

**“Examination of the emission behaviour of various replacement catalytic converters with and without the “Blue Angel” quality seal when new and after ageing in accordance with the RAL-UZ184 Basic Award Criteria”**

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## 1 **Introduction**

Replacement catalytic converters are approved on the basis of Regulation No 103 of the United Nations Economic Commission for Europe (UN/ECE). This Regulation provides for an examination of the durability of such systems over 80,000 km, while however alternatively permitting the use of fixed deterioration factors. In practice, the manufacturer confirms durability of 80,000 km or 5 years, whichever comes first.

The replacement catalytic converters approved in accordance with Regulation No 103 shall be so manufactured as to conform to the type approved in the characteristics as defined under paragraph 2.4 of Regulation No 103 (number of coated substrates, volumes, materials used, etc.). They shall meet the requirements set forth in paragraph 5 (Determination of the basis for comparison, etc.) and, where applicable, fulfil the requirements of the tests specified in Regulation No 103.

The RAL has also awarded the "Blue Angel" quality seal for replacement catalytic converters since 2013. The requirements for this were laid down in the RAL-UZ184 Basic Award Criteria. In contrast to ECE 103, ageing in an oven, new support mat materials for the monoliths, a precious metals analysis and a hot shake test as a follow-up test are prerequisites for the award.

The durability of replacement catalytic converters is examined as part of this investigation. To this end the exhaust gas after-treatment systems are measured in new condition, subsequently aged and then examined after ageing.

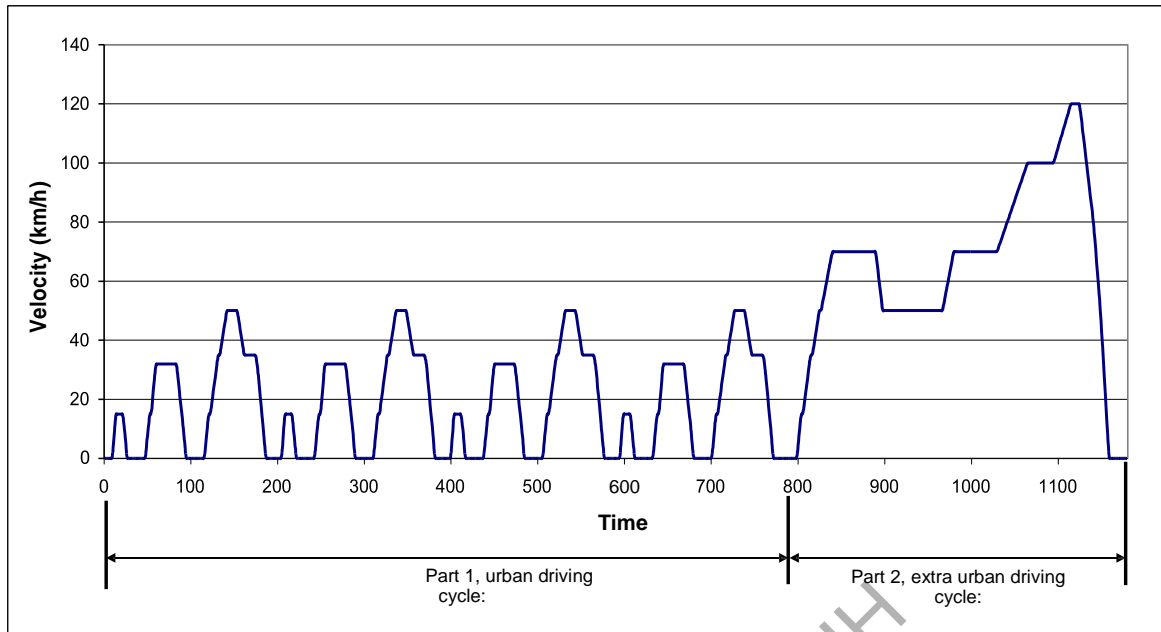
## 2 **Examination programme**

In the first step, exhaust emissions of the test vehicle in an as-delivered condition with a new OEM replacement catalytic converter are measured in the New European Driving Cycle (Type I test, Figure 2.1), to demonstrate that the test vehicle is in good condition with regard to exhaust emissions.

After this, the replacement exhaust gas after-treatment systems to be tested are installed in the test vehicle and are run in with 12 extra urban cycles in accordance with point 5.2.2, subsequently an exhaust gas measurement is carried out, in which exhaust gas emissions are determined in the New European Driving Cycle (Type I test).

If no emission anomalies are detected in the initial measurement, the exhaust gas after-treatment system to be examined is removed from the test vehicle and subjected to oven ageing in accordance with the RAL Basic Award Criteria (RAL-UZ184, Annex IV).

The aged catalytic converters are then measured again in the NEDC and compared with the limit values and the values in new condition.



**Figure 2.1:** New European Driving Cycle (NEDC) in accordance with Directive 98/69/EC

During measurements on the chassis dynamometer, emissions of carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO<sub>x</sub>) and carbon dioxide (CO<sub>2</sub>) are determined. For the load adjustment of the dynamometer the same values are used as for the type test of the test vehicle.

### 3 **Vehicle selection**

In selecting a vehicle, a vehicle was chosen that is found in the field of application of providers of replacement catalytic converters.

The vehicle data is summarised in **Table 3.1**.

Vehicle manufacturer:	VOLKSWAGEN
Manufacturer code:	0603
Type:	3BG
Trade name:	Passat
Engine type:	ALZ
Operating principle:	Positive-ignition
Cubic capacity:	1595 cm <sup>3</sup>
Engine power:	75 kW
Emission standard:	Euro 4
First licensed:	07 / 2003
Mileage at the start of measurements:	92,055 km

**Table 3.1:** Vehicle data of the test vehicle

During the receiving inspection no anomalies were found. The OBD system had not logged any defects relating to the exhaust system.

## 4 Results

The exhaust gas emissions with the replacement catalytic converters in new condition and after ageing in accordance with Annex IV of the RAL-UZ184 Basic Award Criteria are shown in **Table 4.1**.

	CO [g/km]	HC [g/km]	NOx [g/km]
Condition	<b>VW, original replacement catalytic converter</b>		
new	0.465	0.037	0.015
aged	0.649	0.054	0.046
	<b>HJS replacement catalytic converter with Blue Angel</b>		
new	0.222	0.048	0.015
aged	0.340	0.057	0.019
	<b>BLUEKAT replacement catalytic converter with Blue</b>		
new	0.216	0.037	0.013
aged	0.489	0.046	0.041
	<b>Ernst, replacement catalytic converter</b>		
new	0.232	0.042	0.022
aged	0.555	0.085	0.052
	<b>AS, replacement catalytic converter</b>		
new	0.399	0.052	0.037
aged	<b>1.007</b>	<b>0.108</b>	<b>0.133</b>
	<b>ATEC/ATP, replacement catalytic converter (supplied: BM 90954H; purchased at: www.atp-autoteile.de)</b>		
new	0.391	0.045	0.028
aged	0.782	0.100	<b>0.146</b>
	<b>EEC, replacement catalytic converter (EEC AU6005T/EP075441, purchased at: Autoteile-Meile.de)</b>		
new	<b>1.121</b>	0.077	<b>0.164</b>
aged	not performed as limits already exceeded		
	<b>Bandel, replacement catalytic converter (supplied: EEC AU6005T/EP074112, ebay.de/bandelautoteileshop)</b>		
new	<b>1.090</b>	0.077	<b>0.224</b>
aged	not performed as limits already exceeded		
<b>Euro 4 limit</b>	<b>1.0</b>	<b>0.1</b>	<b>0.08</b>

**Table 4.1:** Exhaust gas emissions of the test vehicle (VW Passat) with various replacement catalytic converters when new and after ageing in accordance with RAL-UZ184

The replacement catalytic converters that exceeded the limit values in new condition were not subjected to oven ageing. During the measurement procedure, a deterioration factor of 1.2 for vehicles of the emission classes Euro 1 to Euro 4 is applied in accordance with the ECE Directive 103 for replacement catalytic converters in new condition since ageing is not provided for.

Those catalytic converters that were below the limit values would not have exceeded them had the deterioration factor been taken into account.

The catalytic converters that already exceeded limit values in the initial measurement were additionally subjected to an exhaust gas inspection (AU), as is undertaken in periodic general inspections. In the AU, only CO emissions are considered to be an indicator of the functional capability of the catalytic converter.

The catalytic converters would have remained below the limit values determined for the AU (see Table 4.2) and the MIL (Malfunction Indicator Light) of the On Board Diagnostics (OBD) also showed no error after two additional driving cycles. The threshold values in the On Board Diagnostics are much higher than the limit values of the type test. When monitoring the catalytic converter, the system generally responds visually in the display after three complete driving cycles and if thresholds are exceeded.

	Speed [1/min]	CO [Vol-%]	AU limit value
EEC, Autoteile-Meile.de (EEC AU6005T/EP075441)	869	0.021	0.3
	2743	0.015	0.2
Bandel, ebay.de/bandelautoteileshop (EEC AU6005T/EP074112)	870	0.010	0.3
	2672	0.008	0.2

**Table 4.2:** AU measurements on two replacement catalytic converters

## 5. Summary

The replacement catalytic converters approved under Regulation No 103 must comply with a durability of 80,000 km in accordance with the provisions of Regulation No 83 or alternatively to values with fixed deterioration factors.

On the basis of exhaust gas measurements, this project verified to what extent the durability of eight different replacement catalytic converters is given. The ageing of catalytic converters was carried out in accordance with Annex IV of the RAL-UZ184 Basic Award Criteria of the "Blue Angel" quality seal.

The OEM catalytic converter and three replacement catalytic converters were able to demonstrate that the requirements are met. Two other replacement catalytic converters remained below the limit values in new condition and exceeded these after ageing. The remaining two catalytic converters even exceeded the limit values in new condition. These two catalytic converters were subjected to an AU inspection and an OBD test and achieved positive results nevertheless. The results are shown in **Table 4.1**.