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2ND CITA RESEARCH STUDY PROGRAMME ON EMISSION TESTING AT PERIODIC AND OTHER INSPECTIONS

Study 3

Use of OBD at Periodic Inspection
Interim Report of Test Phase

June 2002

CITA/2E-ERSP/Study3 (Interim)

Note

Although this study was organized in the name of CITA, the conclusions and recommendations contained in this report are a reflection of the views of the three organizations that undertook the work. The report and its conclusions and recommendations have not been formally adopted by the CITA Bureau Permanent or by vote of the rest of the CITA membership. They do not necessarily represent the views of CITA as a whole or of individual CITA members.

Summary

Study 3 in the 2nd CITA Programme of Studies on Emission Testing at Periodic and Other Inspections examined the possible use of OBD information during periodic inspection. 16 vehicles with OBD systems certified to directive 98/69/EC were tested in order to assess their exhaust emission performance with and without induced faults.

This report covers the test phase and initial conclusions of the study and proposes a possible test procedure for use at periodic inspection. A final report will be issued later giving the final conclusions of the study, the results of a cost/benefit evaluation of the proposed procedure, a final proposal for the procedure and suggested amendments to directive 96/96/EC.

Initial findings include –

Although most of the vehicles supported the requirement to communicate with generic scan tools, there were problems with some vehicles.
Not all current OBD equipped and certified vehicles can ensure that important malfunctions that can cause the specified emission thresholds to be exceeded can be detected.
Generally OBD systems could detect electrical failures, but they were not always able to detect simulated aged components.
50% of the vehicles showed increased emissions beyond the threshold for the MIL without the MIL being activated.
OBD systems offer the potential to improve the effectiveness of periodic inspection but the current tailpipe test should be retained.

CONTENTS

1. Introduction

This report covers the work done in the testing phase of the study entitled 'Use of OBD during periodic inspection' (study 3 of the 2nd CITA programme of research studies on emission testing at periodic and other inspections). It also includes initial proposals for a test procedure for use at periodic technical inspection.

A final report will be issued later giving the overall conclusions of the study, including the results of the cost/benefit evaluations of the proposed procedure, a final proposal for the procedure and suggested amendments to directive 96/96/EC.

2. Background

Directive 98/69/EC specifies that petrol vehicles and diesel cars must be fitted with on-board diagnostic systems (OBD) from 2000 and 2003 respectively. Further directives to specify improved OBD systems for cars and for other classes of vehicles are currently under discussion. OBD systems are required to monitor critical functions of the engine and emission control system, store information about deviations and, if the deviations exceed certain levels, report this fact to the driver via a warning lamp. During maintenance, the on-board memory is interrogated to assist with fault diagnosis and fault rectification.

Given their function, it is obvious that the potential of OBD systems required by the directive to enhance the effectiveness of periodic inspection should be investigated. As OBD systems are designed primarily for driver information and for use during maintenance, the information that can be obtained from them must be evaluated for its accessibility and usefulness during periodic inspection. In addition it is necessary to examine its susceptibility to tampering and fraud.

The aims of this study were to examine:-

- (a) how relevant information could be obtained from OBD systems at periodic inspection and, if appropriate, to develop test procedures that could be used during periodic and other inspections of vehicles in use;
- (b) the functionality and usability of equipment (scan tools) currently available to access OBD information;
- (c) the need to continue exhaust emission measurements; and
- (d) the cost-effectiveness of the procedures proposed for including examinations of OBD systems during periodic inspection.

As inter-active communication with on board systems is likely to provide a means of solving future periodic inspection challenges, the study would also evaluate the existing standards for OBD systems (ISO; SAE), the requirements of directive 98/69/EC and the different systems and solutions adopted by vehicle manufacturers. If appropriate, recommendations for the amendment and improvement of the standards and the directive would be made to enhance the future usefulness of OBD systems at periodic inspection.

3. Scan tools - Analysis of available tools and selection of makes form test phase

3.1 Introduction

One of the most important aspects of OBD is the requirement for vehicle manufacturers to standardize certain critical characteristics of OBD systems. Comprehensive standardization assists all concerned persons by providing equal access to essential repair information and requires structuring the information in consistent format from manufacturer to manufacturer. The equipment and diagnostic Scan Tools needed to communicate with OBD systems must meet or exceed the functional specification given in ISO DIS 15031-4.[1] Diagnostic Scan Tools are subject to SAE J 1978.

3.2 Basic technical and theoretical Information

3.2.1 Overview of the different protocols

APPENDIX 1 contains a short overview of the different forms of protocols. Reference should be made to the specific standard for a more detailed description. A good overview is found in SAE J 1979. Similar to it is the overview in ISO 9141-2 and for the Keyword 2000 protocol in ISO/DIS 14230-2.

3.2.2 Diagnostic Connector

The Assignment of each pin is standardized in SAE J1962. ISO 15031-3 adds a CAN connection. The table below shows the different plug contacts.

Table 1 – Assignment of pins

Pin	ISO 15031-3	SAE J 1962
1	Manufacturer specific	Manufacturer specific
2	+J1850	+J1850
3	Manufacturer specific	Manufacturer specific
4	Chassis -	Chassis -
5	Signal -	Signal -
6	CAN H	Manufacturer specific
7	K-Line	K-Line
8	Manufacturer specific	Manufacturer specific
9	Manufacturer specific	Manufacturer specific
10	-J1850	-J1850
11	Manufacturer specific	Manufacturer specific
12	Manufacturer specific	Manufacturer specific
13	Manufacturer specific	Manufacturer specific
14	CAN L	Manufacturer specific
15	L-Line	L-Line
16	+ UBat	+UBat

[1] Directive 98/69/EU annex XI 6.5.3.2.

3.2.3 Accessible Data

According to directive 98/69/EC, Annex XI, the following data has to be accessible:-

3.2.3.1 Freeze-Frame:

If an error occurs the Engine ECU has to store the data which is listed next:

- Calculated load
- Engine speed
- Coolant temperature
- Error which caused the freeze-frame storage

Furthermore, the following data should be stored if it is accessible by the ECU:

- Fuel trim
- Fuel pressure
- Vehicle speed
- Intake manifold pressure
- Status fuel system

3.2.3.2 Other engine data:

Beside freeze-frame data, the ECU has also to transmit other data if available, during normal operation of the engine:

- Error code (DTC)
- Coolant temperature
- Status fuel system
- Fuel trim
- Intake air temperature
- Ignition timing advance
- Intake manifold pressure
- Air flow rate
- Engine speed
- Throttle position
- Status secondary air injection
- Calculated load
- Vehicle speed
- Fuel pressure

Some other, non engine related data has also to be stored:

- Limits which were used at last inspection
- Results at last inspection
- Results for the self diagnosis of the emission related parts
- Type approval limits
- Mileage since the error was stored (valid from 01-01-2005)

3.3 Evaluation of recommended Scan Tools

Table 2 : List of generic scan tools

Scan tool	A	B	C	D	E
Mode					
1	X	X	X	X	X
2	X	X	X		X
3	X	X	X	X	X
4	X	X	X	X	X
5	X	X	X	X	X
6	X	X	X	X	X
7	X	X	X	X	X
8	X	X		X	X
9	X	X	X	X	X
Protocol					
ISO 9141-2	X	X	X	X	X
J1850 VPW	X	X	X		X
J1850 PWM	X	X	X		X
ISO14230	X	X	X		X
CAN					
Instruction	X		X		X

X = available

These Scan Tools were tested by simulating a number of different failures. All but one Scan Tool fulfilled these demands as well. Type D communicates using only one protocol and has no freeze frame information available. However, the manufacturer is likely to make modifications to their current methods to satisfy this requirement.

Table 3 : List of failures tested on each scan tool

Scan tool Fault Code	Fault
PO 101	**Mass or Volume Air Flow Circuit Range/Performance Problem**
PO 111	**Intake Air Temperature Circuit Range/Performance Problem**
PO 201	**Cylinder 1-Injector Circuit Malfunction**
PO 202	**Cylinder 2-Injector Circuit Malfunction**
PO 203	**Cylinder 3-Injector Circuit Malfunction**
PO 300	**Random/Multiple Cylinder Misfire Detected**
PO 304	**Cylinder 4 Misfire Detected**
PO 412	**Secondary Air Injection System Switching valve a circuit Malfunction**
PO 505	**Idle Control System Malfunction**

3.4 Selection of Scan tools for test phase

Taking into consideration the issues outlined above, scan tools were selected and assigned to the test partners as follows. All the selected Scan Tools are manufactured according to SAE J1978 and meet the fixed demands for the test phase.

Table 4 – Assignment of scan tools

Participant Scan Tool	DEKRA	RWTÜV	GOCA / BIVV	UTAC	VI
B	X	X			
C	X	X			
A					X
E			X	X	

4. Development and description of test methodology

4.1 Introduction

The methodology to be used in the test phase was agreed between the partners in order to achieve, as far as is practically possible, comparable results. For completeness the whole document is attached as **APPENDIX 2**.

4.2 Outline of test methodology

In order to achieve the objectives of the study, faults are introduced or simulated in relevant emission system components of the test vehicles. The modified vehicle undertakes a number of test-cycles until the OBD system has been given the opportunity to detect the fault. The driving cycle to be used in this test programme is following: three type I cycles or a practical driving cycle, during which all the systems are monitored once. To establish that the OBD system has been given the opportunity to detect a fault, the readiness codes are reset when building in the fault. The test drive is complete if either the OBD system has set the readiness code linked to the fault without detecting it or the OBD system has registered the fault.

The simulated failures are to be induced without affecting the driveability, and must result in an increase of the emissions. The most interesting failures are those when the MIL was not set.

The OBD information is read and the exhaust gases are measured with a 4-gas analyser and, if relevant, a “type 1” test will be applied to the vehicle so that the faulty emissions can be correctly compared with the emissions data from the approval test.

If there was any doubt about the reliability of the EOBD system or the communication between vehicle and Scan tool a preliminary test is carried out in order to evaluate the presence and good functioning of the EOBD system by disconnection the upstream oxygen sensor. After driving 3 Type I tests cycles the MIL should be triggered.

4.3 Test sequence

The test programme for one vehicle consists of the following sequences:

1. **First Type 1 test.**

The vehicle must be in full working condition. The exhaust gases are measured during the complete cycle and during the second part. A 4-gas test and an EOBD test is also carried out.

HOT EUDC cycles

For each vehicle one or more failures are introduced. During the driving cycle the failure should be detected by the EOBD system. After the driving cycle, a HOT EUDC test, the 4-gas test and an EOBD test are carried out.

HOT EUDC cycles are started with the engine running at the same rpm and the engine oil at the temperature reached during the Type 1 test. These HOT EUDC tests are repeated after each failure of a series of one or more failures. When the whole failure series for the vehicle has been completed, an evaluation is made of the emissions during the HOT EUDC test compared with the results from the measurements of the vehicle with failures to decide which failure setting will be measured during a second complete Type 1 test.

Second Type 1 test

After the series of HOT EUDC cycles, a supplementary Type 1 test is carried out. During this phase, also the 4-gas test and an EOBD test are carried out. So, there will be at least two Type 1 results for each series of HOT EUDC tests.

4.4 Description of test cycles

4.4.1 Description of the T1 and HOT EUDC test:

These tests are outlined in the annex III of the directive 70/220/EEC, last amendment by the directive 2001/1/EC. These two tests differ from each other in the operating cycle. The operating cycle for a type I test is made up of two parts, Part one, the urban cycle, and Part two, an extra-urban cycle. Soak time before cold test shall be more than 12 hours.
The last of the 3 cycles for the Readiness Codes setting shall be the preconditioning phase for the Type I cold test. For the Hot EUDC test the operating cycle is only made up of the extra-urban cycle.

Fuel level: The fuel tank must be filled up to the nominal capacity of the fuel tank.
Reference fuel is not used and refuelling during the test programme is not allowed.
The dynamometer inertia is set at the manufacturer's value or according to the directive.

4.4.2 Description of the EOBD test:

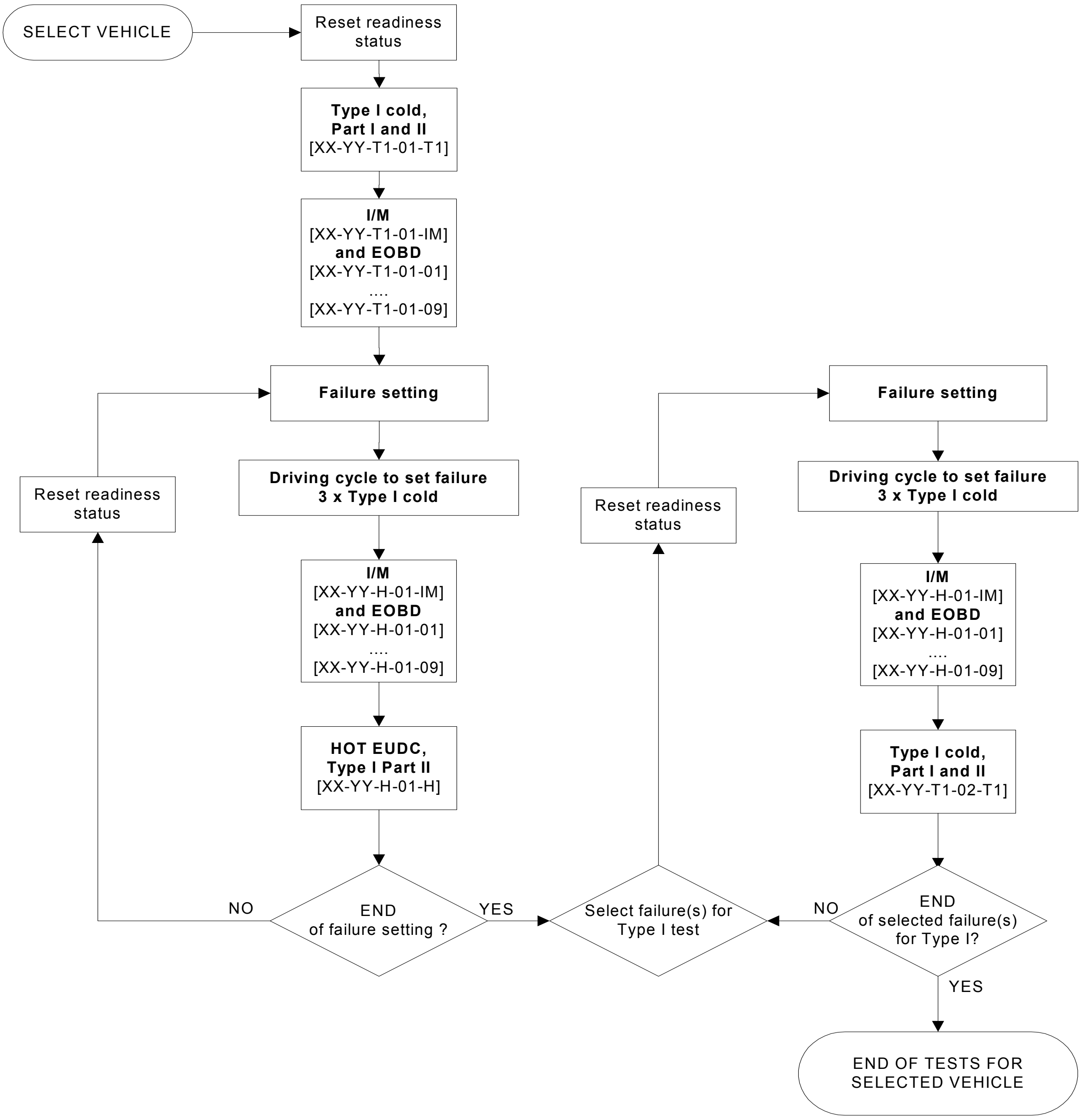
An EOBD check consists of two examination types: A visual check of the dashboard display function and status and a scan of the EOBD computer. These two examinations, taken together, comprise the procedure outlined below.
Visually examine the instrument panel to determine if the MIL illuminates when the ignition key is turned to the "key on, engine off" position.
Start the vehicle's engine and visually check the MIL illumination under the "key on, engine running" condition.
Follow the scan tool manufacturer's instructions to determine the results of each mode.
Turn off the vehicle ignition and disconnect the scan tool.

4.4.3 Description of the 4-gas test:

Before measuring there will be a visual inspection of the exhaust system for any evident leakages.
Oil-temperature: the engine should be fully warm, for instance by checking that the engine oil temperature using a temperature probe in the oil level dipstick tube is at least 70°C, or normal operating temperature if a lower temperature is specified by the manufacturer.
Carbon Monoxide test at idle speed (I/M): determine the air/fuel ratio: λ value (Brettschneider) and the CO content at engine idle and high idle speed.
The CO_2 content (% vol), HC content (ppm vol) and O_2 content (% vol) will also be evaluated.

4.5 Test sequence for each test vehicle

Diagram 1 – Test sequence



5. Vehicle selection

5.1 Introduction

A crucial factor for the quality of the project result is the selection of the vehicles for the test phase. In March 2000, RWTÜV drew up a list of the vehicles which had been tested at this time under Directive 98/69/EC:

5.2 Selection criteria

Since the test was conducted in the European area, distribution within Europe had to be considered when selecting the vehicles. A fully representative vehicle selection is not possible with such a small test sample.

The following major criteria were taken into account:

- manufacturer
- country of manufacture
- cubic capacity of the engine
- type of transmission

Since at the time the vehicles were selected there were no vehicles available which had a high mileage and which were older than 3 years, a simulation of aged components was conducted.

The supplier of the engine control unit was taken as a major selection criterion, e.g.:

- Bosch
- Magneti Marelli
- Sagem
- SIEMENS

5.3 Vehicles

The vehicles selected for testing were representative of the vehicles currently offered for sale in Europe. Most were of European manufacture but vehicles manufactured elsewhere were also included. Account was also taken of whether vehicle manufacturers have experience on the US market, where an OBD is already specified in similar form.

When vehicles were being acquired, the vehicle manufacturer or importer was mostly contacted. In many cases the vehicles were loaned from the manufacturer or importer. In all cases, the manufacturer of the vehicle or the agent in Europe has been given the opportunity to see and discuss the test results for their vehicle.

6. Test phase and results

Appendix 3 contains a description of each vehicle tested, a description of the failures induced on the vehicle and the results of the various emission tests. In addition there is a vehicle specific analysis of the results.

7. Analysis and discussion of results

7.1 The EOBD System

On-Board-Diagnosis systems according to 98/96EU means an on-board diagnostic system for emission control which must have the capability of identifying the likely area of malfunction by means of fault codes stored in computer memory.

The "Malfunction indicator light (MIL)" means a visible or audible indicator that clearly informs the driver of the vehicle in the event of a malfunction of any emission-related component connected to the OBD system, or the OBD system itself. Malfunction means the failure of an emission-related component or system that would result in emissions exceeding the limits in table 5.

Further OBD systems store important information that identify the malfunctioning component or system and describe the nature of the malfunction and the driving conditions under which it was detected. All of the information can be accessed with the use of a generic scan tool according to SAE J1978. This feature allows quick diagnosis by the technicians / inspectors at the periodical inspection or maintenance.[2]

European On-board diagnostics systems "***EOBD"*** are required on all M1[3], N1[3] vehicles build since 2001. These vehicles are being designed to meet emission standards according to the following table.

Table 5- EOBD Emission Standards

	)[1]Emissions (g/km)			)[2]Emission vol. %
	Mass of carbon monoxide	Mass of hydrocarbons	Mass of oxides of nitrogen	Concentration of carbon monoxide for I/M
Threshold EU 3	2,3	0,2	0,15	0,3
Threshold EU 4	1,0	0,1	0,08	0,3
Threshold MIL	3,2	0,4	0,6	

)[1]Vehicle data and emission values according to 98/69/EU)[2]according to 96/96/EU

7.2 Evaluation of the available OBD information

Currently, manufacturers have to guarantee the following requirements in a format that a generic scan tool can process and read. The directive 98/69/EU Annex XI describes the requirements and accessible information:

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2 (98/69EU annex XI 2.)

3 except vehicles the maximum mass of which exceeds 2500 kg

7.2.1 Diagnostic Trouble Code

Each specific fault code according to ISO/DIS 15031-6 has been assigned a description to indicate the circuit, component or system area that was determined to be at fault. The descriptions are organised such that different descriptions related to particular sensors or system are grouped together. In case where there are various fault descriptions for different types of faults, the group also has a “generic” description as the first code/message of the group. A manufacturer has a choice when implementing diagnostics, based on the specific strategy and complexity of the diagnostic, whether to use one “generic” code for any fault of that circuit, component or system or to use the more specific code for better defining the type of fault that was detected. The manufacturer must determine what code and descriptions best fit the diagnostics actually implemented. The intent is to have only one code stored for each fault detected.

For example, in diagnosing a 5V reference Throttle Position Sensor (TP Sensor), if the input signal at the Powertrain Control Module (PCM) is struck near 0 V, a manufacturer has the flexibility to select from either of two codes – P0120 (TP Sensor Circuit Malfunction) or P0122 (TP Sensor Low Input), depending on the manufacturer’s diagnostic procedure. If the input signal at the PCM is struck at 1.5 V at idle instead of the expected 1.0 V, the manufacturer has the flexibility to select from either of two codes – P0120 (TP Sensor Circuit Malfunction) or P0121 (TP Sensor Range/Performance), depending on the manufacturer’s diagnostic procedures. The root cause of the higher than expected TP Sensor voltage may be either a faulty TP Sensor, corrosion in the TP Sensor connections or a misadjusted throttle plate. Identification of the root cause is done using the diagnostic procedures and is not implied by the DTC message, thus allowing the manufacturer the flexibility in assigning DTC’s.[4]

7.2.2 Freeze - Frame

The purpose of this service is to allow access to emission-related data values stored when the malfunction occurs. These stored values should help technicians to diagnose the malfunction. The request message from the ECU includes a parameter identification (PID) value that indicates to the OBD system the specific information requested.

Upon determination of the first malfunction of any component or system, “freeze frame” engine conditions present at the time must be stored in ECU’s memory. Should a subsequent fuel system or misfire malfunction occurs, any previously stored freeze frame conditions must be replaced by the fuel system or misfire conditions (whichever occurs first).

The following table shows the stored engine conditions that must be included and the results for the vehicles tested:

Table 6 – Stored engine conditions

	Available on the tested vehicles?
Calculated load	17 of 17
Engine speed	17 of 17
Coolant temperature	17 of 17
Error which caused the freeze-frame storage	17 of 17

**98/69/EU annex XI chapter 6.5.1.1*

[4] (ISO/DIS 15031-6)

Furthermore, the data in the following table should be stored if it is accessible to the ECU:

Table 7 – Other stored data

	Available on the tested vehicles?
Fuel trim	16 of 17
Fuel pressure	3 of 17
Vehicle speed	17 of 17
Intake manifold pressure	11 of 17
Status fuel system	16 of 17

**98/69/EU annex XI chapter 6.5.1.1*

7.2.3 MIL

The OBD system must incorporate a malfunction indicator readily perceivable to the vehicle operator. The MIL must be activated whenever the engine control enters a permanent emission default mode of operation if the emission limits given in 7.1 are exceeded. The MIL symbol must conform with ISO 2575.

7.2.4 Real Time Value

The purpose of this service is to allow access to current emission-related data values, including analogue inputs and outputs, digital inputs and outputs, and system status information. The request for information includes a parameter identification (PID) value that indicates to the on-board system the specific information requested.
According to 98/69EU the ECU has to transmit the data in the following table if available, during normal operation of the engine[5]:

Table 8 – Real time values

	Available on the vehicles tested?
Coolant temperature	15 of 17
Status fuel system	15 of 17
Fuel trim	14 of 17
Intake air temperature	11 of 17
Ignition timing advance	12 of 17
Intake manifold pressure	11 of 17
Air flow rate	4 of 17
Engine speed	16 of 17
Throttle position	11 of 17
Status secondary air injection	0 of 17
Calculated load	15 of 17
Vehicle speed	15 of 17
Fuel pressure	1 of 17

**98/69/EU annex XI chapter 6.5.1.2.*

[5] ISO/DIS 15031-5

7.2.5 Readiness Code

The readiness status of the emission control related systems and components is checked to determine if the OBD monitors have performed their system evaluations. When the vehicle is scanned, the monitor reports a readiness status of either "complete" if the monitor has run since the memory was last cleared, incomplete if the monitor has not yet had the chance to run since the memory was cleared, or "not applicable" if the monitored component in question is not contained in the vehicle. The readiness information allows a technician or I/M inspector to determine if the memory in the on-board computer has been recently cleared (e.g., by a technician clearing fault codes or disconnecting the battery). Unfortunately, the present of unset readiness flags may also be due to circumstances beyond the driver's control (e.g. the car was not driven under the conditions necessary to run some of the monitors). Readiness code should become a major issue in OBD technology[6][1].

Table 9 – Readiness codes

	Available on the tested vehicles?
Catalyst	16 of 17
Catalyst heater	3 of 17
O_2 sensor	17 of 17
O_2 sensor heater	4 of 17
Secondary air injection	5 of 17
Evaporation system	5 of 17
ARG system	5 of 17
Air condition	2 of 17
misfiring	17 of 17
fuel system	16 of 17
Components	15 of 17

**ISO DIS 15031-5 annex B*

7.3 Opportunities for Exhaust Emission Tests including OBD system

7.3.1 Electric circuit continuity

To satisfy the requirements of 98/96/EU, the OBD system must, as a minimum, meet the following requirements :

Any emission-related powertrain component connected to a computer must be monitored for circuit continuity. 98/69/EU annex XI 3.3.2.
The electronic evaporative emission purge control must, at a minimum, be monitored for circuit continuity. 98/69/EU annex XI 3.3.2.

All the tested vehicles met the requirement to detect all emission related electric circuits.

[6] ISO/DIS 15031-5

7.3.2 Simulation of components which are aged respectively wear and tear

In satisfying the requirements of 98/96/EU the OBD system needs a minimum, monitor for:

- Reduction in the efficiency of the catalytic converter with respect to the emission of HC only;
- The presence of engine misfire in the engine operating region bounded by the limits of 98/69/EU 3.3.3.2.
- Oxygen sensor deterioration;
- Emission control system components or systems, or emission-related powertrain components or systems which are connected to a computer, the failure of which may result in tailpipe emissions exceeding the limits given in 98/69/EU annex XI 3.3.2.

The requirements of 98/96/EU do not prescribe combinations of failures within the scope of the type approval test. The minimum demands are pointed out above. This study includes different failures and combinations of failures according to the description in the chapter "Tests".

7.3.3 Results of the selected failure by the different test methods

The following table shows the most significant results of different emission related failures and failure combinations. The applied criteria for evaluation were the Type 1 test with the related type approval thresholds and the MIL thresholds, the I/M tailpipe test specified in 96/96/EU with the specified threshold limits and the EOBD test.

Table 10: selected failures

Vehicle	Failure / combination	EOBD	Type 1	Type 1 MIL	I/M
1	Catalyst / Injector	pass	fail	fail	fail
2	O2 sensor downstream	pass	fail	fail	fail
3	O2 sensor upstream	pass	fail	fail	fail
4	coolant temp.	pass	fail	fail	fail
5	evaporation	pass	fail	pass	fail
6	O2 downstream	pass	pass	pass	fail
7	dummy catalyst	pass	fail	fail	fail
9	misfire	pass	pass	pass	fail
10	misfire	pass	pass	pass	pass
11	coolant temp.	pass	fail	fail	fail
12	MAP	pass	pass	pass	fail
13	Coolant temp.	pass	pass	pass	pass
14	MAP / misfire	pass	fail	fail	fail
15	MAP / misfire	pass	fail	fail	fail
16	misfire	pass	pass	pass	fail
17		pass	pass	pass	pass
∑ Pass		17	7	8	3

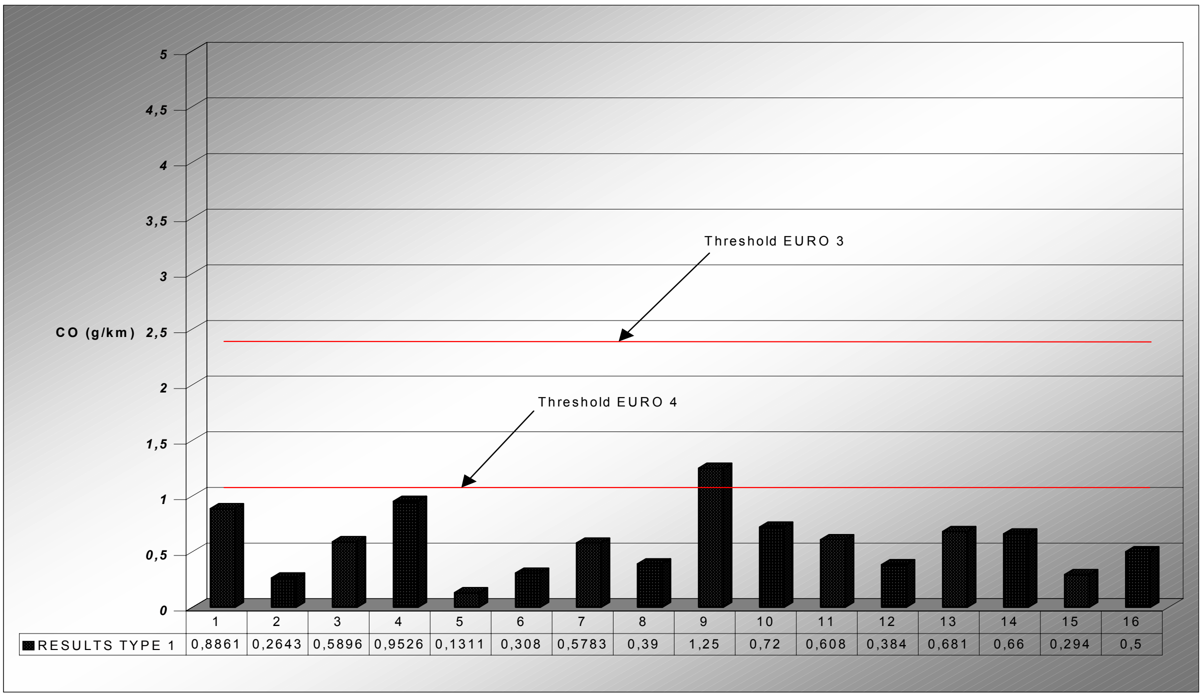
7.3.4 Influence of the simulated failure on the OBD system

Current Inspection programs rely primarily on tailpipe testing (96/96 EU) to find vehicles with emission relevant malfunctions. OBD systems offer the potential to improve this process. Now the question is, whether monitoring the performance through the OBD system really help the I/M procedure to detect exhaust emission relevant malfunctions.

Malfunctions occur more frequently as vehicles age, but OBD vehicles with high mileage could not be procured for this study. So we had to find alternative opportunities. Participants agreed to simulate single failures and also combinations of failure. It is reasonable to consider combinations of failure as older systems tend to wear out in their entirety.

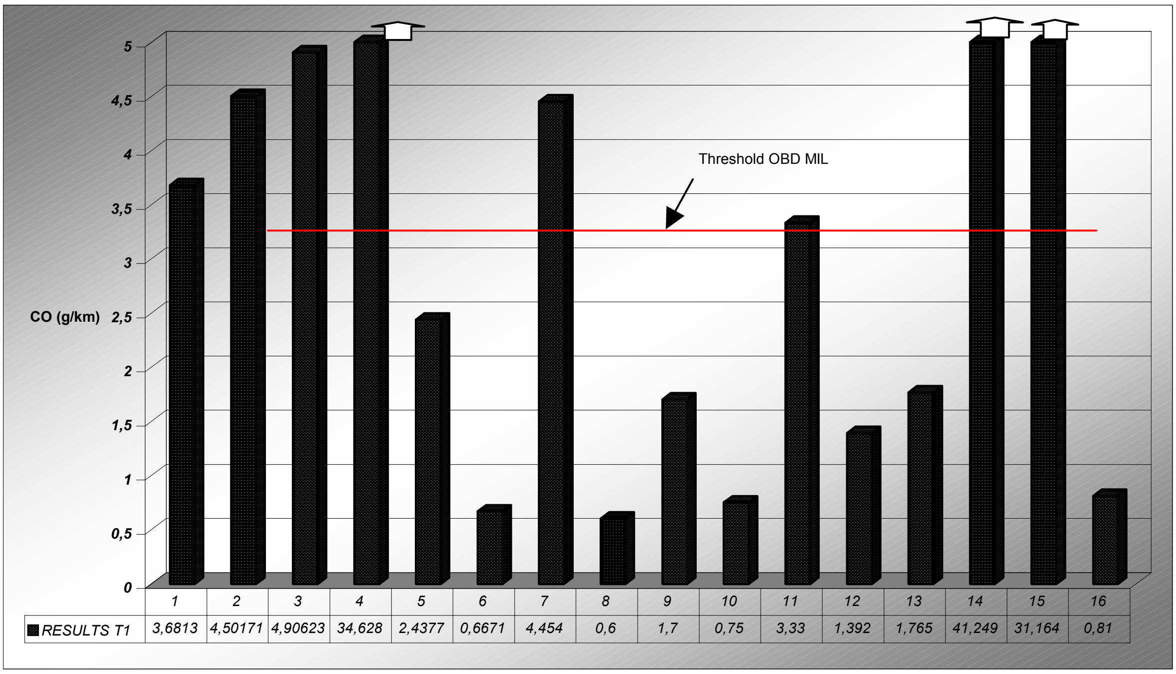
The following diagrams contain the most significant influences of different emission related failures and failure combinations. The description supports the results in the table above. The vehicles were measured ‘as received’ to verify the proper functioning of the vehicles and systems before the introduction of failures.

Diagram 2: Reference Type1 CO



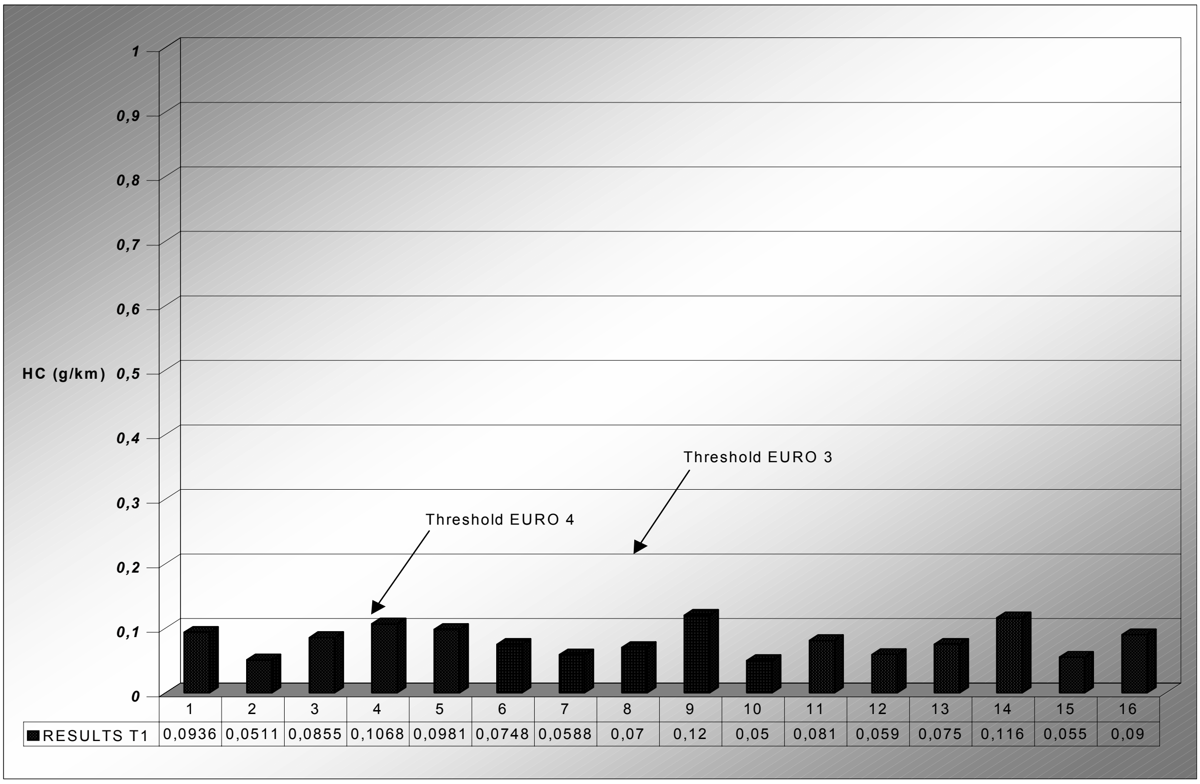
CO emissions do not exceed the thresholds of the type approval test.

Diagram 3: Type 1 CO with failure



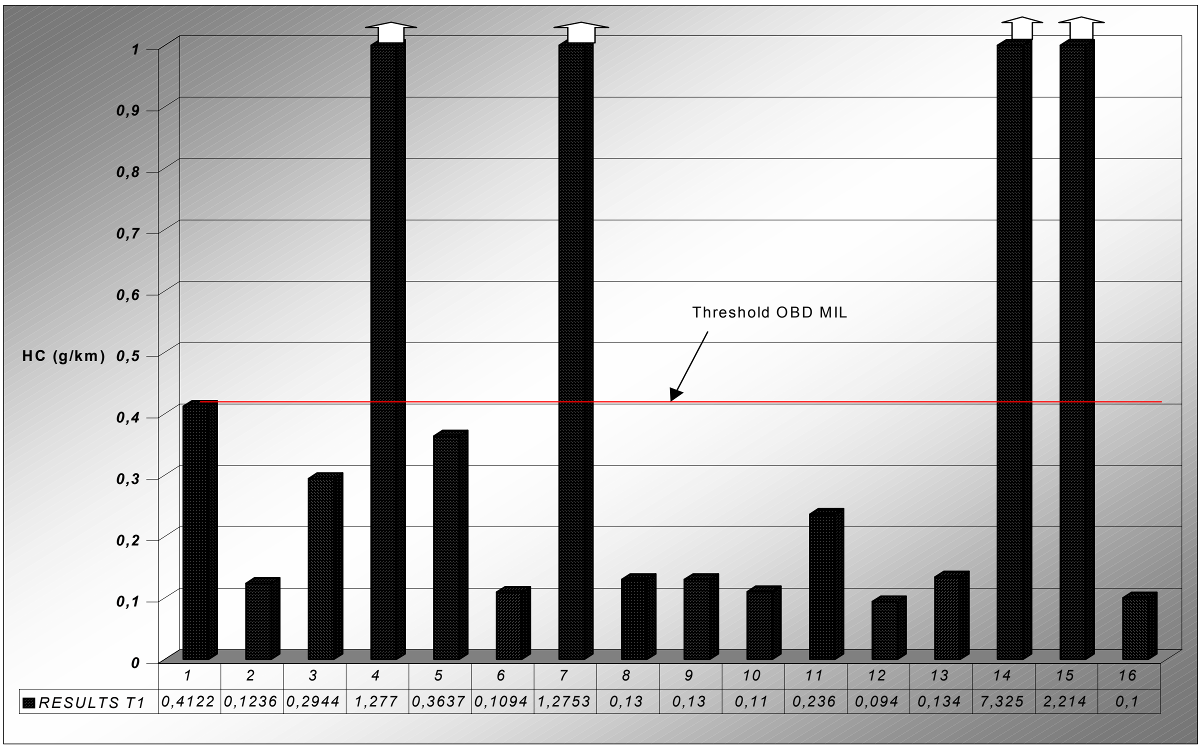
Half of the tested vehicle exceeded the threshold for CO emission during the type approval cycle. In six cases the threshold for CO emission is crossed by a significant amount, in three times the threshold was exceeded by up to twelve times.
The OBD system was not able to detect the emission related failure by MIL or fault code in all cases.

Diagram 4: Reference Type1 HC



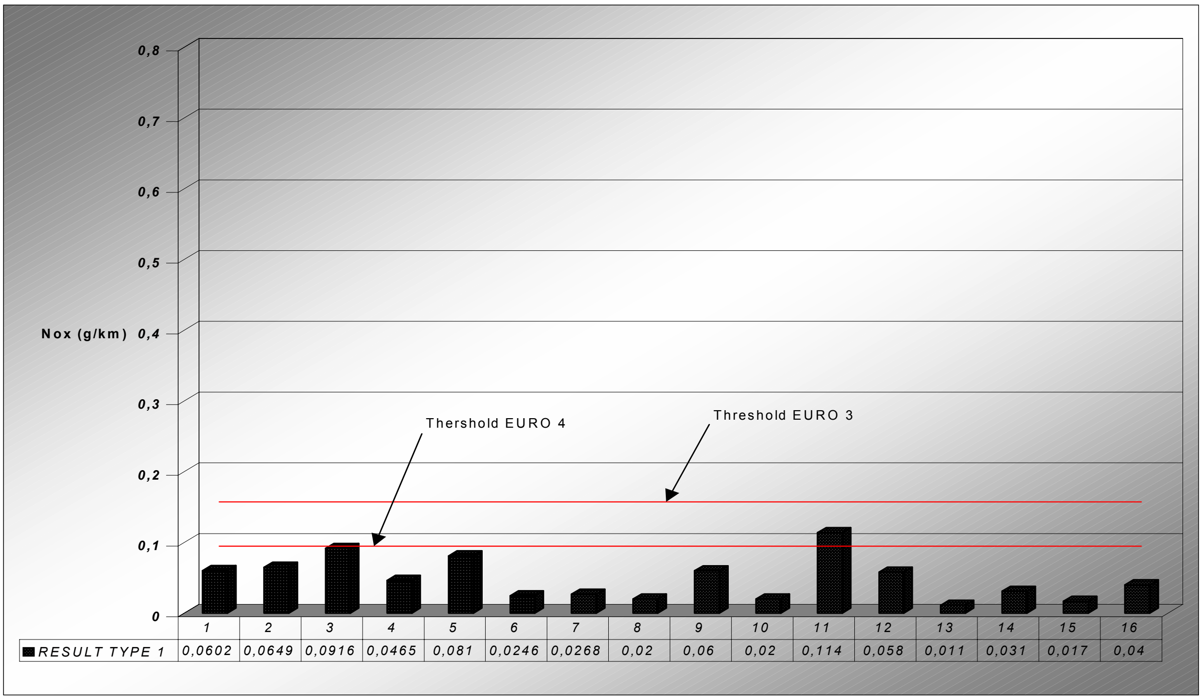
HC emissions stay inside the prescribed thresholds for type approval.

Diagram 5: Type 1 HC with failure



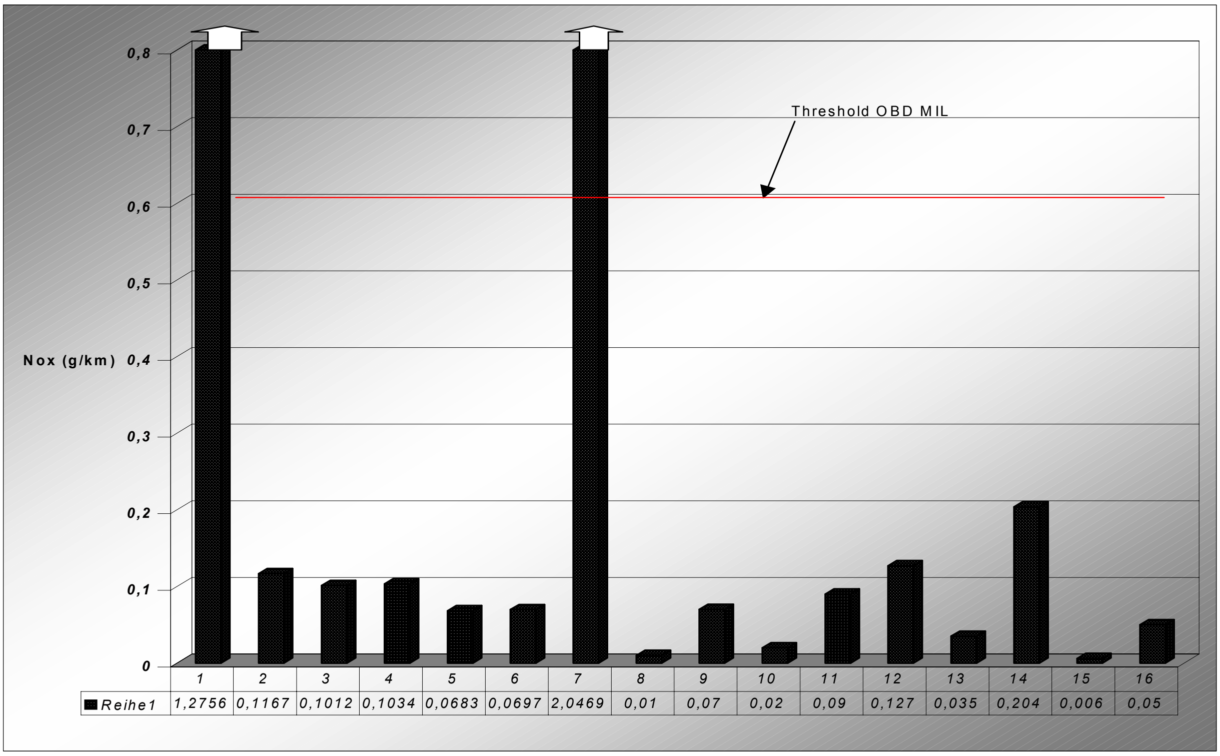
Four vehicles exceeded the limit for HC according to 98/69/EU.

_Diagram 6: Reference Type1 NOX



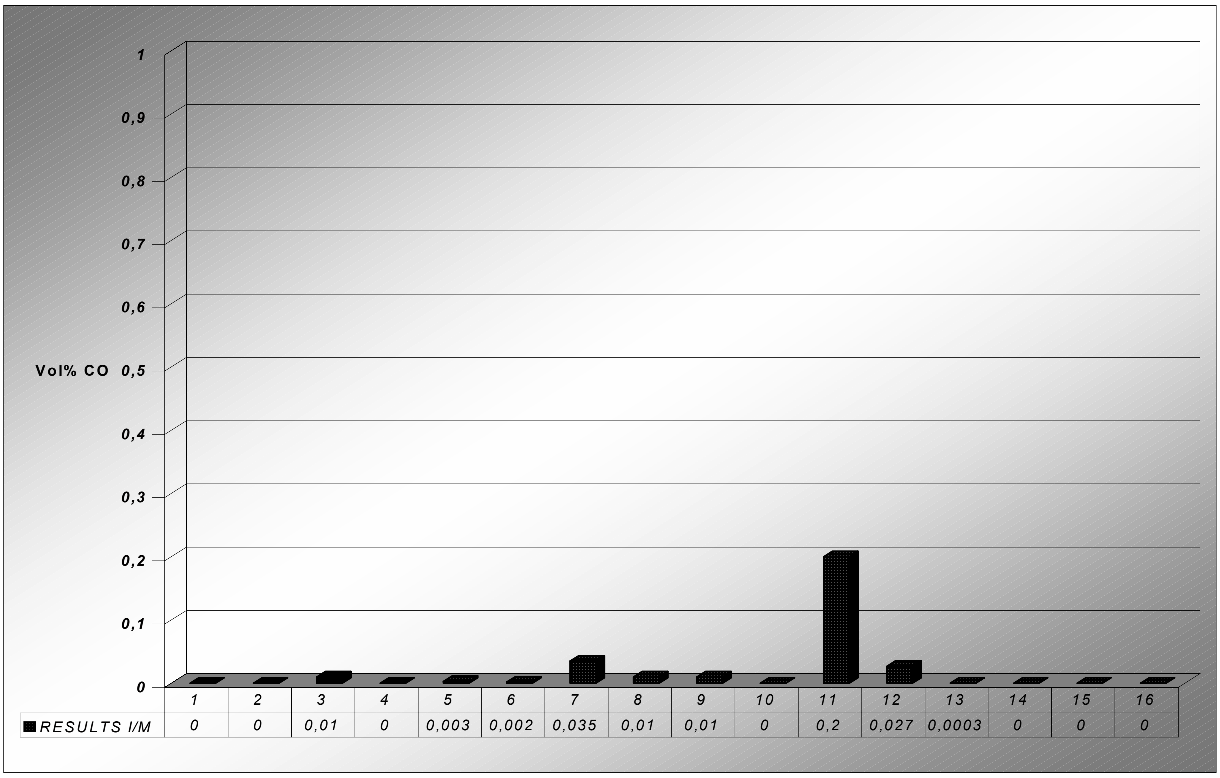
The NOX emissions are inside the prescribed thresholds of the type approval test.

Diagram 7: Type 1 NOX with failure



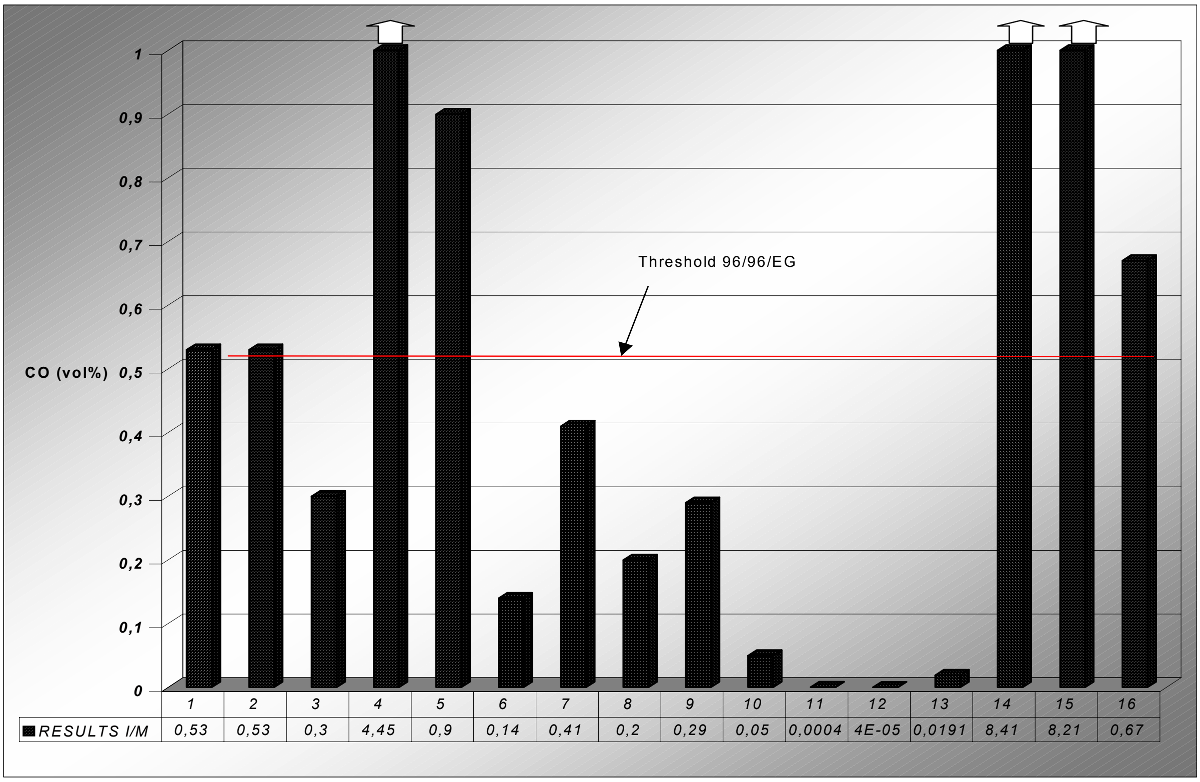
Only two vehicles fail the Type 1 test limits for NOX. In principle NOX is produced by available oxygen. Three-way catalysts that simultaneously convert HC, CO and NOX work at approximately stoichiometric air fuel mixture. Provided the engine management systems maintain the air fuel ratio and only vehicles with a deteriorated catalyst will produce excess NOX. The two vehicles with conspicuously high NOX had deteriorated catalysts.

Diagram 8: Reference I/M CO at idle speed



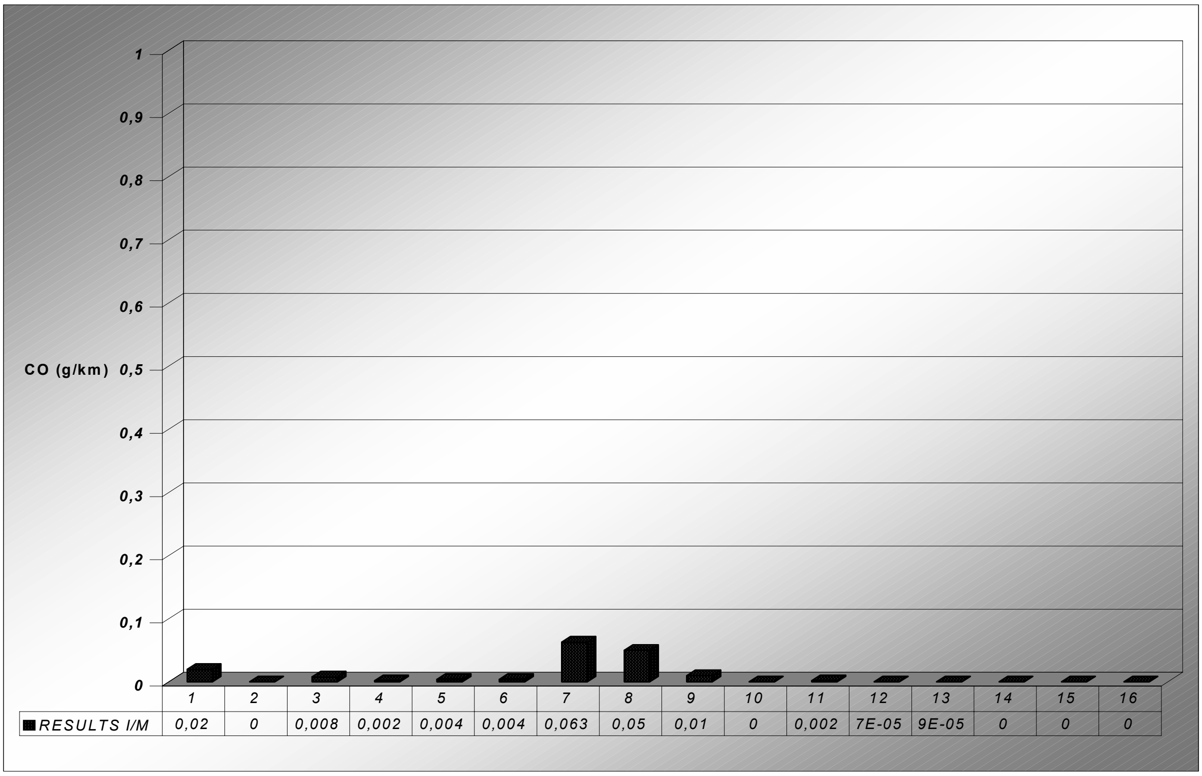
In the main, the CO emissions at idle speed stay well below the prescribed thresholds for the tailpipe test according 96/96/EU. Exceptionally, vehicle 11 emits much more then the others.

Diagram 9: I/M CO high idle with failure



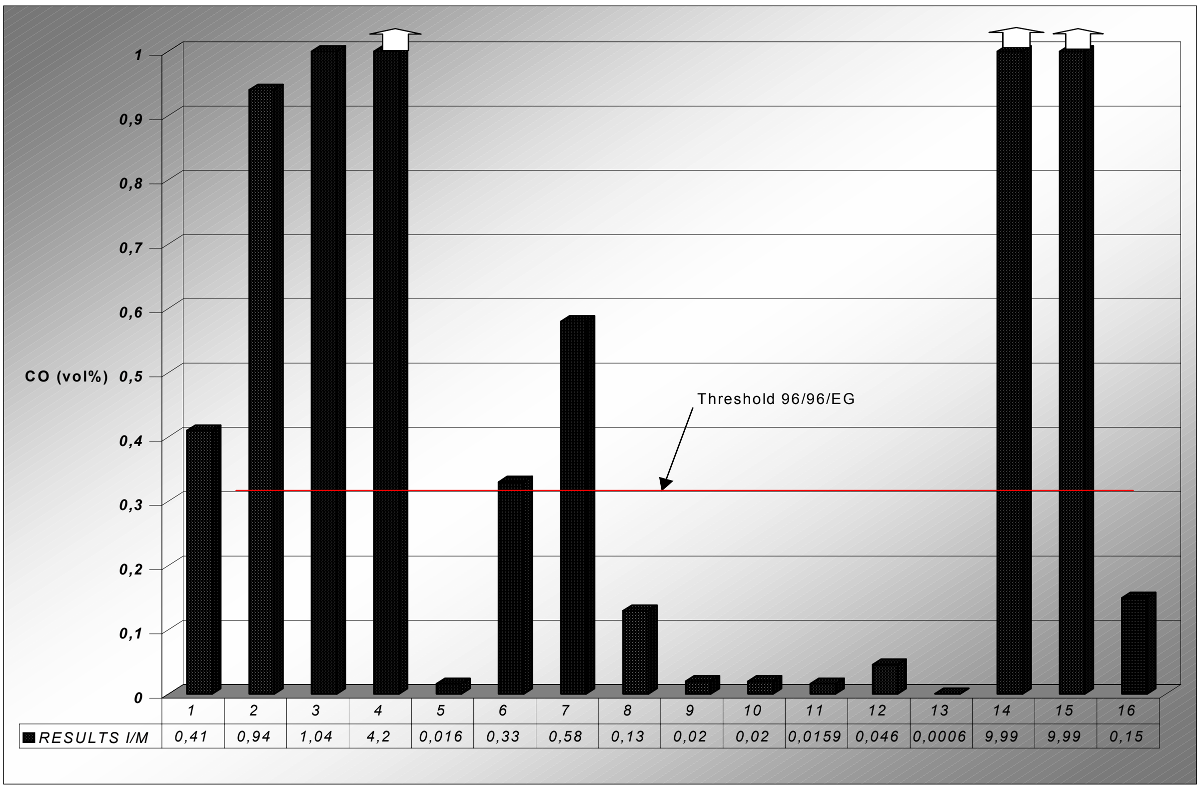
Seven vehicles produce idle speed exhaust emissions beyond the thresholds of 96/96/EU.

Diagram 10: Reference I/M CO high idle



The CO emissions at high idle speed stay well below the prescribed thresholds for the tailpipe test according 96/96/EU for all vehicles.

Diagram 11: I/M CO high idle with failure



Eight of the sixteen vehicles fail this part of the tailpipe test, three of them with high increases.

7.4 Summary of Results

Within the scope of the research study to examine the use of OBD during the periodical inspection, 16 vehicles homologated to 98/69/EU were tested under certain conditions. These cars met the thresholds specified in either EU 3 or EU 4.

Firstly, the participants examined the real communication performance of the OBD system. Most vehicles supported the required performance to communicate most basic information to a generic scan tool. There were some vehicle systems which were not able to communicate correctly:

in one of the excepted cases, the communication continuity was not satisfactory, communication interrupted from time to time;
in other cases the information on the real time values from the engine management was not sufficient, only some values are available;
there were vehicles which reset the readiness codes every time the ignition was disconnected.

For a constantly reproducible OBD test for use during periodical inspection, such system differences are not tolerable. There is a need for greater standardisation of the interpretations used during type approval verification. The potential of OBD systems to be used to enhance periodic inspection will only be realised if systems fulfil all the necessary requirements.

Secondly, participants examined whether the OBD systems could detect electrical failures (i.e. disconnection of components). Spot checks of such failures showed that the tested OBD systems worked correctly.

The third important question was whether the OBD system can detect aged and changed components, such as might be expected on old vehicles with higher mileage. During the study such older vehicles were not available. Participants found alternative ways to simulate aged components.

The simulated failures were related to real ageing of components as much as possible. In addition, some vehicles were tested with combinations of failures. The objective of the research was to find failures which produced exhaust emission relevant changes that were not detected by the OBD system. In many cases, the presence of a failure could not be detected by the ECU. Vehicles were tested under type approval conditions and afterwards under I/M conditions. Half of the prepared vehicles showed increased emissions beyond the MIL threshold but the MIL was not activated.

OBD systems offer the potential to improve the effectiveness of periodical inspections. The OBD system monitors virtually every emission control component for malfunctions during normal driving conditions. In addition, OBD monitoring includes emission-related components and systems that cannot be otherwise be checked during a tailpipe test only, such as cold start emission reduction devices (e.g. secondary air injection, lambda sensor heater....) or other fuel system malfunctions that occur outside of I/M conditions. Further, a combination of OBD and tailpipe inspection does not need much more time then a tailpipe only inspection. The OBD check can be done automatically during the tailpipe test using computer controlled eqyuipment. The research study was not intended to investigate the whole functionality of OBD systems but it shows *that the current systems are not entirely able to observe exhaust emissions alone.* Most of the tested OBD systems are able to support the tailpipe tests for better evaluation.

The requirements of the directive are mostly fulfilled although the interpretation of the directive varies in some cases.

The tests performed focused on fault simulation of aged and changed components on "new" vehicles. One conclusion of this study is that not all today's OBD equipped and certified vehicles can ensure that important malfunctions which cause the specified emission thresholds to be exceeded, can be detected by the OBD system

This study used a random sample of failures which produced malfunctions that were not detected by OBD. As long as malfunctions can occur that are not detected by the OBD system, the requirement for traditional tailpipe tests remains. Measuring tailpipe exhaust emissions within the periodical inspection is necessary to perform a fully effective evaluation. Current OBD systems are able to improve the tailpipe test in most cases e.g. disconnection of several components from CPU. The experience of the next years of use of OBD within periodical inspection will provide valuable information that can be used to support the further OBD system development.

7.5 Assessment

Table 12 – Assessment of OBD and current I/M procedures

	OBD System			***I/M Procedure***	
Performance	Readiness Code	Real time Values	Fault Codes	Measuring CO at special conditions	Measuring Lambda at special conditions
Reliability	+	+	+	+	++
Functionality	++	+	+	++	++
Availability	O	O	+	+++	++
Additional cost	+	+	+	--	--
Additional time	++	++	++	-	-

Key:
O Not satisfactory
\+ Satisfactory
++ Good
+++ Excellent

8. Concluding remarks

This report only covers the evaluation of scan tools, the results of the test phase an analysis of the results and some preliminary conclusions. The views and conclusions expressed are those of the participants. They do not necessarily represent the views of CITA or all CITA members.

The final report of this study will include:-

- A proposed test procedure;
- A draft amendment to directive 96/96/EC to introduce the proposed procedure;
- Recommendations on the specification of scan tools;
- Recommendations for possible improvements to current and future type approval standards for OBD systems;
- Results of the investigations into the cost/benefit of the proposed test procedure
- Overall conclusions

This report will be available later in 2002.

APPENDIX 1 - OVERVIEW OF INTERNATIONAL STANDARDS FOR OBD SYSTEM PROTOCOLS

Standard	Connection	Signal-Form	Baudrate	Protocol												Timing	
				Handshake	Head						Data (manufacturer dependant)			Checksum	Response	Response time	Minimum time between Requests
					Priority		Destination address		Address		Mode	Parameter-ID	Data bytes	ERR	RSP	(max.)	
					Request Scan tool	Response ECU	Request	Response	Request	Response			total				
SAE J 1850	J1850-Line	PWM	41,6 kB	according to SAE J1978	h61	h41	h6A	h6B	hFx	Address	According to SAE J1979	According to SAE J 1979	max. 7	CRC	Yes	100ms	100ms
SAE J 1850	J1850-Line	VPW	10,4 kB		h68	h48	h6A	h6B	hFx	Address			max. 7	CRC	No	100ms	100ms
SAE J 1850	J1850-Line	NRZ	10,4 kB		h68	h48	h6A	h6B	hFx	Address			max. 7	CRC	No	100ms	100ms
ISO 9141-2	K-Line or K- and L-Line	NRZ	10,4 kB	5 Baud	h68	h48	h6A	h6B	hFx	Address			max. 7	Checksum	No	0..25ms	55ms..5s
ISO 14230-1/4 KW2000	K-Line opt. L-Line	NRZ	10,4 kB	-5 Baud -fast initialising	b11LLLLLL (L=Lenght)	b10LLLLLL (L=Length)	h33	hFx	hFx	Address	corresp. to Service-ID SAE J2190, ISO/DIS 14230	corresp. to PID in den Modi nach SAE	max. 7	Checksum (like ISO 9141)	Not applicable	25ms	55ms..5s

See SAE 1979 (from 1998) and ISO/DIS 14230-4 for more specific information on this overview.

APPENDIX 2 - DEFINITION OF VEHICLE TEST PARAMETERS

1. INTRODUCTION

This note defines the parameters of the vehicle test phase of the programme. It includes the choice of vehicles, pre-conditioning and the tests to be performed.

2. BACKGROUND OF PROPOSED TEST PROGRAMME

This proposed test programme, which is based upon findings gathered during studies and at meetings with members of WP number 340, is focused on the following aspects of OBD-I/M testing:

(1) OBD's effectiveness as compared to existing exhaust emission testing (current idle PTI test);

(2) any special implementation issues associated with incorporating checks of the OBD system into a traditional I/M setting.

During the last two decades, manufacturers have achieved significant reductions in the emissions of properly functioning, new vehicles.

The lack of equivalent control over malfunctions and during non-standard conditions has become increasingly evident. Emission-related malfunctions do not always cause an outward indication of a problem (e.g., poor driveability or decreased fuel economy) and thus are sometimes difficult to detect and repair.

Directive 98/69/EC of the European Parliament and of the Council of 13 October 1998 relating to measures to be taken against air pollution by emissions from motor vehicles and amending Council Directive 70/220/EEC, introduced new provisions for incorporation of on-board diagnostic systems (OBD)in new vehicles.

Specifically, the on-board diagnostic system must be capable of identifying catalyst deterioration, engine misfire, oxygen sensor deterioration and any other type of deterioration or malfunction within the powertrain which could, up to 80000 km, cause emission increases greater than or exceeding the threshold levels established in Annex XI of Directive 98/69/EC.

A malfunction indicator (MI) has to indicate when the OBD system detects a failure that results in an increase in emissions above given limits. The purpose of the MI is to inform the vehicle operator of the need for service when the vehicle is operating under potentially high emitting conditions. Once indicated a malfunction, the MI must remain during all periods of engine operation until the trouble codes stored in the on-board computer are cleared by a service technician or after repeated re-evaluation by the OBD system fails to detect a reoccurrence of the problem. (The directive allows the OBD system to extinguish the MI after three subsequent driving cycles of similar operation in which a system fault does not reoccur.)

Codes identifying the likely problem will be stored in the vehicle's on-board computer for ready access by technicians, enabling proper diagnosis and repair.

The OBD systems must offer unrestricted and standardised access to anyone via standardized connectors without requiring access codes or any device only available from the manufacturer.

Further, the OBD system information must be usable without the need for any unique decoding information or device. In accordance with this mandate, the OBD rules require standardized codes conforming to the diagnostic trouble code definitions established in Society of Automotive Engineers (SAE) J2012, dated July 1996.

The OBD system may erase a fault code, and the associated distance travelled and freeze-frame information, if the same fault is not re-registered in at least forty (40) engine warm-up cycles.

Appendix 1 of Annex XI of the Directive describes a method for checking the function of the OBD system installed on the vehicle by failure simulation of relevant systems in the engine management or emission control system. It also sets procedures for determining the durability of OBD systems.

All those requirements are checked during the Type Approval tests. An EC type approved vehicle is considered to be in accordance with the prescriptions of Directive 70/220/EEC (last amended by 99/102/EC). Its OBD system also is considered to work properly.

OBD systems will allow an inspector to scan for any OBD information at the time of the periodic I/M test by simply attaching a computerized scan tool to the standardized plug provided on all OBD equipped vehicles. The presence of one or more emissions-related codes in a vehicle's OBD system will indicate current or recent existence of a malfunction with the potential to cause high emissions.

It is to be expected that OBD will reduce the error of omission / commission in relation to the idle tests currently used in the I/M programs. The development of OBD's capable of monitoring and recording vehicle faults during operation should narrow the gap between test conditions and actual operation in the future. The emission test at PTI should increase accuracy through monitoring the functioning of the vehicle's OBD system.

In addition, visual inspections of emission control devices can only determine their presence and possibly their proper connection but do not necessarily establish that the devices are functioning properly.

Interrogation of the OBD system provides another means of identifying vehicles in need of repair. It also enables more accurate and efficient repairs by identifying vehicle components responsible for emission increases.

The proposed procedure in point 9 is based on a test comparing the OBD results with the idle emission tests results (4 gas analyser) and with the Hot EUDC or Type I test results.

3. DEFINITIONS

I/M measurement: (Inspection and maintenance) emission measurement procedure used for emission measurement during PTI (Periodic Technical Inspection) in different EU countries (Directive 96/96/EC amended by 1999/52/EC, relating to roadworthiness test for motor vehicles).

Emissions data:

Emissions stated by the determination of the efficiency of the vehicle's emission control system by measuring the λ value (Brettschneider) and the CO content;

Results:	at engine idle speed:	CO content (% vol) CO_2 content (% vol); HC content (ppm vol); O_2 content (% vol); NO (ppm vol), if a 5 gas analyser is used;
	at high idle speed:	CO content (% vol) and λ; CO_2 content (% vol); HC content (ppm vol); O_2 content (% vol); NO (ppm vol), if a 5 gas analyser is used;

EOBD measurement: read out EOBD with appropriate scan tool(s), check for fault indication in different modes

T1 measurement: complete legal homologation test, including soak (Directive 70/220/EEC, last amended by 2001/1/EC, relating to measures to be taken against air pollution by emissions from motor vehicles)

Emissions data:

Emissions stated by a test of a Type 1 test cycle:

results: CO (g/km); HC (g/km); NO_x (g/km);

HOT EUDC measurement: test of the part two of the Type I test, the Extra-urban cycle. (Directive 70/220/EEC last amended by 2001/1/EC, relating to measures to be taken against air pollution by emissions from motor vehicles)

Emissions data:

Emissions stated by a test of the part two of the Type 1 test cycle:

results: CO (g/km); HC (g/km); NO_x (g/km);

MALFUNCTION INDICATOR (MI): a visible or audible indicator that clearly informs the driver of the vehicle in the event of a malfunction of any emission-related component connected to the OBD system, or the OBD system itself.

4. SELECTION OF THE VEHICLE TYPES

At the meeting of the 31st January – 1st February 2001 the vehicle types to be tested according to 98/69/EC, were selected. The list was established in order to obtain a representative cross-section of vehicles sold on the European market.

Any changes to the selection of the vehicle types will be communicated to RWTÜV, the leader of WP350: Test Programme.

RWTÜV will supervise the test programme to ensure that during the test phase all types of OBD systems are tested with all the identified modes of failure.

5. SELECTION OF THE PARAMETERS UNDER CONTROL BY THE EOBD AND ARE BASED TO SET FAILURES

Failures are to be induced without affecting the driveability. The driver should not feel a large difference when the failure is present. For example, the engine should not run under a limp home strategy, or should not stall at idle. The dashboard data should also be considered as a drive-ability effect (alarms for coolant temperature or oil pressure, no engine or vehicle speed display, …). The EOBD display or MI must not have been set after the failure has been induced.
The failure must result in an increase of the emissions.

The following list gives the relevant sensors and parameters on which failures are to be set:

Catalyst conversion

Upstream lambda sensor

Downstream lambda sensor

Injectors

Fuel trim value

Misfire

Knock sensor

Air intake temperature

Intake manifold air pressure

Throttle position

Idle speed actuator

Air mass flow sensor

Coolant temperature

Oil temperature

Engine speed

Vehicle speed

Camshaft position

EGR valve

Secondary air injection pump

Canister purge valve

Fuel supply system

6. SELECTION OF THE EOBD PARAMETERS

All readout and display functions using Generic Scan tool will be evaluated.

Mode 1:
Call-up of vehicle specific diagnosis data (P-codes and readiness code). Listing of all supported systems/functions.

Mode 2:
Call-up of “Freeze Frame” data on trouble codes from Mode 1.

Mode 3:
Call-up of all set trouble codes. List of all trouble codes causing MI settings.

Mode 4:
Deletion of EOBD trouble code and Freeze Frame data.

Mode 5:
Monitoring of oxygen sensors.

Mode 6:
Call-up of shadow fault memory of functions not monitored continuously.

Mode 7:
Call-up of shadow fault memory of functions monitored continuously. Trouble codes do not yet have to cause MI settings.

Mode 8:
System or component test. Required for more exact diagnosis steps in service

Mode 9:
Vehicle identification.

7. SELECTION OF ADDITIONAL EQUIPMENT

Non-Dispersive Infrared (NDIR) 4-gas analyser with RPM and temperature measuring;
The NDIR-analyser must be of a type approved or agreed for the purpose of PTI in the country of the work package partner.

Chassis dynamometer, exhaust-gas sampling system and analytical equipment as described in the annex III, Type I test (verifying the average emission of tailpipe emissions after a cold start) of the directive 70/220/EEC, last amended by 2001/1/EC, relating to measures to be taken against air pollution by emissions from motor vehicles).

All test equipment must be calibrated as often as necessary and in any case not more than a month before the test date.

8. TEST SEQUENCE

8.1 Test data number

All data obtained during the tests (print-outs) shall be annotated with a test data number. These test data numbers consists of the following:

XX-YY-ZZ-VV-WW

with

XX: WP partner
G1: WP partner TÜV
G2: WP partner DEKRA
FR: WP partner UTAC
UK: WP partner VI
BE: WP partner GOCA

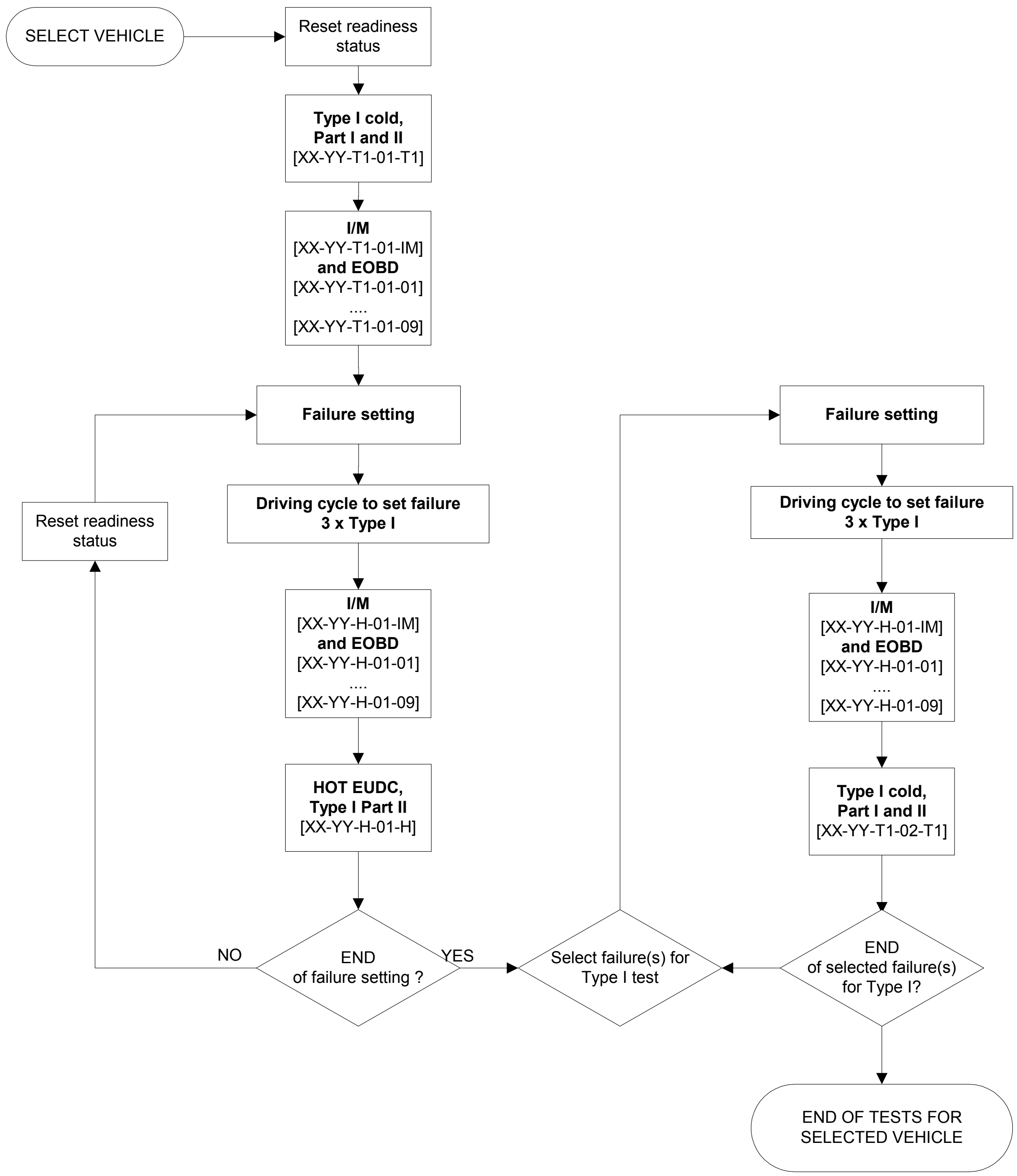
YY: vehicle
01 for a first test vehicle, 02, 03,…

ZZ: kind of test.:
H: HOT EUDC and I/M test
T1: Type 1 and I/M test

VV: sequence of the H or T1 test
01 for the first executed H or T1 test
02 for the second executed H or T1 test
03, …

WW: data related to
T1: for the data related to the Type 1 test
H: for the data related to the HOT EUDC test
IM: for the data related to the I/M test
01: for the data related to the mode 1 of the EOBD test
02: for the data related to the mode 2 of the EOBD test
03: for the data related to the mode 3 of the EOBD test
04: for the data related to the mode 4 of the EOBD test
05: for the data related to the mode 5 of the EOBD test
06: for the data related to the mode 6 of the EOBD test
07: for the data related to the mode 7 of the EOBD test
08: for the data related to the mode 8 of the EOBD test
09: for the data related to the mode 9 of the EOBD test

8.2 Test sequence for each test vehicle:



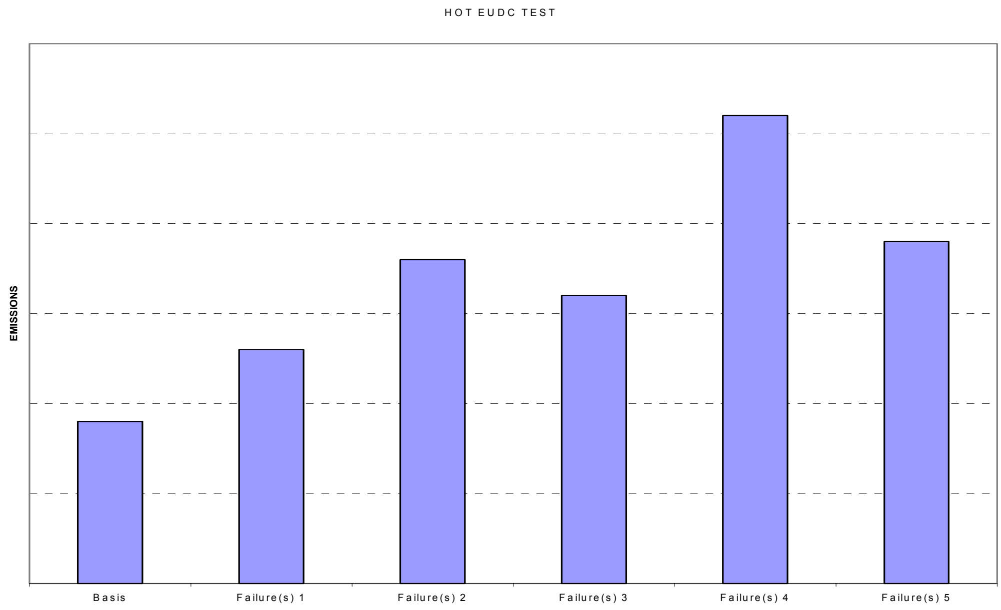
8.3 Test sequence description

The first test to be conducted on a selected vehicle is a Type 1 test. The vehicle must be in full working order. The emissions during the complete cycle and during the second part will be measured. An I/M test and an EOBD test will also be conducted.
The emissions measured during the second part will be compared to the measurements from the vehicles with failures in order to decide which failure setting will be measured during a complete Type 1 test.

For each vehicle one or more failures will be introduced. During the driving cycle the failure should be set in the EOBD system. After the driving cycle, a HOT EUDC test, an I/M test and an EOBD test will be performed. These tests will be repeated after introducing the next failure of the series of one or more failures. For each vehicle a series of 4 or 5 different failures or failures related to the list of paragraph 5 are to be introduced. (During the whole test programme the whole series of possible failures are to be tested at least once on a vehicle).

When the whole failure series for the vehicle has been tested, an evaluation of the emissions during the HOT EUDC test will be made. The test with the failure with the highest combined emissions during the HOT EUDC test, will be retested using a Type 1 test. In this test phase, an I/M and an EOBD test will also be performed.

There will be at least two Type 1 results for each series of HOT EUDC tests, one for the basic and one for the worst case. In this way a relation between the HOT EUDC tests and the Type 1 test can be found.



T1 and HOT EUDC test

These tests are outlined in the annex III of the directive 70/220/EEC, last amendment by the directive 2001/1/EC. The difference between these two tests consists in the operating cycle. The operating cycle for a type I test is made up of a Part one, the urban cycle, and a Part two, extra-urban cycle. For the Hot EUDC test the operating cycle is only made up of the extra-urban cycle.

8.4 Fuel level: The fuel tank level must be filled to the nominal capacity of the fuel tank.
A reference fuel will be used. The specifications for the reference fuel are contained in annex IX of directive 70/220/EEC, last amendment by the 2001/1/EC.
8.5 The inertia used during the test can be the manufacturer's value or set according to the directive.
8.6 The deceleration time from 120 to 20 km/h can be the manufacturer's value or chosen from an equivalent vehicle.

9. EOBD

An EOBD check consists of two types of examination: A visual check of the dashboard display function and status and a scan of the EOBD computer. These two examinations, taken together, comprise the procedure outlined below.

9.1 Visually examine the instrument panel to determine if the MI illuminates when the ignition key is turned to the "key on, engine off" position.
9.2 Start the vehicle's engine and visually check MI illumination under the "key on, engine running" condition.
9.3 Follow the scan tool manufacturer's instructions to determine
9.3.1 Vehicle's readiness status (mode 1)
9.3.2 MI status,
9.3.3 Diagnostic Trouble Codes (DTCs) (in mode 3 and 7),
9.3.4 Freeze frames (mode 2),
9.3.5 Lambda value (mode 5).
9.3.6 Results of the other modes if available (mode 4, 6, 8 and 9)
9.4 Turn off the vehicle ignition and disconnect the scan tool.

10. I/M

The I/M examination comprises of the procedure outlined below.

10.1 Visual inspection of the exhaust system in order to check that there are no leakages.
10.2 Oil-temperature: Engine shall be fully warm, for instance the engine oil temperature measured by a probe in the oil level dipstick tube to be at least 70°C, or normal operating temperature if lower.
10.3 Carbon Monoxide test at idle speed (I/M)
Measuring the air/fuel ratio: λ value (Brettschneider) and the CO content;
At engine idle speed: CO content (% vol) and λ;
CO_2 content (% vol); HC content (ppm vol);
O_2 content (% vol);
At idle there is a negligible amount of NOx emissions.
At high idle speed: CO content (% vol) and λ;
CO_2 content (% vol); HC content (ppm vol);
O_2 content (% vol);
At idle there is a negligible amount of NOx emissions.
High idle speed : a speed of +2000 rpm: 2750 rpm +/- 250 rpm

10.4 Visual inspection of the exhaust system in order to check that there are no leakages.

Comment: If the I/M test in the country of any work-package partner has additional elements: e.g. the close-loop test in Germany, these test shall also be conducted by that work package partner and the results communicated to VI.

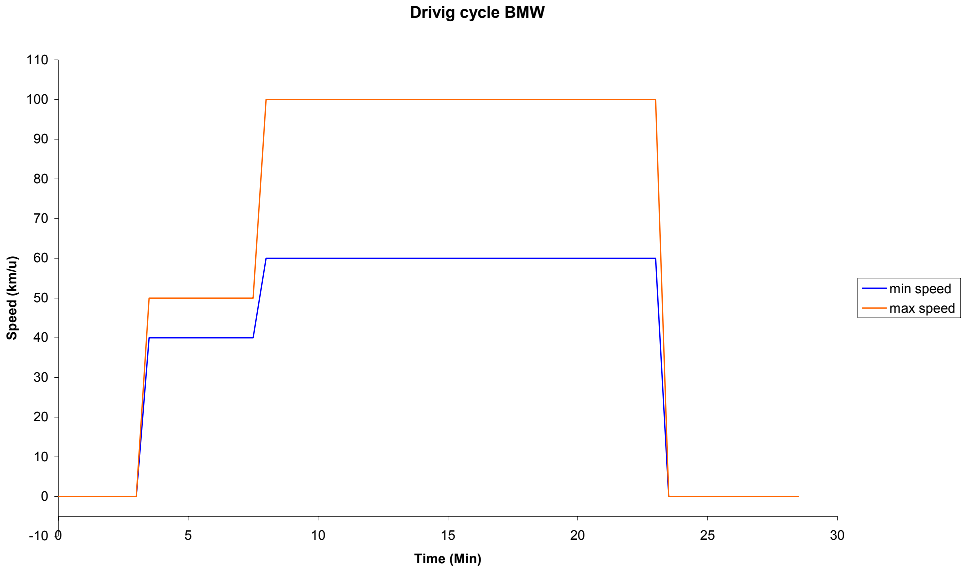
11. DRIVING CYCLE

A driving cycle, consists of engine start-up, driving mode where a malfunction would be detected if present, and engine shut-off.

The driving cycle to be used in this test programme is three type I (both part I and II) cycles.

If the failure or the readiness codes are not set during this cycle, a practical driving cycle defined by the manufacturer, during which all the systems are monitored once, can be used. Normally the driving conditions of the manufacturer's driving cycle can be performed in any order after start-up. This conditions can be performed on a roller dynamometer or even on a test track. If a manufacturer's driving cycle diagram is used; the description shall be added to the test-report.

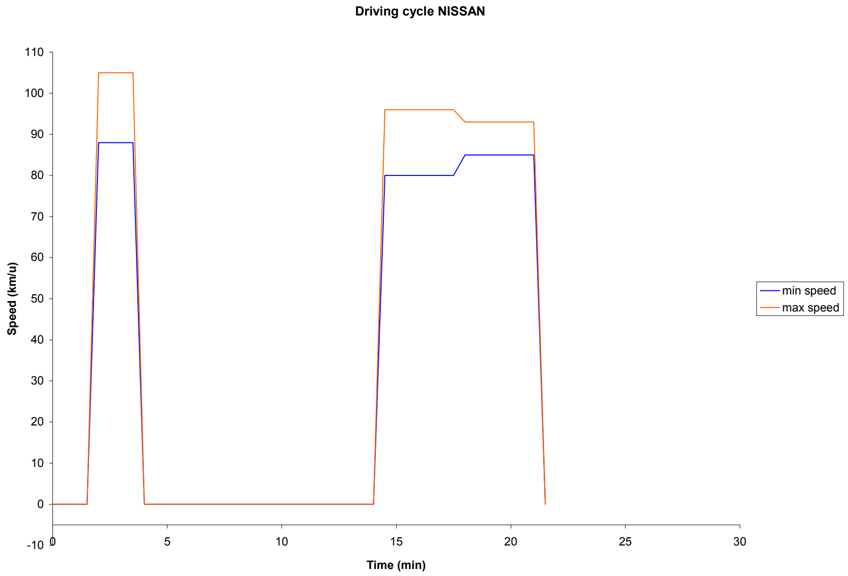
e.g. Driving Cycle BMW



1. **Engine cold start:** idling, approx. 3 minutes
2. **Constant driving at 40 to 50 km/h:** approx. 4 minutes
3. **Constant driving at 60 to 100 km/h:** approx. 15 minutes, Ensure overrunning phases of sufficient length in-between.

NOTE
The diagnostic sequence illustrated above will be interrupted if:
- the engine speed exceeds 3000 rpm
- the accelerator-pedal position fluctuates markedly
- the driving speed exceeds 100 km/h

e.g. Driving Cycle NISSAN



1. **Engine cold start:** idling, approx. 1,5 minutes
2. **Constant driving at 88 - 105 km/h:** approx. 1,5 minutes, selector level 5th, engine. rpm 2000-2800
3. **Allow engine to idle for at least 10 minutes**: Cycle ignition switch off for 10 seconds, Restart engine then immediately, begin next drive pattern section
4. **Cruise at 80-96 km/h**: approx. 3 minutes, Selector lever 4th, Keep engine speed above 3000 rpm, Allow road speed to vary if necessary, Do not decelerate for more than 3 consecutive seconds
5. **Steady state cruise at 85 to 93 km/h:** approx. 3 minutes, Selector lever 5th, Keep road speed as steady as possible, engine. rpm 2300-2400

13. TEST RESULTS

In order to simplify the analysis of the results, all tests are to be communicated in a uniform format. This format will be available as a pre-programmed Excel file.

List of measured parameters

Vehicle data

- Laboratory
- Lab. vehicle. number
- Make
- Model

- Mass (empty vehicle., kg)
- Power absorbed at 80 km/h (kW)
- Engine capacity (cm^3)

- Mileage (km)
- Size of tyres
- Tyre pressure at the test (bar)

- Any additional comment

For each idle test

- Laboratory
- Test vehicle number
- Day-month-year of the test
- Mileage (km)

- Engine speed idle (rpm) - engine speed high idle (rpm))

- For each pollutant: emission (ppm V for HC and NOx, % vol for CO and CO_2)

- EOBD parameters in mode 1,2,3,4,5,6,7,8 and 9

- Any additional comment

For each T1 test and HOT EUDC test

- Laboratory
- Test vehicle number
- Day-month-year of the test
- Mileage (km)

- Atmospheric pressure during the test (mbar or hPa)
- Ambient air temperature (°C)
- Vapour pressure (kpa)

- For each pollutant: emission (g/km)

- EOBD parameters in mode 1,2,3,4,5,6,7,8 and 9

- Any additional comment

Further data to be recorded

EOBD connector location

time needed to establish communications
time and distance between the introduction of the malfunction and MI response

EOBD connector accessibility (easy/difficult/…)

Additional comments

14. EOBD CONNECTOR MAPPING DIAGRAM

Location 1
This location represents a DLC positioned on the underside of the instrument panel directly under the steering column (or approximately 150 mm left or right of the steering column). Visualising the underside of an instrument panel divided into tree equal parts from inside the passenger compartment, this represents the centre section.

Location 2
This location represents a DLC positioned on the underside of the instrument panel between the steering column and the driver’s side passenger door. Visualising the underside of an instrument panel divided into tree equal parts from inside the passenger compartment, this represents the left section.

Location 3
This location represents a DLC positioned on the underside of the instrument panel between the steering column and the centre console. Visualising the underside of an instrument panel divided into tree equal parts from inside the passenger compartment, this represents the right section.

Location 4
This location represents a DLC positioned on the upper part of the instrument panel between the steering column and the centre console (but not on the centre console).

Location 5
This location represents a DLC positioned on the upper part of the instrument panel between the steering column and the driver side, passenger door.

Location 6
This location represents a DLC positioned on the vertical section of the centre console and left of the vehicle centreline.

Location 7
This location represents a DLC positioned 300 mm right of the vehicle centreline either on the vertical section of the centre console or on the passenger side of the vehicle.

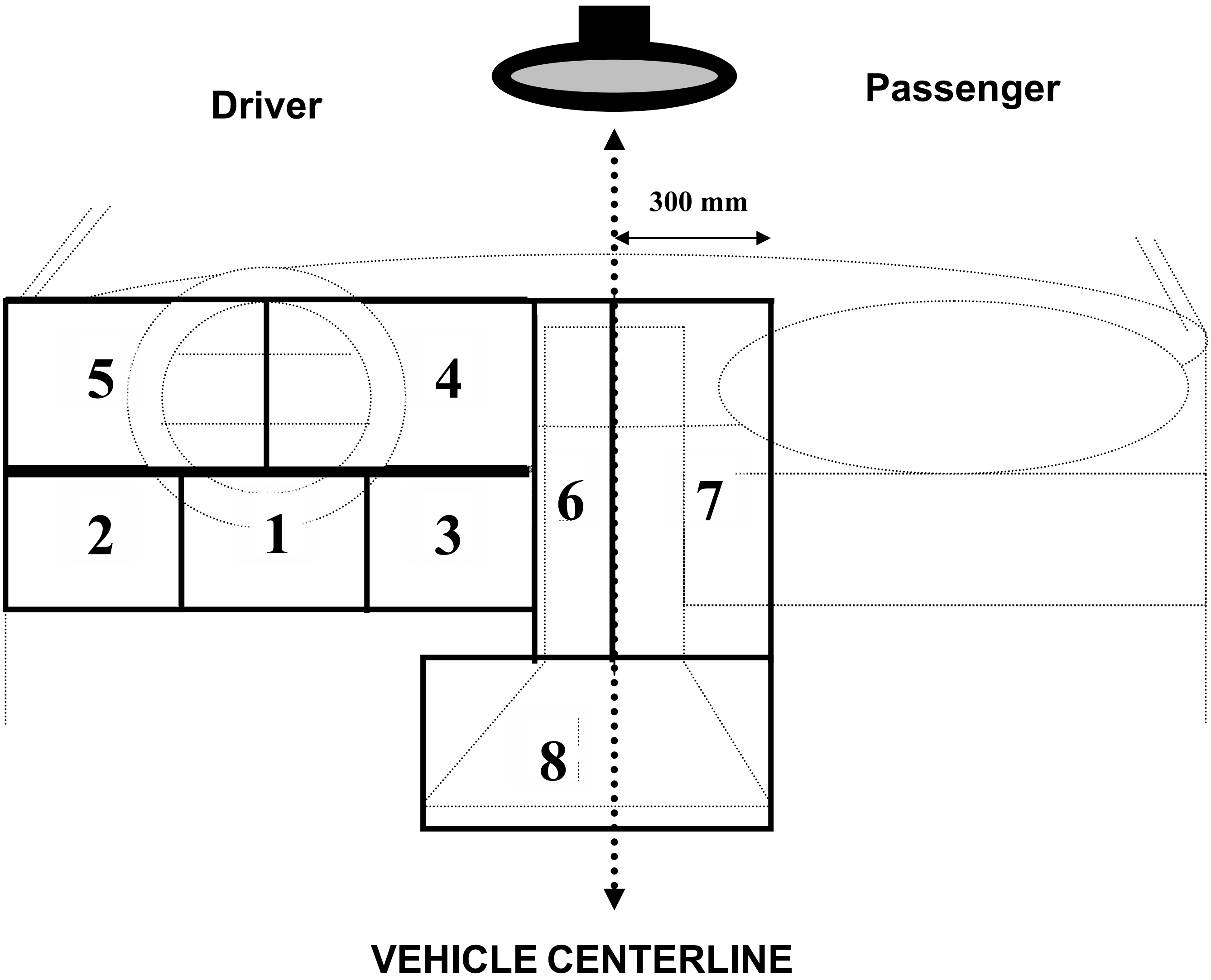
Location 8
This location represents a DLC positioned on the horizontal section of the centre console either left or right of the vehicle centre line. This does not include the horizontal section of the centre console that extends into the rear passenger area.

Location 9
This location represents any DLC positioned in an area other than those mentioned above (e.g. in the rear passenger area on the driver side armrest).

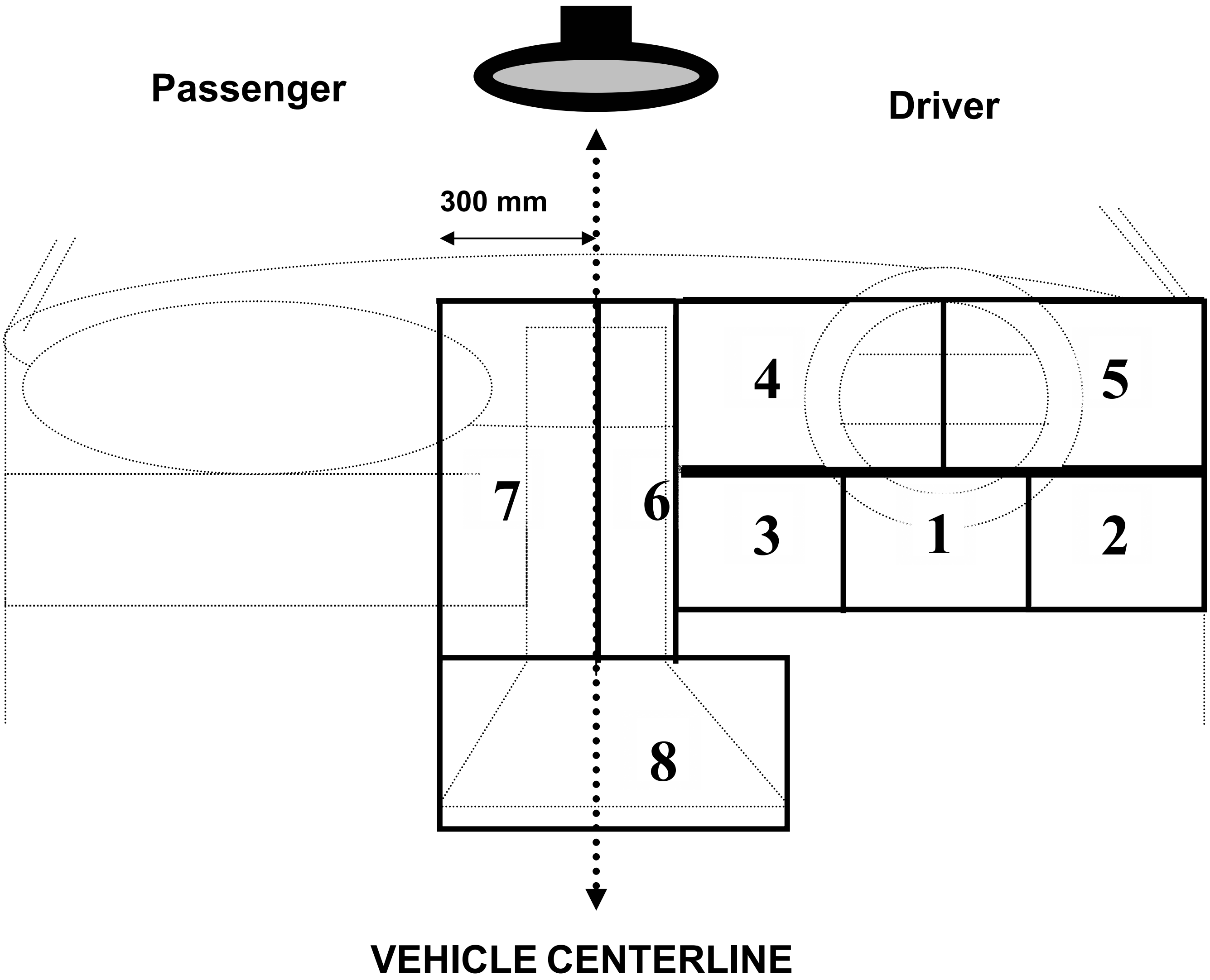
For right-hand drive vehicles the reverse of the above applies.

Diagnostic Link Connector Mapping Diagram

Left-hand drive vehicle



Right-hand drive vehicle



15. PLANNING

Scan tools:
The scan tools will be evaluated by DEKRA. At the beginning of March DEKRA will distribute the scan tools to the working partners.

Test programme evaluation after first test:
All working partners of the Test Programme will execute one test sequence for one vehicle. (VI will, due to the contract with a subcontractor, not be able to execute these tests before the meeting on 21-22 March).
After these tests this document (CITA/WG1/2ERSP/S301-004) and the Excel Matrix Utac12-02.xls will be evaluated again. (Meeting on 21 – 22 March 2001).

Transmission of the data in order to analyse them:
A copy of all test reports and the modified and completed Excel Matrix Utac12-02.xls will be sent to VI after the test programme of a vehicle is finished.
Once results are received, VI can already evaluated the information before starting the Work Package 360: Analysis of results and synthesis of proposals.

APPENDIX 3