Enhanced torque reserve for MAN B&W S and G-type engines for adequate ship acceleration

Introduction
In recent years, the engine power installed in new ship designs has been continuously reduced. The impact on the energy efficiency design index (EEDI) of these ships has been positive, but on the other hand the power available for acceleration of the vessel may have been reduced as well. For this reason it may, in some cases, be necessary to increase the light running margin (LRM).

In recognition of this fact, MAN Diesel & Turbo (MDT) has updated our recommendations for light running margin from 3-7% to 4-10%. It is important to note that excessive light running margins can have a negative impact on the propeller design and, accordingly, the propeller and propulsion efficiency.

With the introduction of the S and G-type dot 5 engines with high torque performance capability, MDT has extended the selection of engine types to allow the shipyard choose the optimal layout for the ship and propeller.

Light running margin considerations
The MAN B&W S and G-type engines have generally demonstrated fully satisfactory service conditions, including ship acceleration and maintaining of the speed in heavy weather condition and with fouled hull. However, we have received a limited number of reports of adverse conditions and small light running margins that have challenged the ship acceleration capability. For this reason, we have updated our recommendations for light running margin from 3-7% to 4-10% % in Market Update Note (MUN 2015/3 - 24 April 2015). The light running margin must be chosen within this range for the specific application. Light running margins in the upper end of the range are relevant for applications where the expected increase in vessel resistance due to adverse conditions is large. An example of such an application is a ship with full lines and a low design speed. Ships may also benefit from a light running margin in the upper end of the range when the location of a barred speed range requires rapid acceleration of the engine at high rpm relative to the SMCR rpm.

Dot 5 engine technology supporting a high torque reserve
Engine torque capability is either limited by the amount of fuel injected into the cylinders or by the amount of air trapped in the cylinder when the exhaust valve is closed.

The free setting of the exhaust valve opening and closing, and the injection timing and profile offered by the electronically controlled S and G-engines ensures a very high torque via an optimally combined selection of trapped air and injected fuel.

On electronically controlled engines, the amount of air trapped in the cylinder will be fully independent of the scavenge air pressure. This is because a high scavenge air pressure layout will be compensated by late closing of the exhaust valve, and a low scavenge air pressure layout will be compensated by early closing of the exhaust. This means that the target value for trapped air is obtained independent of the scavenge air pressure.

Consequently, on an electronically controlled engine there is absolutely no reason for making a high scavenge air pressure layout for the purpose of ensuring the acceleration capability.
of the engine or using excessively sized auxiliary blowers to generate the scavenge air pressure.

As mentioned above, we have experienced a few cases of low acceleration capability on some ships with our ME-C dot 2 and dot 3 engines and have therefore changed the exhaust valve closing timing on the dot 5 engines to ensure a suitable air trapping efficiency.

**New dynamic limiter functionality**

Furthermore, we have recognised that the very static settings of torque and scavenge air limiters in our control system have limited the amount of fuel that is injected into the cylinders, even when there is sufficient air for combusting more fuel and, accordingly, achieve a higher torque.

In response to the above, we are in the process of developing a dynamic torque and scavenge air limiter for our S and G-type ME engines to ensure that engines in dynamic operation always allow the maximum possible fuel injection while at the same time ensuring that the engine does not operate outside the load diagram allowed for continuous operation. In addition, the new limiters will allow for an even further increase of the trapped air amounts during acceleration when needed.

**Roadmap for increased and adequate acceleration**

- For new ships, a sufficient and adequate LRM in the interval of 4-10% should be selected. Furthermore, the engines will be of the dot 5 design which, as explained above, implies an improved torque capability in the low-load range and, in addition, the new dynamic limiter functionality will give a time-limited higher torque capacity for large changes in speed setting, for example during manoeuvring.

- For ships in service with insufficient acceleration and an LRM below 3%, it is recommended to increase the LRM by modifying the propeller to have a lighter characteristic.

- For ships experiencing insufficient acceleration during sea trial or in service, and with an LRM above 3%, the governor index limiters are increased stepwise to ensure a proper engine performance until sufficient acceleration is obtained. A procedure for the adjustment process has been issued to the engine builders. It is important that engines running with increased limiters do not overload the engine in steady-state operation in any other conditions. Fig. 1 shows the stepwise change in the governor index limiter. This is a temporary solution that will be replaced by new software for the engine control system (ECS), which is currently being developed. We have the first version of this countermeasure ready by August and, after intensive testing, it will be fully implemented 4 to 6 weeks later.

The effect of the limiter increase can be enhanced by increasing the $p_{com}/p_{scav}$ (thereby trapping more air) to further enhance the engine acceleration and reduce possible smoke. The new software will be able to activate and deactivate the running condition with the increased parameters depending on the engine speed and load. The method is particularly efficient for shortening the time required for passing the barred speed range. The engine control system will need to be updated accordingly. The procedure for this is described in a new separate document which will be issued to the engine builders.
Governor index limiters

![Graph showing governor index limiters and propeller torque against engine speed.](image)

**Fig. 1: Example of stepwise increase of index torque limiter**

**Conclusion**

The introduction of modern highly efficient ships with optimised hull forms, larger low-speed propellers, hydrodynamic efficiency enhancing devices (such as the Mewis duct), and powered by derated low speed S and G-type engines has resulted in new experience with the dynamic behavior of the ship and its propulsion system.

Some ships have turned out to have too little power reserve in certain conditions. MDT has therefore introduced modifications to the engines to ensure improved acceleration capabilities.

With the S and G-type dot 5 engines with high torque performance capability and the dynamic limiter functionality, MDT will support shipyards in choosing the optimal layout of the ship and propeller.

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