TRANSPORT FOR LONDON (TfL) LOW EMISSIONS CERTIFICATE (LEC) TECHNICAL REQUIREMENTS FOR APPROVAL OF LOW EMISSIONS ADAPTATIONS

'LEC (Adaptations) Technical Requirements'

1 Scope

1.1 **These technical requirements are applicable to Low Emissions Adaptations for fitment to vehicles in order to comply with the provisions of the London Low Emission Zone (LEZ) Scheme Order [*Greater London Low Emission Zone Charging Order 2006*].**

1.2 A Low Emissions Adaptation is a device, system or modification which reduces particulate emissions to enable a vehicle (engine) to meet the technical requirements described in this document.

2 Test Requirements

2.1 Tests will be conducted according to Annex 2 to the London Low Emission Zone Scheme Order. The test provisions are based on the following test cycles:

2.1.1 ***ESC test cycle (Heavy Duty Diesel):***
Test cycle comprising 13 static load conditions, according to the procedure described in Appendix 1 of Annex III of EC Directive 88/77/EEC, as amended.

2.1.2 ***ETC test cycle (Heavy Duty Diesel):***
Test cycle comprising transient steps, according to Appendices 2 and 3 of Annex III of EC Directive 88/77/EEC, as amended.

2.1.2.1 For the purposes of this scheme the ETC engine test bench cycle may be replicated by means of a vehicle drive cycle test on a chassis dynamometer. In this case the drive cycle used shall, as far as possible, represent the ETC cycle. An example of a suitable cycle is the FiGE drive cycle (see Annex).

2.1.3 ***Type I test cycle (Light Duty Vehicles):***
Vehicle drive cycle on a chassis dynamometer according to Annex I Section 5.3 of EC Directive 70/220/EC, as amended.

2.1.4 ***Free Acceleration Smoke Test:***
The opacity is measured during a free acceleration test according to the test procedure described in Directive 72/306 Annex IV Section 2. The result will be used for reference purposes. This is applicable for all stages and for all vehicle categories. The test will be conducted with and without the Low Emissions Adaptation fitted.

2.2 When certification of the Low Emisions Adaptation is to cover its application to more than one engine type, a worst case engine will be selected for the test programme to enable a successful result to cover certification for a range of engines.

3 Particulate Matter (PM) Emission Levels

3.1 Emissions Stages

Vehicle Category	**PM Standard**

	STAGE 1	**STAGE 2**	**STAGE 3**	**STAGE 4**
N_1 (Class II and III) Goods Vehicle (up to 3.5t) M_2 Bus/Coach (up to 5t)	n/a	n/a	B (or A*)	B (or A*)
N_2 HGV (3.5-12t) M_3 Bus/Coach (over 5t)	n/a	A (or B**)	A (or B**)	C (or D**)
N_3 HGV over 12t	A	A	A	C

* depending on Type Approval of base vehicle
** applicable only when base vehicle Type Approved as N_1 Class III

3.2 Limit Values

PM Standards	
A	**Heavy Duty Diesel (88/77/EEC) Euro III** **ESC: 0.1 g/kWh** **ETC: 0.16 g/kWh (for devices ref 1999/96/EC Annex I Section 6.2)**
B	**Light Duty (70/220/EEC) Euro 3** **N_1** **Type I Class II: 0.07 g/km** **Type I Class III: 0.10 g/km** **M_2** **Type I ≤2.5t: 0.05 g/km** **Type I >2.5-3.5t: 0.07 g/km (1305 kg< Ref. Mass ≤1760 kg)** **Type I >2.5-3.5t: 0.10 g/km (Ref. Mass >1760 kg)** **Type I >3.5t: 0.10 g/km**
C	**Heavy Duty Diesel (88/77/EEC) Euro IV** **ESC: 0.02 g/kWh** **ETC: 0.03 g/kWh**
D	**Light Duty (70/220/EEC) Euro 4** **(N_2 category when base vehicle approved as N_1 Class III)** **Type I Class III: 0.06 g/km**

3.3 Required Percentage Reductions (for back to back tests – worst case)

3.3.1 HEAVY DUTY DIESEL EMISSIONS

Base Engine Euro Level	Target Euro Level for Engine with Adaptation	% Particulate Reduction	Minimum Particulate Reduction for any single test
Pre-Euro	Euro III	80%	78%
Euro I	Euro III	77%	75%
Euro II	Euro III	45%	39%
Euro I	Euro IV	95%	95%
Euro II	Euro IV	89%	88%
Euro III	Euro IV	83%	82%

Note: Results to be based on a single set of test results for engine bench tests or an average of three sets of test results for vehicle tests using the FiGE drive cycle.

3.3.2 LIGHT DUTY EMISSIONS

Base Engine Euro Level	Target Euro Level for Engine with Adaptation	% Particulate Reduction	Minimum Particulate Reduction for any single test
Pre-Euro	Euro 3	75%	73%
Euro 1	Euro 3	70%	67%
Euro 2	Euro 3	58%	54%
Euro 1	Euro 4	80%	78%
Euro 2	Euro 4	75%	73%
Euro 3	Euro 4	50%	45%

Note: Results to be based on an average of three sets of test results for vehicle tests using the Light Duty Type I cycle.

4 Test fuel

4.1 Commercially available fuel is acceptable as an alternative to the regulated reference fuels (i.e. if diesel, fuel should meet the specifications of Directive 98/70/EC – BS EN 590).

4.2 Manufacturers must also declare any special fuel/fuel additive requirements necessary for the correct functioning of the Low Emissions Adaptation together with details of the measures taken to ensure the correct in-service operation of the Adaptation.

5 Deterioration Factors

5.1 The measured test results will be multiplied by a Deterioration Factor (DF) and this calculated value will represent the result used to establish compliance with the prescribed limit values given in Section 3.

5.2 The default DF will be 1.2.

5.3 Manufacturers wishing to use an alternative value will be required to conduct additional tests to provide necessary evidence.

6 Other Requirements

6.1 For exhaust after-treatment Adaptations, the length of the exhaust pipe between the system and the outlet of the turbocharger shall be as specified by the manufacturer of the Low Emissions Adaptation and shall be declared in the approval documentation.

6.2 For exhaust after-treatment Adaptations, any increase in exhaust back pressure measured with the Low Emissions Adaptation fitted shall not exceed an average value of 200 mbar absolute (calculated as the average of the values measured during the test or, when more than one test is conducted, the average of the average values measured during each of the tests).

6.3 NO_2 levels shall be monitored when the Low Emissions Adaptation includes catalytic action likely to increase NO_2. The absolute masses and ratios of NO_2 to total NOx with and without the Low Emissions Adaptation shall be reported on a consistent basis for both test procedure and NO_2 ratio calculation methods.

6.4 Ammonia (NH_3) levels shall be monitored (and reported on a ppm concentration basis) when the Low Emissions Adaptation is likely to increase/create ammonia.

6.5 Functionality of the emissions control systems/technology of the vehicle must not be adversely affected by the installation of the Low Emissions Adaptation.

6.6 In the case of a Low Emissions Adaptation with additive supported regeneration, the applicant shall submit evidence that there are no adverse effects from the combination of the additive and the system.

6.7 Any operation likely to result in a non-conforming mode which permits exhaust gas to emerge to atmosphere without the required particulate reduction will be taken into account during the test procedure.

6.8 The manufacturer shall submit a detailed description and analysis of potential operational modes where circumstances may exist in-service which significantly reduce the effectiveness of the Low Emissions Adaptation in controlling particulate emissions. The manufacturer shall also provide details of the methods used to notify the vehicle driver/operator of these conditions when they occur.

6.9 The applicant shall submit evidence that fitment of the Low Emissions Adaptation will not adversely affect the vehicle's noise level.

6.10 If the Low Emissions Adaptation includes any electronic units and/or control units, these must comply with the provisions of the EMC Directive (72/245/EEC, as amended).

6.11 The applicant shall submit evidence that fitment of the Low Emissions Adaptation will not significantly affect the vehicle's CO_2 emissions/fuel consumption.

6.12 Regulated emissions (CO, NOx, HC, NMHC & CH_4 as appropriate) should not be adversely affected by the Low Emissions Adaptation and back to back testing will be conducted to verify this (with and without Adaptation).

7 In-Service Durability

7.1 Free acceleration smoke may be monitored at the time of a vehicle's LEC renewal. The Low Emissions Adaptation should be designed and manufactured to have an objective working life as follows:

7.1.1 100,000 km or five years, whichever is the sooner, in the case of engines to be fitted to vehicles of category N_1 and M_2

7.1.2 200,000 km or six years, whichever is the sooner, in the case of engines to be fitted to vehicles of category N_2, N_3 with a maximum technically permissible mass not exceeding 16 tonnes and M_3 Class I, Class II and Class A, and Class B with a maximum technically permissible mass not exceeding 7.5 tonnes

7.1.3 500,000 km or seven years, whichever is the sooner, in the case of engines to be fitted to vehicles of category N_3 with a maximum technically permissible mass exceeding 16 tonnes and M_3, Class III and Class B with a maximum technically permissible mass exceeding 7.5 tonnes.

7.2 The manufacturer of the Low Emissions Adaptation must supply an in-service warranty (to cover both technical performance & function and quality of manufacture & installation) for at least two years to provide full cover for parts, labour and on-site support costs.

8 Conformity of Production

8.1 The manufacturers of all approved Low Emissions Adaptations will be assessed for suitable conformity of production procedures.

8.2 Every Low Emissions Adaptation granted a component approval under the LEZ Scheme must be so manufactured as to conform to the specification(s) identified in the approval documentation.

8.3 A control plan will be agreed with the manufacturer at the time of application for LEC approval. An Initial review of the control plans will be conducted during the first 6 months production. Ongoing assessments will then be based on projected annual production (but at least once per year).

The manufacturer shall submit annual sales data as required. Where deemed necessary, these reviews may include witnessed tests.

8.3.1 A control plan is the documented description of those procedures checks or assigned activities necessary to verify that production units continue to conform to approval requirements with regard to specification, marking and performance. This could consist of information on activities such as product specification sign-off procedures, in-process controls during manufacture and product testing and inspection

8.4 Product Conformity may also be verified via inspection at the vehicle's annual LEC renewal and any apparent non-conformity may be followed up by factory visits to verify the manufacturer's quality systems/procedures.

8.5 Any non-conformity could result in withdrawal of the approval.

8.6 The costs and expenses related to Conformity of Production verification will be borne by the manufacturer.

9 Information to be provided by the manufacturer of a Low Emissions Adaptation

9.1 Before Approval

9.1.1 Upon application for approval, the manufacturer of a Low Emissions Adaptation shall submit a completed 'LEC (Adaptations) Information Document' together with all necessary drawings and any other technical data needed to fully describe the specification of (and technology used for) the Adaptation.

9.2 After Approval

9.2.1 The manufacturer shall provide every new retrofit Low Emissions Adaptation with an installation and maintenance manual, a copy of the guarantee/warranty statement and a copy of the approval certificate (LEC).

9.2.2 Every Low Emissions Adaptation shall be indelibly marked with at least the following information:

9.2.2.1 Manufacturer's name

9.2.2.2 LEC approval number

9.2.2.3 Part number/type identification of Adaptation

9.2.2.4 Adaptation serial number

9.2.2.5 Substrate batch number (if applicable and if not traceable from the information provided in 9.2.2.4).

9.2.3 The installation manual shall contain at least the following information:

9.2.3.1 The name or trademark of the manufacturer of the Low Emissions Adaptation

9.2.3.2 The type of Low Emissions Adaptation

9.2.3.3 The engine/vehicle types for which the Low Emissions Adaptation has been approved

9.2.3.4 Adequate information for a qualified person to correctly install the Low Emissions Adaptation on the vehicle in line with any restrictions or other criteria identified in the LEC approval documentation

9.2.3.5 The location on the Low Emissions Adaptation where, after installation of the system on the vehicle, the identifying part number and LEC approval number must be located (when the original marking is not visible).

9.2.4 An Installation/Warranty record shall be provided to the vehicle owner/registered keeper, that identifies the:

9.2.4.1 Vehicle Registration Mark

9.2.4.2 Vehicle VIN/chassis number

9.2.4.3 Vehicle make and model

9.2.4.4 Vehicle GVM (kg) and category (N_1, N_2, N_3, M_2, M_3)

9.2.4.5 Engine type

9.2.4.6 Engine base approval level (Euro 1, Euro 2 etc)

9.2.4.7 Engine capacity/displacement

9.2.4.8 Engine maximum power

9.2.4.9	Adaptation details (type code, part and serial numbers)
9.2.4.10	Euro level (particulates) with approved adaptation fitted (Euro 3, Euro 4)
9.2.4.11	Free Acceleration Smoke test reading (K value) m^{-1}
9.2.4.12	Installer contact details (name, company, address, telephone number)
9.2.4.13	Installation date

ANNEX

VEHICLE DRIVE CYCLE TEST ON A CHASSIS DYNAMOMETER AS AN ALTERNATIVE TO THE ETC ENGINE TEST BENCH CYCLE

A1 The vehicle load condition(s) shall typically be 50% of the declared payload but will be subject to a case-by-case review and approval.

A2 Base line testing with the non-Adapted vehicle specification shall be conducted before and, when deemed appropriate, after the tests for the Adaptation. The base line result will be the average of three tests.

A3 The tests required for the vehicle with the Adaptation fitted will be as follows:

A3.1 The result will be the average of three tests.

A3.2 The targeted percentage reduction for each Low Emissions Adaptation will be identified in advance (at a worst case meeting). This percentage will depend on the certified emissions values for the full range of engines to be covered by Adaptation certification.

A3.3 An example of the required percentage reductions/number of tests for a range of engines approved up to the Euro II limit would be as follows:

% Particulate reductions for worst case Euro II engines to achieve Euro III PM:

Average of three results *to be* ***at least 45% reduction*** *with* ***no single test worse than 39 % reduction****. See Section 3.3 for the minimum percentage reductions required for various permutations of base engine and target Euro PM standards.*

A4 Pre-conditioning of the vehicle and/or Low Emissions adaptation will be reviewed on a case by case basis.

A5 A graphical representation of the FiGE cycle (vehicle road speed against time) is given in the diagram on the following page.

FIGE Heavy Duty Vehicle Drive Cycle