.01.01 and 2.01.02.

Eg. 2.01.01

$$SMCR_{power} = PD_{power} \times \frac{\frac{100 + SM}{100}}{\frac{100 - EM}{100}}$$

178 70 80-3.0

Eg. 2.01.02

$$SMCR_{speed} = PD_{speed} \times \left(\frac{SMCR_{power}}{PD_{power}}\right)^{1/3} \times \left(1 - \frac{LRM}{100}\right)$$

178 70 81-5.0

The recommendation towards LRM is applicable to all draughts at which the ship is intended to operate, whether ballast, design or scantling draught. The recommendation is applicable to engine loads from 50 through 100%. If an average of the measured values between 50% and 100% load is used for verification of the attained light running margin, this will smoothen out the effect of measurement uncertainty and other variations.

Note on LRM

Light and heavy running, fouling, and sea margin are partially overlapping terms. Light and heavy running of the propeller refers to hull and propeller deterioration, as well as heavy weather and the resulting shift of the propeller curve towards the left in the load diagram. See for example Fig. 2.01.01. This shift stems from the increased torque required by the propeller during encounters of added resistance on the hull, that is, a lower rpm output at the same power.

The light running margin gives a margin towards engine limitations, see section 2.03. This margin ensures that the ship can deliver maximum power in conditions not as ideal as sea trial conditions. If the light running margin was not included, this might not be the case.

The sea margin gives the power margin necessary to maintain the service speed during average sea conditions with added wave and wind resistance. The light running margin ensures that the necessary power is available.

Within the recommendations for the light running margin, the degree of light running must be decided based on experience from the actual trade, and the hull design of the vessel. In general, slender designs with sharp bows require smaller margins than full-body ships with blunt bows. The latter design results in an increase of the added resistance in adverse weather.

For further information on the effects of engine heavy running, see the later section: "Engine power and speed limits".