Christian Thoma, Vectron Platform Project Manager at Siemens AG

“We decided on a proven single-engine system from MTU due to the low fuel consumption – just as with the predecessor of the Vectron DE, the Eurorunner, which is equipped with an engine of type 16V 4000 R41.”
Installation of engine of type 16V 4000 R84 in the Siemens locomotive plant in Munich-Allach.

The core of the Siemens Vectron DE is an MTU engine from the Series 4000, which complies with the European emission specifications of stage EU IIIB for rail drives.

(Pictured: MTU 12V 4000 RX4)

Installation of engine of type 16V 4000 R84 in the Siemens locomotive plant in Munich-Allach.

 ner – which guarantees optimum lifecycle costs. Retrofitting of additional train protection systems, for example, or further exhaust aftertreatment systems is possible with the diesel locomotive. Furthermore, traction engines can be upgraded or converted for cross-border travel in Europe according to the modular concept. The vehicles can thus be quickly and cost-effectively adapted to changing market conditions, operating areas and legal specifications, which provides customers with a high degree of future and investment safety.

All Vectrons are suitable for multiple traction among one another and together with all modern locomotives from Siemens.

Vectron DE: Modern diesel locomotive with high customer benefits

The Vectron DE is available with an output of 2.4 MW. The fuel tank holds 4,000 liters, although a capacity of 5,000 liters is available as an option. Depending on equipment, the locomotive weighs between 81 and 88 tons and, with a length of 19.98 meters, is slightly longer than the Eurorunner. The starting tractive force is 275 kN; the maximum speed is 160 km/h.

During the development of the diesel-electric Vectron version (Vectron DE), the main focus was also on customer benefits. Siemens also had to make allowance for numerous new specifications enacted by the EU Commission (Technical Specification for Interoperability, TSI). It was also important during the design of a new locomotive that it complied with the new, more stringent emission specifications. For this purpose, the responsible Siemens engineers simulated numerous realistic travel routes for both passenger trains and freight trains and tuned towards the timetables. As far as performance is concerned, the Vectron is perfectly designed for future traction tasks and has sufficient reserves to accelerate to the required maximum speed. Furthermore, Siemens tested alternative drive concepts such as multiple engine systems on the test bench. Examinations revealed that a large, low-consumption diesel engine was overall the most cost-effective concept for final customers. “Ultimately, we decided on a proven single-engine system from MTU due to the low fuel consumption just as with the predecessor of the Vectron DE, the Eurorunner, which is equipped with an engine of type 16V 4000 R41. After all, fuel costs are the definitive motivating force with regard to the lifecycle costs of a diesel locomotive!” explained Christian Thoma, Vectron Platform Project Manager at Siemens AG.

EU IIIB engine from MTU as the core of the Vectron DE

The driving force behind the Vectron DE is an engine from the latest generation of the successful MTU Series 4000. Engines in this series have been used successfully all over the world since 1996 in over 2,000 mainline and shunting locomotives. The required power in the Vectron DE is guaranteed by an engine of type 16V 4000 R84 with an output of 2,400 kW. It falls well below the European emission level specifications of stage EU IIIB for rail drives, which have been in effect since 2012. As early as the Innotrans in 2010, where the engines of the latest generation celebrated their world premiere, they have been certified by the Federal Office for Motor Traffic for this emission stage. In comparison to stage EU IIIA, which was in effect since 2009, the limit values for nitric oxide (NOx) were reduced by 39 percent and for particles (PM) by even 88 percent.

Combination of key technologies for EU IIIB

The emission limits of stage EU IIIB are observed thanks to a combination of engine-internal measures and exhaust aftertreatment. Cooled exhaust gas recirculation core technology is provided inside the engine to reduce nitric oxide
The Vectron was designed with the classic machine compartment layout. The engine compartment is divided into three separate chambers. The power module, consisting of engine and generator, is located centrally in the middle chamber. It is resiliently mounted on the locomotive body.

and comply with emission levels without exhaust aftertreatment. The highly efficient, two-stage turbocharging ensures, in all operating statuses, for example, at extreme temperatures, high altitudes or high exhaust back pressure, that there is sufficient air for efficient, low-soot combustion. The valve timing based on the Miller principle can contribute to a lowering of the nitric oxide emissions and, at the same time, reduces the fuel consumption. An improved common-rail injection system with a maximum injection pressure of 2,200 bar ensures low raw emission levels of particles and thus makes a compact particulate filter possible. This is accommodated in the existing silencer compartment because it also takes on the function of the silencer. The filter is arranged above the engine, which means that fewer and short exhaust lines can be used. The design of the particulate filter and passive regeneration strategy meet the high demands of customers who expect a compact, inherently safe and efficient concept. "Our locomotives must be efficient and, at the same time, extremely reliable and maintenance-friendly. This is only possible with an engine that also meets these criteria – with low emissions and compact design," says Mr. Thoma.

In spite of the drastic reduction in nitric oxide and particle emissions, it was also possible once again to reduce fuel consumption and thus the CO₂ emissions of the future engines.

Engine governor and link to locomotive control systems
The rail engine is equipped with the electronic MTU engine governor, or Engine Control Unit (ECU) with integrated engine management. The ECU monitors the engine and controls the starting sequence and speed regulation. In addition, the ECU is provided with an engine safety system. The central link between the locomotive control system and engine control is the MTU automation module Power Automation Unit Engine (PAU Engine). Similarly, PAU Engine takes over the complex task of locomotive cooling system management to guarantee emission-certified diesel engine operation. The module also has an interface to the driver’s control panel, via which various signals such as engine start and stop, engine speed, lube oil pressure or coolant temperature are provided and shown to the engine driver at the display. If alarms occur, PAU Engine notifies the driver by means of yellow and red alarm signals.

Certification procedure
Whereas electric Vectron locomotives are already running on European tracks, the certification procedure for the Vectron DE is still in progress. The licensing runs related to vehicle operation are already completed; the required model and licensing runs take place in a Siemens test center. Certification for Germany is anticipated at the start of 2014.

MTU Friedrichshafen GmbH
A Rolls-Royce Power Systems Company

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MTU is a brand of Rolls-Royce Power Systems AG. MTU high-speed engines and propulsion systems provide power for marine, rail, power generation, oil and gas, agriculture, mining, construction and industrial, and defense applications. The portfolio is comprised of diesel engines with up to 10,000 kilowatts (kW) power output, gas engines up to 2,150 kW and gas turbines up to 35,320 kW. MTU also offers customized electronic monitoring and control systems for its engines and propulsion systems.