**First Retrofit of Advanced Gas Engine Technology**

# Dual-Fuel Retrofit Lowers Emissions, Adds Fuel Flexibility

**18 November 2008**. MAN Diesel recently completed the first retrofit of its advanced dual-fuel technology on an existing heavy fuel engine in a stationary application.

Executed by MAN Diesel's rapidly expanding PrimeServ after-sales organisation, a twelve cylinder, vee configuration 48/60 engine operating in an industrial cogeneration plant in Portugal was converted to full 51/60DF specification.

"We recently handed over the converted 51/60DF engine to operator Têxtil Manuel Gonçalves, Sociedade de Producao de Electricidade e Calor S.A. (TMG SPE) which runs an adjacent textile works in the town of Vila Nova de Famalicão," notes Manfred Gallersdörfer, leader of the 51/60DF retrofit team at PrimeServ, which handles all engine and turbocharger upgrades.

In over 11 years of operation the 48/60 engine had logged over 88,000 hours in grid parallel baseload mode at the cogeneration plant, where its thermal output is used to raise process steam for the textile works. "Since the 51/60DF dual-fuel engine is based on MAN Diesel's successful 48/60 medium speed engine platform - and since a major overhaul was due - TMG SPE decided it was the perfect opportunity to convert to dual-fuel gas operation," Gallersdörfer states.

Converting to natural gas as the main fuel had several distinct advantages for TMG SPE. Notably, the engine achieves compliance with European Union emissions

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legislation and, due to its application in a high efficiency industrial cogeneration plant, the TMG SPE installation qualifies for preferential prices for the power it feeds to the Portuguese grid. Moreover, dual-fuel technology still allows TMG SPE a high degree of independence from Portugal's gas supply infrastructure, since liquid fuel is still stored on site for pilot injection and can serve as a backup.

**Scope of Work**

As well as exchange of the original cylinder liners and pistons of 480 mm diameter to new 510 mm bore components, other major changes were new piston crowns with piston bowls adapted to gas combustion, new cylinder heads with pilot injectors and gas admission valves (in the inlet ports), new inlet cams and the common rail pilot injection pumps, pressure accumulators and solenoid valve system.

The conversion also included turbocharger rematching for gas engine operation via the fitting of new nozzle rings and further adaptation of the exhaust system.

**Control Upgrade**

The converted engine has also been equipped with MAN Diesel's SaCoS DF safety and control system specifically developed for its dual-fuel gas engines. As well as comprehensive control functions, including remote on-line monitoring capability and extensive redundancy, in combination with the common rail pilot fuel injection system, SaCoS DF allows the outputs of the 51/60DF's individual cylinders to be precisely matched and engine settings to respond to combustion knock signals on a cylinder-to-cylinder basis.

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In gaseous fuel mode, the gas engine readily achieves emissions of oxides of nitrogen (NOx) of 500 mg /$m_n^3$ at 5% $O_2$ and hence complies with emissions legislation based on Germany's TA Luft clean air code and the World Bank Pollution Prevention and Abatement Handbook.

For land-based power generation, the 51/60DF is offered in a nine cylinder inline version and in vee configuration versions with 12, 14, and 18 cylinders. It has a standard mechanical rating of 1000 kW per cylinder for 60 Hz power generation (514 rpm) and 975 kW for 50Hz applications (500 rpm), giving an overall generator-set rating range of 8560 to 17550 kWe.

In the TMG SPE application the output of the retrofitted 51/60DF is adapted to a local gas supply with a nominal methane number of 75, the thermal-versus-electrical energy requirements of the specific 50Hz cogeneration application and ambient air conditions. It equates to 950 kW/cyl under ISO conditions.

As the global natural gas supply infrastructure grows and more areas of the world are subject to emissions regulations, MAN Diesel expects diesel to dual-fuel conversions of this kind to become increasingly popular.

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*The TMG SPE industrial cogeneration plant at Vila Nova de Famalicão in Portugal feeds electrical power to the grid and generates process steam for an adjacent textile works*

*The converted 51/60DF engine at the TMG SPE co-gen plant. The newly installed gas supply lines are clearly visible in their mandatory yellow colour coding.*

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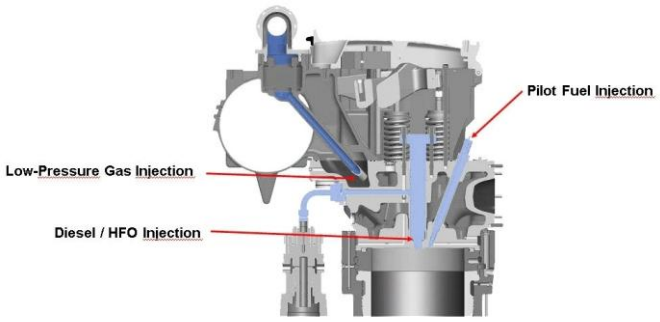
| Four-stroke dual-fuel engines V51/60DF and L51/60DF | |
|---|---|
| Engine cycle: | four-stroke |
| Turbocharging system: | constant pressure |
| Number of cylinders, V-engines: | 18, 14, 12 |
| Number of cylinders, L-engines: | 9 |
| Bore: | 510 mm |
| Stroke: | 600 mm |
| Swept volume per cylinder: | 122.6 $dm^3$ |
| Cylinder output (MCR) | |
| at 514 rpm, 60 Hz: | 1,000 $kW_m$ |
| at 500 rpm, 50 Hz: | 975 $kW_m$ |
| Cooling | |
| Cylinder cooling (single-stage): | fresh water |
| Charge air cooler (two-stage): | fresh water |
| Fuel injector cooling: | fresh water |
| Starting: | compressed air |

*Technical data, MAN Diesel 51/60 DF dual-fuel engines for stationary applications. For power generation the 51/60 DF dual-fuel gas engines offer outputs of 8560 to 17550 kWe.*




*Combustion chamber of the MAN diesel 51/60 DF dual-fuel engine. The micro pilot injector is fed by an electronically controlled common rail injection system and the injector for 100% liquid fuel operation by an electronically governed pump-line-nozzle system. Gas is admitted via electronically controlled valves in the inlet ports.*

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About MAN Diesel

MAN Diesel is the world's leading provider of large-bore diesel engines for marine and power plant applications. The company develops two-stroke and four-stroke engines, auxiliary engines, turbochargers and propulsion packages that are manufactured both by the MAN Diesel Group and its licensees and deliver between 450 kW and 97.3 MW of power. MAN Diesel employs over 6,400 staff, primarily in Germany, Denmark, France, the UK, the Czech Republic and China. The global after-sales organisation, MAN Diesel PrimeServ, comprises a network of the company's own service centres and authorised partners. MAN Diesel is a company of MAN AG, which is listed on the DAX share index of the 30 leading companies in Germany.

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