



Commercial Shipping

LAKE CONSTANCE FERRY 'LODI' POWERED BY ADVANCED-DEVELOPMENT 'IRONMEN' ENGINE

Who Constance Municipal Utility Company
What 8-cylinder Series 4000 *Ironmen* workboat engine achieves compliance with EPA Tier 3 emissions regulations
Where Lake Constance, between Meersburg and Constance-Staad

The Lake Constance ferryboat *Lodi* transports passengers and vehicles from Meersburg to Constance-Staad and back every half hour. Since the start of 2013, the vessel has been powered by a new, latest-generation Series 4000 *Ironmen* engine that meets EPA Tier 3 emissions specifications and has minimum influence on the invaluable drinking water reservoir on which the *Lodi* operates.



Meersburg/Constance – Traffic on Lake Constance is very busy. The six ferries that connect the lake-side cities make about 61,000 trips every year. Together, they transport almost 1.4 million passenger vehicles, 89,000 trucks and around 4.3 million visitors and commuters. To ensure that it can continue to cope with the rising numbers of passengers, the Municipal Utility Company in Constance decided to add an extra vessel to its fleet. In May 2010, the *Lodi* (named for Constance's twin city in Italy) went into service between Meersburg and Constance. At 82-meters, the vessel is the longest on Lake Constance. It is powered by two robust, fuel-efficient 8-cylinder MTU Series 4000 Ironmen engines from Rolls-Royce. In addition to its two Tier-2-certificated Ironmen units, since the beginning of 2013 the 'floating bridge' has been operating with an advanced-development version of the same engine which meets EPA Tier 3 emissions specifications.

The new Ironmen: Perfect for workboats

The new Ironmen units are based on the long-stroke engines in the MTU Series 4000 M23-M63, which fulfill EPA Tier 2, IMO Tier II and CCNR II requirements. Available in 8V, 12V and 16V configurations producing 750 to 2,000 kW, the new-generation 4000 M04 meets EPA Tier 3 specifications using only in-engine technology – without particulate filters or SCR catalyzers. To achieve this, Rolls-Royce has employed its improved and already proven LEAD2 injection system (Low Emission Advanced Design) from the Tier-4i-certificated Series 4000 generation for C&I applications. The system operates with injection pressures up to 2,200 bar so that the combustion process generates extremely low particle emissions. The development team also improved key combustion elements such as turbocharging, pistons and camshaft geometry. Rolls-Royce was able to use this fine-tuning to reduce nitrogen oxide emissions by 20% and fine particulate emissions by 45% in order to comply with Tier 3.

Despite their very low levels of exhaust emissions the new Ironmen engines are extremely fuel-efficient. The aim of the development engineers was to set new benchmarks for consumption and life-cycle costs – and their success has now been confirmed in practice: the *Lodi*'s new engine averages 115 liters of fuel per hour of operation and

interrupts its schedule to fill up in Constance once every three days. If need be, however, its 10,000 liter tank will hold just enough fuel for a week's operation.

High availability levels thanks to enhanced service

In the area of maintenance, Rolls-Royce has also adopted an enhanced approach based on analysis of many hours of registered operation. The point when servicing is due is calculated on the utilization profile, i.e. maintenance is dictated by actual engine use and load and not by a schedule worked out before the engine went into operation. This leads to significantly longer maintenance intervals and means that major overhaul is only due after more than 30,000 hours of operation – reducing maintenance costs even further. This all translates into considerable benefits for the operators of workboats like the *Lodi* which operate continuously and with frequent stopping and starting.

The data needed for analysis is provided by the Municipal Utility Company in Constance with the latest information on factors such as speeds, oil temperatures and fuel consumption being accessed in real time and remotely via a GSM module (Global System for Mobile Communications). Rolls-Royce uses this direct access to operating data on its engines to build up a comprehensive picture of their status so that the Municipal Utility Company can be certain that the *Lodi*'s propulsion plant will continue to be efficiently maintained and serviced well into the future.

RoRo ferry in push-pull mode

One of the 746 kW engines is located at each end of the *Lodi* and because the ferry does not turn round but only reverses direction, the engine that is at the bow in one direction is aft on the return journey. That is why the Ironmen engine which takes the lead on the trip south-west toward Switzerland and Constance-Staad is called the 'Staad engine' whilst its partner at the other end is known as the 'Meersburg engine'. When the ferry is running, both engines are always in operation with one pulling and the other pushing. The pulling engine always runs at slightly higher power than the other (approx. 75% as compared with approx. 65%). In theory, one engine is



At 82 meters, the *Lodi* is the longest vessel on Lake Constance. At full speed, the RoRo ferry can reach 26 kph. (Photo: Rolls-Royce)



Workstation with a view. Every day, the *Lodi*'s skipper guides the vessel with its Ironmen engine into the harbors at Meersburg and Constance-Staad up to 26 times. (Photo: Rolls-Royce)

enough to propel the *Lodi* forward but having two engines ensures that the vessel is never without propulsion and never has to be towed. If one engine fails, the other is still capable of getting the ferry safely back into harbor.

The *Lodi* is steered via two Voith-Schneider propellers (VSP) that are connected with the MTU engines via special couplings and shafts. After start-up, each of the engines ramps up to its rated speed of 1,600 rpm and maintains that speed throughout the trip – steering, propulsion and speed adjustments are regulated by changing the settings of the propeller blades. This enables the *Lodi* to reach speeds up to 14 knots (26kph) and to come to a stop from full speed and reverse up to full speed in the opposite direction within seven seconds.

Monitoring critical systems

The *Lodi*'s propulsion system is controlled by an automation system specially tailored to the vessel's needs. This 'Smartline' system was specifically designed for simplicity and is based on the MCS-5 (Monitoring Control System) technology platform. It is linked with the Ironmen in the engine room via a central interface. Special training and the advantage of experience means that the crew members are able to carry out basic maintenance work themselves. Smartline is capable of actuating almost 300 possible alarm messages which can be stored and evaluated to facilitate long-term prognoses as well as improvements.

Proven technology and new concepts

Once every two days the *Lodi* puts in a 24-hour shift during which she makes the 4.8 kilometer crossing up to 26 times. In one year, the new Ironmen engine logged up around 4,300 hours of operation. The

vessel's tight schedule allows 14 minutes for the crossing and ten minutes at each end for unloading and loading and the *Lodi* is able to keep to that schedule even when she is fully laden or when force ten winds whip up the waves. Ferry cancellation would be an expensive business for Constance's Municipal Utility Company. "We need to be able to rely completely on the technology – from the engine to the steering gear," explained Hans-Dieter May, Technical Director at the utility company. The operator has already gathered excellent experience with MTU engines. Since 1980, all six ferry boats have

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Hans-Dieter May

Technical director at Constance's Municipal Utility Company

been powered by diesel propulsion units from Friedrichshafen and business relations which have developed over many years are a factor in helping to ensure that existing concepts can be continually improved upon. "It is extremely important that we have partners who know us and our requirements and who can deliver exactly what we need," said May. "The *Lodi* was developed in cooperation with the Bodan Shipyard which supplied our first Lake Constance ferry in 1928 and which has built twelve more for us since then. And in order to decide how we can best improve our fleet, we have been working with Rolls-Royce and running trials with new propulsion solutions since 1979."

