



THE UNITED KINGDOM VEHICLE APPROVAL AUTHORITY

COMMUNICATION CONCERNING THE APPROVAL GRANTED <sup>(1)</sup>/~~APPROVAL EXTENDED <sup>(1)</sup>~~  
~~APPROVAL REFUSED <sup>(4)</sup>~~/~~APPROVAL WITHDRAWN <sup>(4)</sup>~~/~~PRODUCTION DEFINITELY~~  
~~DISCONTINUED <sup>(1)</sup>~~ OF A COMPRESSION-IGNITION ENGINE TYPE OR FAMILY OF ENGINE  
TYPES AS SEPARATE TECHNICAL UNITS WITH REGARD TO THE EMISSION OF POLLUTANTS  
PURSUANT TO REGULATION NO. 96.04



Approval No: 96RHA-043422

Extension No: Not applicable

1. Trade name or mark of the engine:  or Dongfeng Cummins
2. Engine type(s)
  - 2.1. Engine family: G30352L0590HN2
  - 2.2. Power band of engine family: H
  - 2.3. ~~VARIABLE SPEED/CONSTANT SPEED~~<sup>(1)</sup>
  - 2.4. Types included in the engine family:  
Parent engine: QSB5.9-C210-30  
Family engines: QSB5.9-C205-30; QSB5.9-C190-30; QSB5.9-C190-31; QSB5.9-C180-30;  
QSB5.9-C180-31; QSB5.9-C180-32; QSB5.9-C180-33; QSB5.9-C180-34
  - 2.5. Tested type of engine or the representative of the engine family: QSB5.9-C210-30
3. Manufacturer's name and address:  
  
Dongfeng Cummins Engine Co., Ltd.  
High and New Technology Industrial Development Zone,  
Xiangyang,  
Hubei Province,  
China 441004
4. If applicable, name and address of manufacturer's representative: Not applicable

MSS365948



5. Maximum allowable intake depression: 3.7 kPa
6. Maximum allowable back pressure: 10 kPa
7. Restriction of use (if any): This approval is issued to a level of regulation which has ceased to be valid within Europe. These engines cannot be placed on the European Community market.
8. Emission levels – final test results with DF:

	NRSC	NRTC
CO (g/kWh)	1.095	N/A
HC+ NO <sub>x</sub> (g/kWh)	3.655	N/A
PM (g/kWh)	0.094	N/A

9. Engine submitted for test on: 21 June 2016
10. Technical service responsible for conducting the approval test: Vehicle Certification Agency
11. Date of test report issued by that service: 18 July 2016
12. Number of test report issued by that service: MSS365948
13. Site of approval mark on the engine: On the cylinder cover
14. Place: BRISTOL
15. Date: 21 JULY 2016
16. Signature:  D LAWLOR  
Head of Technical Standards & Legislation
17. The following documents, bearing the approval number shown above, are annexed to this communication: Yes

One copy of Annex 1A or Annex 1B to this Regulation completed and with drawings and diagrams referred to attached.

Any remarks: Approval to Supplement 1

- (1) Strike out what does not apply.

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## APPENDIX 1

## Test report for compression ignition engines

Test results<sup>(1)</sup>

## Information concerning the test engine

Engine Type: QSB5.9-C210-30

Engine identification number: 78152634

## 1. Information concerning the conduct of the test:

## 1.1. Reference fuel used for test

1.1.1. Cetane number: 52.3

1.1.2. Sulphur content: <300 mg/kg

1.1.3. Density: 837 kg/m<sup>3</sup>

## 1.2. Lubricant

1.2.1. Make(s): China Petrochemical Co., Ltd.

1.2.2. Type(s): 15W/40 CF-4

(state percentage of oil mixture if lubricant and fuel are mixed): Not applicable

## 1.3. Engine driven equipment (if applicable)

1.3.1 Enumeration and identifying details: Without fan (no load)

1.3.2 Power absorbed at indicated engine speeds (as specified by the manufacturer):

<i>Power absorbed by engine driven equipment at various engine speeds<sup>1,2</sup>, taking into account Annex 7</i>			
<i>Equipment</i>	<i>Intermediate speed (if applicable)</i>	<i>Maximum power speed (if different from rated)</i>	<i>Rated speed<sup>(3)</sup></i>
<b>Total:</b>	0	0	0

(1) Delete as appropriate.

(2) Shall not be greater than 10 per cent of the power measured during the test.

(3) Insert values at engine speed corresponding to 100 per cent normalised speed if NRSC test uses this speed.

## 1.4 Engine performance

## 1.4.1 Engine speeds:

Idle: 800±50 min<sup>-1</sup>Intermediate: 1500 min<sup>-1</sup>Maximum Power: 2200 min<sup>-1</sup>Rated<sup>(2)</sup>: 2200 min<sup>-1</sup>1.4.2 Engine power<sup>(3)</sup>

Condition	Power setting (kW) at various engine speeds		
	Intermediate speed (if applicable)	Maximum power speed (if different from rated)	Rated speed <sup>(1)</sup>
Maximum power measured at specified test speed (kW) (a)	128.8		154
Total power absorbed by engine driven equipment as per paragraph 1.3.2 of this appendix taking into account Annex 7 (kW) (b)	0		0
Net engine power as specified in paragraph 2.1.49. (kW) (c)	128.8		154
c = a + b			

(1) Replace with values at engine speed corresponding to 100 per cent normalised speed if NRSC test uses this speed.

## 2. Information concerning the conduct of the NRSC test:

## 2.1. Dynamometer setting (kW)

Per cent load	Dynamometer setting (kW) at various engine speeds	
	Intermediate (if applicable)	Rated speed <sup>(1)</sup>

10 (if applicable)	12.9	15.4
25 (if applicable)	32.2	38.5
50	64.4	77
75	96.6	115.5
100	128.8	154

(1) Replace with values at engine speed corresponding to 100 per cent normalised speed if NRSC test uses this speed.

2.2. Emission results of the **ENGINE/PARENT ENGINE** <sup>(4)</sup>

Deterioration factor (DF): **CALCULATED/FIXED** <sup>(5)</sup>

Specify the DF values and the emission results in the following table <sup>(5)</sup>:

<i>NRSC Test</i>				
	CO	HC+NO <sub>x</sub>	PM	
DF <del>mult</del> /add <sup>(1)</sup>	0.00	0.00	0.00	
Emissions	CO (g/kWh)	HC +NO <sub>x</sub> (g/kWh)	PM (g/kWh)	CO <sub>2</sub> (g/kWh)
Test result	1.095	3.655	0.094	843.453
Final test result with DF	1.095	3.655	0.094	

(1) Delete as appropriate.

<i>Additional control area test points (if applicable): Not applicable</i>						
<i>Emissions at test point</i>	<i>Engine Speed</i>	<i>Load (%)</i>	<i>CO (g/kWh)</i>	<i>HC (g/kWh)</i>	<i>NO<sub>x</sub> (g/kWh)</i>	<i>PM (g/kWh)</i>
Test result 1						
Test result 2						
Test result 3						

2.3. Sampling system used for the NRSC test:

2.3.1. Gaseous emissions<sup>(6)</sup>: 2

2.3.2. PM<sup>(6)</sup>: 13

2.3.2.1. Method<sup>(4)</sup>: SINGLE/MULTIPLE FILTER

3. Information concerning the conduct of the NRTC test (if applicable)<sup>(7)</sup>: Not applicable

3.1 Emission results of the ENGINE/PARENT ENGINE<sup>(4)</sup>

Deterioration factor (DF): CALCULATED/FIXED<sup>(4)</sup>

Specify the DF values and the emission results in the following table<sup>(6)</sup>:

Regeneration related data shall be reported for engines of power bands Q and R.

<i>NRTC Test</i>						
	CO	HC	NO <sub>x</sub>		PM	
DF mult/add <sup>(1)</sup>						
Emissions	CO (g/kWh)	HC (g/kWh)	NO <sub>x</sub> (g/kWh)	HC+ NO <sub>x</sub> (g/kWh)	PM (g/kWh)	
Cold start						
Emissions	CO (g/kWh)	HC (g/kWh)	NO <sub>x</sub> (g/kWh)	HC+ NO <sub>x</sub> (g/kWh)	PM (g/kWh)	CO <sub>2</sub> (g/kWh)
Hot start without regeneration						
Hot start with regeneration <sup>(1)</sup>						
K <sub>r,u</sub> (mult/add) <sup>(1)</sup> K <sub>r,d</sub> (mult/add) <sup>(1)</sup>						
Weighted test results						
Final test result with DF						

(1) Delete as appropriate.

Cycle work for hot start without regeneration kWh

3.2. Sampling system used for NRTC test:

Gaseous emissions<sup>(6)</sup>:

PM<sup>(6)</sup>:

Method<sup>(4)</sup>: SINGLE/MULTIPLE FILTER

- (1) For the case of several parent engines, the following are to be indicated for each of them.
- (2) Insert engine speed corresponding to 100 per cent normalised speed if NRSC test uses this speed.
- (3) Uncorrected power measured in accordance with paragraph 2.1.49.
- (4) Delete as appropriate.
- (5) Replace with values at engine speed corresponding to 100 per cent normalised speed if NRSC test uses this speed.
- (6) Indicate figure numbers of system used as defined in Annex 4A, Appendix 4, or paragraph 9. of Annex 4B to this regulation, as applicable.
- (7) Indicate figure numbers of system used as defined in Annex 4A, Appendix 4, or paragraph 9. of Annex 4B to this regulation, as applicable.

# Annex 1A

## Information document No ... relating to the type approval and referring to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery

Parent engine / engine type<sup>1</sup>: *OSB5.9-C210-30*

### 1. General

1.1. Make (name of undertaking): *Dongfeng Cummins Engine Co., Ltd.*

1.2. Type and commercial description of the parent – and (if applicable) of the family engine(s):

*Parent engine: OSB5.9-C210-30*

*Family engines: OSB5.9-C205-30; OSB5.9-C190-30; OSB5.9-C190-31;*

*OSB5.9-C180-30; OSB5.9-C180-31; OSB5.9-C180-32;*

*OSB5.9-C180-33; OSB5.9-C180-34*

1.3. Manufacturer's type coding as marked on the engine(s):

*OSB5.9-C210-30; OSB5.9-C205-30; OSB5.9-C190-30; OSB5.9-C190-31;*

*OSB5.9-C180-30; OSB5.9-C180-31; OSB5.9-C180-32; OSB5.9-C180-33;*

*OSB5.9-C180-34*

*Location: Engine plate; Method of affixing: Engraved.*

1.4. Specification of machinery to be propelled by the engine<sup>2</sup>:

*Non-road machine*

1.5. Name and address of manufacturer:

*Dongfeng Cummins Engine Co., Ltd.*

*High and New Technology Industrial Development Zone, Xiangyang, Hubei Province, China 441004*

Name and address of manufacturer's authorized representative (if any): *N/A*

1.6. Location, coding and method of affixing of the engine identification:

*Location: at the end plane of cylinder block*

*Method of affixing: Engraved*

*Coding: \*78xxxxx\*, the two symbol "\*" finger the coding's beginning and ending position, the first two number "78" means the engine's manufacturer is Dongfeng Cummins, and it will be changed when the serial number is use out. And the following six number is serial number.*

1.7. Location and method of affixing of the approval mark:

*Location: on the cylinder cover;*

*Method of affixing: stick-on label*

1.8. Address(es) of assembly plant(s):

*Dongfeng Cummins Engine Co., Ltd.*

*High and New Technology Industrial Development Zone, Xiangyang, Hubei Province, China 441004*



**Attachments:**

- 1.1. Essential characteristics of the (parent) engine(s) (*see Appendix 1*)
- 1.2. Essential characteristics of the engine family (*see Appendix 2*)
- 1.3. Essential characteristics of engine types within the family (*see Appendix 3.1~3.8*)
2. Characteristics of engine-related parts of the mobile machinery (if applicable): *Not applicable*
3. Photographs of the parent engine: *See Attachment 1*
4. List further attachments if any  
*Attachment 2. Drawing of combustion chamber and piston crown*  
*Attachment 3. The drawing of intake manifold*  
*Attachment 4. The drawing of exhaust manifold*

Date, file

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<sup>1</sup> Strike out what does not apply.

<sup>2</sup> Specify the tolerance.



# Annex 1A - Appendix 1

## Essential characteristics of the (parent) engine

### 1. Description of engine

- 1.1. Manufacturer: *Dongfeng Cummins Engine Co., Ltd.*
- 1.2. Manufacturer's engine code: *QSB5.9-C210-30*
- 1.3. Cycle: *four stroke / ~~two stroke~~<sup>1</sup>*
- 1.4. Bore: *102 mm*
- 1.5. Stroke: *120 mm*
- 1.6. Number and layout of cylinders:  
*6 Cylinders, In-line, Vertical*
- 1.7. Engine capacity:  *$5.9 \times 10^3 \text{ cm}^3$*
- 1.8. Rated speed: *2200 rpm*
- 1.9. Maximum torque speed: *1500 rpm*
- 1.10. Volumetric compression ratio<sup>2</sup>: *17.3:1*
- 1.11. Combustion system description: *Compression ignition & direct injection*
- 1.12. Drawing(s) of combustion chamber and piston crown:  
*Refer to the drawing of Attachment 2.*
- 1.13. Minimum cross sectional area of inlet and outlet ports:  
*Inlet: 1381mm<sup>2</sup>, Outlet: 993mm<sup>2</sup>*
- 1.14. Cooling system
- 1.14.1. Liquid
- 1.14.1.1. Nature of liquid: *Water/Glycol Mix(50/50)*
- 1.14.1.2. Circulating pump(s): *yes / ~~no~~<sup>1</sup>*
- 1.14.1.3. Characteristics or make(s) and type(s) (if applicable):  
*Make: Motor Pump Co., Ltd*  
*Type: Centrifugal pump*
- 1.14.1.4. Drive ratio(s) (if applicable): *2.0:1*
- 1.14.2. Air: *N/A*
- 1.15. Temperature permitted by the manufacturer
- 1.15.1. Liquid cooling: Maximum temperature at outlet: *373 K*
- 1.15.2. Air cooling: Reference point: *N/A*  
Maximum temperature at reference point: *N/A K*
- 1.15.3. Maximum charge air outlet temperature of the inlet intercooler (if applicable):  
*326 K*
- 1.15.4. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s): *973 K*
- 1.15.5. Fuel temperature: *min: 303 K; max: 323 K*
- 1.15.6. Lubricant temperature: *min: 333 K; max: 393 K*
- 1.16. Pressure charger: *yes / ~~no~~<sup>1</sup>*
- 1.16.1. Make: *Wuxi Cummins Turbo Technologies Co., Ltd*



- 1.16.2. Type: *HE250WG*
- 1.16.3. Description of the system (e.g. max charge pressure, waste-gate, if applicable):  
*Waste-gate turbocharger*
- 1.16.4. Intercooler: *yes / no<sup>1</sup>*
- 1.17. Intake system: Maximum allowable intake depression at rated engine speed and at 100 per cent load: *3.7 kPa*
- 1.18. Exhaust system: Maximum allowable exhaust backpressure at rated engine speed and at 100 per cent load: *10 kPa*

**2. Measures taken against air pollution:** *N/A*

**3. Fuel feed**

- 3.1. Feed pump  
Pressure<sup>2</sup> or characteristic diagram: *500±50 kPa*
- 3.2. Injection system
- 3.2.1. Pump
- 3.2.1.1. Make(s): *Denso*
- 3.2.1.2. Type(s): *HP3*
- 3.2.1.3. Delivery: *129 mm<sup>3</sup> per stroke<sup>2</sup> or cycle at engine speed of: 1500 rpm at full injection, or characteristic diagram.*  
Mention the method used: *On engine / on pump bench<sup>1</sup>*
- 3.2.1.4. Injection advance
- 3.2.1.4.1. Injection advance curve<sup>2</sup>: *Controlled by ECU*
- 3.2.1.4.2. Timing<sup>2</sup>: *Controlled by ECU*
- 3.2.2. Injection piping
- 3.2.2.1. Length: *Pump-rail: 385 mm, rail-injector: 585 mm*
- 3.2.2.2. Internal diameter: *Pump-rail: 3.5 mm, rail-injector: 3.5 mm*
- 3.2.3. Injector(s)
- 3.2.3.1. Make(s): *Denso*
- 3.2.3.2. Type(s): *G3AM*
- 3.2.3.3. Opening pressure<sup>2</sup> or characteristic diagram: *Controlled by ECU kPa*
- 3.2.4. Governor
- 3.2.4.1. Make(s): *Cummins Inc.*
- 3.2.4.2. Type(s): *CM2880*
- 3.2.4.3. Speed at which cut-off starts under full load<sup>2</sup>: *2230 rpm*
- 3.2.4.4. Maximum no-load speed<sup>2</sup>: *2380 rpm*
- 3.2.4.5. Idling speed<sup>2</sup>: *800±50 rpm*
- 3.2.5. Electronic Engine Management Control Unit
- 3.2.5.1. Make(s): *Cummins Inc.*
- 3.2.5.2. Type: *CM2880*
- 3.2.5.3. Software calibration number(s): *SC92844*
- 3.3. Cold Start System



- 3.3.1. Make(s): Wenzhou Hua-ke Industry Developing Co., Ltd.
- 3.3.2. Type(s): HK0701M
- 3.3.3. Description: Electrical Grid Heater (24V)

**4. Valve timing**

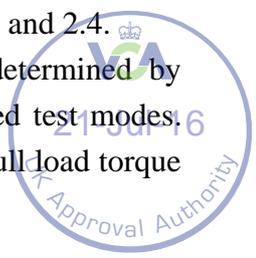
- 4.1. Maximum lift and angles of opening and closing in relation to dead centres or equivalent data:  
Maximum lift of inlet valve: 10 mm; Maximum lift of outlet valve: 11.8 mm  
Angles of inlet valve opening: 11.5 °BTDC; closing: 9.5 °ABDC  
Angles of outlet valve opening: 53 °BBDC; closing: 19 °ATDC
- 4.2. Reference and / or setting ranges<sup>1</sup>  
Intake: 0.25 mm, exhaust: 0.51 mm

**5. ADDITIONAL INFORMATION ON TEST CONDITIONS**

- 5.1. Reference fuel used for test
- 5.1.1. Cetane number: 52.3
- 5.1.2. Sulphur content: <300mg/kg
- 5.1.3. Density at 15 °C<sup>5/</sup>: 837 kg/m<sup>3</sup>
- 5.2. Lubricant
- 5.2.1. Lubricant used: Oil
- 5.2.2. Make(s): China Petrochemical Co., Ltd.
- 5.2.3. Type(s): 15W/40 CF-4  
 (state percentage of oil in mixture if lubricant and fuel are mixed): N/A
- 5.3. Engine driven equipment (if applicable)
- 5.3.1. Enumeration and identifying details: without fan (no load)
- 5.3.2. Power absorbed at indicated engine speeds  
 (as specified by the manufacturer):

Equipment	Power absorbed (kW) at various engine speeds <sup>3/</sup>	
	Intermediate	Rated
<b>TOTAL:</b>	<b>0</b>	<b>0</b>

- 5.4. Determination of dynamometer settings  
 The settings of inlet restriction and exhaust pipe backpressure shall be adjusted to the manufacturer's upper limits, in accordance with Annex 4, paragraphs 2.3. and 2.4.  
 The maximum torque values at the specified test speeds shall be determined by experimentation in order to calculate the torque values for the specified test modes.  
 For engines which are not designed to operate over a speed range on a full load torque



curve, the maximum torque at the test speeds shall be declared by the manufacturer. The engine setting for each test mode shall be calculated using the formula:

$$S = [(P_M + P_{AE}) \times L / 100] - P_{AE}$$

If the ratio,

$$P_{AE} / P_M \geq 0.03$$

the value of  $P_{AE}$  may be verified by the Technical Authority granting type approval.

5.5. Dynamometer setting (kW)

{PRIVATE}	Dynamometer setting (kW) at various engine speeds	
Percent Load	Intermediate	Rated
10	12.9	15.4
25	32.2	38.5
50	64.4	77
75	96.6	115.5
100	128.8	154

**6. Engine performance**

6.1 Engine speeds:

Idle: 800±50 rpm

Intermediate: 1500 rpm

Rated: 2200 rpm

6.1 Engine power

{PRIVATE}	Power setting (kW) at various engine speeds	
Condition	Intermediate	Rated
Maximum power measured on test ( $P_M$ ) (kW) (a)	128.8	154
Total power absorbed by engine driven equipment as per paragraph 5.3. of this annex ( $P_{AE}$ ) (kW) (b)	0	0
Net engine power as specified in paragraph 2.8. of this Regulation (kW) (c)	128.8	154

$$c = a + b$$

<sup>1</sup> Strike out what does not apply.  
<sup>2</sup> Specify the tolerance.



# Annex 1A - Appendix 2

## Essential characteristics of the engine family

### 1. Common parameters<sup>1</sup>

- 1.1. Combustion cycle: *Four stroke*
- 1.2. Cooling medium: *Water/Glycol Mix(50/50)*
- 1.3. Method of air aspiration: *Turbocharger & intercooler*
- 1.4. Combustion chamber type/design:  
*Refer to the drawing of Attachment 2.*
- 1.5. Valve and porting<sup>3/4</sup> configuration, size and number:  
*Two valves per cylinder, Intake  $\Phi 45 \times 1$ , Exhaust  $\Phi 42 \times 1$*
- 1.6. Fuel system: *High Pressure Common Rail (HPCR)*
- 1.7. Engine management systems  
Proof of identity pursuant to drawing number(s):
- 1.7.1. Charge cooling system: *Yes*
- 1.7.2. Exhaust gas recirculation<sup>2</sup>: *No*
- 1.7.3. Water injection/emulsion<sup>2</sup>: *No*
- 1.7.4. Air injection<sup>2</sup>: *No*
- 1.8. Exhaust after-treatment system<sup>2</sup>: *N/A*  
Proof of identical (or lowest for the parent engine) ratio: system capacity/fuel delivery per stroke, pursuant to diagram number(s): *N/A*

### 2. Engine family listing

- 2.1. Engine family name: *G30352L0590HN2*



2.2. Specification of engines within this family:

Engine type	No. of cylinders	Rated speed (rpm)	Fuel delivery (mm <sup>3</sup> /str)	Rated net power (kW)	Maximum torque speed (rpm)	Fuel delivery (mm <sup>3</sup> /str)	Maximum torque (Nm)	Low idle speed (rpm)
<i>QSB5.9-C205-30</i>	<i>6</i>	<i>2200</i>	<i>109</i>	<i>151</i>	<i>1500</i>	<i>127</i>	<i>810</i>	<i>800±50</i>
<i>QSB5.9-C190-30</i>	<i>6</i>	<i>2000</i>	<i>112</i>	<i>142</i>	<i>1400</i>	<i>125</i>	<i>800</i>	<i>800±50</i>
<i>QSB5.9-C190-31</i>	<i>6</i>	<i>2200</i>	<i>102</i>	<i>142</i>	<i>1500</i>	<i>125</i>	<i>800</i>	<i>800±50</i>
<i>QSB5.9-C180-30</i>	<i>6</i>	<i>2200</i>	<i>95</i>	<i>132</i>	<i>1500</i>	<i>125</i>	<i>800</i>	<i>800±50</i>
<i>QSB5.9-C180-31</i>	<i>6</i>	<i>2400</i>	<i>87</i>	<i>132</i>	<i>1500</i>	<i>125</i>	<i>800</i>	<i>800±50</i>
<i>QSB5.9-C180-32</i>	<i>6</i>	<i>2000</i>	<i>105</i>	<i>133</i>	<i>1400</i>	<i>110</i>	<i>708</i>	<i>800±50</i>
<i>QSB5.9-C180-33</i>	<i>6</i>	<i>2200</i>	<i>94</i>	<i>133</i>	<i>1500</i>	<i>125</i>	<i>800</i>	<i>800±50</i>
<i>QSB5.9-C180-34</i>	<i>6</i>	<i>2000</i>	<i>105</i>	<i>133</i>	<i>1400</i>	<i>120</i>	<i>770</i>	<i>800±50</i>
Parent engine (for full details see Annex 1A)								
<i>QSB5.9-C210-30</i>	<i>6</i>	<i>2200</i>	<i>112</i>	<i>154</i>	<i>1500</i>	<i>129</i>	<i>820</i>	<i>800±50</i>

2.3. In addition, for each engine type within the family, the information required in Annex 1B – Appendix 3 shall be submitted to the Type Approval Authority.

<sup>1</sup> Strike out what does not apply.

<sup>2</sup> Specify the tolerance.



# Annex 1A - Appendix 3.1

## Essential characteristics of engine types within the family

### 1. Description of engine

- 1.1. Manufacturer: *Dongfeng Cummins Engine Co., Ltd.*
- 1.2. Manufacturer's engine code: *QSB5.9-C205-30*
- 1.3. Cycle: *four stroke /two stroke<sup>1</sup>*
- 1.4. Bore: *102 mm*
- 1.5. Stroke: *120 mm*
- 1.6. Number and layout of cylinders:  
*6 Cylinders, In-line, Vertical*
- 1.7. Engine capacity:  *$5.9 \times 10^3 \text{ cm}^3$*
- 1.8. Rated speed: *2200 rpm*
- 1.9. Maximum torque speed: *1500 rpm*
- 1.10. Volumetric compression ratio<sup>2</sup>: *17.3:1*
- 1.11. Combustion system description: *Compression ignition & direct injection*
- 1.12. Drawing(s) of combustion chamber and piston crown:  
*Refer to the drawing of Attachment 2.*
- 1.13. Minimum cross-sectional area of inlet and outlet ports:  
*Inlet: 1381mm<sup>2</sup>, Outlet: 993mm<sup>2</sup>*
- 1.14. Cooling system
- 1.14.1. Liquid
- 1.14.1.1. Nature of liquid: *Water/Glycol Mix(50/50)*
- 1.14.1.2. Circulating pump(s): *yes /no<sup>1</sup>*
- 1.14.1.3. Characteristics or make(s) and type(s) (if applicable):  
*Make: Motor Pump Co., Ltd*  
*Type: Centrifugal pump*
- 1.14.1.4. Drive ratio(s) (if applicable): *2.0:1*
- 1.14.2. Air: *N/A*
- 1.15. Temperature permitted by the manufacturer
- 1.15.1. Liquid cooling: Maximum temperature at outlet: *373 K*
- 1.15.2. Air cooling: Reference point: *N/A*  
Maximum temperature at reference point: *N/A K*
- 1.15.3. Maximum charge air outlet temperature of the inlet intercooler (if applicable):  
*326 K*
- 1.15.4. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s): *973 K*
- 1.15.5. Fuel temperature: min: *303 K* max: *323 K*
- 1.15.6. Lubricant temperature: min: *333 K* max: *393 K*
- 1.16. Pressure charger: *yes /no<sup>1</sup>*
- 1.16.1. Make: *Wuxi Cummins Turbo Technologies Co., Ltd*



- 1.16.2. Type: *HE250WG*
- 1.16.3. Description of the system (e.g. max. charge pressure, waste-gate, if applicable):  
*Waste-gate turbocharger*
- 1.16.4. Intercooler: *yes / no<sup>1</sup>*
- 1.17. Intake system: Maximum allowable intake depression at rated engine speed and at 100 per cent load: *3.7 kPa*
- 1.18. Exhaust system: Maximum allowable exhaust backpressure at rated engine speed and at 100 per cent load: *10 kPa*

**2. Measures taken against air pollution:** *N/A*

**3. Fuel feed**

- 3.1. Feed pump  
Pressure<sup>2</sup> or characteristic diagram: *500±50 kPa*
- 3.2. Injection system
- 3.2.1. Pump
- 3.2.1.1. Make(s): *Denso*
- 3.2.1.2. Type(s): *HP3*
- 3.2.1.3. Delivery: *127 mm<sup>3</sup> per stroke<sup>2</sup> or cycle at engine speed of 1500 rpm at full injection, or characteristic diagram.*  
Mention the method used: *On engine / on pump bench<sup>1</sup>*
- 3.2.1.4. Injection advance
- 3.2.1.4.1. Injection advance curve<sup>2</sup>: *Controlled by ECU*
- 3.2.1.4.2. Timing<sup>2</sup>: *Controlled by ECU*
- 3.2.2. Injection piping
- 3.2.2.1. Length: *Pump-rail: 385 mm, rail-injector: 585 mm*
- 3.2.2.2. Internal diameter: *Pump-rail: 3.5 mm, rail-injector: 3.5 mm*
- 3.2.3. Injector(s)
- 3.2.3.1. Make(s): *Denso*
- 3.2.3.2. Type(s): *G3AM*
- 3.2.3.3. Opening pressure<sup>2</sup> or characteristic diagram: *Controlled by ECU*
- 3.2.4. Governor
- 3.2.4.1. Make(s): *Cummins Inc.*
- 3.2.4.2. Type(s): *CM2880*
- 3.2.4.3. Speed at which cut-off starts under full load<sup>2</sup>: *2230 rpm*
- 3.2.4.4. Maximum no-load speed<sup>2</sup>: *2380 rpm*
- 3.2.4.5. Idling speed<sup>2</sup>: *800±50 rpm*
- 3.2.5. Electronic Engine Management Control Unit
- 3.2.5.1. Make(s): *Cummins Inc.*
- 3.2.5.2. Type: *CM2880*
- 3.2.5.3. Software calibration number(s): *SC93616*
- 3.3. Cold Start System



- 3.3.1. Make(s): *Wenzhou Hua-ke Industry Developing Co., Ltd.*
- 3.3.2. Type(s): *HK0701M*
- 3.3.3. Description: *Electrical Grid Heater (24V)*

**4. Valve timing**

- 4.1. Maximum lift and angles of opening and closing in relation to dead centres or equivalent data:

*Maximum lift of inlet valve: 10 mm; Maximum lift of outlet valve: 11.8 mm*

*Angles of inlet valve opening: 11.5 °BTDC; closing: 9.5 °ABDC*

*Angles of outlet valve opening: 53 °BBDC; closing: 19 °ATDC*

- 4.2. Reference and/or setting ranges<sup>1</sup>:

*Intake: 0.25 mm, exhaust: 0.51 mm*

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<sup>1</sup> Strike out what does not apply.

<sup>2</sup> Specify the tolerance.

## Annex 1A - Appendix 3.2

### Essential characteristics of engine types within the family

#### 1. Description of engine

- 1.1. Manufacturer: *Dongfeng Cummins Engine Co., Ltd.*
- 1.2. Manufacturer's engine code: *QSB5.9-C190-30*
- 1.3. Cycle: *four stroke /two stroke<sup>1</sup>*
- 1.4. Bore: *102 mm*
- 1.5. Stroke: *120 mm*
- 1.6. Number and layout of cylinders:  
*6 Cylinders, In-line, Vertical*
- 1.7. Engine capacity:  *$5.9 \times 10^3 \text{ cm}^3$*
- 1.8. Rated speed: *2000 rpm*
- 1.9. Maximum torque speed: *1400 rpm*
- 1.10. Volumetric compression ratio<sup>2</sup>: *17.3:1*
- 1.11. Combustion system description: *Compression ignition & direct injection*
- 1.12. Drawing(s) of combustion chamber and piston crown:  
*Refer to the drawing of Attachment 2.*
- 1.13. Minimum cross-sectional area of inlet and outlet ports:  
*Inlet: 1381mm<sup>2</sup>, Outlet: 993mm<sup>2</sup>*
- 1.14. Cooling system
- 1.14.1. Liquid
- 1.14.1.1. Nature of liquid: *Water/Glycol Mix(50/50)*
- 1.14.1.2. Circulating pump(s): *yes /no<sup>1</sup>*
- 1.14.1.3. Characteristics or make(s) and type(s) (if applicable):  
*Make: Motor Pump Co., Ltd*  
*Type: Centrifugal pump*
- 1.14.1.4. Drive ratio(s) (if applicable): *2.0:1*
- 1.14.2. Air: *N/A*
- 1.15. Temperature permitted by the manufacturer
- 1.15.1. Liquid cooling: Maximum temperature at outlet: *373 K*
- 1.15.2. Air cooling: Reference point: *N/A*  
Maximum temperature at reference point: *N/A K*
- 1.15.3. Maximum charge air outlet temperature of the inlet intercooler (if applicable):  
*326 K*
- 1.15.4. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s): *973 K*
- 1.15.5. Fuel temperature: min: *303 K* max: *323 K*
- 1.15.6. Lubricant temperature: min: *333 K* max: *393 K*
- 1.16. Pressure charger: *yes /no<sup>1</sup>*
- 1.16.1. Make: *Wuxi Cummins Turbo Technologies Co., Ltd*



- 1.16.2. Type: *HE250WG*
- 1.16.3. Description of the system (e.g. max. charge pressure, waste-gate, if applicable):  
*Waste-gate turbocharger*
- 1.16.4. Intercooler: *yes / no<sup>1</sup>*
- 1.17. Intake system: Maximum allowable intake depression at rated engine speed and at 100 per cent load: *3.7 kPa*
- 1.18. Exhaust system: Maximum allowable exhaust backpressure at rated engine speed and at 100 per cent load: *10 kPa*

**2. Measures taken against air pollution:** *N/A*

**3. Fuel feed**

- 3.1. Feed pump  
Pressure<sup>2</sup> or characteristic diagram: *500±50 kPa*
- 3.2. Injection system
- 3.2.1. Pump
- 3.2.1.1. Make(s): *Denso*
- 3.2.1.2. Type(s): *HP3*
- 3.2.1.3. Delivery: *125 mm<sup>3</sup> per stroke<sup>2</sup> or cycle* at engine speed of *1400 rpm* at full injection, or characteristic diagram.  
Mention the method used: *On engine / on pump bench<sup>1</sup>*
- 3.2.1.4. Injection advance
- 3.2.1.4.1. Injection advance curve<sup>2</sup>: *Controlled by ECU*
- 3.2.1.4.2. Timing<sup>2</sup>: *Controlled by ECU*
- 3.2.2. Injection piping
- 3.2.2.1. Length: *Pump-rail: 385 mm, rail-injector: 585 mm*
- 3.2.2.2. Internal diameter: *Pump-rail: 3.5 mm, rail-injector: 3.5 mm*
- 3.2.3. Injector(s)
- 3.2.3.1. Make(s): *Denso*
- 3.2.3.2. Type(s): *G3AM*
- 3.2.3.3. Opening pressure<sup>2</sup> or characteristic diagram: *Controlled by ECU*
- 3.2.4. Governor
- 3.2.4.1. Make(s): *Cummins Inc.*
- 3.2.4.2. Type(s): *CM2880*
- 3.2.4.3. Speed at which cut-off starts under full load<sup>2</sup>: *2030 rpm*
- 3.2.4.4. Maximum no-load speed<sup>2</sup>: *2170 rpm*
- 3.2.4.5. Idling speed<sup>2</sup>: *800±50 rpm*
- 3.2.5. Electronic Engine Management Control Unit
- 3.2.5.1. Make(s): *Cummins Inc.*
- 3.2.5.2. Type: *CM2880*
- 3.2.5.3. Software calibration number(s): *SC93617*
- 3.3. Cold Start System



- 3.3.1. Make(s): Wenzhou Hua-ke Industry Developing Co., Ltd.
- 3.3.2. Type(s): HK0701M
- 3.3.3. Description: Electrical Grid Heater (24V)

**4. Valve timing**

- 4.1. Maximum lift and angles of opening and closing in relation to dead centres or equivalent data:

Maximum lift of inlet valve: 10 mm; Maximum lift of outlet valve: 11.8 mm

Angles of inlet valve opening: 11.5 °BTDC; closing: 9.5 °ABDC

Angles of outlet valve opening: 53 °BBDC; closing: 19 °ATDC

- 4.2. Reference and/or setting ranges<sup>1</sup>:

Intake: 0.25 mm, exhaust: 0.51 mm

---

<sup>1</sup> Strike out what does not apply.

<sup>2</sup> Specify the tolerance.

# Annex 1A - Appendix 3.3

## Essential characteristics of engine types within the family

### 1. Description of engine

- 1.1. Manufacturer: *Dongfeng Cummins Engine Co., Ltd.*
- 1.2. Manufacturer's engine code: *QSB5.9-C190-31*
- 1.3. Cycle: *four stroke /two stroke<sup>1</sup>*
- 1.4. Bore: *102 mm*
- 1.5. Stroke: *120 mm*
- 1.6. Number and layout of cylinders:  
*6 Cylinders, In-line, Vertical*
- 1.7. Engine capacity:  *$5.9 \times 10^3 \text{ cm}^3$*
- 1.8. Rated speed: *2200 rpm*
- 1.9. Maximum torque speed: *1500 rpm*
- 1.10. Volumetric compression ratio<sup>2</sup>: *17.3:1*
- 1.11. Combustion system description: *Compression ignition & direct injection*
- 1.12. Drawing(s) of combustion chamber and piston crown:  
*Refer to the drawing of Attachment 2.*
- 1.13. Minimum cross-sectional area of inlet and outlet ports:  
*Inlet: 1381mm<sup>2</sup>, Outlet: 993mm<sup>2</sup>*
- 1.14. Cooling system
- 1.14.1. Liquid
- 1.14.1.1. Nature of liquid: *Water/Glycol Mix(50/50)*
- 1.14.1.2. Circulating pump(s): *yes /no<sup>1</sup>*
- 1.14.1.3. Characteristics or make(s) and type(s) (if applicable):  
*Make: Motor Pump Co., Ltd*  
*Type: Centrifugal pump*
- 1.14.1.4. Drive ratio(s) (if applicable): *2.0:1*
- 1.14.2. Air: *N/A*
- 1.15. Temperature permitted by the manufacturer
- 1.15.1. Liquid cooling: Maximum temperature at outlet: *373 K*
- 1.15.2. Air cooling: Reference point: *N/A*  
Maximum temperature at reference point: *N/A K*
- 1.15.3. Maximum charge air outlet temperature of the inlet intercooler (if applicable):  
*326 K*
- 1.15.4. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s): *973 K*
- 1.15.5. Fuel temperature: min: *303 K* max: *323 K*
- 1.15.6. Lubricant temperature: min: *333 K* max: *393 K*
- 1.16. Pressure charger: *yes /no<sup>1</sup>*
- 1.16.1. Make: *Wuxi Cummins Turbo Technologies Co., Ltd*



- 1.16.2. Type: *HE250WG*
- 1.16.3. Description of the system (e.g. max. charge pressure, waste-gate, if applicable):  
*Waste-gate turbocharger*
- 1.16.4. Intercooler: *yes / no<sup>1</sup>*
- 1.17. Intake system: Maximum allowable intake depression at rated engine speed and at 100 per cent load: *3.7 kPa*
- 1.18. Exhaust system: Maximum allowable exhaust backpressure at rated engine speed and at 100 per cent load: *10 kPa*

**2. Measures taken against air pollution:** *N/A*

**3. Fuel feed**

- 3.1. Feed pump  
Pressure<sup>2</sup> or characteristic diagram: *500±50 kPa*
- 3.2. Injection system
- 3.2.1. Pump
- 3.2.1.1. Make(s): *Denso*
- 3.2.1.2. Type(s): *HP3*
- 3.2.1.3. Delivery: *125 mm<sup>3</sup> per stroke<sup>2</sup> or cycle* at engine speed of *1500 rpm* at full injection, or characteristic diagram.  
Mention the method used: *On engine / on pump bench<sup>1</sup>*
- 3.2.1.4. Injection advance
- 3.2.1.4.1. Injection advance curve<sup>2</sup>: *Controlled by ECU*
- 3.2.1.4.2. Timing<sup>2</sup>: *Controlled by ECU*
- 3.2.2. Injection piping
- 3.2.2.1. Length: *Pump-rail: 385 mm, rail-injector: 585 mm*
- 3.2.2.2. Internal diameter: *Pump-rail: 3.5 mm, rail-injector: 3.5 mm*
- 3.2.3. Injector(s)
- 3.2.3.1. Make(s): *Denso*
- 3.2.3.2. Type(s): *G3AM*
- 3.2.3.3. Opening pressure<sup>2</sup> or characteristic diagram: *Controlled by ECU*
- 3.2.4. Governor
- 3.2.4.1. Make(s): *Cummins Inc.*
- 3.2.4.2. Type(s): *CM2880*
- 3.2.4.3. Speed at which cut-off starts under full load<sup>2</sup>: *2230 rpm*
- 3.2.4.4. Maximum no-load speed<sup>2</sup>: *2380 rpm*
- 3.2.4.5. Idling speed<sup>2</sup>: *800±50 rpm*
- 3.2.5. Electronic Engine Management Control Unit
- 3.2.5.1. Make(s): *Cummins Inc.*
- 3.2.5.2. Type: *CM2880*
- 3.2.5.3. Software calibration number(s): *SC92962*
- 3.3. Cold Start System



- 3.3.1. Make(s): Wenzhou Hua-ke Industry Developing Co., Ltd.
- 3.3.2. Type(s): HK0701M
- 3.3.3. Description: Electrical Grid Heater (24V)

**4. Valve timing**

- 4.1. Maximum lift and angles of opening and closing in relation to dead centres or equivalent data:

Maximum lift of inlet valve: 10 mm; Maximum lift of outlet valve: 11.8 mm

Angles of inlet valve opening: 11.5 °BTDC; closing: 9.5 °ABDC

Angles of outlet valve opening: 53 °BBDC; closing: 19 °ATDC

- 4.2. Reference and/or setting ranges<sup>1</sup>:

Intake: 0.25 mm, exhaust: 0.51 mm

---

<sup>1</sup> Strike out what does not apply.

<sup>2</sup> Specify the tolerance.

# Annex 1A - Appendix 3.4

## Essential characteristics of engine types within the family

### 1. Description of engine

- 1.1. Manufacturer: *Dongfeng Cummins Engine Co., Ltd.*
- 1.2. Manufacturer's engine code: *QSB5.9-C180-30*
- 1.3. Cycle: *four stroke / ~~two stroke~~<sup>1</sup>*
- 1.4. Bore: *102 mm*
- 1.5. Stroke: *120 mm*
- 1.6. Number and layout of cylinders:  
*6 Cylinders, In-line, Vertical*
- 1.7. Engine capacity:  *$5.9 \times 10^3 \text{ cm}^3$*
- 1.8. Rated speed: *2200 rpm*
- 1.9. Maximum torque speed: *1500 rpm*
- 1.10. Volumetric compression ratio<sup>2</sup>: *17.3:1*
- 1.11. Combustion system description: *Compression ignition & direct injection*
- 1.12. Drawing(s) of combustion chamber and piston crown:  
*Refer to the drawing of Attachment 2.*
- 1.13. Minimum cross-sectional area of inlet and outlet ports:  
*Inlet: 1381mm<sup>2</sup>, Outlet: 993mm<sup>2</sup>*
- 1.14. Cooling system
- 1.14.1. Liquid
- 1.14.1.1. Nature of liquid: *Water/Glycol Mix(50/50)*
- 1.14.1.2. Circulating pump(s): *yes / ~~no~~<sup>1</sup>*
- 1.14.1.3. Characteristics or make(s) and type(s) (if applicable):  
*Make: Motor Pump Co., Ltd*  
*Type: Centrifugal pump*
- 1.14.1.4. Drive ratio(s) (if applicable): *2.0:1*
- 1.14.2. Air: *N/A*
- 1.15. Temperature permitted by the manufacturer
- 1.15.1. Liquid cooling: Maximum temperature at outlet: *373 K*
- 1.15.2. Air cooling: Reference point: *N/A*  
Maximum temperature at reference point: *N/A K*
- 1.15.3. Maximum charge air outlet temperature of the inlet intercooler (if applicable):  
*326 K*
- 1.15.4. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s): *973 K*
- 1.15.5. Fuel temperature: min: *303 K* max: *323 K*
- 1.15.6. Lubricant temperature: min: *333 K* max: *393 K*
- 1.16. Pressure charger: *yes / ~~no~~<sup>1</sup>*
- 1.16.1. Make: *Wuxi Cummins Turbo Technologies Co., Ltd*



- 1.16.2. Type: *HE250WG*
- 1.16.3. Description of the system (e.g. max. charge pressure, waste-gate, if applicable):  
*Waste-gate turbocharger*
- 1.16.4. Intercooler: *yes / no<sup>1</sup>*
- 1.17. Intake system: Maximum allowable intake depression at rated engine speed and at 100 per cent load: *3.7 kPa*
- 1.18. Exhaust system: Maximum allowable exhaust backpressure at rated engine speed and at 100 per cent load: *10 kPa*

**2. Measures taken against air pollution:** *N/A*

**3. Fuel feed**

- 3.1. Feed pump  
Pressure<sup>2</sup> or characteristic diagram: *500±50 kPa*
- 3.2. Injection system
- 3.2.1. Pump
- 3.2.1.1. Make(s): *Denso*
- 3.2.1.2. Type(s): *HP3*
- 3.2.1.3. Delivery: *125 mm<sup>3</sup> per stroke<sup>2</sup> or cycle* at engine speed of *1500 rpm* at full injection, or characteristic diagram.  
Mention the method used: *On engine / on pump bench<sup>1</sup>*
- 3.2.1.4. Injection advance
- 3.2.1.4.1. Injection advance curve<sup>2</sup>: *Controlled by ECU*
- 3.2.1.4.2. Timing<sup>2</sup>: *Controlled by ECU*
- 3.2.2. Injection piping
- 3.2.2.1. Length: *Pump-rail: 385 mm, rail-injector: 585 mm*
- 3.2.2.2. Internal diameter: *Pump-rail: 3.5 mm, rail-injector: 3.5 mm*
- 3.2.3. Injector(s)
- 3.2.3.1. Make(s): *Denso*
- 3.2.3.2. Type(s): *G3AM*
- 3.2.3.3. Opening pressure<sup>2</sup> or characteristic diagram: *Controlled by ECU*
- 3.2.4. Governor
- 3.2.4.1. Make(s): *Cummins Inc.*
- 3.2.4.2. Type(s): *CM2880*
- 3.2.4.3. Speed at which cut-off starts under full load<sup>2</sup>: *2230 rpm*
- 3.2.4.4. Maximum no-load speed<sup>2</sup>: *2380 rpm*
- 3.2.4.5. Idling speed<sup>2</sup>: *800±50 rpm*
- 3.2.5. Electronic Engine Management Control Unit
- 3.2.5.1. Make(s): *Cummins Inc.*
- 3.2.5.2. Type: *CM2880*
- 3.2.5.3. Software calibration number(s): *SC92963*
- 3.3. Cold Start System



- 3.3.1. Make(s): Wenzhou Hua-ke Industry Developing Co., Ltd.
- 3.3.2. Type(s): HK0701M
- 3.3.3. Description: Electrical Grid Heater (24V)

**4. Valve timing**

- 4.1. Maximum lift and angles of opening and closing in relation to dead centres or equivalent data:

Maximum lift of inlet valve: 10 mm; Maximum lift of outlet valve: 11.8 mm

Angles of inlet valve opening: 11.5 °BTDC; closing: 9.5 °ABDC

Angles of outlet valve opening: 53 °BBDC; closing: 19 °ATDC

- 4.2. Reference and/or setting ranges<sup>1</sup>:

Intake: 0.25 mm, exhaust: 0.51 mm

---

<sup>1</sup> Strike out what does not apply.

<sup>2</sup> Specify the tolerance.

# Annex 1A - Appendix 3.5

## Essential characteristics of engine types within the family

### 1. Description of engine

- 1.1. Manufacturer: *Dongfeng Cummins Engine Co., Ltd.*
- 1.2. Manufacturer's engine code: *QSB5.9-C180-31*
- 1.3. Cycle: *four stroke /two stroke<sup>1</sup>*
- 1.4. Bore: *102 mm*
- 1.5. Stroke: *120 mm*
- 1.6. Number and layout of cylinders:  
*6 Cylinders, In-line, Vertical*
- 1.7. Engine capacity:  *$5.9 \times 10^3 \text{ cm}^3$*
- 1.8. Rated speed: *2400 rpm*
- 1.9. Maximum torque speed: *1500 rpm*
- 1.10. Volumetric compression ratio<sup>2</sup>: *17.3:1*
- 1.11. Combustion system description: *Compression ignition & direct injection*
- 1.12. Drawing(s) of combustion chamber and piston crown:  
*Refer to the drawing of Attachment 2.*
- 1.13. Minimum cross-sectional area of inlet and outlet ports:  
*Inlet: 1381mm<sup>2</sup>, Outlet: 993mm<sup>2</sup>*
- 1.14. Cooling system
- 1.14.1. Liquid
- 1.14.1.1. Nature of liquid: *Water/Glycol Mix(50/50)*
- 1.14.1.2. Circulating pump(s): *yes /no<sup>1</sup>*
- 1.14.1.3. Characteristics or make(s) and type(s) (if applicable):  
*Make: Motor Pump Co., Ltd*  
*Type: Centrifugal pump*
- 1.14.1.4. Drive ratio(s) (if applicable): *2.0:1*
- 1.14.2. Air: *N/A*
- 1.15. Temperature permitted by the manufacturer
- 1.15.1. Liquid cooling: Maximum temperature at outlet: *373 K*
- 1.15.2. Air cooling: Reference point: *N/A*  
Maximum temperature at reference point: *N/A K*
- 1.15.3. Maximum charge air outlet temperature of the inlet intercooler (if applicable):  
*326 K*
- 1.15.4. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s): *973 K*
- 1.15.5. Fuel temperature: min: *303 K* max: *323 K*
- 1.15.6. Lubricant temperature: min: *333 K* max: *393 K*
- 1.16. Pressure charger: *yes /no<sup>1</sup>*
- 1.16.1. Make: *Wuxi Cummins Turbo Technologies Co., Ltd*



- 1.16.2. Type: *HE250WG*
- 1.16.3. Description of the system (e.g. max. charge pressure, waste-gate, if applicable):  
*Waste-gate turbocharger*
- 1.16.4. Intercooler: *yes / no<sup>1</sup>*
- 1.17. Intake system: Maximum allowable intake depression at rated engine speed and at 100 per cent load: *3.7 kPa*
- 1.18. Exhaust system: Maximum allowable exhaust backpressure at rated engine speed and at 100 per cent load: *10 kPa*

**2. Measures taken against air pollution:** *N/A*

**3. Fuel feed**

- 3.1. Feed pump  
Pressure<sup>2</sup> or characteristic diagram: *500±50 kPa*
- 3.2. Injection system
- 3.2.1. Pump
- 3.2.1.1. Make(s): *Denso*
- 3.2.1.2. Type(s): *HP3*
- 3.2.1.3. Delivery: *125 mm<sup>3</sup> per stroke<sup>2</sup> or cycle* at engine speed of *1500 rpm* at full injection, or characteristic diagram.  
Mention the method used: *On engine / on pump bench<sup>1</sup>*
- 3.2.1.4. Injection advance
- 3.2.1.4.1. Injection advance curve<sup>2</sup>: *Controlled by ECU*
- 3.2.1.4.2. Timing<sup>2</sup>: *Controlled by ECU*
- 3.2.2. Injection piping
- 3.2.2.1. Length: *Pump-rail: 385 mm, rail-injector: 585 mm*
- 3.2.2.2. Internal diameter: *Pump-rail: 3.5 mm, rail-injector: 3.5 mm*
- 3.2.3. Injector(s)
- 3.2.3.1. Make(s): *Denso*
- 3.2.3.2. Type(s): *G3AM*
- 3.2.3.3. Opening pressure<sup>2</sup> or characteristic diagram: *Controlled by ECU*
- 3.2.4. Governor
- 3.2.4.1. Make(s): *Cummins Inc.*
- 3.2.4.2. Type(s): *CM2880*
- 3.2.4.3. Speed at which cut-off starts under full load<sup>2</sup>: *2430 rpm*
- 3.2.4.4. Maximum no-load speed<sup>2</sup>: *2600 rpm*
- 3.2.4.5. Idling speed<sup>2</sup>: *800±50 rpm*
- 3.2.5. Electronic Engine Management Control Unit
- 3.2.5.1. Make(s): *Cummins Inc.*
- 3.2.5.2. Type: *CM2880*
- 3.2.5.3. Software calibration number(s): *SC92846*
- 3.3. Cold Start System



- 3.3.1. Make(s): Wenzhou Hua-ke Industry Developing Co., Ltd.
- 3.3.2. Type(s): HK0701M
- 3.3.3. Description: Electrical Grid Heater (24V)

**4. Valve timing**

- 4.1. Maximum lift and angles of opening and closing in relation to dead centres or equivalent data:

Maximum lift of inlet valve: 10 mm; Maximum lift of outlet valve: 11.8 mm

Angles of inlet valve opening: 11.5 °BTDC; closing: 9.5 °ABDC

Angles of outlet valve opening: 53 °BBDC; closing: 19 °ATDC

- 4.2. Reference and/or setting ranges<sup>1</sup>:

Intake: 0.25 mm, exhaust: 0.51 mm

---

<sup>1</sup> Strike out what does not apply.

<sup>2</sup> Specify the tolerance.

# Annex 1A - Appendix 3.6

## Essential characteristics of engine types within the family

### 1. Description of engine

- 1.1. Manufacturer: *Dongfeng Cummins Engine Co., Ltd.*
- 1.2. Manufacturer's engine code: *QSB5.9-C180-32*
- 1.3. Cycle: *four stroke /two stroke<sup>1</sup>*
- 1.4. Bore: *102 mm*
- 1.5. Stroke: *120 mm*
- 1.6. Number and layout of cylinders:  
*6 Cylinders, In-line, Vertical*
- 1.7. Engine capacity:  *$5.9 \times 10^3 \text{ cm}^3$*
- 1.8. Rated speed: *2000 rpm*
- 1.9. Maximum torque speed: *1400 rpm*
- 1.10. Volumetric compression ratio<sup>2</sup>: *17.3:1*
- 1.11. Combustion system description: *Compression ignition & direct injection*
- 1.12. Drawing(s) of combustion chamber and piston crown:  
*Refer to the drawing of Attachment 2.*
- 1.13. Minimum cross-sectional area of inlet and outlet ports:  
*Inlet: 1381mm<sup>2</sup>, Outlet: 993mm<sup>2</sup>*
- 1.14. Cooling system
- 1.14.1. Liquid
- 1.14.1.1. Nature of liquid: *Water/Glycol Mix(50/50)*
- 1.14.1.2. Circulating pump(s): *yes /no<sup>1</sup>*
- 1.14.1.3. Characteristics or make(s) and type(s) (if applicable):  
*Make: Motor Pump Co., Ltd*  
*Type: Centrifugal pump*
- 1.14.1.4. Drive ratio(s) (if applicable): *2.0:1*
- 1.14.2. Air: *N/A*
- 1.15. Temperature permitted by the manufacturer
- 1.15.1. Liquid cooling: Maximum temperature at outlet: *373 K*
- 1.15.2. Air cooling: Reference point: *N/A*  
Maximum temperature at reference point: *N/A K*
- 1.15.3. Maximum charge air outlet temperature of the inlet intercooler (if applicable):  
*326 K*
- 1.15.4. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s): *973 K*
- 1.15.5. Fuel temperature: min: *303 K* max: *323 K*
- 1.15.6. Lubricant temperature: min: *333 K* max: *393 K*
- 1.16. Pressure charger: *yes /no<sup>1</sup>*
- 1.16.1. Make: *Wuxi Cummins Turbo Technologies Co., Ltd*



- 1.16.2. Type: *HE250WG*
- 1.16.3. Description of the system (e.g. max. charge pressure, waste-gate, if applicable):  
*Waste-gate turbocharger*
- 1.16.4. Intercooler: *yes / no<sup>1</sup>*
- 1.17. Intake system: Maximum allowable intake depression at rated engine speed and at 100 per cent load: *3.7 kPa*
- 1.18. Exhaust system: Maximum allowable exhaust backpressure at rated engine speed and at 100 per cent load: *10 kPa*

**2. Measures taken against air pollution:** *N/A*

**3. Fuel feed**

- 3.1. Feed pump  
Pressure<sup>2</sup> or characteristic diagram: *500±50 kPa*
- 3.2. Injection system
- 3.2.1. Pump
- 3.2.1.1. Make(s): *Denso*
- 3.2.1.2. Type(s): *HP3*
- 3.2.1.3. Delivery: *110 mm<sup>3</sup> per stroke<sup>2</sup> or cycle* at engine speed of *1400 rpm* at full injection, or characteristic diagram.  
Mention the method used: *On engine / on pump bench<sup>1</sup>*
- 3.2.1.4. Injection advance
- 3.2.1.4.1. Injection advance curve<sup>2</sup>: *Controlled by ECU*
- 3.2.1.4.2. Timing<sup>2</sup>: *Controlled by ECU*
- 3.2.2. Injection piping
- 3.2.2.1. Length: *Pump-rail: 385 mm, rail-injector: 585 mm*
- 3.2.2.2. Internal diameter: *Pump-rail: 3.5 mm, rail-injector: 3.5 mm*
- 3.2.3. Injector(s)
- 3.2.3.1. Make(s): *Denso*
- 3.2.3.2. Type(s): *G3AM*
- 3.2.3.3. Opening pressure<sup>2</sup> or characteristic diagram: *Controlled by ECU*
- 3.2.4. Governor
- 3.2.4.1. Make(s): *Cummins Inc.*
- 3.2.4.2. Type(s): *CM2880*
- 3.2.4.3. Speed at which cut-off starts under full load<sup>2</sup>: *2030 rpm*
- 3.2.4.4. Maximum no-load speed<sup>2</sup>: *2170 rpm*
- 3.2.4.5. Idling speed<sup>2</sup>: *800±50 rpm*
- 3.2.5. Electronic Engine Management Control Unit
- 3.2.5.1. Make(s): *Cummins Inc.*
- 3.2.5.2. Type: *CM2880*
- 3.2.5.3. Software calibration number(s): *SC92964*
- 3.3. Cold Start System



- 3.3.1. Make(s): *Wenzhou Hua-ke Industry Developing Co., Ltd.*
- 3.3.2. Type(s): *HK0701M*
- 3.3.3. Description: *Electrical Grid Heater (24V)*

**4. Valve timing**

- 4.1. Maximum lift and angles of opening and closing in relation to dead centres or equivalent data:

*Maximum lift of inlet valve: 10 mm; Maximum lift of outlet valve: 11.8 mm*

*Angles of inlet valve opening: 11.5 °BTDC; closing: 9.5 °ABDC*

*Angles of outlet valve opening: 53 °BBDC; closing: 19 °ATDC*

- 4.2. Reference and/or setting ranges<sup>1</sup>:

*Intake: 0.25 mm, exhaust: 0.51 mm*

---

<sup>1</sup> Strike out what does not apply.

<sup>2</sup> Specify the tolerance.

# Annex 1A - Appendix 3.7

## Essential characteristics of engine types within the family

### 1. Description of engine

- 1.1. Manufacturer: *Dongfeng Cummins Engine Co., Ltd.*
- 1.2. Manufacturer's engine code: *QSB5.9-C180-33*
- 1.3. Cycle: *four stroke /two stroke<sup>1</sup>*
- 1.4. Bore: *102 mm*
- 1.5. Stroke: *120 mm*
- 1.6. Number and layout of cylinders:  
*6 Cylinders, In-line, Vertical*
- 1.7. Engine capacity:  *$5.9 \times 10^3$  cm<sup>3</sup>*
- 1.8. Rated speed: *2200 rpm*
- 1.9. Maximum torque speed: *1500 rpm*
- 1.10. Volumetric compression ratio<sup>2</sup>: *17.3:1*
- 1.11. Combustion system description: *Compression ignition & direct injection*
- 1.12. Drawing(s) of combustion chamber and piston crown:  
*Refer to the drawing of Attachment 2.*
- 1.13. Minimum cross-sectional area of inlet and outlet ports:  
*Inlet: 1381mm<sup>2</sup>, Outlet: 993mm<sup>2</sup>*
- 1.14. Cooling system
- 1.14.1. Liquid
- 1.14.1.1. Nature of liquid: *Water/Glycol Mix(50/50)*
- 1.14.1.2. Circulating pump(s): *yes /no<sup>1</sup>*
- 1.14.1.3. Characteristics or make(s) and type(s) (if applicable):  
*Make: Motor Pump Co., Ltd*  
*Type: Centrifugal pump*
- 1.14.1.4. Drive ratio(s) (if applicable): *2.0:1*
- 1.14.2. Air: *N/A*
- 1.15. Temperature permitted by the manufacturer
- 1.15.1. Liquid cooling: Maximum temperature at outlet: *373 K*
- 1.15.2. Air cooling: Reference point: *N/A*  
Maximum temperature at reference point: *N/A K*
- 1.15.3. Maximum charge air outlet temperature of the inlet intercooler (if applicable):  
*326 K*
- 1.15.4. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s): *973 K*
- 1.15.5. Fuel temperature: min: *303 K* max: *323 K*
- 1.15.6. Lubricant temperature: min: *333 K* max: *393 K*
- 1.16. Pressure charger: *yes /no<sup>1</sup>*
- 1.16.1. Make: *Wuxi Cummins Turbo Technologies Co., Ltd*



- 1.16.2. Type: *HE250WG*
- 1.16.3. Description of the system (e.g. max. charge pressure, waste-gate, if applicable):  
*Waste-gate turbocharger*
- 1.16.4. Intercooler: *yes / no<sup>1</sup>*
- 1.17. Intake system: Maximum allowable intake depression at rated engine speed and at 100 per cent load: *3.7 kPa*
- 1.18. Exhaust system: Maximum allowable exhaust backpressure at rated engine speed and at 100 per cent load: *10 kPa*

**2. Measures taken against air pollution:** *N/A*

**3. Fuel feed**

- 3.1. Feed pump  
Pressure<sup>2</sup> or characteristic diagram: *500±50 kPa*
- 3.2. Injection system
- 3.2.1. Pump
- 3.2.1.1. Make(s): *Denso*
- 3.2.1.2. Type(s): *HP3*
- 3.2.1.3. Delivery: *125 mm<sup>3</sup> per stroke<sup>2</sup> or cycle* at engine speed of *1500 rpm* at full injection, or characteristic diagram.  
Mention the method used: *On engine / on pump bench<sup>1</sup>*
- 3.2.1.4. Injection advance
- 3.2.1.4.1. Injection advance curve<sup>2</sup>: *Controlled by ECU*
- 3.2.1.4.2. Timing<sup>2</sup>: *Controlled by ECU*
- 3.2.2. Injection piping
- 3.2.2.1. Length: *Pump-rail: 385 mm, rail-injector: 585 mm*
- 3.2.2.2. Internal diameter: *Pump-rail: 3.5 mm, rail-injector: 3.5 mm*
- 3.2.3. Injector(s)
- 3.2.3.1. Make(s): *Denso*
- 3.2.3.2. Type(s): *G3AM*
- 3.2.3.3. Opening pressure<sup>2</sup> or characteristic diagram: *Controlled by ECU*
- 3.2.4. Governor
- 3.2.4.1. Make(s): *Cummins Inc.*
- 3.2.4.2. Type(s): *CM2880*
- 3.2.4.3. Speed at which cut-off starts under full load<sup>2</sup>: *2230 rpm*
- 3.2.4.4. Maximum no-load speed<sup>2</sup>: *2380 rpm*
- 3.2.4.5. Idling speed<sup>2</sup>: *800±50 rpm*
- 3.2.5. Electronic Engine Management Control Unit
- 3.2.5.1. Make(s): *Cummins Inc.*
- 3.2.5.2. Type: *CM2880*
- 3.2.5.3. Software calibration number(s): *SC92845*
- 3.3. Cold Start System



- 3.3.1. Make(s): *Wenzhou Hua-ke Industry Developing Co., Ltd.*
- 3.3.2. Type(s): *HK0701M*
- 3.3.3. Description: *Electrical Grid Heater (24V)*

**4. Valve timing**

- 4.1. Maximum lift and angles of opening and closing in relation to dead centres or equivalent data:

*Maximum lift of inlet valve: 10 mm; Maximum lift of outlet valve: 11.8 mm*

*Angles of inlet valve opening: 11.5 °BTDC; closing: 9.5 °ABDC*

*Angles of outlet valve opening: 53 °BBDC; closing: 19 °ATDC*

- 4.2. Reference and/or setting ranges<sup>1</sup>:

*Intake: 0.25 mm, exhaust: 0.51 mm*

---

<sup>1</sup> Strike out what does not apply.

<sup>2</sup> Specify the tolerance.

# Annex 1A - Appendix 3.8

## Essential characteristics of engine types within the family

### 1. Description of engine

- 1.1. Manufacturer: *Dongfeng Cummins Engine Co., Ltd.*
- 1.2. Manufacturer's engine code: *QSB5.9-C180-34*
- 1.3. Cycle: *four stroke / ~~two stroke~~<sup>1</sup>*
- 1.4. Bore: *102 mm*
- 1.5. Stroke: *120 mm*
- 1.6. Number and layout of cylinders:  
*6 Cylinders, In-line, Vertical*
- 1.7. Engine capacity:  *$5.9 \times 10^3 \text{ cm}^3$*
- 1.8. Rated speed: *2000 rpm*
- 1.9. Maximum torque speed: *1400 rpm*
- 1.10. Volumetric compression ratio<sup>2</sup>: *17.3:1*
- 1.11. Combustion system description: *Compression ignition & direct injection*
- 1.12. Drawing(s) of combustion chamber and piston crown:  
*Refer to the drawing of Attachment 2.*
- 1.13. Minimum cross-sectional area of inlet and outlet ports:  
*Inlet: 1381mm<sup>2</sup>, Outlet: 993mm<sup>2</sup>*
- 1.14. Cooling system
- 1.14.1. Liquid
- 1.14.1.1. Nature of liquid: *Water/Glycol Mix(50/50)*
- 1.14.1.2. Circulating pump(s): *yes / ~~no~~<sup>1</sup>*
- 1.14.1.3. Characteristics or make(s) and type(s) (if applicable):  
*Make: Motor Pump Co., Ltd*  
*Type: Centrifugal pump*
- 1.14.1.4. Drive ratio(s) (if applicable): *2.0:1*
- 1.14.2. Air: *N/A*
- 1.15. Temperature permitted by the manufacturer
- 1.15.1. Liquid cooling: Maximum temperature at outlet: *373 K*
- 1.15.2. Air cooling: Reference point: *N/A*  
Maximum temperature at reference point: *N/A K*
- 1.15.3. Maximum charge air outlet temperature of the inlet intercooler (if applicable):  
*326 K*
- 1.15.4. Maximum exhaust temperature at the point in the exhaust pipe(s) adjacent to the outer flange(s) of the exhaust manifold(s): *973 K*
- 1.15.5. Fuel temperature: min: *303 K* max: *323 K*
- 1.15.6. Lubricant temperature: min: *333 K* max: *393 K*
- 1.16. Pressure charger: *yes / ~~no~~<sup>1</sup>*
- 1.16.1. Make: *Wuxi Cummins Turbo Technologies Co., Ltd*



- 1.16.2. Type: *HE250WG*
- 1.16.3. Description of the system (e.g. max. charge pressure, waste-gate, if applicable):  
*Waste-gate turbocharger*
- 1.16.4. Intercooler: *yes / no<sup>1</sup>*
- 1.17. Intake system: Maximum allowable intake depression at rated engine speed and at 100 per cent load: *3.7 kPa*
- 1.18. Exhaust system: Maximum allowable exhaust backpressure at rated engine speed and at 100 per cent load: *10 kPa*

**2. Measures taken against air pollution:** *N/A*

**3. Fuel feed**

- 3.1. Feed pump  
Pressure<sup>2</sup> or characteristic diagram: *500±50 kPa*
- 3.2. Injection system
- 3.2.1. Pump
- 3.2.1.1. Make(s): *Denso*
- 3.2.1.2. Type(s): *HP3*
- 3.2.1.3. Delivery: *120 mm<sup>3</sup> per stroke<sup>2</sup> or cycle* at engine speed of *1400 rpm* at full injection, or characteristic diagram.  
Mention the method used: *On engine / on pump bench<sup>1</sup>*
- 3.2.1.4. Injection advance
- 3.2.1.4.1. Injection advance curve<sup>2</sup>: *Controlled by ECU*
- 3.2.1.4.2. Timing<sup>2</sup>: *Controlled by ECU*
- 3.2.2. Injection piping
- 3.2.2.1. Length: *Pump-rail: 385 mm, rail-injector: 585 mm*
- 3.2.2.2. Internal diameter: *Pump-rail: 3.5 mm, rail-injector: 3.5 mm*
- 3.2.3. Injector(s)
- 3.2.3.1. Make(s): *Denso*
- 3.2.3.2. Type(s): *G3AM*
- 3.2.3.3. Opening pressure<sup>2</sup> or characteristic diagram: *Controlled by ECU*
- 3.2.4. Governor
- 3.2.4.1. Make(s): *Cummins Inc.*
- 3.2.4.2. Type(s): *CM2880*
- 3.2.4.3. Speed at which cut-off starts under full load<sup>2</sup>: *2030 rpm*
- 3.2.4.4. Maximum no-load speed<sup>2</sup>: *2170 rpm*
- 3.2.4.5. Idling speed<sup>2</sup>: *800±50 rpm*
- 3.2.5. Electronic Engine Management Control Unit
- 3.2.5.1. Make(s): *Cummins Inc.*
- 3.2.5.2. Type: *CM2880*
- 3.2.5.3. Software calibration number(s): *SC93315*
- 3.3. Cold Start System



- 3.3.1. Make(s): Wenzhou Hua-ke Industry Developing Co., Ltd.
- 3.3.2. Type(s): HK0701M
- 3.3.3. Description: Electrical Grid Heater (24V)

**4. Valve timing**

- 4.1. Maximum lift and angles of opening and closing in relation to dead centres or equivalent data:

Maximum lift of inlet valve: 10 mm; Maximum lift of outlet valve: 11.8 mm

Angles of inlet valve opening: 11.5 °BTDC; closing: 9.5 °ABDC

Angles of outlet valve opening: 53 °BBDC; closing: 19 °ATDC

- 4.2. Reference and/or setting ranges<sup>1</sup>:

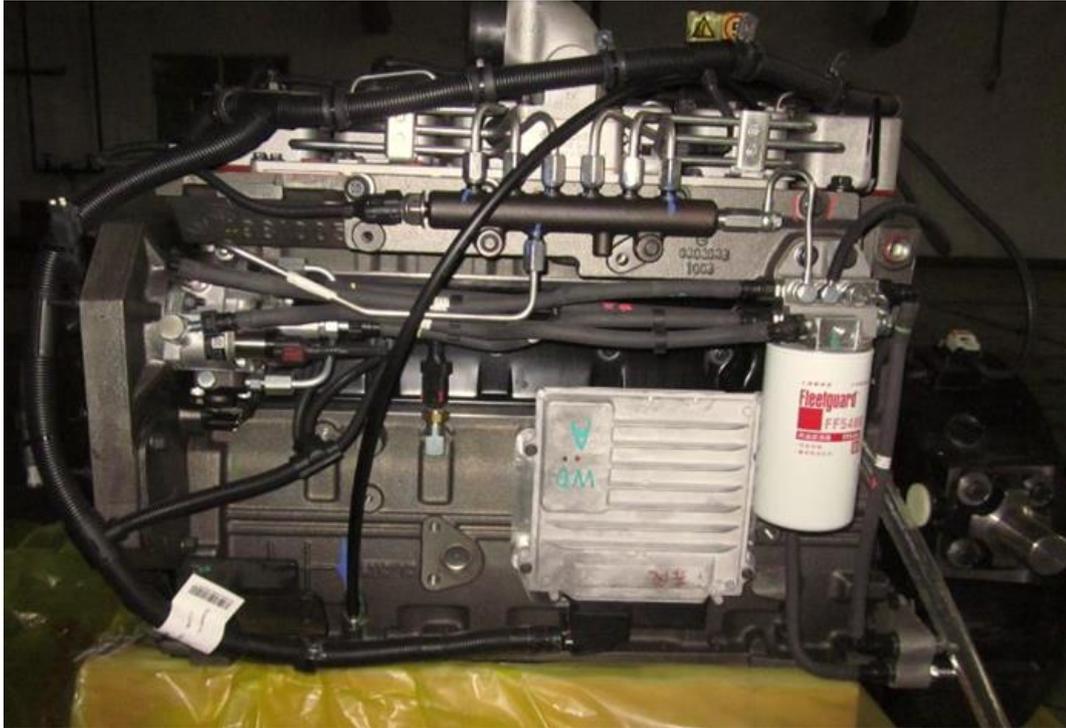
Intake: 0.25 mm, exhaust: 0.51 mm

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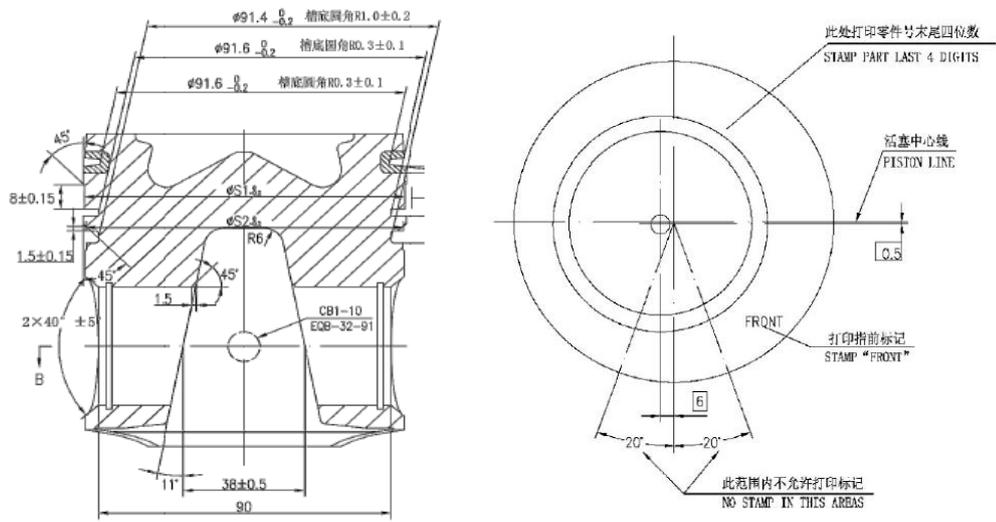
<sup>1</sup> Strike out what does not apply.

<sup>2</sup> Specify the tolerance.

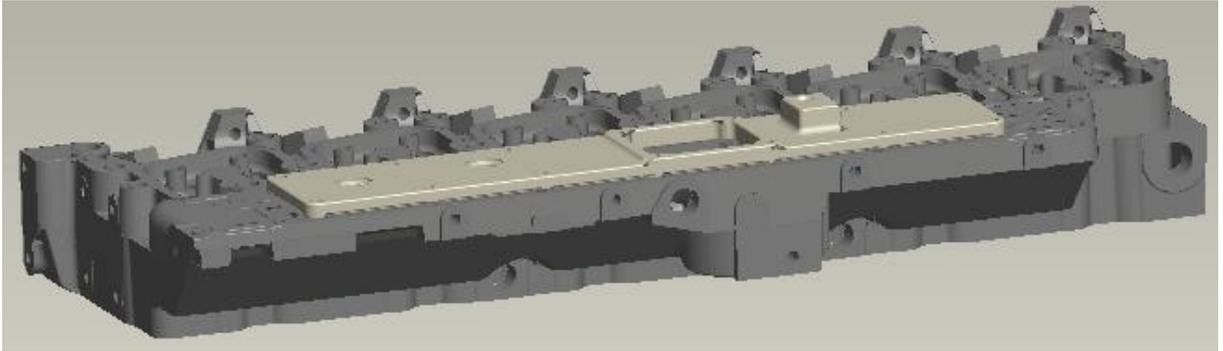
*Attachment 1. The photograph of parent engine*



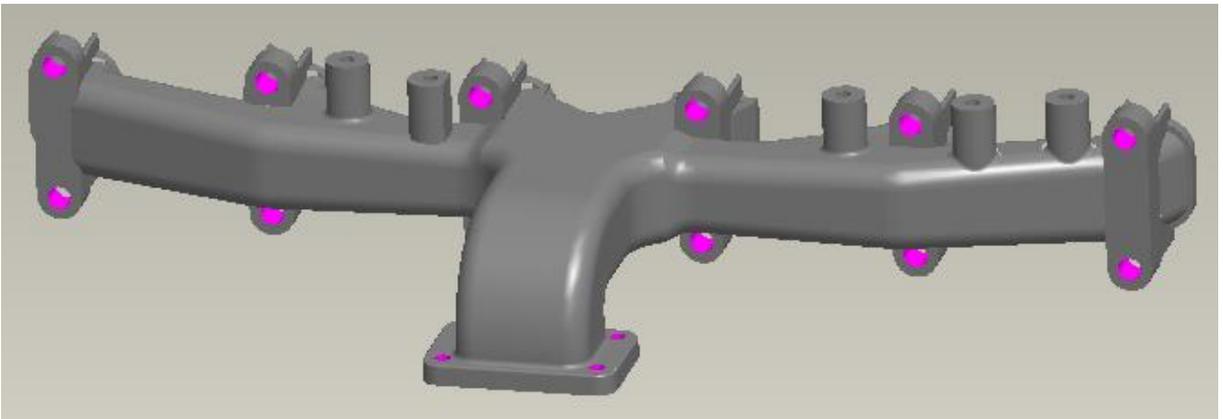
**Attachment 2. Drawing of combustion chamber and piston crown**



*Attachment 3. The drawing of intake manifold*



*Attachment 4. The drawing of exhaust manifold*





Vehicle Certification Agency  
1 The Eastgate Office Centre  
Eastgate Road  
Bristol  
BS5 6XX  
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Email: [enquiries@vca.gov.uk](mailto:enquiries@vca.gov.uk)  
[www.dft.gov.uk/vca/](http://www.dft.gov.uk/vca/)

**TEST REPORT: Non-Road Mobile Machinery – Compression Ignition, NRSC & NRTC**

UNECE Regulation 96.04 (Revision 3)

**REPORT/JOB NUMBER:** MSS365948

**TEST DETAILS**

Location of Test	Dongfeng Cummins Engine Co., Ltd. High and New Technology Industrial Development Zone, Xiangyang, Hubei Province, China 441004
Date of Test	21 June 2016
VCA Representative(s)	Oliver Lue
Manufacturer's Representative(s)	Mr. Li Yugui
Reason for Test	New approval

**MANUFACTURER DETAILS**

Manufacturer's Name	Dongfeng Cummins Engine Co., Ltd.
Manufacturer's Address	High and New Technology Industrial Development Zone, Xiangyang, Hubei Province, China 441004
Model Type & description	QSB5.9-C210-30
Category	Power Band H

**CONCLUSION**

The above mentioned vehicle/component was tested in accordance with UNECE Regulation 96.04 Supp 1(Rev 3, Amend 1) and was found to comply in all respects

Signature:   
Name: Oliver Lue  
Position: Type Approval Engineer  
Date: 18 July 2016

**LIST OF ANNEXES**

ANNEX	No of PAGES	SUBJECT
1	1	Test photos
2	4	Lab test report

**CROSS REFERENCES**

NOx Control Measures – VCA job no.	Not applicable
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**TEST REPORT: Non-Road Mobile Machinery – Compression Ignition,  
NRSC & NRTC**

UNECE Regulation 96.04

**TEST SPECIFICATION AND WORST CASE RATIONALE**

Parent engine: QSB5.9-C210-30, family engines: QSB5.9-C205-30; QSB5.9-C190-30; QSB5.9-C190-31; QSB5.9-C180-30; QSB5.9-C180-31; QSB5.9-C180-32; QSB5.9-C180-33; QSB5.9-C180-34

According to the worse case selection criterion, engine type QSB5.9-C210-30 with the highest fuel delivery per stroke at the declared maximum torque speed is selected as the parent engine.

Tests required (if more than one is applicable)

- NRSC
- ~~Random Points (stage IV only)~~
- ~~NRTC (Cold and Hot Start)~~
- ~~After treatment regeneration~~
- ~~NOx control measures~~

**COMPONENT SPECIFICATION (as specified in agreed worse case rationale)**

Engine Serial Number	78152634
Engine Calibration Number	SC92844
Declared Maximum Power	154kW / 2200rpm
Declared Exhaust Back Pressure	10 kPa
Declared Air Inlet Restriction	3.7 kPa
ATS maximum distance	N/A

**MANUFACTURER'S DOCUMENTATION**

Manufacturer's documentation is complete and reflects the agreed specification for the component tested and covers all variants and versions agreed in the worst case rationale Yes

**FACILITY AND EQUIPMENT CHECKS**

1	Generic Risk assessment followed <i>Insert RA identifier here</i>	N/A	N/A
	OR		
	Specific Risk assessment completed and stored in electronic job folder		N/A
2	Facilities and test equipment are appropriate Brief description of test equipment:		Yes
3	Calibration certificates checked and valid, recorded in the following table		Yes

Equipment / Test	Acceptance	Frequency	Serial No. / Value	Calibration Due Date
Dynamometer	< 2%	3 Months	80014102/1 2011	2016/08/12



**TEST REPORT: Non-Road Mobile Machinery – Compression Ignition,  
NRSC & NRTC**

UNECE Regulation 96.04

Fuel Certificate	Annex V	per batch	N/A	N/A
Gas analyser linearity	< 2%	3 Months	0.537%	2016/08/12
NOx converter efficiency	> 95%	1 Month	98.27%	2016/07/05
Equipment accuracy	Table 3	As required	N/A	2016/09/01
CVS		As required	N/A	N/A
Propane shot leak check	< 3%	As required	N/A	N/A
Particulate balance		As required	400126802960	2016/08/12
Particulate flow	< 2%	3 Months	1.027%	2016/08/12

**TEST REQUIREMENTS**

Complies  
Yes / N/A

**Test Specification**

<i>Annex I, 1.</i>	Engine installed in machinery which meets the following specific requirements: (i) C.I. engine with net power greater or equal than 19kW but not greater than 560kW operated under intermittent speed	Yes						
	(ii) C.I. engine with net power greater or equal than 19kW but not greater than 560kW operated under constant speed	N/A						
	(iv) Engine designed for propulsion of railcars	N/A						
	(v) Engine designed for propulsion of locomotives	N/A						
<i>Annex III, 1.1.</i>	NRSC shall be used for engines of category (i) and (ii) for stage I, II, IIIA, IIIB and IV emissions limits	Yes						
<i>Annex III, 1.1.</i>	NRTC shall be used for engines of category (i) for stage IIIB and IV emissions limits	N/A						
<i>Annex III, 1.1.</i>	NRSC shall be used for engines of category (iv) and (v) for stage IIIA and IIIB emissions limits	N/A						
<i>Annex III, 3.7.1.1.</i>	NRSC specification A (8 mode) used for engines covered by (i) and (iv)	Yes						
<i>Annex III, 3.7.1.2.</i>	NRSC specification B (5 mode) used for engines covered by (ii)	N/A						
<i>Annex III, 3.7.1.4.</i>	NRSC specification D (3 mode) used for engines covered by (v)	N/A						
<i>Annex III, App 5, 1.</i>	Durability factor shall apply for CI engines for stage IIIA, IIIB and IV	Yes						
<i>Annex III, App 5, 2.1.</i>	Durability periods shall be as follows;							
	<table border="1"> <thead> <tr> <th>Category</th> <th>Useful Life (Hours)</th> </tr> </thead> <tbody> <tr> <td>≤ 37 kW (constant speed)</td> <td>3,000</td> </tr> <tr> <td>≤ 37 kW (not constant speed)</td> <td>5,000</td> </tr> </tbody> </table>	Category	Useful Life (Hours)	≤ 37 kW (constant speed)	3,000	≤ 37 kW (not constant speed)	5,000	
Category	Useful Life (Hours)							
≤ 37 kW (constant speed)	3,000							
≤ 37 kW (not constant speed)	5,000							
		N/A						
		N/A						



# TEST REPORT: Non-Road Mobile Machinery – Compression Ignition, NRSC & NRTC

UNECE Regulation 96.04

> 37 kW	8,000	Yes
Railcar engines	10,000	N/A

## Test Conditions

Annex III, 1.2.	Engine mounted on test bench and connected to a dynamometer	Yes
Annex VI, 1.	Indicate sampling system number used for test	Gaseous Emissions 2 Particulates 13
Annex III, 2.2.	Atmospheric parameter is $0.96 < f_a < 1.06$ before and during test <i><math>f_a = (99/ps) \times (T/298)^{0.7}</math>: Naturally aspirated and mechanically supercharged engines</i> <i><math>f_a = (99/ps)^{0.7} \times (T/298)^{1.5}</math>: Turbocharged engine with or without cooling of the intake air</i>	Yes
Annex III, 2.2.3.	Cooling medium and charge air temperature recorded	Yes
Annex III, 2.3.	Air inlet restriction within $\pm 300$ Pa of the value specified by the manufacturer at rated speed and full load	Yes
Annex III, 2.4.	Exhaust back pressure within $\pm 650$ Pa of the value specified by the manufacturer at rated speed and full load	Yes
Annex III, 2.7.	Fuel temperature at the injection pump inlet is between 33 – 43°C	Yes
Annex I, 2.4.	Correct auxiliaries fitted as required by R85 (but not fan)	Yes
Annex I, 8.4 / 8.5	NOx control measures according to stage IIIB / IV requirements (if applicable)	N/A
Annex I, 8.7.	Crankcase emissions discharged before after-treatment system or added to measured exhaust emissions (stage IV only)	N/A

## Non-Road Steady Cycle (NRSC) (Stage I, II, IIIA, IIIB and IV)

### Pre Test

Annex III, 3.1	Dynamometer settings according load calculation and specification	Yes
Annex III, 3.1.	Power absorbed ( $P_{AE}$ ) for auxiliaries provided if required	Yes
Annex III, App 1, 1.4.3.3.	Heated HC sample line maintained between 180 – 200°C	Yes
Annex III, App 1, 1.4.3.4	Heated NOx sample line maintained between 55 – 200°C	Yes
	<ul style="list-style-type: none"> <li>Raw gas measurement: AVL / AMA i60</li> </ul>	
Annex III, 3.7.4	Exhaust gas measured at least during last 180s of each mode	Yes



**TEST REPORT: Non-Road Mobile Machinery – Compression Ignition,  
NRSC & NRTC**

UNECE Regulation 96.04

- Particulates: AVL / SPC-472

<i>Annex III, 3.7.5.</i>	Minimum particulate sampling time > 20s (single filter) or > 60s (multi filter)	Yes
<i>Annex III, 3.7.2.</i>	Engine warmed up and parameters stabilized	Yes
<i>Annex I, 8.6.1.</i>	3 random points selected and added to end of cycle (Stage IV)	N/A

**Post Test**

<i>Annex III, 3.7.3.</i>	Specified speed and torque within tolerance	Yes
<i>Annex III, App 3, 1.1.</i>	Emissions data for minimum of the last 60 secs of mode used in calculations	Yes
<i>Annex III, 3.8.</i>	Zero and span pre / post difference < 2%	Yes
<i>Annex III, 3.5</i>	Particulate filter face temperature less than or equal to 325 K (52°C)	Yes
<i>Annex III, App 3, 1.2.</i>	Particulate filter conditioned between 1 – 80 hours before weighing	Yes
<i>Annex III, App 1, 1.5.2.2.</i>	If the average weight of the reference filters (reference filter pairs) changes between sample filter weighing by more than 10µg, then all sample filters shall be discarded and the emissions test repeated.	Yes
<i>Annex III, 3.5.</i>	For partial flow dilution systems with single filter method, the mass flow rate through the filter shall be constant within ± 5% with respect to the averaged value of the mode	Yes
<i>Annex III, 3.5.</i>	For the single and multiple filter methods, the sample mass flow rate through the filter shall be maintained at a constant proportion of the dilute exhaust mass flow rate for full flow systems for all modes. This mass ratio shall be within ± 5% with respect to the averaged value of the mode.	N/A
<i>Annex III, App 3, 1.4.6.</i>	The value of the effective weighting factors shall be within ± 0,005 (absolute value) of the weighting factors listed in Annex III, section 3.7.1 (single filter)	Yes

**Non-Road Transient Cycle (NRTC) (Stages IIIB and IV) – Not applicable**



**TEST REPORT: Non-Road Mobile Machinery – Compression Ignition,  
NRSC & NRTC**

UNECE Regulation 96.04

**TEST RESULTS (Delete / repeat tables as necessary)**

**Non-Road Steady Cycle (NRSC / RMC) (Stages I, II, IIIA, IIIB and IV)**

Test ID: MSS365948

**Note:**

The manufacturer declares that DF of this engine family is the same as the engine QSZ-C500-III. Please cross refer to the job number CSM248927 in detail.

	CO	HC	NOX	HC+NOX	PM
DF	0.00	---	---	0.00	0.00

Emissions durability period is 8000 hours, and the durability test period is one quarter of the emission durability period – 2000 hours.

NRSC / RMC Results	CO (g/kWh)	HC (g/kWh)	NOx (g/kWh)	HC+NOx (g/kWh)	PM (g/kWh)
H: 130 kW ≤ P ≤ 560 kW					
Measured	1.0950	0.1810	3.4740	3.655	0.09400
Additive DF	0.0000			0.000	0.00000
Regeneration Factor, kur					
Final Value	1.095	N/A	N/A	3.655	0.0940
Stage IIIA Limit	3.50	N/A	N/A	4.000	0.200
% of Limit	31.3%	N/A	N/A	91.4%	47.0%

Measured CO <sub>2</sub> (g/kWh)	843.453
----------------------------------	---------

**Random Points (Stage IV) – Not applicable**

**Non-Road Transient Cycle (NRTC) (Stages IIIB and IV) – Not applicable**

**Continuous Regeneration (if applicable) – Not applicable**

**Infrequent Regeneration (if applicable) – Not applicable**

Remarks (if applicable): None



**ANNEX 1 Test photos**





# ISO8178 C1 8 Mode

(ISO8178)

## Overall Test Data

operator	17#
test date	2016/6/21
testcell name	TC17
project	AVL
test serie	QSB5.9
testname	78152634(17#20160621)210-8GK1(1)



### TEST IDENTIFICATION

start time of test	hhmmss	15:32:38	system parameter	-	SYS_GEM301EC_DCEC_TC17_DOE_CB
end time of test	hhmmss	17:02:09	unit under test parameter	-	UUT_GEM301EC_DCEC_TC17_2_cuty
			test facility parameter	-	TFP_GEM301EC_DCEC_DOE_TC17
			test parameter	-	TST_GEM301EC_ISO_8178_CUTY_PID

### ENGINE DATA

manufacturer	-	Cummins	rated speed	rpm	2200.00
engine number	-	78271581	maximum engine speed	rpm	2380.00
engine family	-	QSB5.9-C210-30	idle speed	rpm	800.00
injection system	-	DI	model year	-	2016
transmission type	-	Manual	number of cylinders	-	
engine type	-	compression ignition	engine displacement	dm3	5.9000

### FUEL DATA

fuel name	-	Diesel 1	massfraction H	-	0.13400
fuel id	-	1	massfraction C	-	0.86600
fuel density	g/cm3	0.833	massfraction O	-	0.00000
molar mass fuel	-	13.869	massfraction W	-	0.00000
H/C ratio	-	1.830	massfraction N	-	0.00000
stoichiometric factor	-	13.486	massfraction S	-	0.00000

### BRAKE SPECIFIC RESULT

CO2	g/kW.h	843.453	0.000	-
CO	g/kW.h	1.095	5.000	Ok
NOx	g/kW.h	3.474	9.200	Ok
THC	g/kW.h	0.181	1.300	Ok
CH4	g/kW.h	0.009	0.000	-
NMHC	g/kW.h	0.173	0.000	-
			0.000	
brake spec. PM emission	g/kW.h	0.094	0.540	Ok
NMHC+NOX	g/kW.h	3.6465	0.000	-



# ISO8178 C1 8 Mode

(ISO8178)

## Environment Data

operator  
test date  
testcell name  
project  
test serie  
testname

17#  
2016/6/21  
TC17  
AVL  
QSB5.9  
78152634(17#20160621)210-8GK1(1)



### TESTCELL DATA

mode	-	1	2	3	4	5	6	7	8
temperature air testcell		25.468	25.007	25.609	25.427	25.657	25.678	25.688	26.047
pressure air testcell	kPa	99.981	99.984	99.985	99.977	99.977	99.968	99.975	99.967
relative humidity of testcell	%	47.624	48.705	47.694	48.515	48.641	48.057	48.655	47.590

### ENGINE INFO

mode	-	1	2	3	4	5	6	7	8
temperature of engine inlet air		25.468	25.007	25.609	25.427	25.657	25.678	25.688	26.047
pressure air engine inlet	kPa	99.981	99.984	99.985	99.977	99.977	99.968	99.975	99.967
relative humidity air engine inlet	%	47.624	48.705	47.694	48.515	48.641	48.057	48.655	47.590
absolute humidity	g/kg	9.799	9.750	9.898	9.962	10.127	10.017	10.150	10.142
fuel temperature		39.367	39.375	39.310	39.076	39.334	39.265	39.214	38.758
correctionfactor NOx	-	0.981	0.982	0.982	0.984	0.986	0.984	0.986	0.985
F - Factor	-	1.007	1.005	1.008	1.007	1.009	1.009	1.009	1.011
F - Factor limit check	-	Ok	Ok						
actual speed	rpm	2200.013	2199.899	2200.131	2199.972	1499.915	1500.037	1500.034	800.008
actual torque	Nm	666.106	502.617	334.933	67.066	814.269	615.313	410.462	-0.001
net power	kW	153.458	115.792	77.170	15.450	127.897	96.654	64.477	0.037



# ISO8178 C1 8 Mode

(ISO8178)

## Particulate Data Raw

operator  
test date  
testcell name  
project  
test serie  
testname

17#  
2016/6/21  
TC17  
AVL  
QSB5.9  
78152634(17#20160621)210-8GK1(1)



### PARTIAL FLOW DILUTION

mode	-	1	2	3	4	5	6	7	8
massflow exhaust raw	kg/h	960.027	953.186	922.707	517.309	742.247	673.833	546.345	148.920
massflow through filter	g/s	1.302	1.302	1.302	1.302	1.302	1.302	1.302	1.302
massflow probe	g/s	0.213	0.212	0.205	0.115	0.165	0.150	0.121	0.033
proportionality factor	%	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
dilutionratio	-	6.106	6.145	6.353	11.306	7.900	8.698	10.734	39.330
dilutionfactor	-	0.164	0.163	0.157	0.088	0.127	0.115	0.093	0.025
particulate loading time	s	152.300	152.400	152.300	102.300	102.300	102.400	102.300	152.300
filter temperature max.		44.833	45.536	45.235	43.328	42.827	42.626	41.221	39.916
filter temperature min.		40.818	41.823	43.227	40.016	40.117	41.020	39.816	36.404
dilution air temperature max.		21.622	21.520	21.622	21.520	21.520	21.622	21.521	21.622
dilution air temperature min.		20.912	21.520	21.013	21.318	21.520	21.013	21.505	21.013
weighting factor	-	0.150	0.150	0.150	0.100	0.100	0.100	0.100	0.150
weighting factor effective	-	0.150	0.150	0.150	0.100	0.101	0.100	0.100	0.149
weighting factor deviation	-	-0.000	-0.000	-0.000	0.000	0.001	0.000	0.000	-0.001

### PARTICULATE RESULTS MDS based on 0.10 mg

assumed particulate mass		126.310
assumed brake specific emission	g/kW.h	0.005

### FINAL PARTICULATE RESULTS MDS

filterpair ID MDS	-	1.0000
samplemass filter		1.738
particulate mass		2195.269
brake spec. PM emission	g/kW.h	0.094



# ISO8178 C1 8 Mode

(ISO8178)

Tailpipe Gaseous

operator  
test date  
testcell name  
project  
test serie  
testname

17#  
2016/6/21  
TC17  
AVL  
QSB5.9  
78152634(17#20160621)210-8GK1(1)



## CONCENTRATION VALUES

mode	-	1	2	3	4	5	6	7	8
sampletime - gaseous	s	178.300	181.300	181.300	181.300	181.300	181.300	181.300	181.300
concentration tailpipe CO2	ppm	83630.570	71783.350	53449.690	27507.120	83739.360	71787.790	62138.720	11124.400
concentration tailpipe CO	ppm	153.150	184.702	112.734	116.088	119.496	93.433	121.650	70.569
concentration tailpipe NOx	ppm	391.378	207.118	131.506	95.844	475.391	335.570	237.637	160.524
concentration tailpipe THC	ppm	26.904	33.194	58.357	99.573	31.917	42.660	49.159	57.548
concentration tailpipe CH4	ppm	1.229	2.042	2.601	3.699	1.053	1.140	1.431	2.398
concentration tailpipe NMHC	ppm	25.675	31.152	55.756	95.874	30.863	41.520	47.729	55.150

## MASSFLOW EMISSION VALUES

massflow CO2 tailpipe	g/h	121796	103798	74816	21586	94289	73382	51501	2513
massflow CO tailpipe	g/h	142.03	170.07	100.48	58.01	85.68	60.82	64.20	10.15
massflow NOx tailpipe	g/h	584.60	307.52	189.01	77.38	551.77	352.86	203.07	37.33
massflow THC tailpipe	g/h	12.372	15.155	25.792	24.674	11.347	13.769	12.865	4.105
massflow CH4 tailpipe	g/h	0.6526	1.0764	1.3272	1.0582	0.4323	0.4250	0.4322	0.1975
massflow NMHC tailpipe	g/h	11.807	14.223	24.642	23.757	10.973	13.401	12.490	3.934

## BRAKE SPECIFIC EMISSIONS

CO2	g/kW.h	843.453
CO	g/kW.h	1.095
NOx	g/kW.h	3.474
THC	g/kW.h	0.181
CH4	g/kW.h	0.009
NMHC	g/kW.h	0.173

## USED DELAYTIMES/CUTTER EFFICIENCY

efficiency ethane tailpipe	-	1.000
efficiency methane tailpipe	-	0.000
delaytime CO2 tailpipe	s	6.500
delaytime COL tailpipe	s	6.950
delaytime COH tailpipe	s	0.000
delaytime NOx tailpipe	s	5.400
delaytime THC tailpipe	s	5.920
delaytime CH4 tailpipe	s	6.730

## FUEL CONSUMPTION

fuel consumption measured	kg/h	37.095	31.475	22.478	6.687	28.226	21.957	15.394	0.795
fuel consumption calculated	kg/h	38.466	32.810	23.653	6.856	29.768	23.169	16.275	0.801
deviation meas. - calc.	%	3.694	4.243	3.882	2.528	3.462	3.523	3.725	0.710