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NATIONAL ENVIRONMENTAL PROTECTION
STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

HJ 689-2014

**Limit and Measurement Methods for Exhaust Pollutants from
Diesel Engines of Urban Vehicles (WHTC)
城市车辆用柴油发动机排气污染物排放限值
及测量方法（WHTC 工况法）**

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Limit and Measurement Methods for Exhaust Pollutants from Diesel Engines of Urban Vehicles (WHTC)

1 Application Scope

This standard specifies the limits and measurement methods for exhaust pollutants from diesel engines of urban vehicles (WHTC).

This standard is applicable to the type approval, production conformity inspection and in-service conformity inspection of urban vehicles with the total mass greater than 3,500 kg and their diesel engines.

2 Normative References

This standard makes reference to the following documents and the provisions in them, for undated references, the latest editions are applicable to this standard.

- | | |
|---------------|--|
| GB 17691-2005 | Limits and Measurement Methods for Exhaust Pollutants from Compression Ignition and Gas Fuelled Positive Ignition Engines of Vehicles (III IV V) |
| HJ 437-2008 | Technical Specification for On-board Diagnostic (OBD) System of Compression Ignition and Gas Fuelled Positive Ignition Engines of Vehicles |
| HJ 438-2008 | Durability of Emission Control Systems of Compression Ignition and Gas Fuelled Positive Ignition Engines of Vehicles |
| HJ 439-2008 | In-service Conformity of Compression Ignition and Gas Fuelled Positive Ignition Engines of Vehicles |

The modification plan of [2008 No.24] Announcement of the Ministry of Environmental Protection "Limits and Measurement Methods for Exhaust Pollutants from Compression Ignition and Gas Fuelled Positive Ignition Engines of Vehicles (III IV V)" (GB 17691-2005), hereinafter referred to as "Modification Plan".

3 Terminologies and Definitions

For the purpose of this standard, the following terminologies and definitions and those established in GB 17691-2005 apply.

3.1

WHTC test (World Harmonized Transient Cycle test)

It refers to the transient cycle including 1,800 working conditions transforming second by second in the Appendix A of this standard.

3.2**Urban vehicles**

It refers to the buses, mail cars and sanitation trucks operating in the city.

4 Type Approval and Application**4.1 Type approval application**

For the new type vehicles or engines within the application scope of this standard, the vehicle or engine (or family) manufacturing enterprise or its authorized agency shall propose the type approval application to the type approval competent departments according to the requirements of GB 17691-2005 and this standard, and shall complete the specified inspection items.

4.2 Type approval

If the vehicles or engines (family) within the application scope of this standard meet the requirements of GB 17691-2005 and its "Modification Plan" as well as those specified in this standard, the type approval shall be conducted and the type approval certificate in accordance with Appendix B shall be issued.

5 Technical Requirements and Tests**5.1 Exhaust requirements of gaseous pollutants and particulate matters**

For the engine or vehicle which is conducted with type approval according to this standard, the WHTC cold starting and hot starting emission tests shall be conducted according to the test procedures specified in Appendix A to determine the exhaust of gaseous pollutants and particulate matters.

5.1.1 The results of exhaust pollutants measured by cold starting and hot starting tests shall be weighted according to the following formula.

$$e = \frac{(0.14 \times m_{cold}) + (0.86 \times m_{hot})}{(0.14 \times W_{act,cold}) + (0.86 \times W_{act,hot})}$$

Where,

m_{cold} - the mass of various exhaust pollutants in cold starting cycle, g/cycle;

6 Marking of Engine

For the engine approved according to this standard, its mark shall meet the requirements of Chapter 6 in GB 17691-2005, and the text "meeting the requirements of HJ 689-2014" also shall be indicated on the nameplate.

7 Production Conformity

7.1 The manufacturing enterprise shall take measures to ensure the production conformity.

7.2 Production conformity inspection and judgment shall be conducted according to the requirements of GB 17691-2005. Not only the corresponding technical requirements of GB 17691-2005, but also the WHTC exhaust pollutants shall be inspected, the calibration shall be conducted according to deterioration coefficient or correction value to meet the limit requirements specified in this standard.

8 Engine Family

The engines in same family shall not only meet the requirements of Chapter 9 in GB 17691-2005, but also shall meet the requirements of this standard in the aspect having same emission control strategies, measures and technical parameters [e.g., optimal control strategy and urea injection strategy (Mapping adjustment), improving the catalyst activity, exhaust heat management, etc.], and related materials shall be provided to the type approval organization to prove that it can reach the same control effect.

9 Implementation of Standard

9.1 Type approval

The type approval of engines or vehicles within the application scope of this standard shall be implemented from the issuance date of this standard.

9.2 Registration, sales and service

For the engines or vehicles within the application scope of this standard, from the date specified in Table 2, the new vehicles failing to meet the requirements of this standard shall not be sold or registered, and the new engines failing to meet the requirements of this standard shall not be sold or put into service.

Table 2 -- Implementation Date for Registration, Sales and Service

Stage	Stage IV	Stage V
Implementation date	January 1st, 2015	Being consistent with Stage V in GB 17691-2005

Appendix A

(Normative)

WHTC Test Specification

A.1 Overview

A.1.1 This appendix specifies the test specification for measuring the engine exhaust pollutants by WHTC test cycle.

A.1.2 The test shall be carried out on the engine dynamometer rack.

A.1.3 Exhaust pollutants measuring system

This standard specifies two measuring principles with equivalent function:

- Gas components shall be measured by direct sampling method; particulate matters shall be measured by fractional flow dilution system;
- Gas components and particulate matters shall be measured by full-flow dilution constant volume sampling system (CVS system).

Both of the two principles may be used in WHTC test cycle, and the two principles may be randomly combined (such as gas direct sampling measurement and particulate matter full flow measurement).

The engine shall be operated according to the requirements of WHTC test cycle.

WHTC test cycle:

WHTC test cycle includes a group of standard percentage values (percentage in rated speed or rated torque, refer to Attachment AA) of rotational speed and torque which vary second by second; refer to Figure A.1 for WHTC test cycle. In order to conduct the test on engine test bench, convert the percentage value into actual value according to the mapping curve of each engine so as to form reference cycle. The test cycle shall be conducted according to the engine reference cycle and the test shall be conducted. Operate the test cycle on the test bench according to the reference rotational speed and torque value, and record the actual speed, torque and power. In order to guarantee the test validity, regression analysis of actual speed, torque and power shall be conducted by comparing the reference ones after completion of the test.

In order to calculate exhaust volume ratio, integrate the engine actual power of the complete cycle so as to calculate the power of the actual cycle. In order to guarantee the test validity, the actual cycle power must be within the specified limit value of reference cycle power.

As for gaseous pollutants, continuous record shall be made, or the gaseous pollutants shall be

engine shall be heated in the maximum power state for the purpose of stabilizing the engine operation. After the engine operation is stable, the engine mapping shall be determined according to the following procedures:

- (a) The engine shall be unloaded and operated at idle speed;
- (b) The engine shall be operated when the fuel injection pump is at full load and at the minimum mapping rotational speed;
- (c) The average increase rate of the engine from the minimum mapping rotational speed to the maximum mapping rotational speed is (8 ± 1) (r/min)/s. The engine speed and torque shall be recorded at a sampling rate at least one point per second.

A.4.3 Alternative performance measurement

If the manufacturing plant considers that the above-mentioned engine mapping curve determination technology is unsafe or cannot represent the engine, alternative engine mapping curve determination technology may be adopted. Alternative engine mapping curve determination technology must reach the purpose of the determination specification of the specified engine mapping curve, i.e. the maximum effective torque capable of being generated within the determined whole permissible rotational speed range of the engine. If the engine mapping curve determination technology specified in this article is not adopted due to the safety or representativeness reasons, it shall be approved by the type approval authority, and the rationality of alternative method shall be described. As for turbocharged engine or governor controlled engine, engine speed continuous deceleration method must not be adopted.

A.4.4 Repeated test

Before each test cycle, it is unnecessary to conduct engine mapping curve determination. In case of the following conditions, engine mapping curve determination shall be conducted again before test cycle:

- It is judged that it is too long since the last engine mapping curve determination according to the engineering experience;
- The machine elements possibly influencing the engine performance changed or calibrated/adjusted again.

A.5 Formation of reference test cycle

A.5.1 Actual rotational speed

Convert the standard value of rotational speed in Attachment AA into actual value by using the Formula (A.1):

$$\text{Actual speed} = n_{s \text{ standard value}} \times (0.45 \times n_{t0} + 0.45 \times n_{pref} + 0.1 \times n_{hi} - n_{idle}) \times 2.0327 + n_{idle} \quad (\text{A.1})$$

addition, carbon dioxide is frequently used as tracer gas to determine the dilution ratio of fractional flow dilution to total flow dilution system.

The foregoing pollutants shall be inspected in designated test cycle process. The gaseous components of complete cycle shall be determined according to the analyzer signal integration of original exhaust or the CVS total flow dilution system integration of diluted exhaust or bag sample. The particulate matters are sampled proportionally from the diluted exhaust through fractional flow or total flow dilution system and placed on specific filter paper. According to the adopted method, the diluted or non-diluted exhaust flow of the complete cycle shall be determined and used to calculate the emission amount of pollutant mass. The mass of each kind of pollutant emitted per kilowatt hour can be obtained by dividing the mass emission value by the engine power calculated according to A.6.1.

A.7.2 Test preparation procedures

A.7.2.1 Engine preparation

The engine preparation includes engine performance inspection and system calibration, which shall be carried out before engine mapping test.

A.7.2.2 Engine cooling

Natural or forced cooling method shall be adopted.

A.7.2.2.1 Natural cooling

The engine shall be put in a room at temperature of 293 ~303 K (20~30°C) in advance and for a period of at least 6h until the temperature of engine lubricant, cooling fluid (if any) and after-treatment system reaches the room temperature.

A.7.2.2.2 Forced cooling

A system shall be established according to good engine engineering experience to convey cold air to pass through the engine, to force the cooling oil flow through the lubrication system of engine, dissipate the heat of engine cooling system and after-treatment system. During the forced cooling process of after-treatment device, cold air cannot be used for cooling unless the after-treatment system has cooled to a temperature lower than the catalytic activation temperature. Cooling procedure that may result in non-representative emission is not allowed.

A.7.2.3 Preparation of sampling filter paper, installation of measurement equipment, starting of particulate matter sampling system, adjustment of dilution system and inspection of analyzer shall be carried out according to those specified in Attachment BB in GB 17691-2005.

A.7.3 Cold starting procedure of engine

When the temperature of engine lubricant, cooling fluid and after-treatment system reaches 293 ~303K (20~30°C), cold starting test can be carried out. The engine can be started by one of the

following methods:

- (a) According to the suggestions in user operation manual, the engine should be started by starting motor and adaptive storage battery or appropriate power supply;
- (b) The engine shall be dragged by dynamometer and be controlled within $\pm 25\%$ of the typical starting rotational speed. Dragging shall be stopped within 1s after engine starting. If the engine fails to start after 15s, stop dragging and determine the reasons for starting failure, unless the user operation manual or service maintenance manual describes that long starting time is normal.

A.7.4 Cycle operation

The cycle operation of test shall be carried out according to the requirements of Attachment BB.3.8 in GB 17691-2005; therein, the test cycle shall adopt the reference cycle determined in A.5 of this standard, and operation test cycle and sampling shall be commenced immediately after the engine is started.

A.7.5 Hot starting test

A.7.5.1 Hit dipping

After the completion of cold starting test, hot dipping for (10 ± 1) min shall be conducted immediately and regarded as the pretreatment of engine hot starting test.

A.7.5.2 Engine starting procedure

After the hot dipping period defined in A.7.5.1, one of the two starting modes given in A.7.3 shall be adopted to start the engine.

A.7.5.3 Cycle operation

The test cycle shall be operated according to those specified in A.7.4.

A.8 Measurement and sampling regulations

The measurement and sampling regulations shall comply with Attachment BD in GB 17691-2005.

A.9 Calibration regulations

The calibration regulations shall comply with Attachment BE in GB 17691-2005.

A.10 Analysis and sampling system

The analysis and sampling system shall comply with Appendix D in GB 17691-2005.

A.11 Calculation of pollutant emission amount

Appendix B

(Normative)

Type Approval Certificate

According to the requirements of _____ (name and SN of standard), the following vehicle / independent technical assembly (engine type / engine family / components) ¹⁾ are conducted with type approval / type approval extension ¹⁾.

Type approval No.: Type extension No.:

B.1 Overview

B.1.1 Brand of vehicle / independent technical assembly / components ¹⁾:

B.1.2 Name of manufacturing plant of vehicle / independent technical assembly / components ¹⁾.

B.1.3 Model of vehicle / independent technical assembly / components ¹⁾:

B.1.4 Vehicle category:

B.1.5 Engine category: diesel engine / NG / LPG ¹⁾

B.1.6 Name and address of the manufacturing plant:

B.2 Brief description (if applicable): see attachment:

B.3 Inspection body responsible for test:

B.4 Test report date:

B.5 Test report No.:

B.6 Basis of type approval extension:

B.7 Remarks (if any): see Attachment BA.2

B.8 Place:

B.9 Date:

B.10 Signature:

B.11 Type approval application data list:

¹⁾ Scratch out the one not applicable.

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