

## **Chapter 7**

### **Procedure for Conducting The Test for Durability of Emission Control Systems**

#### **1. INTRODUCTION:**

This Chapter details the procedures for selecting a family of engines to be tested over a service accumulation schedule for the purpose of determining deterioration factors. Such deterioration factors will be applied to the measured emissions from engines.

This Chapter also details the emission and non-emission-related maintenance that will be carried out on engines undergoing a service accumulation schedule.

#### **2. SELECTION OF ENGINES FOR ESTABLISHING USEFUL LIFE DETERIORATION FACTORS:**

2.1. Engines will be selected from the engine family defined in section 8.1 of chapter I to this Part for emission testing to establish useful life deterioration factors.

2.2 Engines from different engine families may be further combined into families based on the type of exhaust after treatment system utilised. In order to place engines with different numbers of cylinders and different cylinder configuration but having the same technical specifications and installation for the exhaust after treatment systems into the same engine-after treatment system family, the manufacturer shall provide data to the approval authority that demonstrates that the emissions of such engines are similar.

2.3 One engine representing the engine-after treatment system family shall be selected by the engine manufacturer for testing over the service accumulation schedule defined in section 3.2 of this chapter, according to the criteria for selecting engines given in section 8.2 of chapter I to this part and shall be reported to the type-approval authority before any testing commences.

2.3.1 If the type-approval authority decides that the worst case emission rate of the engine-after treatment system family can be characterised better by another engine then the test engine shall be selected jointly by the type-approval authority and the engine manufacturer.

#### **3. ESTABLISHING USEFUL LIFE DETERIORATION FACTORS**

##### **3.1 General**

Deterioration factors applicable to an engine-after treatment system family are developed from the selected engines based on a distance and service accumulation procedure that includes periodic testing for gaseous and particulate emissions over the ESC and ETC tests.

### **3.2 Service accumulation schedule**

Service accumulation schedules may be carried out at the choice of the manufacturer by running a vehicle equipped with the selected parent engine over an “in-service accumulation” schedule or by running the selected parent engine over a “dynamometer service accumulation” schedule.

#### **3.2.1 In-service and dynamometer service accumulation**

3.2.1.1 The manufacturer shall determine the form and extent of the distance and service accumulation for engines, consistent with good engineering practice.

3.2.1.2 The manufacturer will determine when the engine will be tested for gaseous and particulate emissions over the ESC and ETC tests.

3.2.1.3 A single engine-operating schedule shall be used for all engines in an engine-after treatment system family.

3.2.1.4 At the request of the manufacturer and with the agreement of the type-approval authority, only one test cycle (either the ESC or ETC test) need be run at each test point with the other test cycle run only at the beginning and at the end of the service accumulation schedule.

3.2.1.5 Operating schedules may be different for different engine-after treatment system families.

3.2.1.6. Operating schedules may be shorter than the useful life period provided that the number of test points allows for a proper extrapolation of the test results, according to section 3.5.2 in this chapter. In any case, the service accumulation shall not be shorter than shown in the table in section 3.2.1.8 of this chapter.

3.2.1.7 The manufacturer has to provide the applicable correlation between minimum service accumulation period (driving distance) and engine dynamometer hours, for example, fuel consumption correlation, vehicle speed versus engine revolutions correlation etc.

### 3.2.1.8 Minimum service accumulation

<b>Category of Vehicle in which engine will be installed</b>	<b>Minimum Service accumulation period</b>
Category N1 Vehicles	100,000 km
Category N2 Vehicles	125,000 km
Category N3 Vehicles with GVW equal to or less than 16,000 kg	125,000 km
Category N3 Vehicles with GVW above 16,000 kg	167,000 km
Category M2 Vehicles	100,000 km
Category M3 Vehicles with GVW equal to or less than 7,500 kg	125,000 km
Category M3 Vehicles with GVW above 7,500 kg	167,000 km

3.2.1.9 The in-service accumulation schedule shall be fully described in the application for type-approval and reported to the type-approval authority before the start of any testing.

3.2.2 If the type-approval authority decides that additional measurements need to be carried out on the ESC and ETC tests between the points selected by the manufacturer it shall notify the manufacturer. The revised in-service accumulation schedule or dynamometer service accumulation schedule shall be prepared by the manufacturer and agreed by the type-approval authority.

## 3.3 Engine testing

### 3.3.1 Start of the service accumulation schedule

3.3.1.1 For each engine-after treatment system family, the manufacturer shall determine the number of hours of engine running after which the operation of the engine-after treatment system has stabilised. If requested by the approval authority the manufacturer shall make available the data and analysis used to make this determination. As an alternative, the manufacturer may elect to run the engine for 125 hours to stabilise the engine after treatment system.

3.3.1.2 The stabilisation period determined in section 3.3.1.1 will be deemed to be the start of the service accumulation schedule.

### 3.3.2. Service accumulation testing

3.3.2.1. After stabilisation, the engine will be run over the service accumulation schedule selected by the manufacturer, as described in section 3.2 of this chapter. At the periodic intervals in the service accumulation schedule

determined by the manufacturer, and, where appropriate, also stipulated by the type-approval authority according to section 3.2.2 of this chapter, the engine shall be tested for gaseous and particulate emissions over the ESC and ETC tests. In accordance with section 3.2 of this chapter, if it has been agreed that only one test cycle (ESC or ETC) be run at each test point, the other test cycle (ESC or ETC) must be run at the beginning and end of the service accumulation schedule.

3.3.2.2 During the service accumulation schedule, maintenance will be carried out on the engine according to section 4 of this chapter.

3.3.2.3 During the service accumulation schedule, unscheduled maintenance on the engine or vehicle may be performed, for example if the OBD system has specifically detected a problem that has resulted in the malfunction indicator (MI) being activated.

### **3.4 Reporting**

3.4.1 The results of all emission tests (ESC and ETC) conducted during the service accumulation schedule shall be made available to the type-approval authority. If any emission test is declared to be void, the manufacturer shall provide an explanation of why the test has been declared void. In such a case, another series of emission tests over the ESC and ETC tests shall be carried out within a further 100 hours of service accumulation.

3.4.2 Whenever a manufacturer tests an engine over a service accumulation schedule for the establishment of deterioration factors, the manufacturer shall retain in its records all information concerning all the emission tests and maintenance carried out on the engine during the service accumulation schedule. This information shall be submitted to the approval authority along with the results of the emission tests conducted over the service accumulation schedule.

### **3.5 Determination of deterioration factors**

3.5.1 For each pollutant measured on the ESC and ETC tests and at each test point during the service accumulation schedule, a “best fit” regression analysis shall be made on the basis of all test results. The results of each test for each pollutant shall be expressed to the same number of decimal places as the limit value for that pollutant, as shown in the tables in section 6.2.1 of chapter I to this part, plus one additional decimal place. In accordance with section 3.2 of this chapter, if it has been agreed that only one test cycle (ESC or ETC) be run at each test point and the other test cycle (ESC or ETC) run only at the beginning and end of the service accumulation schedule, the regression analysis shall be made only on the basis of the test results from the test cycle run at each test point.

3.5.2 On the basis of the regression analysis, the manufacturer shall calculate the projected emission values for each pollutant at the start of the service accumulation schedule and at the useful life that is applicable for the engine under test by extrapolation of the regression equation as determined in section 3.5.1 of this chapter.

3.5.3 For engines not equipped with an exhaust after treatment system, the deterioration factor for each pollutant is the difference between the projected emission values at the useful life period and at the start of the service accumulation schedule.

For engines equipped with an exhaust after treatment system, the deterioration factor for each pollutant is the ratio of the projected emission values at the useful life period and at the start of the service accumulation schedule.

In accordance with section 3.2 of this chapter, if it has been agreed that only one test cycle (ESC or ETC) be run at each test point and the other test cycle (ESC or ETC) run only at the beginning and end of the service accumulation schedule, the deterioration factor calculated for the test cycle that has been run at each test point shall be applicable also for the other test cycle, provided that for both test cycles, the relationship between the measured values run at the beginning and at the end of the service accumulation schedule are similar.

3.5.4 The deterioration factors for each pollutant on the appropriate test cycles shall be recorded in Type Approval Certificate.

**3.6 As an alternative to using a service accumulation schedule to determine deterioration factors, engine manufacturers may choose to use the following deterioration factors:**

Engine type	Test cycle	CO	HC	NMHC	CH <sub>4</sub>	NO <sub>x</sub>	PM
Diesel engine	ESC	1.1	1.05	-	-	1.05	1.1
	ETC	1.1	1.05	-	-	1.05	1.1
CNG, LPG or Gaseous fuelled engine	ETC	1.1	1.05	1.05	1.2	1.05	-

3.6.1 The manufacturer may select to carry across the DF's determined for an engine or engine/after treatment combination to engines or engine/after treatment combinations that do not fall into the same engine family category as determined according to section 2.1 of this chapter. In such cases, the manufacturer must demonstrate to the approval authority that the base engine or engine/after treatment combination and the engine or engine/after treatment combination for which the DF's are being carried over have the same technical

specifications and installation requirements on the vehicle and that the emissions of such engine or engine/after treatment combinations are similar.

### **3.7 Checking of conformity of production**

3.7.1 Conformity of production for emissions compliance is checked on the basis of section 9 of chapter I to this part.

3.7.2 At the time of type-approval, the manufacturer may choose to measure at the same time the pollutant emissions before any exhaust after treatment system. In so doing, the manufacturer may develop an informal deterioration factor separately for the engine and the after treatment system that may be used by the manufacturer as an aid to end of production line auditing.

3.7.3 For the purposes of type-approval, only the deterioration factors adopted by the manufacturer from section 3.6.1 of this chapter or the deterioration factors developed according to section 3.5 shall be recorded in Type approval certificate.

## **4. MAINTENANCE**

During the service accumulation schedule, maintenance performed on engines and proper consumption of any required reagent used to determine deterioration factors are classified as either emission-related or non-emission-related and each of these can be classified as scheduled and unscheduled. Some emission-related maintenance is also classified as critical emission-related maintenance.

### **4.1 Emission-related scheduled maintenance**

4.1.1 This section specifies emission-related scheduled maintenance for the purpose of conducting a service accumulation schedule and for inclusion in the maintenance instructions furnished to owners of new heavy-duty vehicles and heavy-duty engines.

4.1.2 All emission-related scheduled maintenance for purposes of conducting a service accumulation schedule must occur at the same or equivalent distance intervals that will be specified in the manufacturer's maintenance instructions to the owner of the heavy-duty vehicle or heavy-duty engine. This maintenance schedule may be updated as necessary throughout the service accumulation schedule provided that no maintenance operation is deleted from the maintenance schedule after the operation has been performed on the test engine.

4.1.3 Any emission-related maintenance performed on engines must be necessary to assure in-service conformity with the relevant emission standards. The manufacturer shall submit data to the type-approval authority to demonstrate that all of the emission-related scheduled maintenance is technically necessary.

4.1.4 The engine manufacturer shall specify the adjustment, cleaning and maintenance (where necessary) of the following items:

- Filters and coolers in the exhaust gas re-circulation system
- Positive crankcase ventilation valve
- Fuel injector tips (cleaning only)
- Fuel injectors
- Turbocharger
- Electronic engine control unit and its associated sensors and actuators
- Particulate filter system (including related components)
- Exhaust gas re-circulation system, including all related control valves and tubing
- Any exhaust after treatment system.

4.1.5 For the purposes of maintenance, the following components are defined as critical emission-related items:

- Any exhaust after treatment system
- Electronic engine control unit and its associated sensors and actuators
- Exhaust gas re-circulation system including all related filters, coolers, control valves and tubing
- Positive crankcase ventilation valve.

4.1.6 All critical emission-related scheduled maintenance must have a reasonable likelihood of being performed in-service. The manufacturer shall demonstrate to the approval authority the reasonable likelihood of such maintenance being performed in-service and such demonstration shall be made prior to the performance of the maintenance during the service accumulation schedule.

4.1.7 Critical emission-related scheduled maintenance items that satisfy any of the conditions defined in sections 4.1.7.1 to 4.1.7.4 of this chapter will be accepted as having a reasonable likelihood of the maintenance item being performed in-service.

4.1.7.1 Data is submitted which establishes a connection between emissions and vehicle performance such that as emissions increase due to lack of maintenance, vehicle performance will simultaneously deteriorate to a point unacceptable for typical driving.

4.1.7.2 Survey data is submitted which demonstrates that, at an 80 % confidence level, 80 % of such engines already have this critical maintenance item performed in-service at the recommended interval(s).

4.1.7.3 In association with the requirements of section 4.2 of chapter VIII to this part, a clearly visible indicator shall be installed on the dashboard of the vehicle to alert the driver that maintenance is due. The indicator shall be actuated at the appropriate distance or by component failure. The indicator must remain activated while the engine is in operation and shall not be erased without the required maintenance being carried out. Re-setting of the signal shall be a required step in the maintenance schedule. The system must not be designed to deactivate upon the end of the appropriate useful life period of the engine or thereafter.

4.1.7.4 Any other method which the approval authority determines as establishing a reasonable likelihood that the critical maintenance will be performed in-service.

## **4.2. Changes to scheduled maintenance**

4.2.1 The manufacturer must submit a request to the type-approval authority for approval of any new scheduled maintenance that it wishes to perform during the service accumulation schedule and thereby recommend to owners of heavy-duty vehicles and engines. The manufacturer shall also include its recommendation as to the category (i.e. emission-related, non-emission-related, critical or non-critical) of the new scheduled maintenance being proposed and, for emission-related maintenance, the maximum feasible maintenance interval. The request must be accompanied by data supporting the need for the new scheduled maintenance and the maintenance interval.

## **4.3 Non-emission-related scheduled maintenance**

4.3.1 Non-emission-related scheduled maintenance which is reasonable and technically necessary (e.g. oil change, oil filter change, fuel filter change, air filter change, cooling system maintenance, idle speed adjustment, governor, engine bolt torque, valve lash, injector lash, timing, adjustment of the tension of any drive-belt, etc) may be performed on engines or vehicles selected for the service accumulation schedule at the least frequent intervals recommended by the manufacturer to the owner (e.g. not at the intervals recommended for severe service).

#### **4.4 Maintenance on engines selected for testing over a service accumulation schedule**

4.4.1 Repairs to the components of an engine selected for testing over a service accumulation schedule other than the engine, emission control system or fuel system shall be performed only as a result of part failure or engine system malfunction.

4.4.2 Equipment, instruments or tools may not be used to identify malfunctioning, maladjusted or defective engine components unless the same or equivalent equipment, instruments or tools will be available to dealerships and other service outlets and,

\_\_\_ Are used in conjunction with scheduled maintenance on such components,

and

— Are used subsequent to the identification of an engine malfunction.

#### **4.5 Critical emission-related unscheduled maintenance**

4.5.1 The consumption of a required reagent is defined as critical emission-related unscheduled maintenance for the purpose of conducting a service accumulation schedule and for inclusion in the maintenance instructions furnished by manufacturers to owners of new heavy-duty vehicles or heavy-duty engines.

### **5. Useful Life period**

(a) 100 000 km or five years, whichever is the sooner, in the case of engines to be fitted to vehicles of category N1 and M2;

(b) 200 000 km or six years, whichever is the sooner, in the case of engines to be fitted to vehicles of category N2, N3 with a maximum technically permissible mass not exceeding 16 tonnes and M3 Class I, Class II and Class A, and Class B with a maximum technically permissible mass not exceeding 7,5 tonnes;

(c) 500 000 km or seven years, whichever is the sooner, in the case of engines to be fitted to vehicles of category N3 with a maximum technically permissible mass exceeding 16 tonnes and M3, Class III and Class B with a maximum technically permissible mass exceeding 7,5 tonnes.