Market Update Note

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An Evaluation of the Possible Options for a Future Tier III Ready Retrofit Solution

Due to widespread uncertainty in the marine market about the regulatory requirements to Tier III technologies, combined with considerations regarding installation and operational expenses, MAN Diesel & Turbo has recieved inquiries about Tier III retrofit solutions and prepared-for-future-retrofit solutions from owners who, understandably, prefer to take a wait-and-see attitude. The IMO NO_x Tier III regulation applies to all newbuildings operating in NECA areas, and retrofitting a Tier III technology on a two-stroke marine engine in service is considered to be technically challenging and expensive.

Owners can choose between three Tier III technologies for MAN B&W two-stroke diesel engines:

1. High-pressure exhaust gas recirculation (HP-EGR)
2. High-pressure selective catalytic reduction (HP-SCR)
3. Low-pressure selective catalytic reduction (LP-SCR).

The HP-EGR and HP-SCR solutions have been approved after long-time service testing. LP-SCR is currently undergoing long-term service testing and subsequent approval.

From a regulatory point of view, challenges with regard to retrofitting NO_x Tier III technologies are also expected with regard to certification, especially measurements for technical file amendments. MAN Diesel & Turbo sees the following two options as the most likely approaches:

- Major rebuilding to include Tier III hardware followed by full re-certification.
- Hardware modifications that allow change from one engine group to another with a Tier III compliant parent engine.

The rebuilding and re-certification process must, regardless of the approach chosen, always be followed by an onboard verification survey. The onboard method corresponds to the onboard survey method described in the NO_x technical file.

As the current Tier III regulations only apply for vessels with keel laying after 1 January 2016, and as a retrofit installation will be rather comprehensive, retrofit installations are expected to take place mainly in connection with docking, which in the majority of cases means after 2021. Hence, there will be ample time for the regulatory bodies to get such framework in place.

There seems to be a broad variety of possibilities for preparing for future Tier III retrofits. MAN Diesel & Turbo is primarily investigating various solutions for two-stroke engines, two for HP-EGR and one for LP-SCR.

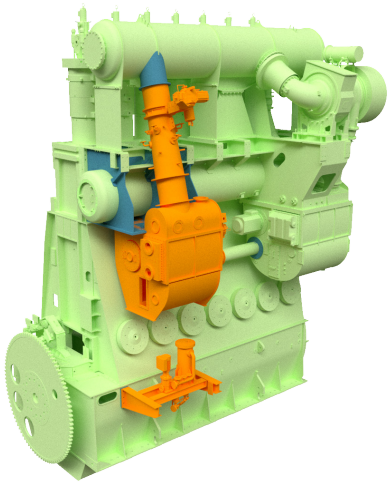

Fig. 1: Tier III HP-EGR engine prepared with key EGR equipment (Solution 1)

1. HP-EGR

Solution 1: The HP-EGR solution in Fig. 1, is suitable for owners who definitely expect to retrofit a solution in the future, but who would like to postpone the first-cost expenses for sub-components. This solution entails that a parent engine of a certain vessel series is tested and certified as a Tier III engine from start and, subsequently, the components are removed from the (parent and not installed on member) engine(s) and blinding flanges are installed accordingly, see Fig. 2. This makes retrofit easier and limits certification issues with very limited Tier II SFOC changes compared to Tier II engines.

Solution 2: The HP-EGR prepared solution in Fig. 2 is suitable for owners who do not know whether retrofit for Tier III is going to be relevant in the future. This solution only includes making space in the engine room and ensuring tank capacity along with minor modifications to the engine, such as preparing specific flanges and supports for more weight and making room for certain valves. This solution would require a major retrofit job. In addition to the cost of the Tier III equipment and its installation, expenses for modification of the engine and T/C components should be included. In conclusion, the engine will need re-certification or technical file amendments for both Tier II and Tier III modes, which calls for a sea trial, onboard survey and class approval.

2. LP-SCR

The LP-SCR solution is a system located in the exhaust gas duct after the turbocharger and, therefore, not physically connected to the engine. However, the necessary space in the engine room and exhaust gas duct has to be prepared for to allow later installation. The pressure drop and turbocharger/auxiliary blower layout needs to be evaluated, adjusted and prepared accordingly for LP-SCR application. This can be carried out either in connection with the installation of the engine, or in connection with later installation of the LP-SCR system.

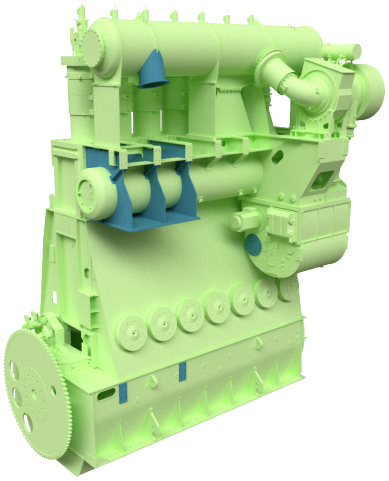

Fig. 2: HP-EGR prepared solution without EGR equipment installed (Solution 2)

It is recommended that all engines prepared for Tier III retrofit are delivered with either a Tier II low-load exhaust gas bypass-tuned (LL-EGB) setup or as Tier III engines. Both versions are described in our latest Marine Engine Programme booklet and can be calculated in CEAS at www.marine.man.eu.

With regard to preparation for retrofit of HP-SCR, the challenge and dominant factor is space and the general arrangement in the engine room. It is therefore recommended that any intention of later retrofitting of HP-SCR is discussed with the yard when the vessel/engine room is designed. On the engine side, the turbocharger layout and auxiliary blowers will be influenced.

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