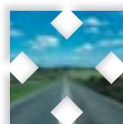




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THE 1.6-LITRE HDi/Duratorq TDCi

Developed as part of the co-operative agreement between PSA Peugeot Citroën and Ford Motor Company, the new 1.6-litre HDi (PSA)/Duratorq TDCi (Ford) powerplant represents the latest addition to what promises to be a long, successful line of diesel engines.

It was derived from the 1.4-litre HDi/Duratorq TDCi, a highly popular diesel that currently equips small cars produced by both manufacturers. Launched in June 2001 at the Française de Mécanique plant in Douvrin and in October 2002 at the Trémery facility, production was ramped up at an extremely fast pace. The engine is now produced at a rate of 2,400 units a day, with annual output scheduled to reach 680,000 in 2003. To date, it has already been installed in 400,000 cars made by the two partners.

➡ **AMBITIOUS OBJECTIVES**

The 1.6-litre HDi/Duratorq TDCi lists all the original features of its parent family, but it is more than just a scaled-up version of the 1.4-litre engine.

To enhance drivability, design specifications called for a significant increase in power and torque-weight ratio. They also required engineering development, in anticipation of the Euro IV emission standards, while integrating particle filter technology to exceed particulate emission reduction standards. This achievement will position the 1.6-litre HDi/Duratorq TDCi as one of the cleanest and most technologically advanced diesel engines on the market. Specific introduction timing will vary by partner, model and market.

The engine will be available in two versions: an initial 110 PS/81 kW unit, to be followed by a 90 PS/66 kW version.

In addition, like its 1.4-litre predecessor, the new powerplant represents an extraordinary manufacturing challenge, in terms of production volumes (ultimately more than one million units a year) and the number of different applications for the two partners.



➔ **LEADING-EDGE TECHNOLOGY**

■ **Architecture**

The 1.6-litre HDi/Duratorq TDCi's all-aluminium construction has maintained its weight at a very low 120 kilos. It is equipped exclusively with a 16-valve cylinder head derived directly from the head used on the 1.4-litre HDi/Duratorq TDCi, whose engine block displacement was increased to 1,560 cc by increasing both the stroke (by 6.3 mm) and bore (by 1.3 mm).

The engine block of the 110 hp version is made of pressure-cast aluminium.

To help enhance drivability and performance, the engine uses a Garrett Variable Geometry Turbine (VGT) turbocharger developed especially for this engine. The size and inertia of the VGT unit were optimised to achieve the fastest possible response time, thus enhancing drivability.

■ **New combustion system**

The combustion system of the 1.6-litre HDi/Duratorq TDCi engine benefits from the latest technologies:

- a Bosch second-generation common-rail injection system, with maximum pressures increased to 1,600 bar and small-diameter injector nozzles (six 0.135 mm inlet ports), enhances the fuel spray and produces a uniform fuel/air mix, thus minimising emissions at the source;
- the combustion chamber was redesigned to reduce swirl (i.e. air movement in the chamber), in order to improve efficiency. It features an enlarged bowl, with a wider injection spray angle;
- in addition, the chamber enables the common-rail system to realize the full potential of its multiple injection technology and the enhanced management of fuel injection parameters. The new, more powerful electronic control units, plus the new, more precise fuel injectors, enable up to six injections per engine cycle:
 - two pilot injections to reduce combustion noise;
 - two main injections to reduce nitrogen oxide emissions at the source;
 - two post-injections to improve regeneration efficiency of the particle filter system.

These new advances in common-rail technology directly benefit customers by influencing features to which they are sensitive, both as users (noise and vibration performance, fuel economy, and drivability) and as responsible citizens (reduction of emissions).



➡ **ADVANCED ENVIRONMENTAL PROTECTION CAPABILITIES**

The combination of Euro IV compliance (applicable from 2005) and the availability of the particle filter – depending on partner, model, and market – makes this one of the very cleanest diesel engines of its size on the market.

The particle filter virtually eradicates diesel particulate emissions, and it offers two additional advantages:

- the electronic control unit has been programmed with new control parameters to improve the filter regeneration process (which involves burning the trapped particles) by increasing the exhaust temperature under urban and suburban driving conditions, during which the engine usually runs in a low-temperature range;
- the filter uses a new additive, which improves durability and reliability.

➡ **HIGH PERFORMANCE AND DRIVABILITY**

With an output of 110 PS for the main version (90 PS for the entry-level version) and a torque of 240 Nm at 1,750 rpm (215 Nm for the 90 PS version), the new 1.6-litre powerplant will ensure outstanding drivability in all its vehicle applications.

The HDi/Duratorq TDCi is a high-torque powerplant designed to deliver flexible response and powerful acceleration at low speed. As a result, 70 per cent of maximum torque is already available at 1,250 rpm. The overboost function can temporarily provide additional reserve torque of 20 Nm, enhancing active safety in overtaking or in emergencies.

➡ **INVESTMENT AND PRODUCTION FACILITIES**

Production of the 1.6-litre HDi/Duratorq TDCi uses an expanded version of the concept used to engineer the 1.4-litre HDi/Duratorq TDCi engine production process.

With output scheduled to reach 1.1 million units a year (5,000 engines a day) by 2005, the new powerplant will equip three PSA Peugeot Citroën platforms and two Ford architectures. Thanks to its modular, building block design, it will be available on a total of 37 different vehicles, providing a tremendous marketing advantage for both manufacturers.



■ Two new production modules at the Trémery plant

To support the fast ramp-up needed to meet short and medium-term demand, two production modules will be dedicated to the HDi/Duratorq TDCi at the PSA Peugeot Citroën plant in Trémery, which was the world's largest automotive diesel engine factory even before the new engine was launched.

Production facilities for the 1.6-litre unit have been "copied and pasted", with an organization directly derived from the 1.4-litre HDi/Duratorq TDCi production module currently on stream at the Française de Mécanique plant in Douvrin. This approach has helped maintain tight control over the related capital expenditure, while benefiting from feedback from the Douvrin module.

The production rate of 2,500 engines per module a day represents the economic optimum in terms of each module's machining and assembly cycle times.

The first module, totalling 40,000 square meters, was inaugurated at the Trémery plant in November 2002. It currently produces 1.4-litre 16-valve engines, demonstrating its high production flexibility.

A second module with a capacity of 2,500 engines a day will also be installed at Trémery, with start-up scheduled for May 2004. This second unit is currently in the initial construction phase at our plant in the Moselle region of eastern France.



THE 2.0-LITRE HDi/Duratorq TDCi

The new 2.0-litre HDi/Duratorq TDCi engine represents the latest development in the 2.0-litre HDi family, which has equipped PSA Peugeot Citroën's low-mid and high-mid range cars since 1998. It is the product of the second phase in the co-operative agreement on diesel engines signed by PSA Peugeot Citroën and Ford Motor Company.

The engine benefits from the technical, marketing and industrial feedback gained from a family of highly successful engines, of which more than three million units have already been sold. By leveraging the most recent advances in combustion systems, it offers a full array of highly improved environmental protection features.

➡ FURTHER DEVELOPMENT OF A SUCCESSFUL ENGINE

The new engine uses the architecture of the highly successful DW10 powerplant, a core engine family with proven uniformity and consistency. From this base, the project team wanted to design an engine with substantially enhanced drivability compared with the previous generation.

These goals were met without increasing fuel consumption, which remains very low, while in terms of environmental protection, the new engine ranks amongst the world's cleanest-burning power plants. Depending on partner, vehicle, and country it will be available with Euro IV compliance and a diesel particle filter.

Like its 1.6-litre sibling, the 2.0-litre HDi/Duratorq TDCi will offer a full array of world-class performance features thanks to the extensive flexibility of the common-rail direct injection system and advances in engine electronic control. One of the design's particular strengths is the wide flexibility it allows for control of engine running parameters. This means it can simultaneously control such performance characteristics as power and torque while precisely managing the internal combustion process, thus delivering premium environmental protection.



➔ IMPROVING ARCHITECTURE AND SAFETY

The 2.0-litre HDi/Duratorq TDCi engine uses the same basic architecture as its DW10 parent family. It is designed around a cast-iron block topped with a 16-valve aluminium cylinder head. Displacement remains the same (1,998 cc), with an 88 mm stroke and 85 mm bore.

Substantial efforts were made to reduce engine height and width to improve the integration of front-end design parameters and ensure better energy dissipation in case of frontal impacts. Compared with the previous generation, width was reduced by 40 mm to integrate frontal impact design parameters and height was reduced by 15 mm to 20 mm to integrate pedestrian impact design parameters.

■ Multiple common-rail injections

The engine's new-generation common-rail direct injection system is supplied by Siemens. It features multiple injection capability enabling control of up to six different injections:

- two pilot injections for noise control;
- two main injections for torque and power;
- two post-injections for particle filter regeneration.

The system delivers an injection pressure of 1,600 bars controlled by piezoelectronic actuators. Forced induction is provided by a Garrett VGT turbocharger with an air/air intercooler.

The cooling system is equipped with an electronic-controlled heat management unit that enables the system to reach maximum efficiency more quickly, while helping to reduce fuel consumption.

➔ HIGH PERFORMANCE AND DRIVABILITY

For customers, the new 2.0-litre HDi/Duratorq TDCi will deliver drivability and a sense of smoothness that aims to establish the engine as a market benchmark.

At 136 hp (100 kW), it offers 25 per cent more power than its predecessor, with the same fuel consumption.



However, to provide the drivability and flexibility demanded by an overwhelming majority of customers, the designers focused more on torque than power. Maximum torque, for example, is 36 per cent higher, reaching 340 Nm at 2,000 rpm with overboost. This figure, which is attractive in itself, is further enhanced by excellent low-speed response, since 200 Nm is already delivered at 1,250 rpm.

➡ **CONTINUOUS IMPROVEMENT IN ENVIRONMENTAL PROTECTION**

The HDi/Duratorq TDCi technology demonstrates that the common-rail direct injection diesel is already the engine best positioned to offer an effective, industrially viable solution for controlling greenhouse gas emissions. The technology reduces emissions at the source through an internal combustion process that has been further optimised to increase efficiency.

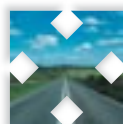
PSA Peugeot Citroën and Ford Motor Company have continued actively to improve emission-reducing technology, and – depending on partner, model, and market – the new engine will be available with a second-generation particle filter. The combination of a new additive and new engine control strategies (thanks to a new generation of electronic control units) has further improved the regeneration process and reduced system maintenance requirements.

➡ **INVESTMENT AND PRODUCTION FACILITIES**

The engine will be manufactured at PSA Peugeot Citroën's plant in Trémery. Output is scheduled to reach at least 2,300 units a day by 2005.

Research and development outlays benefited from the synergies leveraged with the rest of the engine family and continued use of production facilities at the Trémery plant.

Capital expenditure was committed to adapt the existing production line to handle the new engines, while improving working conditions. In particular, postural ergonomics were enhanced, with an emphasis on more effective management of quality and operator well being.

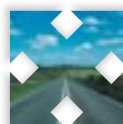


➔ THE 1.6-LITRE HDi/Duratorq TDCi ENGINE AT A GLANCE

Displacement	1,560 cc
Bore x stroke	75 x 88.3 mm
Max. power at 4,000 rpm	66 - 80 kW * or 90 - 110 PS
Max. torque	215/235 Nm* at 1,750 rpm 240/260 Nm* at 1,750 rpm
Cylinder block pressure-cast aluminium	
16-valve cylinder head aluminium alloy	
Bosch direct injection system – 1,600 bar	
Turbocharging with intercooler and variable geometry	
Emission standards compliance Euro IV with particle filter or Euro III – depending on company, car, and country	

* With Overboost

- Plant location: **Trémery, in the Moselle region of France;**
- Planned output: **1.1 million engines a year in 2005;**
- Total Investment: **more than 800 million €.**



➡ THE 2.0-LITRE HDi/Duratorq TDCi ENGINE AT A GLANCE

Displacement	1,998 cc
Bore x stroke	85 x 88 mm
Max. power at 4,000 rpm	100 kW or 136 PS
Max. torque	320/340 Nm* at 2,000 rpm
Cylinder block Cast iron	
16-valve cylinder head Aluminium alloy	
Siemens common rail direct injection system – 1,600 bar	
Turbocharging with intercooler and variable geometry	
Emission standards compliance Euro IV with particle filter or Euro III – depending on company, car, and country	

* With Overboost

- Plant location: **Trémery, in the Moselle region of France;**
- Planned output: **2,300 engines a day by 2005;**
- Total Investment: **€ 159 million.**



PSA PEUGEOT CITROËN AND FORD MOTOR COMPANY : A LARGE-SCALE COOPERATIVE VENTURE IN DIESEL ENGINES

The launch of the new powerplants marks the second phase of the agreements the partners signed on September 29, 1998 and expanded a year later, on October 8, 1999, with the signature of a vast cooperative program concerning diesel engines.

The program calls for the joint design and production of four families of common-rail direct-injection diesels:

- 1.4-liter engines ;
- Second-generation 1.6-liter and 2-liter engines ;
- 2.7-liter V6 engines ;
- A new family of engines for light commercial vehicles.

Implementation of the agreements will enable both manufacturers to develop a comprehensive range of diesel engines, while generating unprecedented economies of scale in the production of mechanical components.

With this strategy, both companies will soon become the world's largest diesel engine manufacturers, with joint output of more than three million engines a year, or 12,000 engines a day.