VEHICLE STANDARD (AUSTRALIAN DESIGN RULE 80/00 — EMISSION CONTROL FOR HEAVY VEHICLES) 2005

APPENDIX B

1 EVIDENCE REQUIREMENTS

1.1 Evidence submitted in accordance with either Section 2 or Section 3 of this Appendix B will be accepted as demonstrating compliance with the requirements on the use of Auxiliary Emission Control Devices referred to in clause 6.2.1 of this vehicle standard.

2 EVIDENCE VIA CERTIFICATE OF CONFORMITY

2.1 A certificate of conformity issued by the US Environment Protection Agency under Part 86 of Title 40 of the US Code of Federal Regulations, for 2000, 2001, 2002, 2003, 2004, 2005 or 2006 model year "diesel heavy duty engines and vehicles" is deemed to be acceptable evidence of compliance with clause 6.2.1 of this vehicle standard.

3 ALTERNATIVE EVIDENCE

3.1 Compliance with the requirements of paragraphs 3.1.1, 3.1.2 and 3.1.3 of this Appendix B is deemed to be acceptable evidence of compliance with clause 6.2.1 of this vehicle standard.

3.1.1 European Steady State Test

3.1.1.1 The engines shall comply with the technical requirements of the ESC test in Appendix A, except that the emission limits specified in Table 1, subject to the provisions of paragraph 3.1.3 of this Appendix B, apply in lieu of the ESC limits in Table 1 to section 6.2.1 of Annex I of Appendix A.

Table 1 – Emission Limits under ESC Test

Engine Type [2]	Emission Limits (g/kWh)			
	Mass of Carbon Monoxide	Mass of Hydrocarbons	Mass of Oxides of Nitrogen	Mass of Particulates
LMB	20.8	1.75	5.4	0.13
HHDDE	20.8	1.75	8.0	0.13

3.1.2 NTE Test

3.1.2.1 The engine shall comply with the technical requirements of the Not to Exceed (NTE) screening tool described in Attachment A to this Appendix B and meet the emission limits in Table 2 when operated in the NTE Control Area. In relation to the smoke and opacity limits, the engine is required to comply with either the Smoke or Alternate Opacity limits in the table, not both.

Table 2 – Emission Limits under the NTE Screening Tool

Engine Type	Emission Limits			
	Mass of Oxides of Nitrogen (g/kWh)	Smoke (Filter No)	Alternate Opacity	
			Steady State (10s average, 12.7cm path)	Transient (30s average, 12.7cm path)
LMB	6.7	1.0	4%	4%
HHDDE	9.4	1.0	4%	4%

[2] LMB means a LHDDE or MHDDE, or any HHDDE offered for sale or intended for installation in an urban bus (as defined by the US EPA). LHDDE, MHDDE or HHDDE means a Light, Medium or Heavy, Heavy Duty Diesel Engine certified in accordance with the definition of primary intended service class in US Code of Federal Regulations Part 86.085-2.

The manufacturer need not submit test data at the time of certification to satisfy the NTE screening limits. The manufacturer shall state in the certification application that the engine is designed to meet the NTE limits specified above and have a sound technical basis for making such a statement

3.1.3 Use of AECDs

3.1.3.1 The use of any Auxiliary Emission Control Device (AECD) must be in accordance with all the requirements of this paragraph 3.1.3. AECD means any device or element of design that senses temperature, vehicle speed, engine RPM, transmission gear, manifold vacuum, or any other parameter for the purpose of activating, modulating, delaying, or deactivating the operation of the emission control system.

3.1.3.2 The manufacturer shall comply with all applicable AECD reporting requirements specified by the US EPA and the US Code of Federal Regulations Part 86.

3.1.3.3 An AECD shall not be active unless engine operating conditions are generally correlatable to sustained highway operation (vehicle speed of 80 km/h or greater) or generally correlatable to sustained high load operation (greater than 85% of maximum load at that RPM for a one minute rolling average or greater than 75% of maximum load at that RPM for a two minute rolling average). Such AECDs shall return the engine to the injection timing values used to meet the Oxide of Nitrogen (NOx) levels specified in 40 CFR 86.098-11 when engine operations return to transient conditions.

3.1.3.4 The manufacturer may install the following AECD to protect the engine or vehicle from damage due to overheating: timing may be advanced when coolant temperature and/or intake manifold temperature rises 2.8 ^{o}C or more above cooling fan-on temperature even if emissions exceed the applicable limits in Tables 1 and 2 of this Appendix B. This feature must be inactive when the coolant temperature and/or intake manifold temperature is below 2.8 ^{o}C above fan-off temperature. For modulated or variable-speed fans, fan-on temperature refers to the temperature at which the fan drive is fully engaged, or at which the fan is set to maximum speed; and fan-off refers to the point at which the fan drive begins to modulate off, or at which the fan is set to less than maximum speed. If the fan is not controlled directly by the engine control module, then set points for AECD activation and deactivation shall be referenced to fan-on and fan-off temperatures specified by the manufacturer, and subject to the above temperature difference limits and fan control state definitions.

3.1.3.5 The AECD described in paragraph 3.1.3.4 (correlated to coolant temperature and/or other engine operating parameter(s)) is the only timing strategy that may be employed for overheat protection. This strategy may only be employed where the manufacturer's specifications for cooling system, charge air cooler, and/or other requirements are such that the engine can operate without the need for such AECDs at both ambient temperatures below 38 ^{o}C and loads below 75 % maximum at that RPM. Such specifications shall be determined by establishing engine cooling and other system requirements based on testing at conditions at least as severe as 75 % load and 38 ^{o}C ambient air and representative operating conditions. This AECD shall be limited to the lowest practicable NOx level for the purposes of overheat protection.

3.1.3.6 Any altitude AECD may not be active at pressure above 82.5 kPa (below 1675m equivalent) and is limited to the lowest practicable NOx level after consideration of unburned hydrocarbons, black smoke and engine protection.

3.1.3.7 Any White Smoke AECD to control unburned hydrocarbons shall be limited to the lowest practicable NOx level after consideration of unburned hydrocarbon emissions, and engine misfire. In addition, the manufacturer must justify any White Smoke AECD that is active at conditions correlatable to an intake manifold temperature greater than 15 ^{o}C.

3.1.3.8 Any Idle AECD shall be limited to the lowest practicable NOx level after consideration of unburned hydrocarbon emissions, engine misfire, and engine protection and must be correlated with any relevant engine operating parameter.

Attachment A to Appendix B

Not To Exceed (NTE), Smoke or Alternate Opacity Requirements

1. Requirements

The Not To Exceed (NTE), Smoke or alternate Opacity limits stated in Table 2 of section 3 of Appendix B apply to engines when tested under conditions which can reasonably be expected to be encountered in normal vehicle operation and use. The limits apply when new and in-use throughout the useful life of the engine. In order to satisfy the NTE screening guidelines, the manufacturer must adhere to the requirements and protocols described in sections 2 and 3 of this Attachment A.

2. NTE Requirements

2.1 Except as described in paragraph 2.1.2 below, the NTE Control Area includes all operating speeds above the "15% ESC Speed" calculated as in the following paragraph 2.1.1, and all engine load points at 30% or more of the maximum torque value produced by the engine (refer Figure 2(a) and Figure 2(b)). In addition, notwithstanding the provisions of paragraph 2.1.2, the NTE Control Area includes all operating speed and load points with brake specific fuel consumption (BSFC) values within 5% of the minimum BSFC value of the engine, unless during Certification the manufacturer demonstrates to the satisfaction of the '*Administrator*' that the engine is not expected to operate at such points in normal vehicle operation and use. Current engine designs equipped with drivelines with multi-speed manual transmissions or automatic transmissions with a finite number of gears are not subject to the 5% minimum BSFC additional NTE region.

2.1.1 The 15% ESC Speed is calculated using the formula $n_{lo} + 0.15(n_{hi} - n_{lo})$, where n_{lo} and n_{hi} are the low and high engine speeds defined in Annex III, Appendix 1, Section 1.1 of Appendix A.

2.1.2 The area below 30% of the maximum power value produced by the engine is excluded from the NTE Control Area

Figure 2(a)

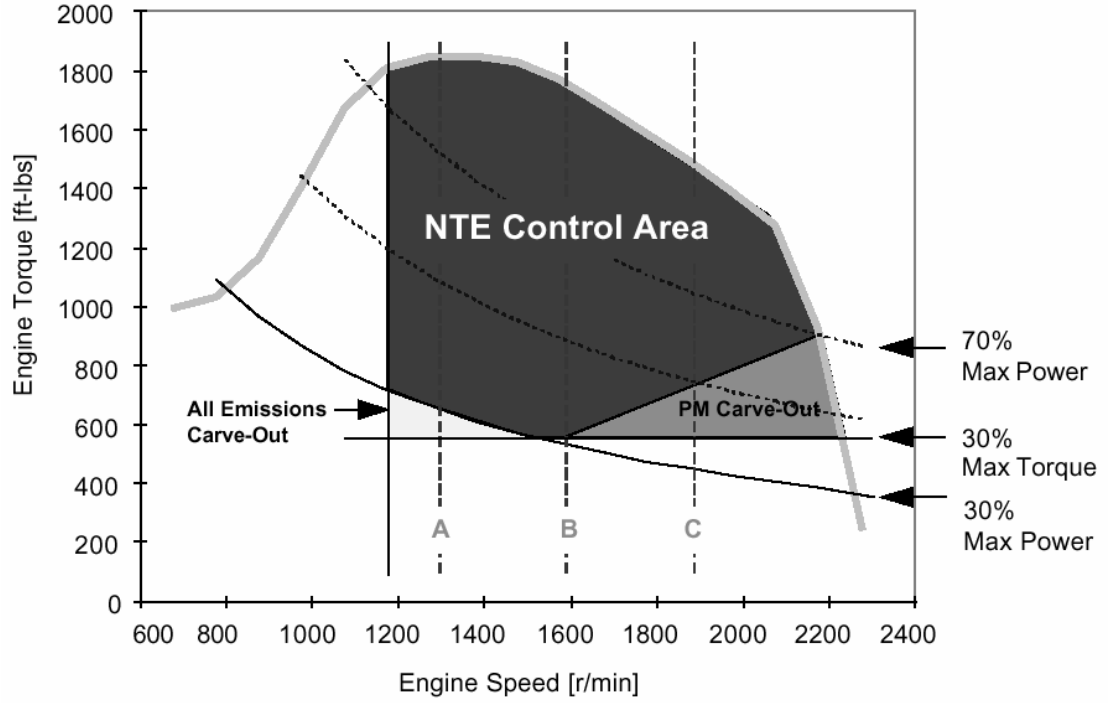
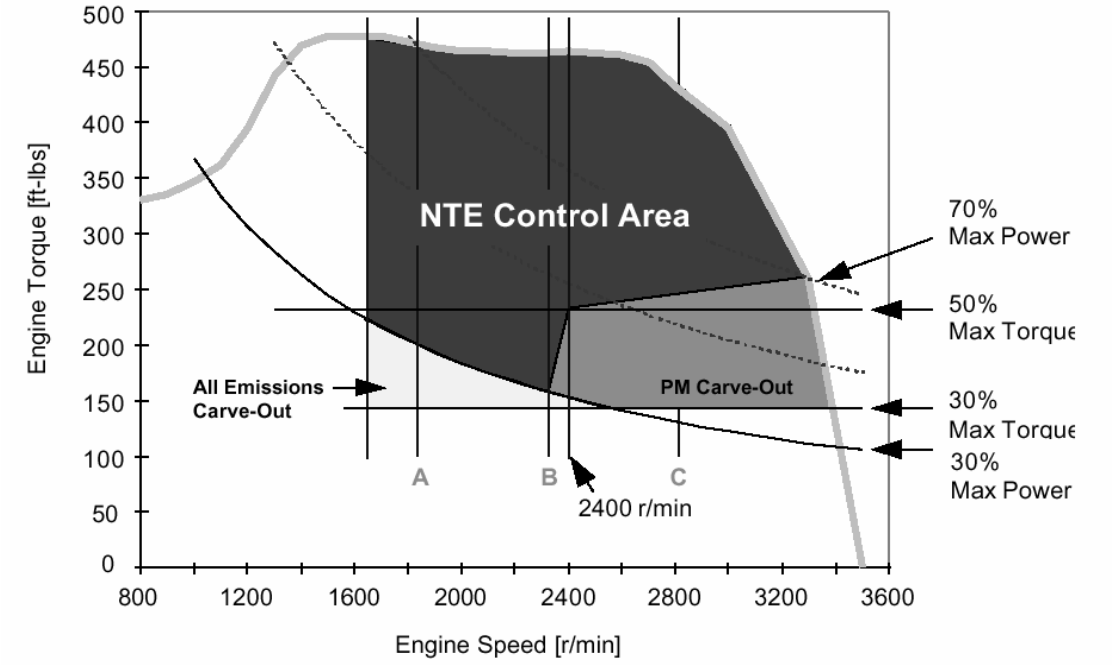


Figure 2(b)



2.2 Within the NTE Control Area, emissions of Oxides of Nitrogen (NOx), when averaged over a minimum time of 30 seconds, shall not exceed the applicable NTE limit values specified in Table 2 of Section 3 of Appendix B. In addition, within the NTE Control Area, smoke and opacity shall not exceed the applicable Smoke or alternate Opacity limit values specified in Table 2.

2.2.1 The NTE and Smoke or alternate Opacity limit values apply to certification, production line and in-use engines.

2.2.2 The engine must comply with the applicable NTE and Smoke or alternate Opacity limit values under all conditions which may reasonably be expected to be encountered in normal vehicle operation and use.

2.2.3 The humidity correction factors found in 40 CFR Part 86 shall be used for NOx. Outside the temperature range of 20-30 ^{o}C, NOx emissions shall be corrected to 20 ^{o}C if below 20 ^{o}C, or to 30 ^{o}C if above 30 ^{o}C.

3. **Supplemental Emissions Test Smoke Measurements**

Supplemental emission tests may use steady-state or transient smoke measurements. Steady-state smoke measurements may be conducted using opacimeters or filter-type smokemeters. Opacimeter types include partial-flow and full-flow. Only full-flow opacimeters may be used to measure smoke during transient conditions.

3.1 For steady-state or transient smoke testing using full-flow opacimeters, equipment meeting the requirements of CFR 40, Part 86, subpart I "Emission Regulations for New Diesel Heavy-Duty Engines; Smoke Exhaust Test Procedure or ISO/DIS-11614 "Reciprocating internal combustion compression-ignition engines -Apparatus for measurement of the opacity and for determination of the light absorption coefficient of exhaust gas" is recommended.

3.1.1 All full-flow opacimeter measurements shall be reported as the equivalent percent opacity for a 12.7 cm effective optical path length using the Beer-Lambert relationship.

3.1.2 Zero and full-scale (100% opacity) span shall be adjusted prior to testing.

3.1.3 Post test zero and full scale span checks shall be performed. For valid tests, zero and span drift between the pre-test and post-test checks shall be less than 2% of full scale.

3.1.4 Opacimeter calibration and linearity checks shall be performed using manufacturer's recommendations or good engineering practice.

3.2 For steady-state testing using filter-type smokemeter, equipment meeting the requirements of ISO-8178-3 and ISO/FDIS-10054 “Internal combustion compression-ignition engines – Measurement apparatus for smoke from engines operating under steady-state conditions – Filter-type smokemeter” is recommended.

3.2.1 All filter-type smokemeter results shall be reported as a filter smoke number (FSN) that is similar to the Bosch smoke number (BSN) scale.

3.2.2 Filter-type smokemeters shall be calibrated every 90 days using manufacturer’s recommended practices or good engineering practice.

3.3 For steady-state testing using partial-flow opacimeter, equipment meeting the requirements of ISO-8178- 3 and ISO/DIS-11614 is recommended.

3.3.1 All partial-flow opacimeter measurements shall be reported as the equivalent percent opacity for a 12.7 cm effective optical path length using the Beer-Lambert relationship.

3.3.2 Zero and full scale (100% opacity) span shall be adjusted prior to testing.

3.3.3 Post test zero and full scale span checks shall be performed. For valid tests, zero and span drift between the pre-test and post-test checks shall be less than 2% of full scale.

3.3.4 Opacimeter calibration and linearity checks shall be performed using manufacturer’s recommendations or good engineering practice.

3.4 Replicate smoke tests may be run to improve confidence in single test or stabilization. If replicate tests are run, 3 additional valid test will be run, and the final reported test results must be the average of all the valid tests.

3.5 A minimum of 30 seconds sampling time will be used for average transient smoke measurements.