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MAINTENANCE OF THE N47 INTERNAL-COMBUSTION DIESEL ENGINE

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Abstract: The N47 engine debuted in March 2007 in the facelifted BMW 1 Series E87 and E81 and was also available in the BMW 1 Series E82 and E88, which were introduced the same year. The N47 engine replaced the M47 engine that had been in production for 8 years. The M47 construction underwent several modifications, so the injection system was changed, the cylinder head now consists of two parts, and the engine block is made of aluminium. Two main versions of the N47 engine are known: N47D16 (1.6 L) and N47D20 (2.0 L). In the case of both versions, several models with different performances were born. After the distribution of BMW passenger cars equipped with the N47D20 engine, it received a lot of negative criticism due to malfunctions. In this article, I would like to present the maintenance of the engine, which can be used to avoid the failure of passenger cars equipped with the N47D20 diesel engine with huge material damage.

Keywords: *N47, diesel engine, self-ignition, timing chain snaps, DPF, EGR*

1. INTRODUCTION

The appearance of the N47 diesel engine was justified by the desire to reduce fuel consumption and increase engine performance. The first two versions were the smaller 105kW N47D20U0 and the 130kW N47D20O0 engine. After that, the 150kW N47D20T0 with two turbochargers appeared. The motorcycles thus completed set out on their journey in the hope of great popularity. Due to the problems experienced, the manufacturer announced a recall campaign for its engines completed up to March 2011 due to failures related to the timing chain [1]. *Table 1* shows the different versions of the N47 diesel engines.

Table 1
The variants of N47 diesel engine [4]

Engine	Displacement	Compression Ratio	Power	Years
N47D16	1.6 L (1598 cm^3)	16.5 : 1	70 kW (94 hp) at 4000 rpm	2013
			85 kW (114 hp) at 4000 rpm	2012

Engine	Displacement	Compression Ratio	Power	Years
N47D20	2.0 L (1995 cm^3)	16.5 : 1	85 kW (114 hp) at 4000 rpm	09/2009
			105 kW (141 hp) at 4000 rpm	03/2007
			120 kW (161 hp) at 4000 rpm	09/2009
			130 kW (174 hp) at 4000 rpm	03/2007
			135 kW (181 hp) at 4000 rpm	03/2010
		16.1 : 1	150 kW (201 hp) at 4400 rpm	03/2010
		16.5 : 1	160 kW (215 hp) at 4400 rpm	2011

2. THE MAIN MALFUNCTIONS OF THE N47 ENGINE

The N47 engine family is prone to excessive timing chain wear and premature failure [BBC.co.uk: BMW deny engine failures are due to manufacturing fault, 2013]. A rattling noise from the rear of the engine indicates the condition. Timing chain failure may require engine replacement or costly repairs. The units most seriously affected and in need of the greatest repair were between 1. 3. 2007 and 5. 1. 2009 was produced [1]. However, there have been frequent reports of timing chain failure *(Figure 1)* in BMW 1, 3 and 5 series diesel engines manufactured from 2004 to at least 2011. The failure occasionally resulted in the engine stalling dangerously while the vehicle was being driven sometimes at relatively high speeds. A "Quality Enhancement" was issued by BMW for some, but not all vehicles, but has since been discontinued.

Figure 1. *Timing chain failure (break)*

If the vacuum hose supplying the EGR (Exhaust Gas Recirculation) cooler bypass valve gets a hole rubbed in it, or breaks down from old age and oil spray, the EGR cooler will not get bypassed during the engine warmup period. This causes excessive build-up in the cooler matrix, and when the engine warms up these solid chunks of build-up can detach from the EGR cooler and get sucked into the plastic intake tube, melting holes in the intake tube, causing a massive boost leak and in very rare cases an engine fire *(Figure 2)*. BMW has issued a recall to over 1.6 million vehicles in 2018 for the EGR issues (Braithwaite-Smith G.: Massive BMW diesel engine recall is expanded, Motoring Research, 2019).

Figure 2. *Vehicle with N47 engine after catching fire*

3. PREVENTIVE MAINTENANCE OF THE MAIN FAULTS OF THE N47 ENGINE

In the case of regular maintenance [3], [6], the N47 engine should be serviced between 200,000 and 300,000 km, unless otherwise indicated. In the case of the N47 engine that I renovated, I examined the following seven segments, and they were repaired (replaced).

3.1. Timing chain inspection

The first and most important thing is to replace the timing chain and its associated components (sprockets, tensioners, etc.). Since the timing chain is located at the rear of the N47 engine, it is recommended to remove the engine block for professional inspection and repair work *(Figure 3)*.

Figure 3. *The engine compartment without the engine and the removal of N47 engine*

Timing chain elongation can also be determined from the condition of the tension cartridges *(Figure 4)*.

Since the engine block must be disassembled for the inspection, replacement is recommended even if the timing chain is still in good condition. If the timing chain is broken in the block, further tests are suggested to determine the exact damage.

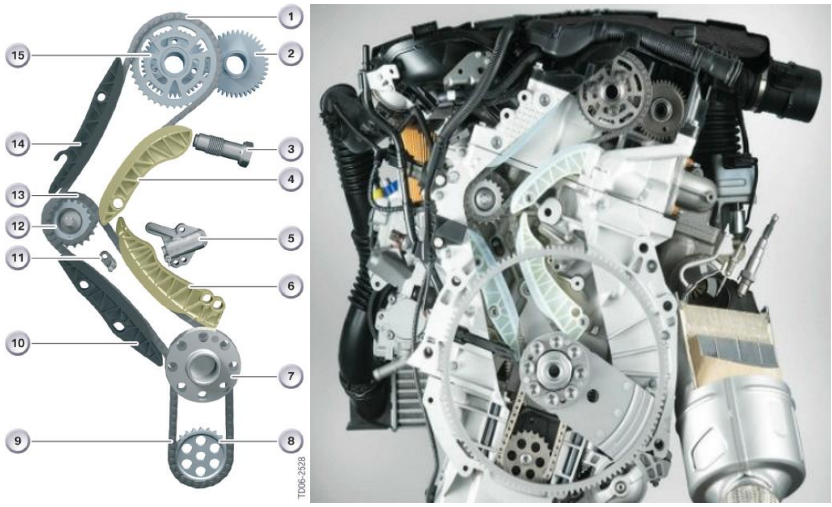

Figure 4. *The timing chain system (Tumblr, N47 timing chain, source of a picture)*

3.2. Intake manifold and EGR cooler

The EGR cooler and suction line or the examination of its related elements must be carried out together. An exhaust gas recirculation system is one of the ways to reduce engine emissions. It is an important part of the engine system, and like all heavy-duty components, it must perform in an extremely harsh environment.

Exhaust gas recirculation (EGR) reduces combustion temperatures by diluting the air/fuel mixture with a small amount of inert exhaust gas. The EGR cooler is a water-to-air heat exchanger located between the turbo and the EGR valve. The body has a hollow tube or series of tubes through which the hot exhaust passes. Heat from the exhaust system is transferred to the vehicle's cooling system. This excess heat simply escapes through the radiator. Since the EGR cooler connects the engine's exhaust and cooling systems, malfunctions inside the cooler can lead to coolant loss, overheating, and engine damage. Therefore, one of the results can be a decrease in the amount of coolant. In such cases, it is worth cleaning the intake line *(Figure 5)* and replacing the EGR cooler under warranty. Of course, replacing the EGR cooler under warranty does not solve the problem, because later the above-mentioned problems will reappear.

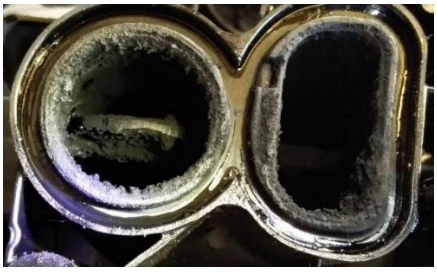

Figure 5. *Oily soot deposits in the plastic intake pipe*

The leakage of coolant caused by the EGR is only a small element in the set of errors. The first and biggest problem is that the plastic intake manifold, like all direct injection engines, gets oily soot. Only the second stage is the failure of the EGR cooler. If this does not cool the recirculated gases enough, they will easily ignite the deposits in the intake line, which are already at the flash point. Then, due to the turbo pressure, the glowing oil and soot melt the plastic intake pipe. Once it is pierced, it is just a matter of luck as to what the resulting stabbing flame will achieve (0).

Figure 6. *Melting of the cover on the engine as a result of the puncture of the intake pipe*
(Zách D.: Miért gyulladnak ki a BMW-k?
Totalcar 2019. [in Hungarian] source of a picture)

If the complex error of the EGR system occurs on the highway in the summer, the vehicle will most likely catch fire.

3.3. The puncture of the Diesel Particulate filter (DPF)

The particulate filter *(Figure 7)*, which collects the soot produced by the car's engine, is located directly on the right side of the cylinder bank. The filter must be burned out at certain intervals. This is solved by burning the excess diesel fuel added to the engine, the process starts while driving, typically when driving on the highway. The car does not indicate anything, the driver has no special task. However, the particle filter heats up to a temperature of 600 degrees, and if it has already been punctured, a piercing flame is created through the hole, which easily ignites the surrounding plastic coverings of the engine compartment. There are several of these, the N47D20 is heavily coated from above and below. Based on the experience so far, the punctured filter, which will certainly occur over time, can also cause the car to catch fire.

Figure 7. *Diesel Particulate filter*

3.4. Inspection of oil filter housing and oil cooler seals

It is worth replacing the oil cooler seal together with the timing chain. A characteristic symptom of seal wear is the formation of oil sludge under the oil cooler. The shaft located at the bottom of the oil filter housing *(Figure 8)* and oil cooler must be checked, as it is possible that the socket is cracked, which may later lead to premature failure of the engine bearings.

Figure 8. *Oil filter housing shaft. The socket may crack*

3.5. Checking the generator

The generator can be easily inspected in the case of an advanced engine [4], therefore it is worth checking the condition of the carbon brushes (to be replaced at the voltage regulator) and their bearings. Once the generator has been disassembled for inspection, we can also inspect the freewheel of the pulley.

3.6. High pressure fuel pump

The task of the diesel high-pressure pump, together with the low-pressure pump, is to deliver fuel from the fuel tank to the vehicle's engine [6]. High pressure pump failure can have a significant impact on engine performance. Signs of diesel high pressure pump failure:

- the engine starts delayed,
- fuel consumption increases,
- high engine temperature,
- the fuel pressure gauge measures a low value.

The easiest way to check is to remove the sensor from the pump and check the condition of the shaft *(Figure 9)*. If we find that, in contrast to the factory shine, it has started to dull (piston, shaft), it is worth refurbishing or replacing it. If the piston rotates relative to the shaft, the fine metal dust coming off the shaft as a result of friction can enter the fuel supply system and cause enormous damage.

Figure 9. *The high-pressure fuel pump, and wear resulting from the sticking of the piston, which results in the entry of metal dust into the system* (BMW E91 N47 high pressure pump failure and repair, YouTube, source of picture)

3.7. Inspection of the balancing shafts

As previously mentioned, the balancing shafts *(Figure 10)* of the N47 engine are located inside the crankcase. They are inserted from the front. It is advisable to check the wear of the bushings by moving the balancing shafts, as it can cause strong vibrations, which can lead to further engine failure. It is advisable to check the wear of the bushes by moving the balancing shafts, as it can cause strong vibrations, which can lead to further engine failure.

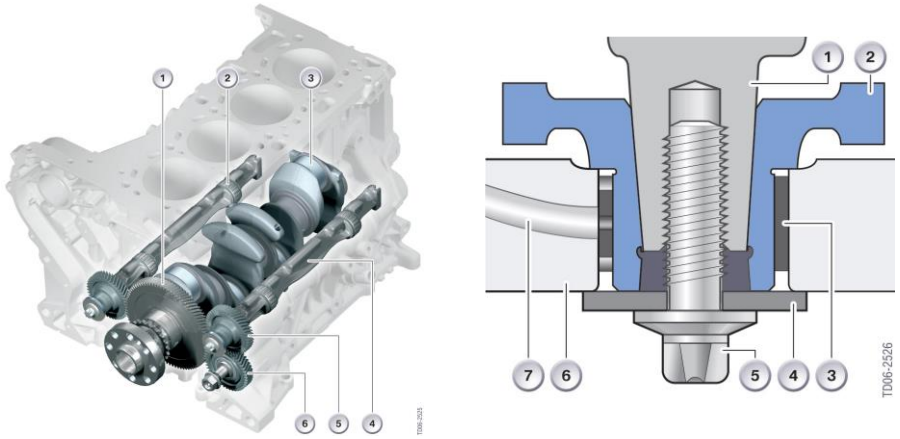

Figure 10. *The balancing shafts and the bush (denoted with number 3)* [2]

4. SUMMARY

As with all vehicles, the most important thing for the N47 engine is regular maintenance and proper operation. We can ensure the lifetime of the timing chain –according to our service experience– by changing the engine oil before the predefined replacement period by the manufacturer (2 years or 30,000 km), but it is recommended after driving between 15,000 and 20,000 km. The N47 engine I dismantled had 235,000 km, but due to regular maintenance and more frequent oil changes, the timing chain was still in good condition and therefore it would not have to be replaced yet. It is unfortunate that the brand dealership gives the answer to replace the timing chain that the brand service can determine, and the brand service does this with noble simplicity based on mileage (as long as there is no noise or other complaints). In this regard, it would be good if the timing chain tension pins were equipped with a transmitter, because the condition of the chain can only be confirmed if the engine is removed and disassembled. The service life of the high-pressure pump is usually 10 years or between 150,000 and 200,000 km, thus it is worth paying attention to this, because in the case of the N47 engine, significant damage can occur due to metal dust. The condition of the DPF filter, EGR cooler and intake manifold must be checked regularly (approx. 50,000 km), because it can lead to the vehicle catching fire. An additional solution against ignition can be if the plastic suction tube is replaced with one made of a material that does not melt under the influence of a flame.

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