



Queen Mary 2 has been enjoying the benefits of Wärtsilä common rail technology since 2004.

**IN THE MID-1990s**, suppliers of gas turbines pushed to replace diesel engines on cruise ships using smokeless operation as their major argument. Wärtsilä responded by introducing its common rail injection engine, and is now the market's runaway leader.

## NOTHING COMMON ABOUT COMMON RAIL

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PHOTOS: WÄRTSILÄ

**T** rue environmental arguments are driving most businesses these days, and it is no surprise that this also applies to the large engines in big cruise vessels. In the mid-1990s there was a major push by companies supplying gas turbines to replace diesel engines on cruise ships.

“The main thrust of their argument centred on lower emissions and the higher power density of the gas turbine. In other words, they said they’d supply more power from a smaller, cleaner machine,” says **Bill Page**, President, Wärtsilä in the UK.

“Using gas turbines was claimed to release more space for cabins, which in turn would increase a ship’s revenue earning potential. That freedom would offset the increased costs of having to run on more expensive fuel. Wärtsilä had to come up with an improvement that also reduced emissions

while maintaining the flexibility of being able to operate with different types of fuel,” says Page.

### Optimizing combustion by direct control

That improvement was common rail injection, a method of injecting fuel into an engine cylinder under absolute control and thereby achieving optimal combustion. Initial development began in the late 1990s. In 2001, the first common rail engine rolled off the Wärtsilä production line.

Today, common rail systems are available with the Wärtsilä 20, Wärtsilä 32, Wärtsilä 38, Wärtsilä 46F and Wärtsilä 46 medium-speed engines as well as a range of Wärtsilä’s low-speed engines from RT-flex50 to RT-flex96C.

In a normal diesel engine, fuel is injected at a fixed rate by a pump, and common practice is to adjust this pump to run

at an optimal setting – the ideal injection time and so on – for 85% engine performance. Everything is done mechanically.

### Avoiding visible smoke

“With common rail, we can adjust engine performance to be optimal even as the situation changes because fuel can be injected at high pressure at any point in time. Using electronic control, the injection timing (when fuel injection starts and stops) can be adjusted as desired,” says **Carl-Henrik Björk**, Vice President, Cruise & Ferry, Wärtsilä Ship Power.

“Usually, all engines smoke at lower loads and/or speeds, but because common rail allows the combustion process to be adjusted at lower loads, no visible smoke is released,” he says.

“Common rail allows you to accurately control the injection profile, its duration and its timing, or even to have fuel injection in several stages. All of this can be adjusted using software. The engineer has the tools required to carry out very accurate and flexible changes to the system. In the old system, adjusting these parameters meant that you had to change parts, fuel pumps and so on, and maintaining good injection characteristics at low speed and loads was impossible,” says Page.

The main objective behind the development of common rail technology was to make engines as environmentally friendly as possible and the first production engines were sold with a guaranteed smoke value (Filter Smoke Number) of 0.4. The limit for visible smoke is FSN values higher than 0.3-0.4.

Today’s production engines are capable of smoke values below FSN 0.1, and even when these engines are running on very-poor-quality high-ash fuel, smoke levels remain below FSN 0.2.

### Avoiding penalties and problems

Having a clean exhaust is not only environmentally friendly, it can be a real advantage as some harbours in Europe, particularly Rotterdam, Hamburg and Venice, have started to impose requirements on levels of visible smoke. Coastal authorities in California and Alaska also have a penalty system which can lead to permission for a ship to operate in those waters being revoked.

“Local authorities at Glacier Bay in Alaska

imposed heavy penalties on black smoke in the area. Fines ran into hundreds of thousands of dollars,” says Page. That’s one benefit for the customer. Another is the fuel flexibility that makes both financial and environmental (and therefore public relations) sense.

### Flexibility in fuel use

“Fuel flexibility is very important because it allows our customers to continue to use low-grade residual fuel whereas gas turbines – at least until now - rely on high-grade fuel,” says Page.

With common rail technology, engines can use both types of fuel. Strict emission thresholds mean that vessels must use high-grade fuel in coastal areas, but they can switch back to residual fuel – and the best performance - when they get to the open sea.

And as the price differences between different grades can be several hundred dollars, financial consequences are significant. “Every day at sea, a very large container vessel uses some EUR 60,000 of fuel, so small percentages translate into major savings,” says Björk.

### Improved fuel consumption at low loads

Also, fuel flexibility is achieved without any cost in levels of fuel consumption, says Page. “Common rail improves fuel consumption at low loads. It’s much the same as other systems at full load, but at part load, common rail uses less fuel per kilowatt than a standard engine. With common rail, combustion is always optimized,” says Björk.

On the other hand, while cruise lines can reap great benefits from improved fuel flexibility, the shipyards building them face premium prices. One of the reasons common rail is now gaining ground is that modern technology has finally made it a realistic alternative. Ten years ago, when development of Wärtsilä’s common rail systems began, many shipyards were hesitant to embrace a new technology that involved electronics, but the situation has now changed dramatically.

Queen Mary 2’s environmental footprint is as small as it can be.



“There were plans and ideas much earlier, but developments in modern electronics were key,” says **Juhani Hupli**, in charge of product engineering at the Trieste delivery centre in Italy. “We need to be able to control the process in an intelligent manner, and that’s why there are processors that monitor different parameters and map and steer them to optimize combustion.”

### Partnership essential for success

The “If you build it, they will come” approach may be good enough for a successful book or Hollywood movie, but in business, it is not an axiom that guarantees success. A reliable partner, willing to shoulder some of the risk, is crucial.

“Carnival was supportive, and the first common rail engine to run in service was installed on Carnival Spirit. We converted one engine out of the vessel’s six to use common rail technology, so that even if we ran into a problem, the ship could continue operating. At the same time, we needed regular access to the engine, so it was a two-way partnership,” says Page.

Future developments include achieving smokeless operation with the even stricter emission limits expected in the future, as well as introducing common rail technology into single main engines. “We’re lucky that we were led by such forward-thinking people in the past. We now have exceeded 540,000 hours of operating experience with common rail, while our competitors are just starting to introduce their engines. I believe the common rail injection engine will be the standard for the next twenty years and beyond.” ●