Vehicle & Operator Services Agency

VPB/07/24/20

1996 MOT EXHAUST GAS ANALYSER SPECIFICATION

Issue Date: May 1995
1st Revision: June 1995
2nd Revision: August 1995
3rd Revision: September 1996
4th Revision: July 1999
5th Revision: June 2001
6th Revision May 2003
7.1 Revision March 2004

CONTENTS

1 INTRODUCTION

This specification covers exhaust gas analysers to be used for statutory testing in the MOT scheme as from 1 January 1996. These exhaust gas analysers will be used for testing both catalyst-equipped vehicles and non-catalyst equipped vehicles.

2 GENERAL SPECIFICATION

The analyser shall meet all the requirements of the ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE - "Instruments for measuring vehicle exhaust emissions" OIML R99 (Class I Instruments),

with the additional requirements as detailed in the remainder of this specification.

3 DEFINITIONS

Definitions are identical to those in OIML R99.

Fast idle - an engine speed >2000rpm. Fast idle is defined in terms of a minimum and maximum value, either in the test procedure or by the vehicle specific emission data/default values.

Pre-conditioning - warming the engine (eg. by running at fast idle, or by driving the vehicle) to assist catalyst light off.

Engine covers - parts of the engine included to either protect engine components or improve the appearance of the engine and which, if removed, do not affect the running of the engine.

Engine components - parts of the engine which, when disconnected or removed, would affect the running of the engine.

4 MEASUREMENT ABILITY

4.1 Analysers shall measure O_2 using an electro-chemical cell as per table 1:

Table 1 : Oxygen analyser specification

Meter	**Gas**	**Scale Range** % vol	**Resolution** % vol	**Maximum permissible Error[1)]**	
				Relative[2)] %	Absolute % vol
Digital	O_2	0 to 21	0.02 up to 4% vol 0.1 above 4% vol	±5	±0.1

1) Whichever is the greater of the two errors.

2) All values of relative error are indicated as relative values % to the measured value

4.2 Response time : The O_2 measurement channel must display a value less than 0.1 vol% within 60 seconds with a change from 20.9% vol O_2 to 0% O_2.

4.3 Analysers shall be provided with a means to observe negative O_2 indications near zero for approval test purposes.

4.4 Analysers shall calculate and display the normalised air-fuel ratio (lambda (λ)) using the Brettschneider equation as defined in Appendix 3.

Resolution : 0.01
Minimum range : 0.6 to 1.7
Display : Digital

5 TECHNICAL REQUIREMENTS

Analysers shall :

5.1 have a gas-tight gas handling system. Analysers shall be capable of performing a leak check which will detect a leak sufficient to cause a shift of 0.1% vol O_2 if air is drawn in;

5.2 automatically recognise O_2 sensor function error (due to ageing, contamination, interruption of connection line, impairment of function owing to excessively high foreign gas content etc) and prevent measurements of all gases and λ (during the MOT procedure) when the O_2 error exceeds the requirements of paragraph 4.1;

5.3 be capable of measuring engine speed with an accuracy of ±5% relative. Measuring probes may be attached to engine components in order to measure engine speed provided they do not cause damage (engine covers may be removed in order to attach probes). However, measuring probes which require disconnection of engine components in order to measure engine speed are not permitted;

5.4 include equipment which permits engine speed measurement for the following ignition systems;

a) Conventional HT (high tension) System — ie. an electronic or mechanically distributed HT system with a HT spark generated for every two engine revolutions.

(NB. where the equipment connects to the HT circuit, it must be able to pick up from both the coil lead and the spark plug lead.)

b) Distributorless Wasted Spark System — ie. an electronically distributed HT system with a HT "spark" generated for each engine revolution.

c) Distributorless direct ignition — ie. a system where there are no HT cables - each spark plug incorporates a small HT coil which is triggered electronically from the feeding low tension circuit at the rate of one spark per two engine revolutions.

In addition, the analyser should be designed to facilitate connection of other/new engine speed measurement technologies which may be specified in the future (ie optical sensors or other suitable devices which will be considered on merit).

5.5 be capable of measuring engine oil temperature with an accuracy of ±5% relative (between 60°C and 90°C). The measurement probe shall be capable of measuring oil temperature for all catalyst equipped vehicles (excluding dry sump systems). The length of the measurement probe shall be adjustable to match the length of the dipstick for all catalyst equipped vehicles.

5.6 include an alpha-numeric display which can show measurements and prompt the operator as necessary;

5.7 permit alpha-numeric data entry;

5.8 include a real time clock and a four year calendar which operates even when the mains is disconnected. The time shall be adjustable by the operator. However, adjustment of the date shall only be accessible to the calibration technician.

6 OPERATIONAL REQUIREMENTS

6.1 Serial Port

6.1.1 Analysers (whether Personal Computer (PC) based or otherwise) shall be able to send data to a remote IBM or IBM compatible PC at the end of each complete test to enable storage of the result. The communication hardware, the data, and the order in which the data is to be transmitted are specified in Appendix 2.

6.2 Vehicle Specific Data Storage

6.2.1 Analysers shall be capable of storing manufacturers' data for all positive ignition (petrol) engine vehicles where the exhaust emissions are controlled by an advanced emission control system such as a three-way catalytic converter which is lambda probe controlled. (There shall be sufficient data storage capacity on the analyser (ie. enough free space for 100% more data) to allow for updates with new vehicle model data in the future.) The data shall be retrievable by automatic selection (e.g by using menu prompts for make and model) and used in the software controlled test procedure in Appendix 1.

6.2.2 The minimum data required is as follows:

1. Idle CO - upper limit
2. Idle speed - lower limit
3. Idle speed - upper limit
4. Fast idle speed - lower limit
5. Fast idle speed - upper limit
6. Fast idle λ - lower limit
7. Fast idle λ - upper limit
8. Minimum oil temperature

NB. For items (2), (3), (4) and (5) above, a tolerance of ±50rpm shall be added to the

engine speed limits. For example, where the manufacturer's data specifies an idle speed of 725-775rpm, the analyser shall use an idle speed range of 675-825rpm.

6.3 Printout

6.3.1 The analyser shall be equipped with a data printer which has a physical connection between the analyser and printer.

6.3.2 The data transmission from the instrument to the printer shall be designated so that results cannot be falsified.

6.3.3 A printout shall be produced after each test. The analyser shall have the facility to print further copies if required.

6.3.4 The information to be included in the printout is given in Appendix 1.

6.3.5 No malfunction of the printer shall affect the measurement ability of the meter.

6.4 Operating Instructions

Each meter shall be supplied with a comprehensive user manual in English including:-

a) an explanation of the types of vehicles for which the meter is "MOT Approved";

b) a complete description of the test instrument and the monitoring equipment;

c) information on operating conditions;

d) safety instructions;

e) using the instrument to carry out an emissions test according to the MOT Inspection Manual;

f) information on routine maintenance. The replacement procedure for consumable items must be fully described;

g) how to carry out a calibration check (if applicable) and replace the oxygen sensor;

h) contact address (in the UK) for service and spare parts.

6.5 Calibration Manual

A calibration manual shall be provided with each instrument supplied for type approval testing and its adequacy and completeness shall be checked by the Approval Laboratory.

The manual shall contain all the information necessary to carry out a full calibration as specified by the Vehicle & Operator Services Agency. Before the Vehicle & Operator Services Agency issues an approval for a meter, the meter manufacturer (or UK importer) may provide a written declaration that one copyright copy of this manual will be made available to any third parties requiring the information to gain UKAS (formerly NAMAS) accreditation at a reasonable price (which shall not exceed 2.5% of the retail price of the analyser). If additional software is required for calibration purposes, he may also declare that this will be made available at a reasonable fee. The Vehicle & Operator Services Agency will make clear which manufacturers have made this declaration when it publishes lists of acceptable exhaust gas analysers.

7 PROCESS CONTROL

Analysers shall:

7.1 automatically prevent measurements of all gases and λ and prompt the user when the analyser is due for calibration ie once a month for calibration scheme 2(A) and every 3, 6 or 12 months for calibration scheme 2(B) (see Appendix 7, ref. VPB/07/24/20/CAL);

7.2 only permit adjustment with calibration or zero gas after the warming up period has elapsed and after all other possible adjustments which are necessary for the instrument to function correctly have been made;

7.3 automatically perform a HC residue check before each test. All gas and λ measurements shall be prevented until the HC residue check has been completed successfully;

7.4 automatically prompt a leak check every 24hrs. All gas and λ measurements shall be prevented until the leak check has been completed successfully;

7.5 monitor the oxygen transducer voltage and prevent measurements when, in ambient air, the voltage falls below a value of 2mV lower than the lowest value given by the specification for a new oxygen sensor. In the above situation, measurements should be prevented for all gases and λ (during the catalyst MOT procedure) and an error message should be displayed. The operator may replace the sensor if a newly fitted sensor can be automatically adjusted by the test device, tested for correct operation and the replacement can be fitted without damaging the calibration authority's security tag. The analyser shall only permit measurements when replacement oxygen transducers show a voltage, in ambient air, within the limits given by the specification for the new oxygen sensor ;

7.6 include a software controlled pre-conditioning and test sequence as detailed in Appendix 1;

7.7 be able to show the current set of test results on the display until the next test is started or until the analyser has been switched off.

7.8 be capable of displaying the calibration gas pressure when a pressure measuring device is used to correct the calibration gas pressure to ambient pressure as part of the calibration procedure. The pressure need only be displayed during the UKAS calibration procedure.

7.9 have the facility to measure alternative fuel types, ie. Liquid Petroleum Gas. When this option is selected, the analyser shall automatically convert the hydrocarbon reading into a propane reading using the "propane/hexane equivalency factor". (Liquid petroleum gas shall be assumed to be 100% propane).

7.10 perform a readjustment of at least the measuring channel affected if, at any time, negative values appear which are outside the range given by the maximum permissible errors on initial verification.

8 PATTERN APPROVAL PROCEDURES

Testing shall be carried out on at least one unit (selected by the test house on a statistical basis) which, in the opinion of the test house, represents the definitive pattern. Test houses will normally expect instruments to be provided complete with the following documents (in English):-

a) Instructions for use and operation,

b) Descriptions of
- design and operation of the measuring instrument,
- devices ensuring correct operation,
- regulating and adjusting devices,

c) For measuring instruments with electronic components
- block diagrams of the signal flow
- data sheets, functioning and connections of the integrated circuits,
- circuit diagrams containing data of the components,
- printed circuit board assembly diagrams,
- data concerning the protection against operational errors and the perception of operational errors,

d) For processor controlled measuring instruments (programmable measuring instruments)
- a listing of the program or the program stored by a memory, eg an Eprom
- a program flow chart
- a described data flow diagram

e) Diagrams for assembly of the measuring instruments as well as individual diagrams covering integral components, if so needed. The diagrams must include a number and a date;

g) schematic diagrams as well as illustrations of the measuring instrument,

h) details of how calculations are performed;

i) a fully documented calibration procedure

The pattern approval test requirements can be found in Appendix 5 and a "Route to Approval" guide can be found in Appendix 6. Before testing begins, the suitability of a particular test house should be confirmed with the Vehicle & Operator Services Agency.

When pattern approval tests have successfully been completed, application for inclusion on the MOT List of Acceptable Equipment should be made to:

Garage Equipment Association
2/3 Church Walk
DAVENTRY
Northants
NN11 4BL

Applications should include:

1) a copy of the test reports;
2) a copy of the user manual;
3) a photograph of the meter;
4) any declaration made under paragraph 6.5;
5) a declaration that any changes, as listed in the pattern approval report, which were

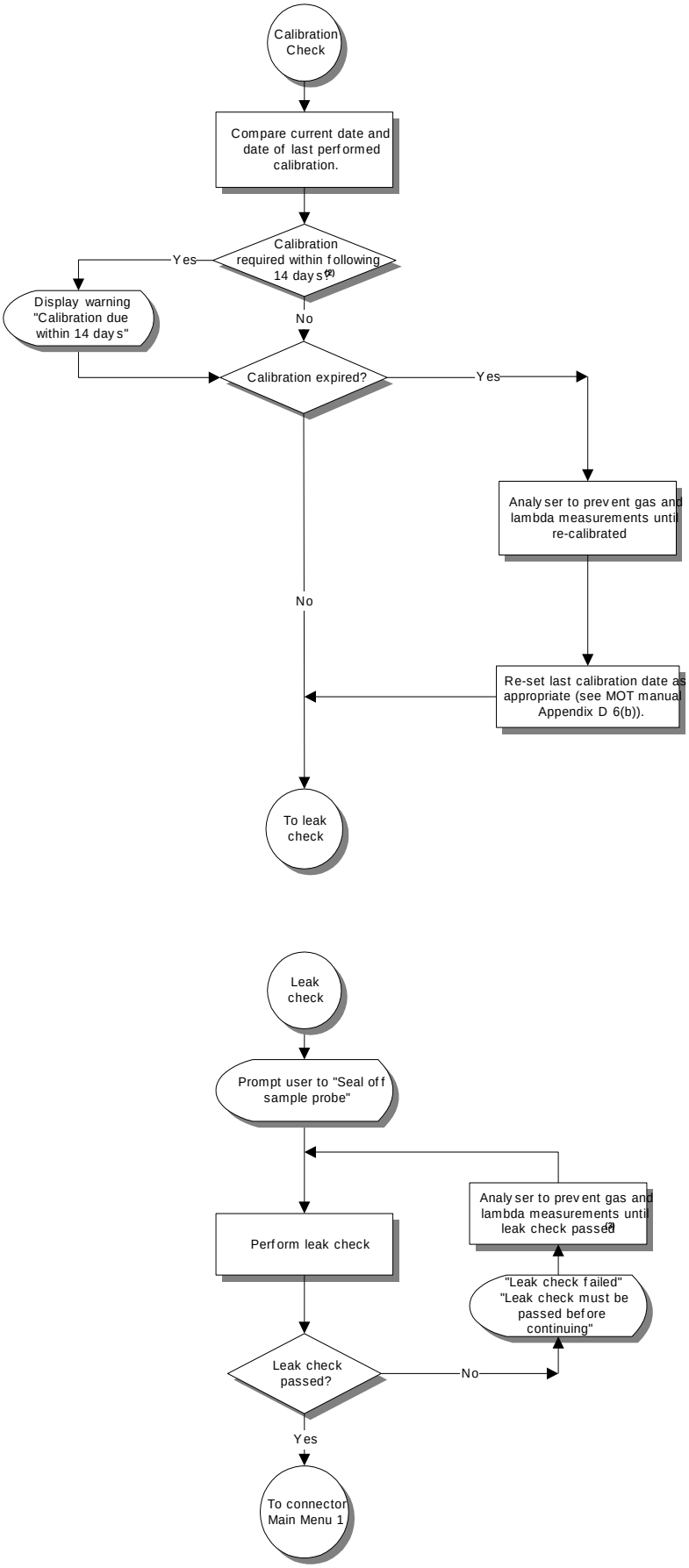
required to obtain approval will be made to all production models;
6) a declaration that any future design modifications will be notified to the UK test house.

9 ANNUAL CONFORMITY OF PRODUCTION TESTING

The analyser will be subject to annual conformity of production testing as per Appendix 4.

Appendix 1 Software Controlled MOT Emission Test Procedure (BET update June2001)

DAILY CHECKS [1]
(on first switch on, or at the beginning of each day)



Notes

1. The daily checks must be performed before the analyser can be used.

2. Calibration period: 3, 6, or 12 months (see Appendix 7).

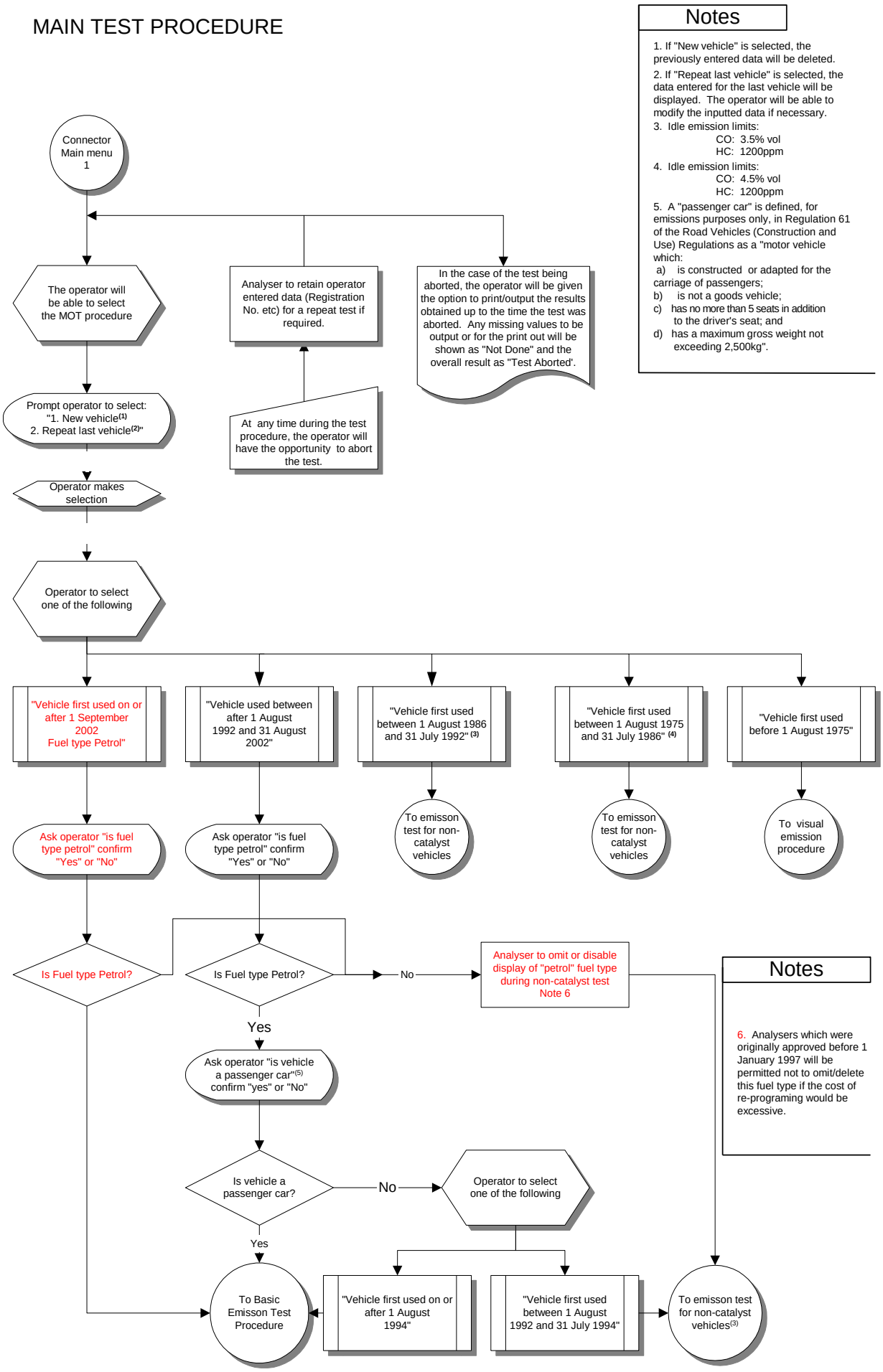
3. This applies to all leak checks whether or not performed at the start of the day.

SYMBOL IDENTIFICATION

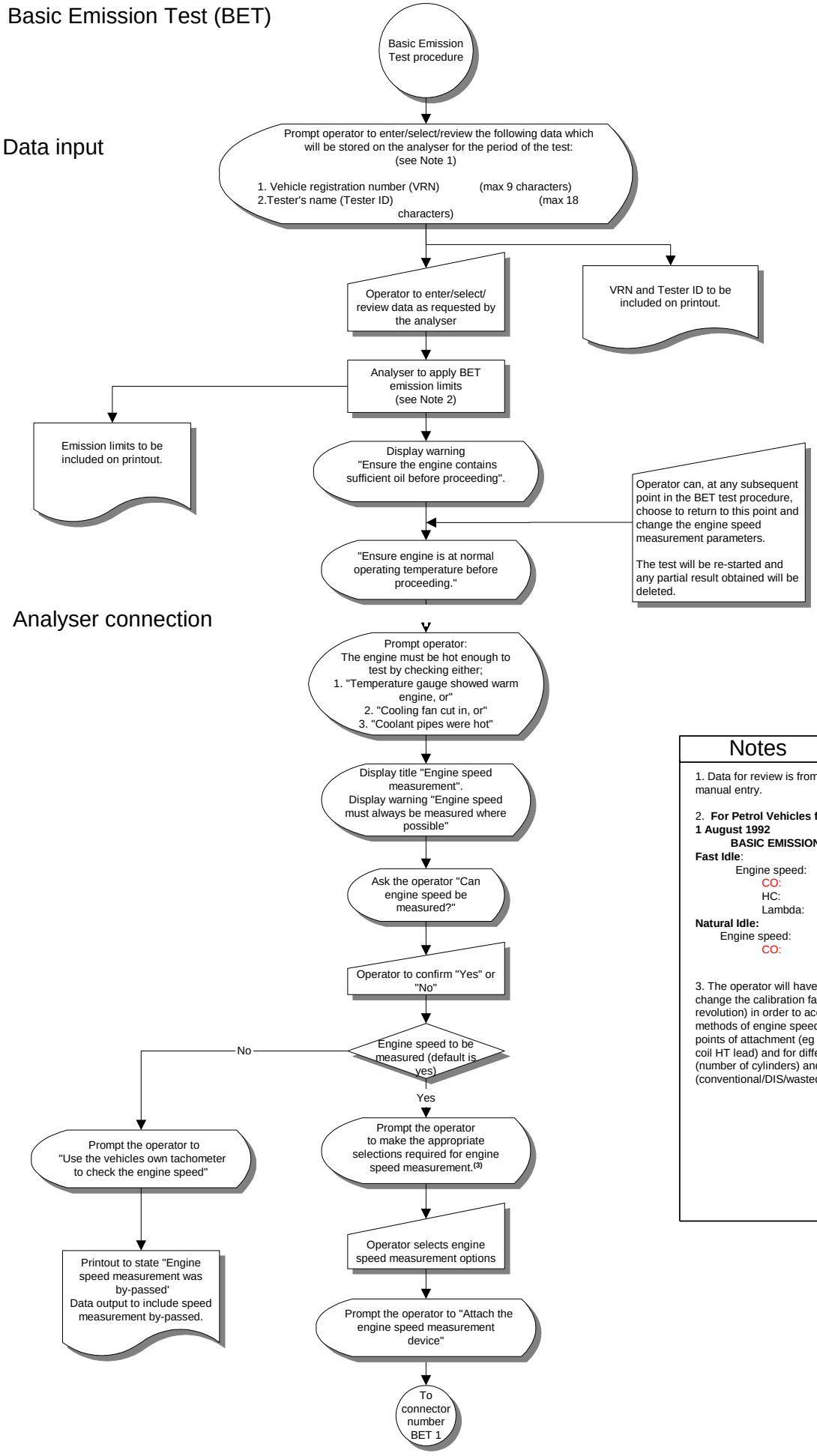
Each symbol represents the following:

- Any kind of processing function
- An analyser decision or switching type function
- Human readable data, such as printed output
- A named process, such as a subroutine, or a module
- data which is directly accessible, such as data stored on disk drives
- data input by manual means, such as with a keyboard
- data that is displayed for human use, such as data on a monitor screen.
- modifications (by the operator) such as setting a switch, or initialising a routine.
- an exit to, or an entry from, another part of the same flowsheet.

MAIN TEST PROCEDURE



Basic Emission Test (BET)



Notes

1. Data for review is from previous test or manual entry.

2. **For Petrol Vehicles first used on or after 1 August 1992**
BASIC EMISSION TEST LIMITS -
Fast Idle:

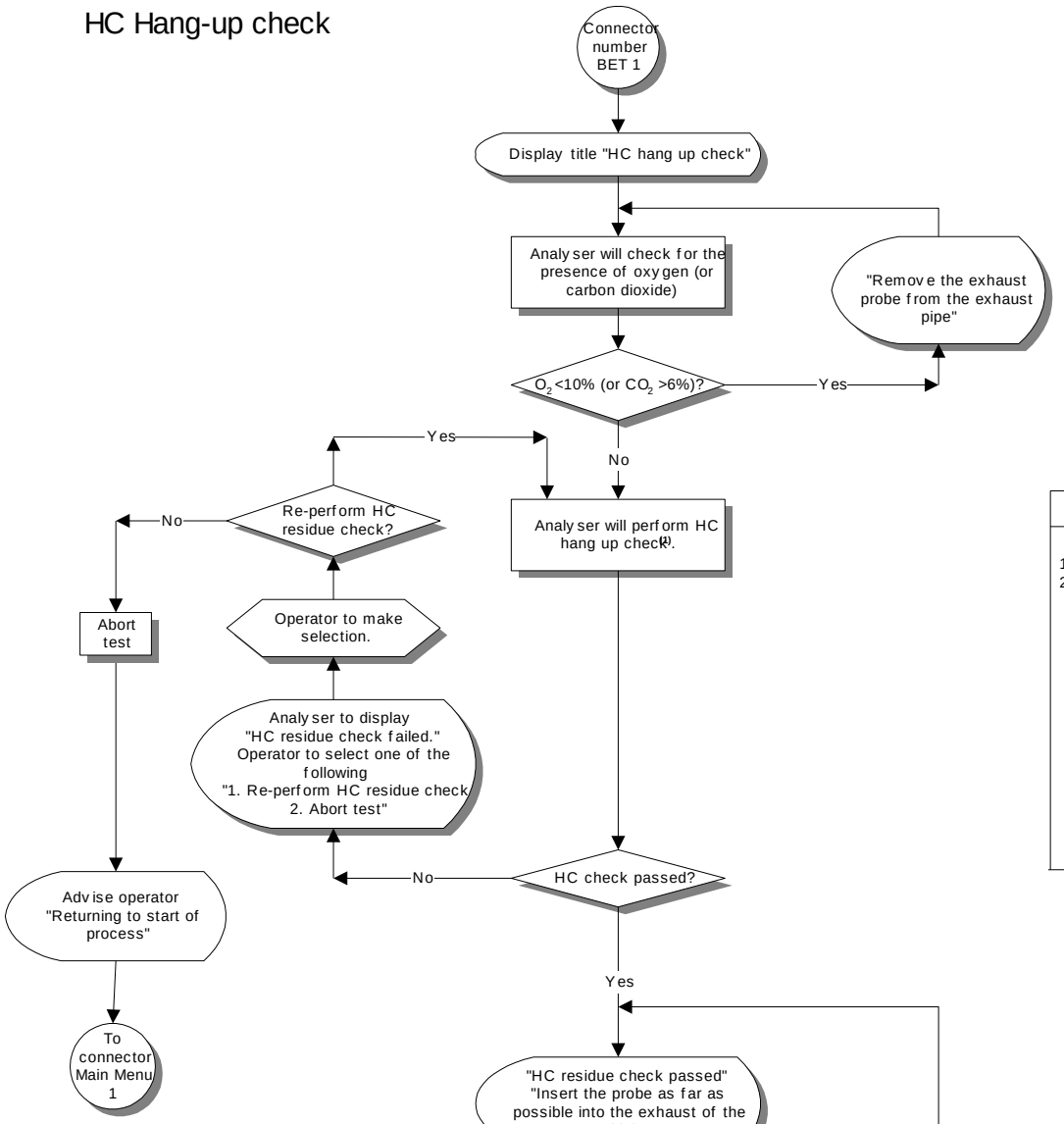
Engine speed:	2500-3000 rpm
CO:	=<0.2%vol
HC:	=<200ppm
Lambda:	0.97-1.03

Natural Idle:

Engine speed:	450 - 1500 rpm
CO:	=<0.3%vol

3. The operator will have the opportunity to change the calibration factor (ie pulses per revolution) in order to account for different methods of engine speed measurement, different points of attachment (eg spark plug HT lead or coil HT lead) and for different engine layouts (number of cylinders) and ignition systems (conventional/DIS/wasted spark/direct).

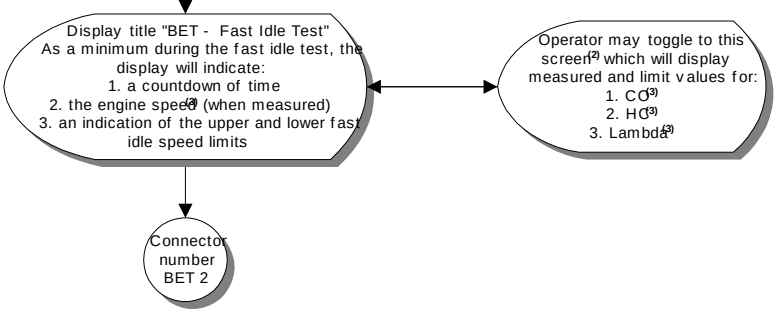
HC Hang-up check

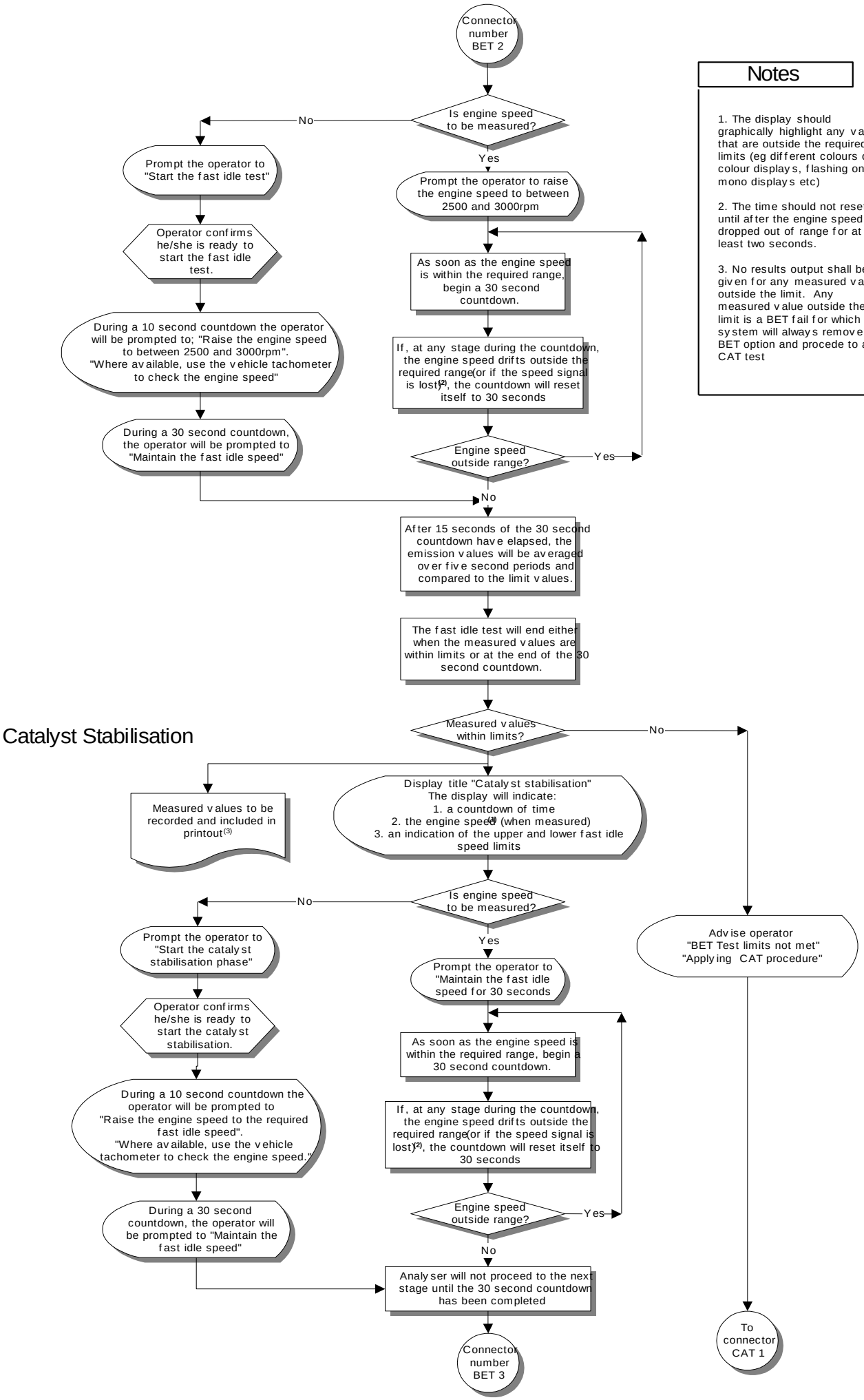


Notes

1. HC residue must be less than 20ppm to pass the test.
2. The measured and the limit values for CO, HC and Lambda should preferably be displayed on the same screen as "time" and "engine speed"; but may, as an alternative be available to the operator by toggling to an additional screen.
3. The time should not reset until after the tachometer has dropped out of range for at least two seconds.

BET - Fast Idle Test





Catalyst Stabilisation

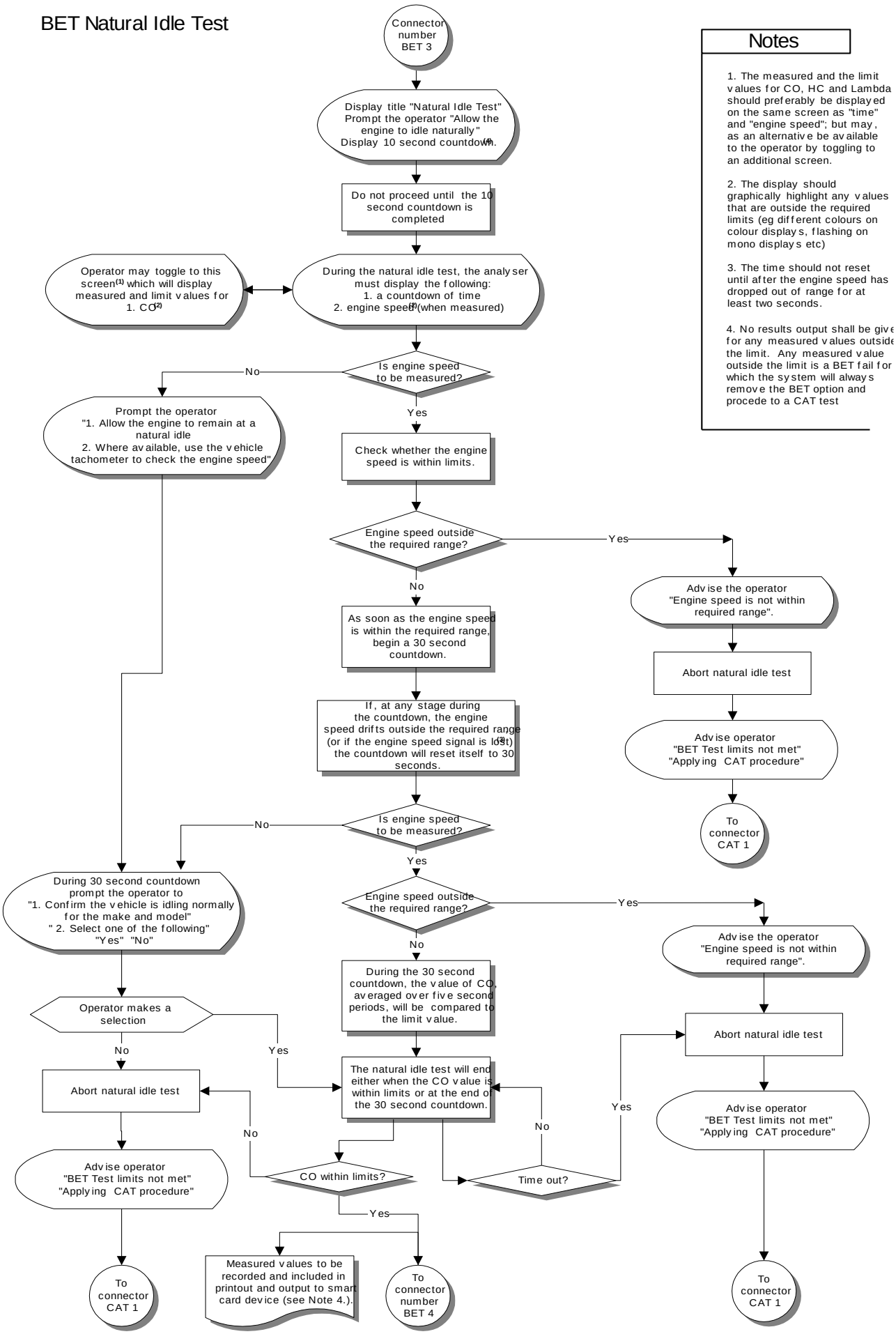
Notes

1. The display should graphically highlight any values that are outside the required limits (eg different colours on colour displays, flashing on mono displays etc)

2. The time should not reset until after the engine speed has dropped out of range for at least two seconds.

3. No results output shall be given for any measured values outside the limit. Any measured value outside the limit is a BET fail for which the system will always remove the BET option and procede to a CAT test

BET Natural Idle Test



Notes

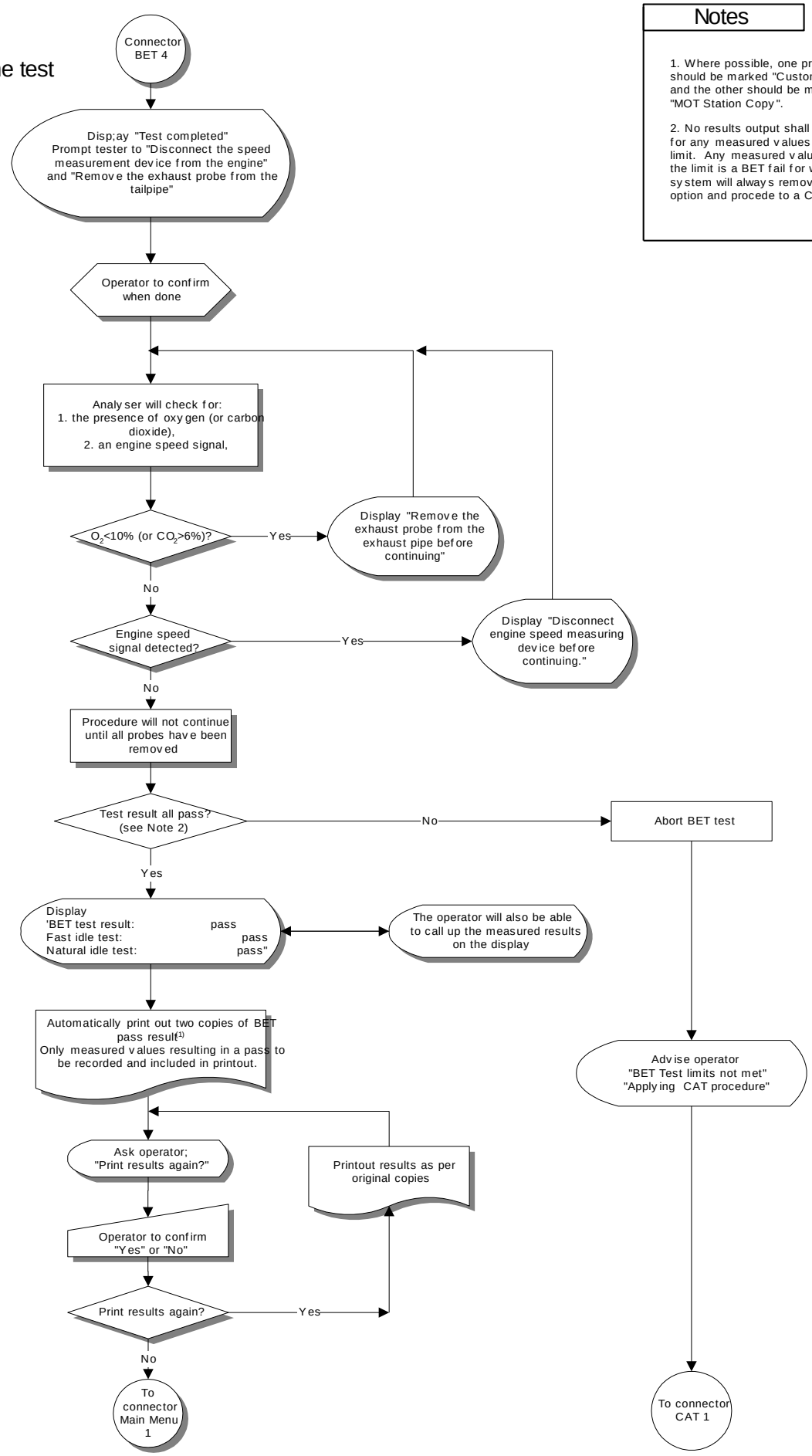
1. The measured and the limit values for CO, HC and Lambda should preferably be displayed on the same screen as "time" and "engine speed"; but may, as an alternative be available to the operator by toggling to an additional screen.

2. The display should graphically highlight any values that are outside the required limits (eg different colours on colour displays, flashing on mono displays etc)

3. The time should not reset until after the engine speed has dropped out of range for at least two seconds.

4. No results output shall be given for any measured values outside the limit. Any measured value outside the limit is a BET fail for which the system will always remove the BET option and procede to a CAT test

Results of the test

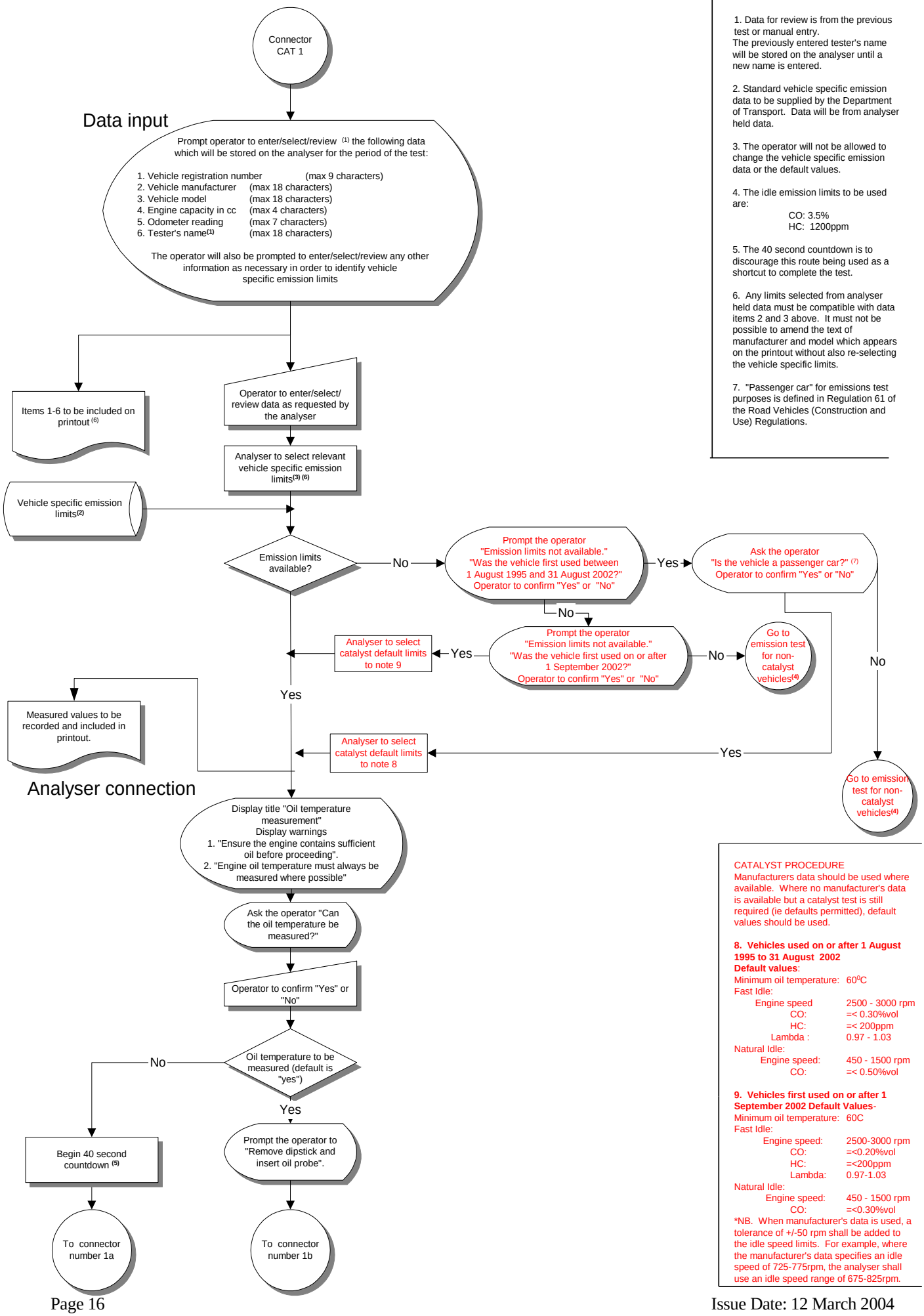


Notes

1. Where possible, one print copy should be marked "Customer Copy and the other should be marked "MOT Station Copy".

2. No results output shall be given for any measured values outside t limit. Any measured value outside the limit is a BET fail for which the system will always remove the BE option and procede to a CAT test

CATALYST PROCEDURE



Notes

1. Data for review is from the previous test or manual entry.
The previously entered tester's name will be stored on the analyser until a new name is entered.

2. Standard vehicle specific emission data to be supplied by the Department of Transport. Data will be from analyser held data.

3. The operator will not be allowed to change the vehicle specific emission data or the default values.

4. The idle emission limits to be used are:
CO: 3.5%
HC: 1200ppm

5. The 40 second countdown is to discourage this route being used as a shortcut to complete the test.

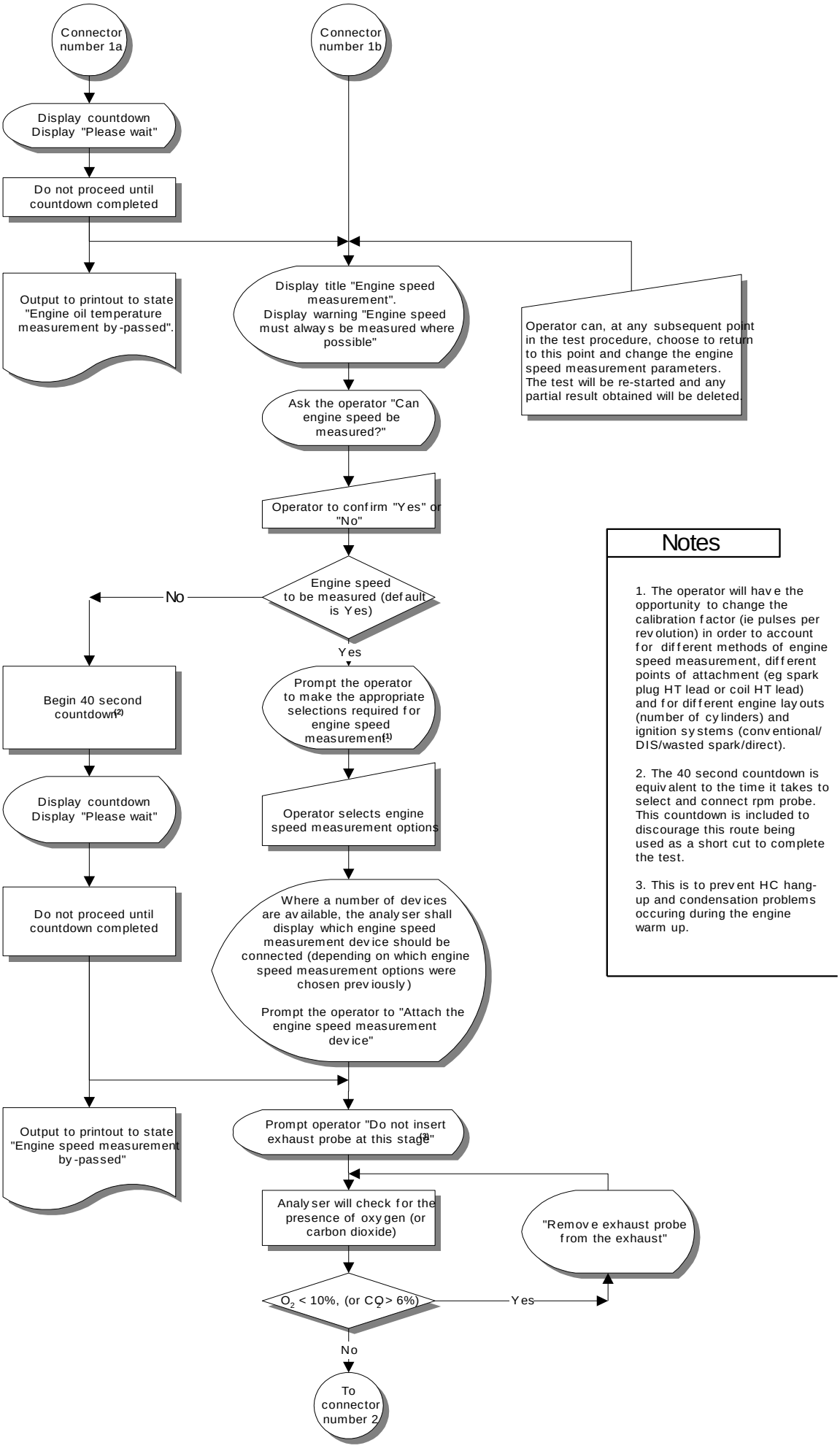
6. Any limits selected from analyser held data must be compatible with data items 2 and 3 above. It must not be possible to amend the text of manufacturer and model which appears on the printout without also re-selecting the vehicle specific limits.

7. "Passenger car" for emissions test purposes is defined in Regulation 61 of the Road Vehicles (Construction and Use) Regulations.

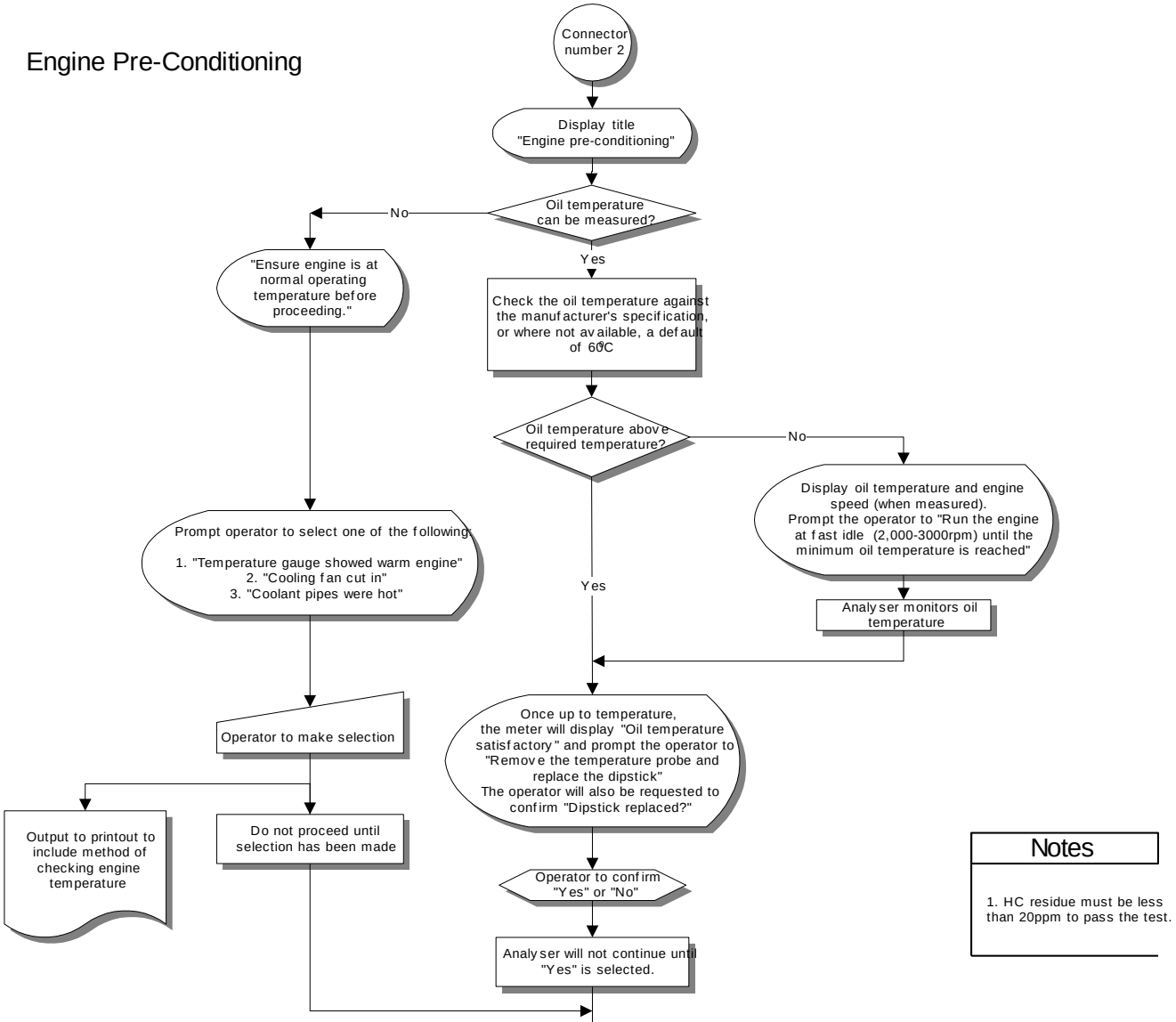
CATALYST PROCEDURE
Manufacturers data should be used where available. Where no manufacturer's data is available but a catalyst test is still required (ie defaults permitted), default values should be used.

8. Vehicles used on or after 1 August 1995 to 31 August 2002
Default values:
Minimum oil temperature: 60^0C
Fast Idle:
Engine speed 2500 - 3000 rpm
CO: =< 0.30%vol
HC: =< 200ppm
Lambda : 0.97 - 1.03
Natural Idle:
Engine speed: 450 - 1500 rpm
CO: =< 0.50%vol

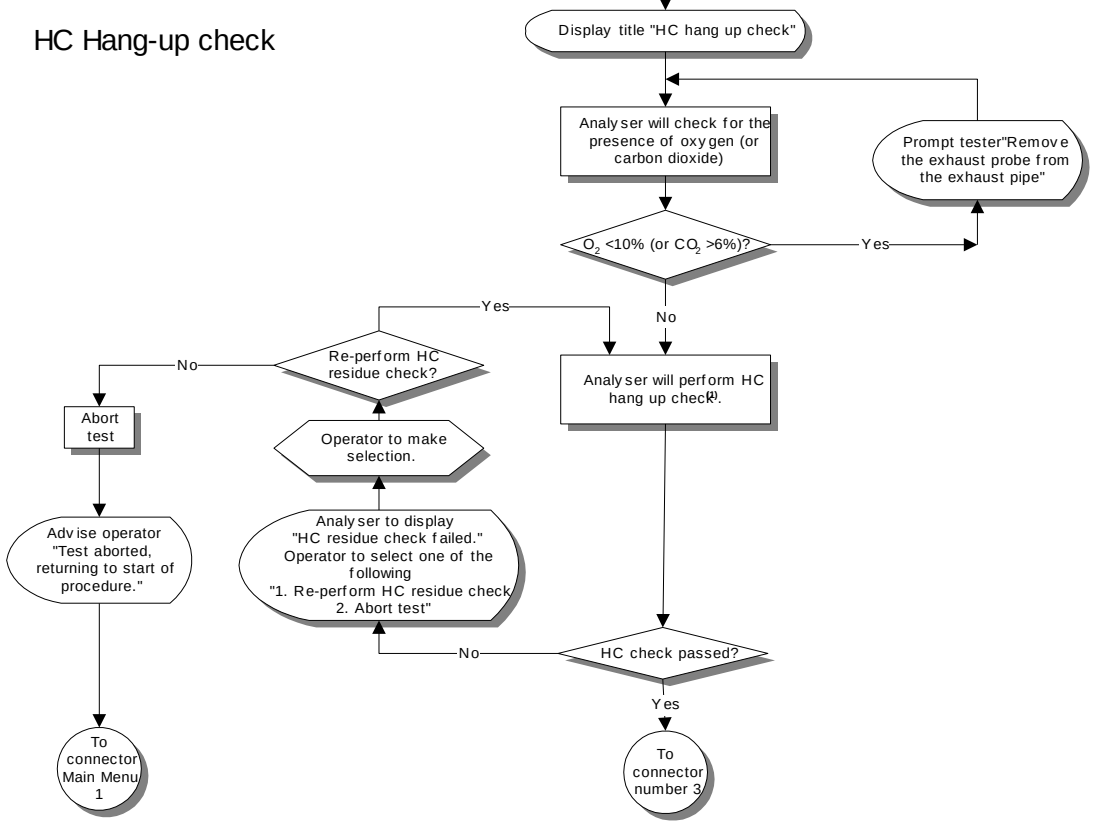
9. Vehicles first used on or after 1 September 2002 Default Values-
Minimum oil temperature: 60C
Fast Idle:
Engine speed: 2500-3000 rpm
CO: =<0.20%vol
HC: =<200ppm
Lambda: 0.97-1.03
Natural Idle:
Engine speed: 450 - 1500 rpm
CO: =<0.30%vol
*NB. When manufacturer's data is used, a tolerance of +/-50 rpm shall be added to the idle speed limits. For example, where the manufacturer's data specifies an idle speed of 725-775rpm, the analyser shall use an idle speed range of 675-825rpm.


Connector number 1a
Connector number 1b
Display countdown Display "Please wait"
Do not proceed until countdown completed
Output to printout to state "Engine oil temperature measurement by-passed".
Display title "Engine speed measurement". Display warning "Engine speed must always be measured where possible"
Operator can, at any subsequent point in the test procedure, choose to return to this point and change the engine speed measurement parameters. The test will be re-started and any partial result obtained will be deleted.
Ask the operator "Can engine speed be measured?"
Operator to confirm "Yes" or "No"
Engine speed to be measured (default is Yes)
No
Yes
Begin 40 second countdown(2)
Prompt the operator to make the appropriate selections required for engine speed measurement(1)
Display countdown Display "Please wait"
Operator selects engine speed measurement options
Do not proceed until countdown completed
Where a number of devices are available, the analyser shall display which engine speed measurement device should be connected (depending on which engine speed measurement options were chosen previously)
Prompt the operator to "Attach the engine speed measurement device"
Output to printout to state "Engine speed measurement by-passed"
Prompt operator "Do not insert exhaust probe at this stage"(3)
Analyser will check for the presence of oxygen (or carbon dioxide)
"Remove exhaust probe from the exhaust"
O_2 < 10%, (or CO_2 > 6%)
Yes
No
To connector number 2
Notes
1. The operator will have the opportunity to change the calibration factor (ie pulses per revolution) in order to account for different methods of engine speed measurement, different points of attachment (eg spark plug HT lead or coil HT lead) and for different engine layouts (number of cylinders) and ignition systems (conventional/ DIS/wasted spark/direct).
2. The 40 second countdown is equivalent to the time it takes to select and connect rpm probe. This countdown is included to discourage this route being used as a short cut to complete the test.
3. This is to prevent HC hang-up and condensation problems occuring during the engine warm up.

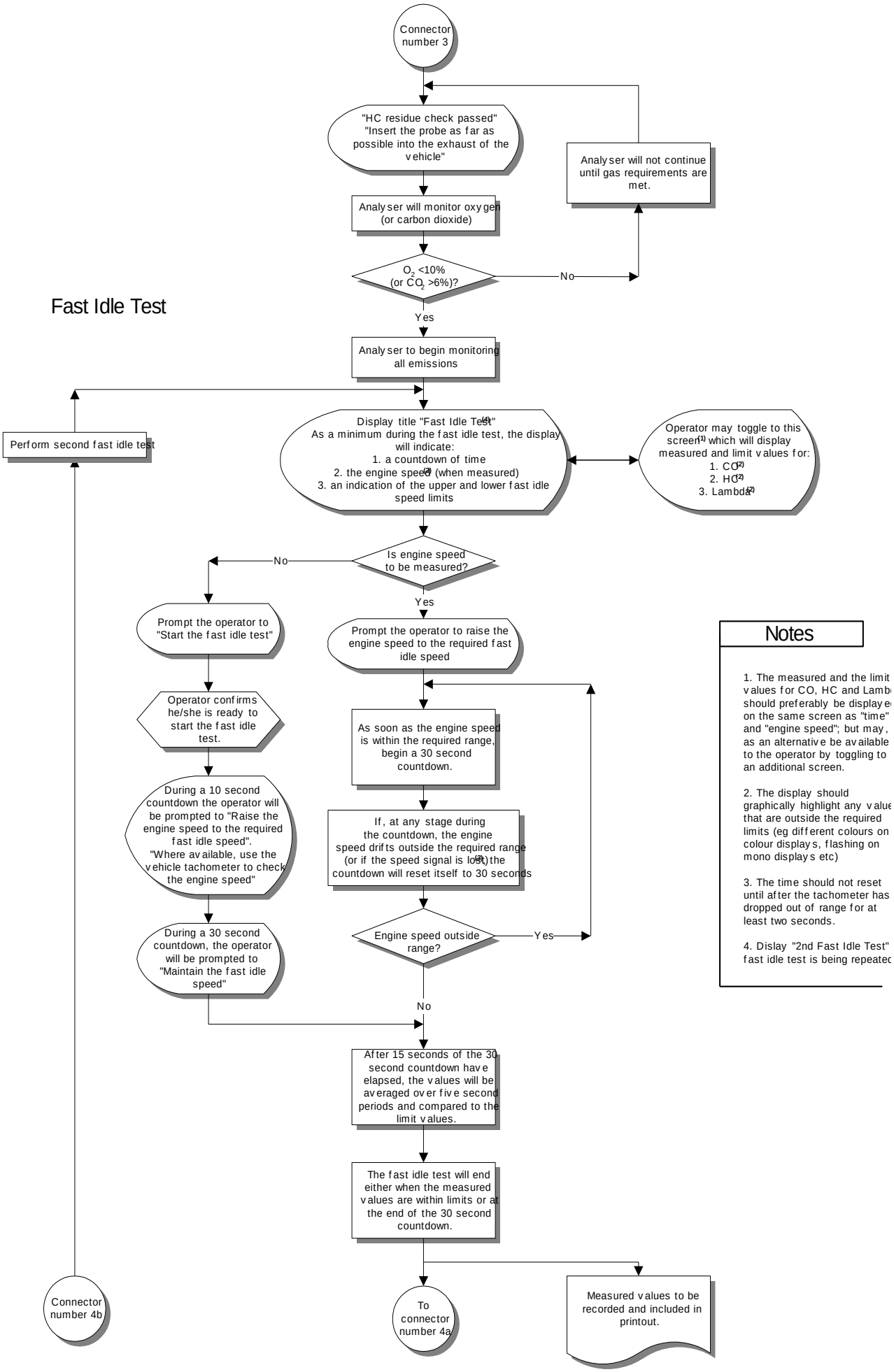
Engine Pre-Conditioning



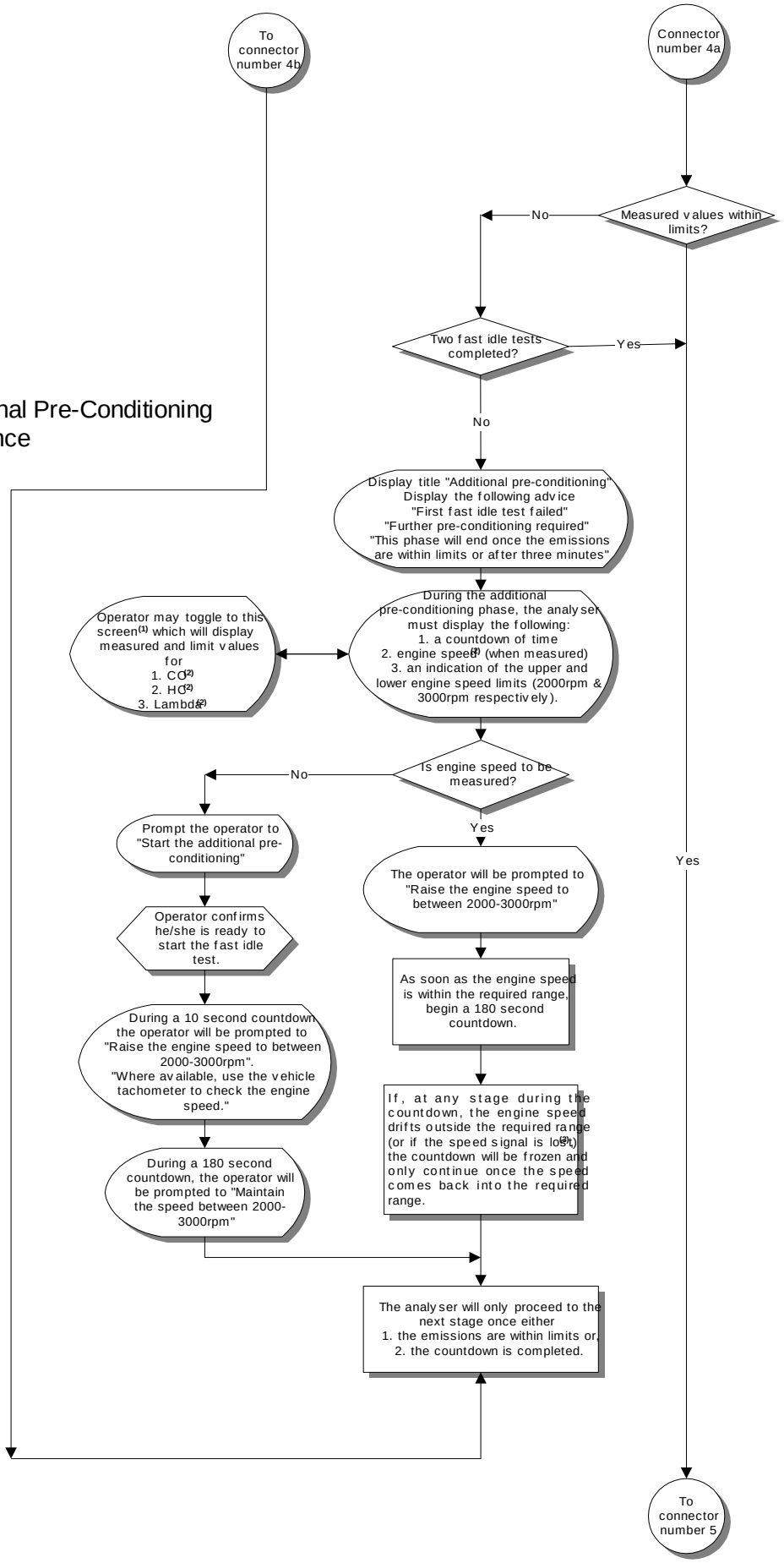
HC Hang-up check



Fast Idle Test



Additional Pre-Conditioning Sequence



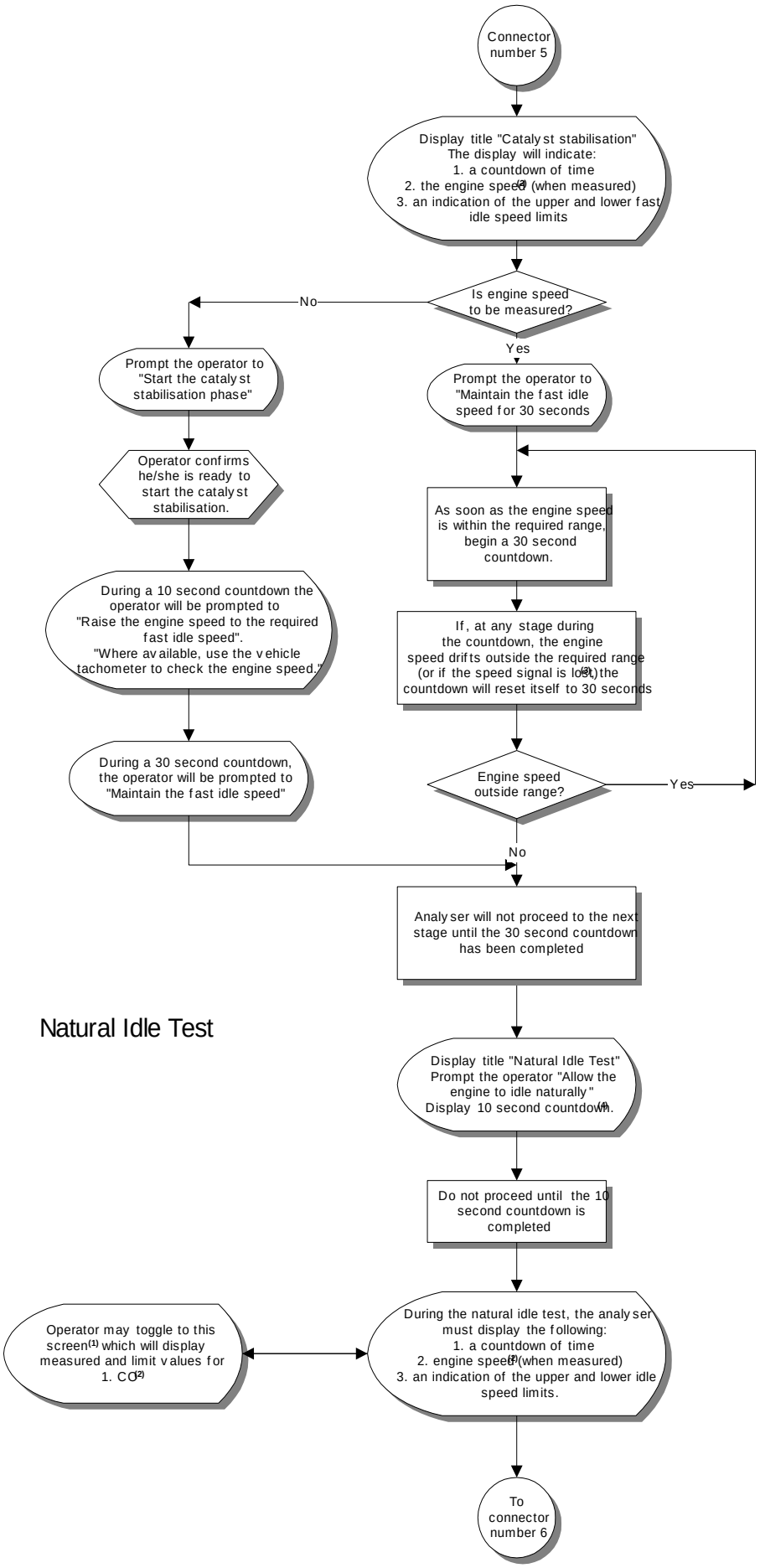
Notes

1. The measured and the limit values for CO, HC and Lambda should preferably be displayed on the same screen as "time" and "engine speed"; but may, as an alternative be available to the operator by toggling to an additional screen.

2. The display should graphically highlight any value that are outside the required limits (eg different colours on colour displays, flashing on mono displays etc)

3. The countdown should not be frozen until after the tachometer has dropped out of range for at least two seconds

Catalyst Stabilisation



Natural Idle Test

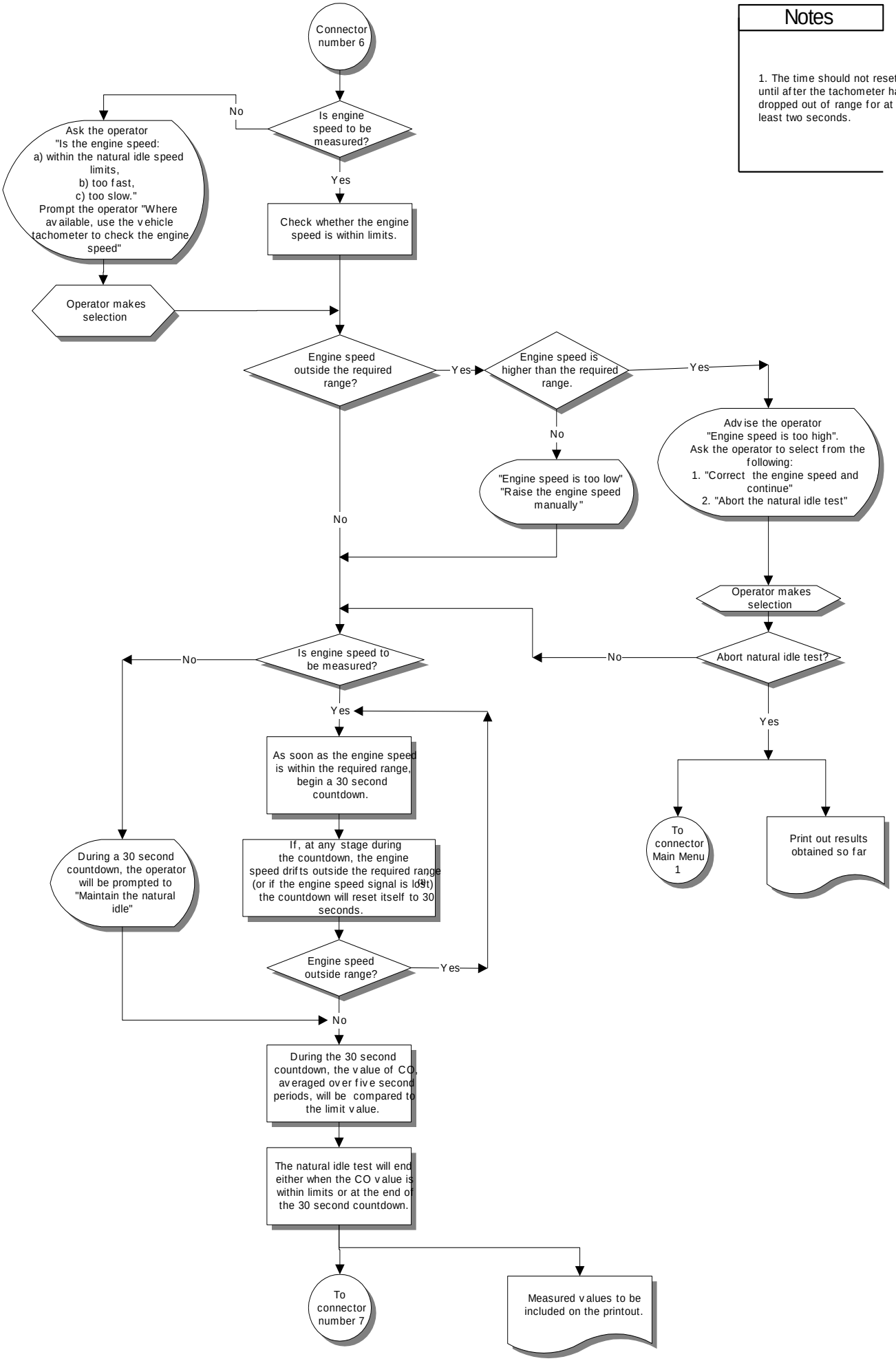
Notes

1. The measured and the limit value for CO should preferably be displayed on the same screen as "time" and "engine speed"; but may, as an alternative be available to the operator by toggling to an additional screen.

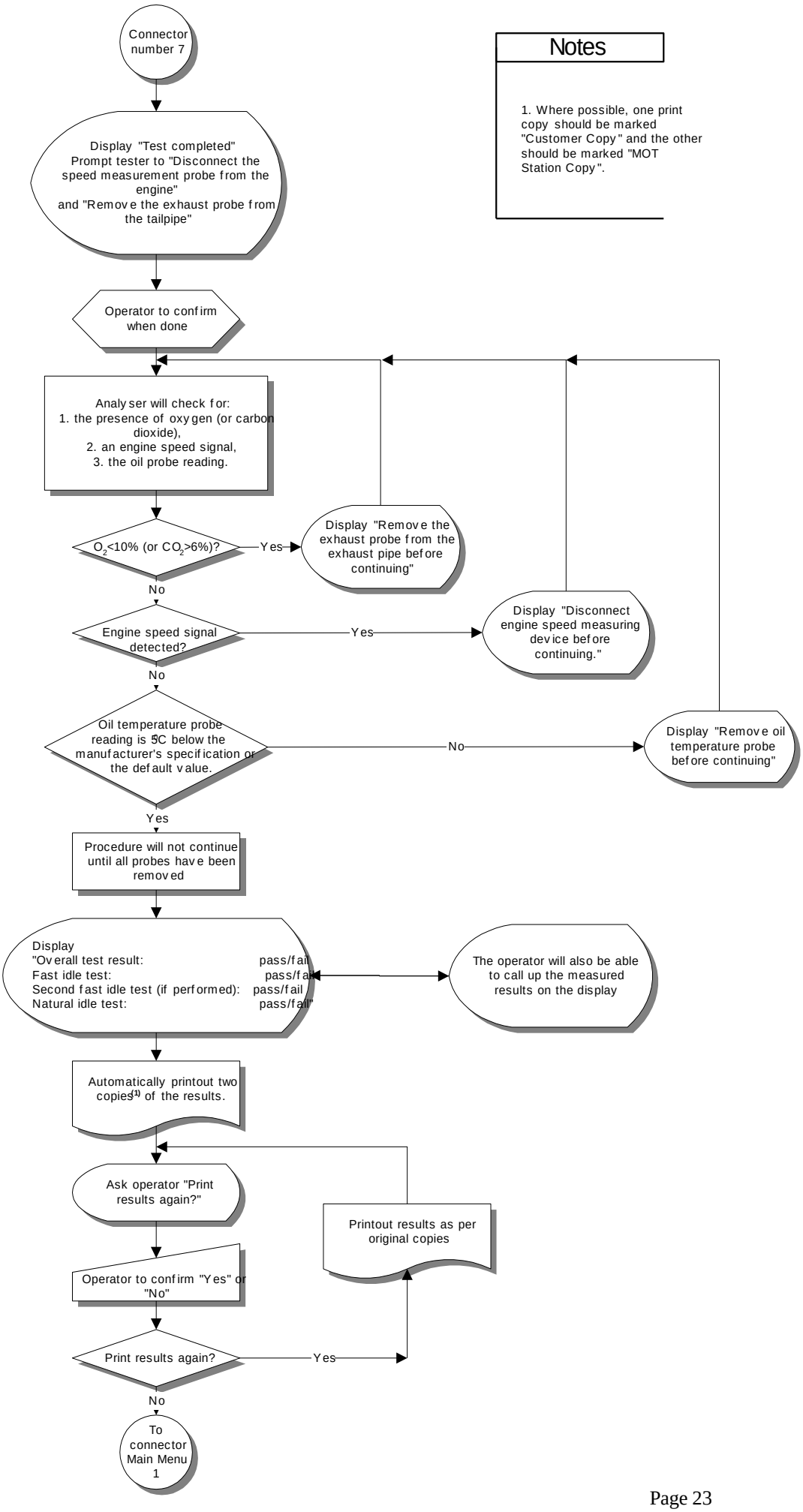
2. The display should graphically highlight any values that are outside the required limits (eg different colours on colour displays, flashing on mono displays etc)

3. The countdown should not be reset until after the tachometer has dropped out of range for at least two seconds.

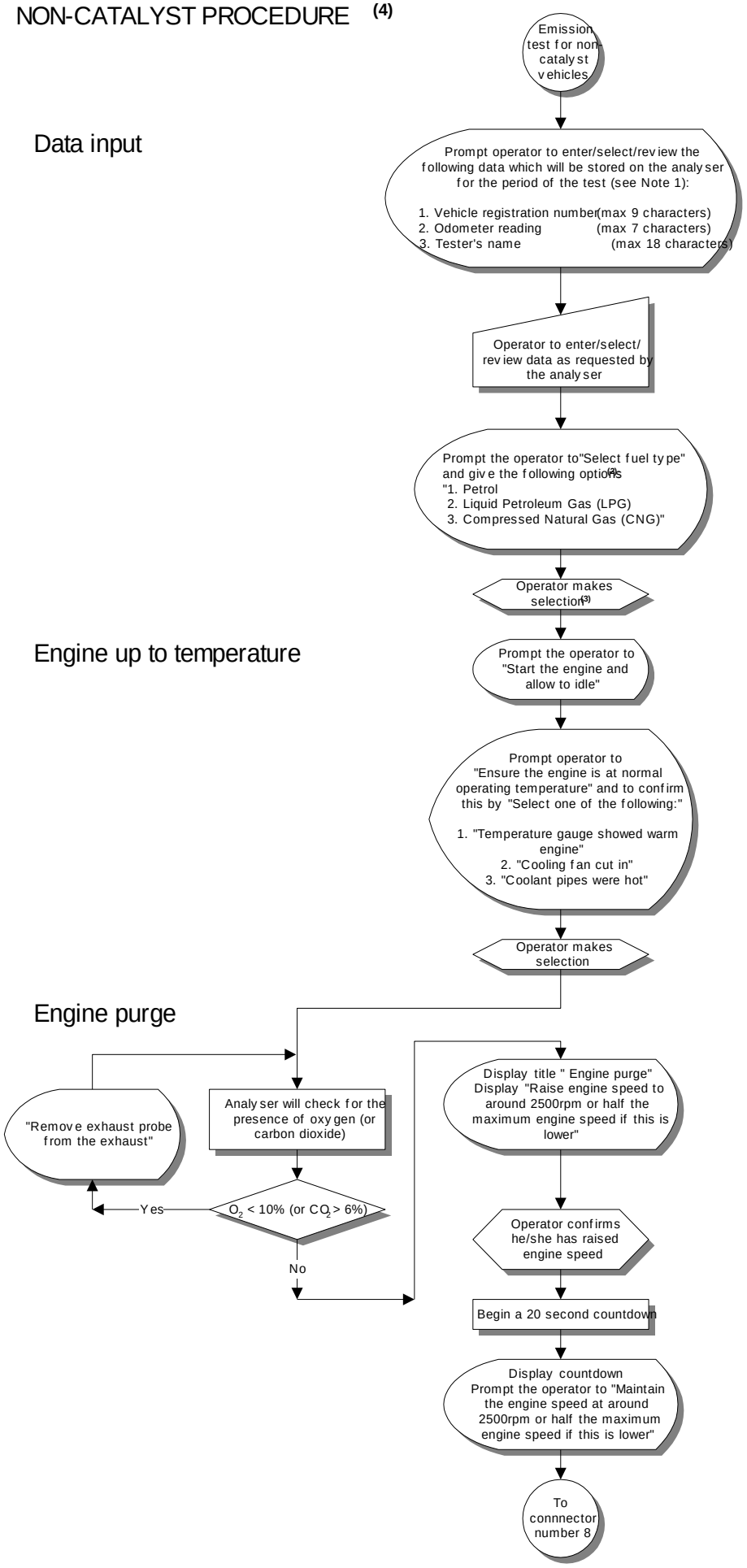
4. This is to allow the emissions and the idle speed to stabilise after the fast idle test.


Notes
1. The time should not reset until after the tachometer has dropped out of range for at least two seconds.
Connector number 6
Is engine speed to be measured?
No
Yes
Ask the operator "Is the engine speed: a) within the natural idle speed limits, b) too fast, c) too slow." Prompt the operator "Where available, use the vehicle tachometer to check the engine speed"
Operator makes selection
Check whether the engine speed is within limits.
Engine speed outside the required range?
Yes
Engine speed is higher than the required range.
Yes
No
"Engine speed is too low" "Raise the engine speed manually"
Advise the operator "Engine speed is too high". Ask the operator to select from the following: 1. "Correct the engine speed and continue" 2. "Abort the natural idle test"
No
Operator makes selection
Is engine speed to be measured?
No
Abort natural idle test?
No
Yes
Yes
As soon as the engine speed is within the required range, begin a 30 second countdown.
During a 30 second countdown, the operator will be prompted to "Maintain the natural idle"
If, at any stage during the countdown, the engine speed drifts outside the required range (or if the engine speed signal is lost) the countdown will reset itself to 30 seconds.
Engine speed outside range?
Yes
No
During the 30 second countdown, the value of CO, averaged over five second periods, will be compared to the limit value.
The natural idle test will end either when the CO value is within limits or at the end of the 30 second countdown.
To connector Main Menu 1
Print out results obtained so far
To connector number 7
Measured values to be included on the printout.

Results of the test



NON-CATALYST PROCEDURE (4)



Notes

1. Data for review is from previous test or manual entry.

The previously entered tester's name will be stored on the analyser until a new name is entered.

2. Default setting is petrol unless petrol is omitted or disabled from main test procedure.

3. The gases which must be measured during the test will vary depending on the fuel type selected:

	CO	HC
Petrol	Yes	Yes
LPG	Yes	Yes*
CNG	Yes	No

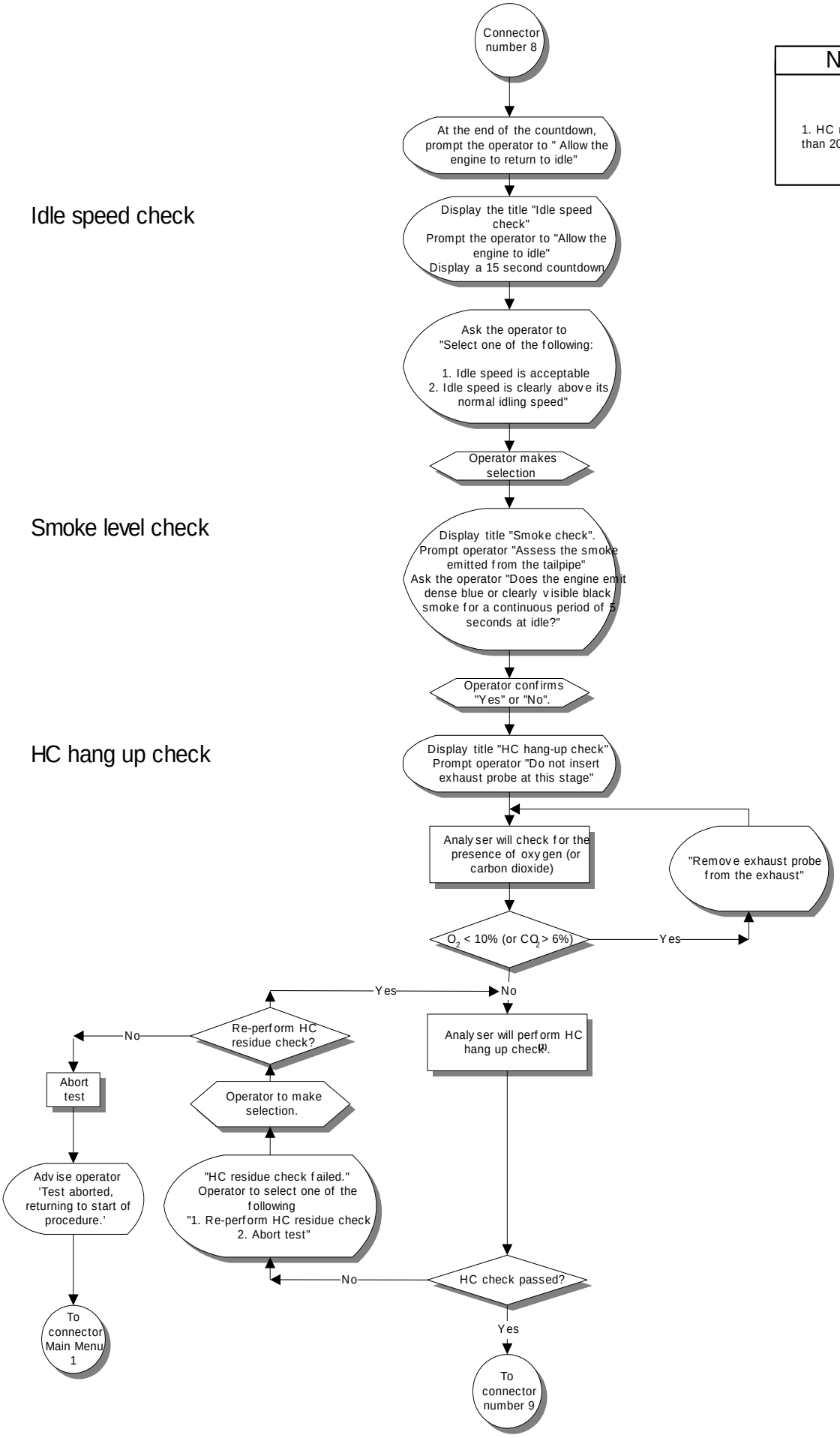
* The HCs should be automatically corrected using the C_3/C_6 (PEF) factor.

4. The non-catalyst procedure does not include engine speed or oil temperature measurement. However, it must be possible to include this feature in the software procedure at a later date for a reasonable price (ie not more than 2% of the retail price of the meter).

Idle speed check

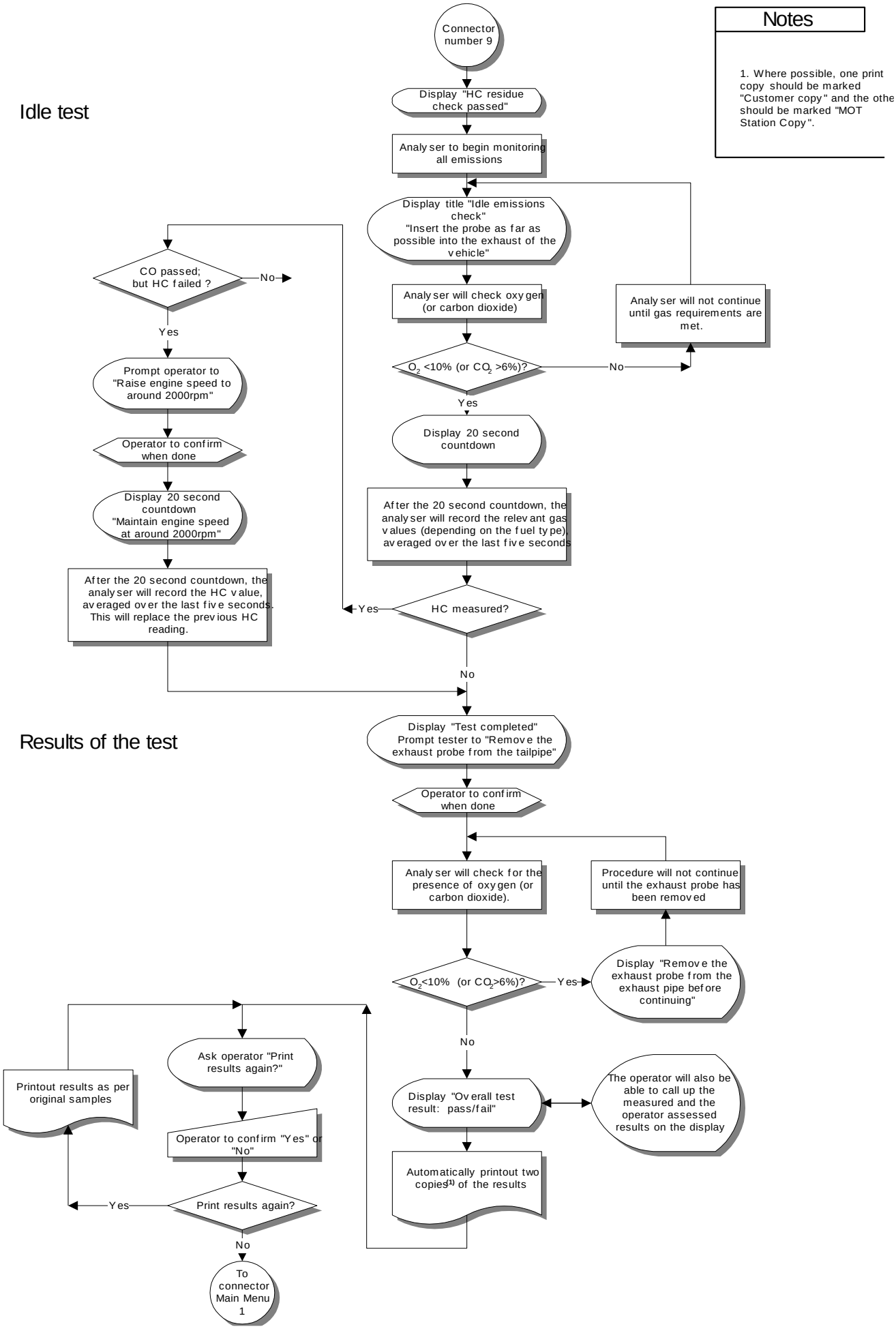
Smoke level check

HC hang up check



Notes

1. HC residue must be less than 20ppm to pass the test.


Notes
1. Where possible, one print copy should be marked "Customer copy" and the othe should be marked "MOT Station Copy".
Idle test
Connector number 9
Display "HC residue check passed"
Analyser to begin monitoring all emissions
Display title "Idle emissions check"
"Insert the probe as far as possible into the exhaust of the vehicle"
Analyser will check oxygen (or carbon dioxide)
O2 <10% (or CO2 >6%)?
No
Analyser will not continue until gas requirements are met.
Yes
Display 20 second countdown
After the 20 second countdown, the analyser will record the relevant gas values (depending on the fuel type), averaged over the last five seconds
HC measured?
Yes
CO passed; but HC failed ?
No
Yes
Prompt operator to "Raise engine speed to around 2000rpm"
Operator to confirm when done
Display 20 second countdown "Maintain engine speed at around 2000rpm"
After the 20 second countdown, the analyser will record the HC value, averaged over the last five seconds. This will replace the previous HC reading.
No
Results of the test
Display "Test completed" Prompt tester to "Remove the exhaust probe from the tailpipe"
Operator to confirm when done
Analyser will check for the presence of oxygen (or carbon dioxide).
Procedure will not continue until the exhaust probe has been removed
O2<10% (or CO2>6%)?
Yes
Display "Remove the exhaust probe from the exhaust pipe before continuing"
No
Display "Overall test result: pass/fail"
The operator will also be able to call up the measured and the operator assessed results on the display
Automatically printout two copies(1) of the results
Ask operator "Print results again?"
Printout results as per original samples
Operator to confirm "Yes" or "No"
Yes
Print results again?
No
To connector Main Menu 1

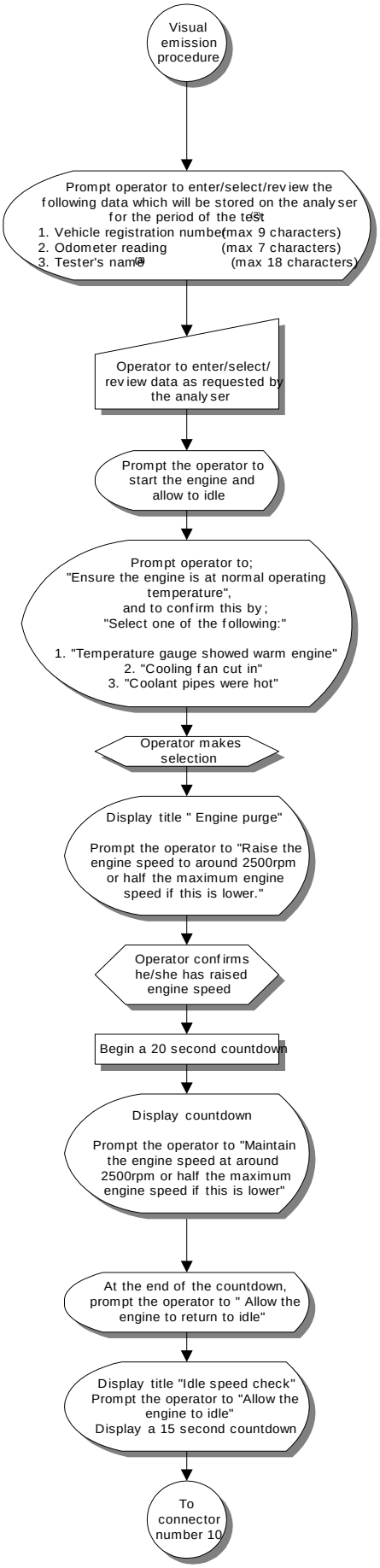
VISUAL PROCEDURE (1)

Data input

Engine up to temperature

Engine purge

Idle speed check



Notes

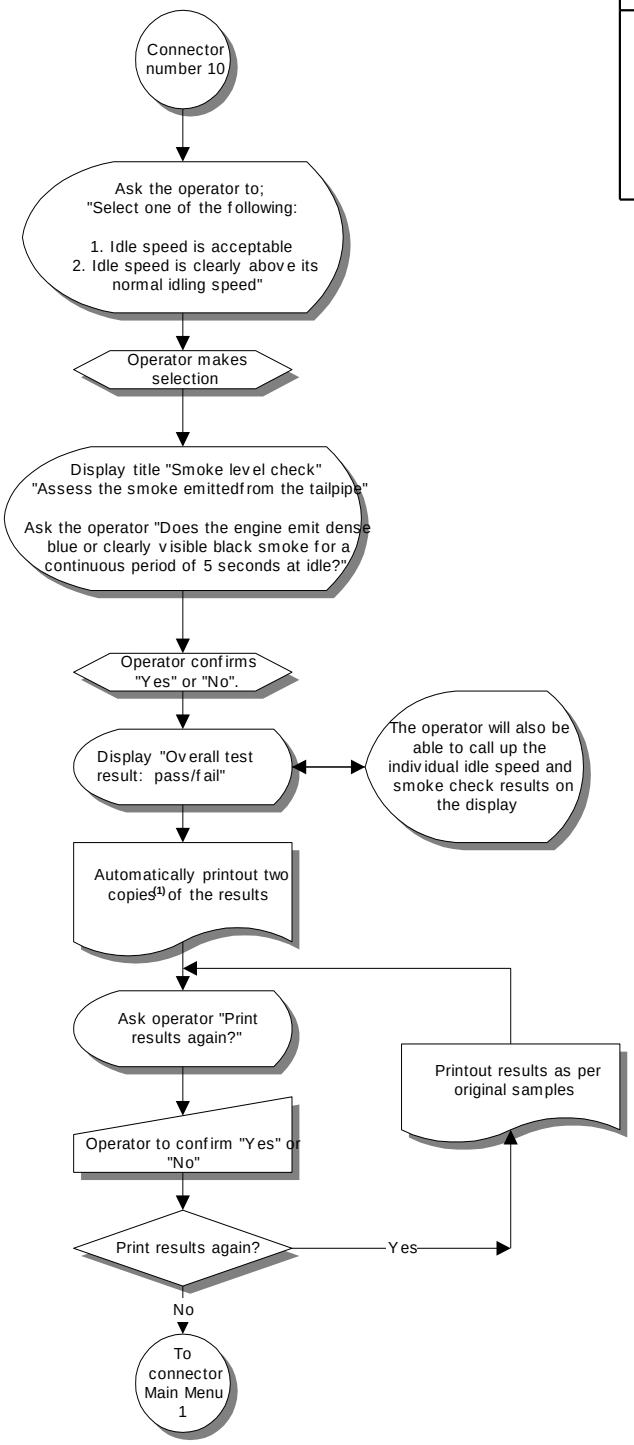
1. This routine must be included on the analyser, although its use by the operator will be optional.

2. Data for review is from the smart card, previous test or manual entry.

3. The previously entered tester's name will be stored on the analyser until a new name is entered.

Smoke level check

Results of the test



Notes

1. Where possible, one print copy should be marked "Customer Copy" and the othe should be marked "MOT Station Copy".

Example 1 INFORMATION TO BE CONTAINED ON THE PRINTOUT

MOT Exhaust Emissions Test Results:
Basic Emission Test

Test Station
(Name, address, VIEA test station number)

Date of Test: Time of Test:

Vehicle Details

Vehicle Registration Number:

Engine temperature measurement by manual observation of; temperature gauge, cooling fan or coolant pipes

Engine speed measurement by manual observation *(only print where applicable).*

DESCRIPTION	**Limits**	**Actual Value**	
Fast Idle Test:			
Engine Speed:	2500-3000 rpm	___ rpm / manual check	Pass
CO:	≤0.30%	___ %	Pass
HC:	≤200 ppm	___ ppm	Pass
λ:	0.97-1.03	____	Pass
Natural Idle Test:			
Engine Speed:	450-1500 rpm	___ rpm / manual check	Pass
CO:	≤0.50%	___ %	Pass

Overall Result: Exhaust Emissions Test **PASSED**

Tested By:[*Operators Name*] Signature:

Example 2 INFORMATION TO BE CONTAINED ON THE PRINTOUT

MOT Exhaust Emissions Test Results:
Catalyst equipped vehicle with closed loop control

Test Station
(Name, address, VIEA test station number)

Date of Test: Time of Test:

Vehicle Details

Vehicle Registration Number:
Vehicle Manufacturer:
Vehicle Model:
Engine Capacity:
Odometer Reading:

Engine speed measurement was by-passed *(only print where applicable).*
Engine oil temperature measurement was by-passed *(only print where applicable)*

DESCRIPTION	**Limits***	**Actual Value**	
Engine Oil Temperature	Min 60°C	__ °C	OK/Temp gauge checked/cooling fan cut in/coolant pipes hot

Fast Idle Test: **PASS/FAIL**

Engine Speed: 2500-3000 rpm		__ rpm	Pass/Fail/Not checked
CO:	≤0.30%	__ %	Pass/Fail
HC:	≤200 ppm	__ ppm	Pass/Fail
λ:	0.97-1.03	__	Pass/Fail

Second Fast Idle Test: **PASS/FAIL**
(Only print if applicable)

Engine Speed: 2500-3000 rpm		__ rpm	Pass/Fail/Not checked
CO:	≤0.30%	__ %	Pass/Fail
HC:	≤200 ppm	__ ppm	Pass/Fail
λ:	0.97-1.03	__	Pass/Fail

Natural Idle Test: **PASS/FAIL**

Engine Speed: 550-1100 rpm		__ rpm	Pass/Fail/Not checked
CO:	≤0.50%	__ %	Pass/Fail/Not checked

Overall Result: Exhaust Emissions Test **PASSED/FAILED**

Tested By: [Operators Name] Signature:

***** *Default values shown as an example.*

Example 3 INFORMATION TO BE CONTAINED ON THE PRINTOUT

MOT Exhaust Emissions Test Results:
Non-catalyst equipped vehicle (metered check)

Test Station
(Name, address, VIEA test station number)

Date of Test: Time of Test:

Vehicle Details

Vehicle Registration Number:
Fuel type:
Odometer Reading:

DESCRIPTION	**Limits**	**Actual Value**	
CO:	Max	__ %	Pass/Fail
HC:	Max	__ ppm	Pass/Fail
Idle speed:	--		Pass/Fail
Smoke level:	--		Pass/Fail

Overall Result: Exhaust Emissions Test **PASSED/FAILED**

Tested By: [Operators Name] Signature:

Example 4 INFORMATION TO BE CONTAINED ON THE PRINTOUT

MOT Exhaust Emissions Test Results:
Non-catalyst equipped vehicle (visual check)

Test Station
(Name, address, VIEA test station number)

Date of Test: Time of Test:

Vehicle Details

Vehicle Registration Number:
Fuel type:
Odometer Reading:

DESCRIPTION

Idle speed: Pass/Fail
Smoke level: Pass/Fail

Overall Result: Exhaust Emissions Test **PASSED/FAILED**

Tested By: [Operators Name] Signature:

Appendix 2 : Serial Port Specification

Communication between the Gas Analyser and a remote Personal Computer (PC)

1: Packet Structure (PC to Analyser & Analyser to PC)

1st Byte:	Total message length	(including Checksum)
2nd Byte:	Command number	
n Bytes:	Data	(Length n Bytes, 0≤n≤251)
Last-1 Byte:	Checksum LSB	(Checksum = sum of all bytes in packet)
Last Byte:	Checksum MSB	

2: Commands

Command No:	PC to Analyser Commands	
0	**SEND STATUS**	**Data Bytes = 0**
1	**SEND TEST DATA**	**Data Bytes = 0**
2	**CLEAR TEST DATA**	**Data Bytes = 0**

Command No:	Analyser to PC Responses	
0	**SEND STATUS**	**Data Bytes = 1**

Data Byte1

Bit 7	6	5	4	3	2	1	0	
X	X	X	X	X	X	X	1	Error (OR of all other errors)
X	X	X	X	X	X	1	X	Received length error
X	X	X	X	X	1	X	X	Received parity error
X	X	X	X	1	X	X	X	Received Time-out error
X	X	X	1	X	X	X	X	Received Checksum error
X	X	1	X	X	X	X	X	Test data available
X	1	X	X	X	X	X	X	Busy
1	X	X	X	X	X	X	X	Reserved

X = Don't care

1	**SEND TEST DATA**	**Data Bytes = 106**	
	Data Byte1	Test Type (0=NOCAT, 1=CAT, 2=CAT & 2 Fast idle tests)	
	Data Byte2	RPM measurement	(0=By-passed, 1=Not By-passed)
	Data Byte3	Oil Measurement	(0=By-passed, 1=Not By-passed)
	Data Byte4/5	WORD: Oil Temperature - Initial (°C)	
	Date Byte6/7	WORD: Oil Temperature - Limit (°C)	
	Data Byte8/9	WORD: Oil Temperature - after passing temp check (°C)	
	Data Byte10/11	WORD: rpm @ Fast Idle Limit value - Min	
	Data Byte12/13	WORD: rpm @ Fast Idle Limit value - Max	
	Data Byte14/15	WORD: Lambda @ Fast Idle Limit value – Min	(In 1000^{ths})
	Data Byte16/17	WORD: Lambda @ Fast Idle Limit value – Max	(In 1000^{ths})
	Data Byte18/19	WORD: rpm @ Fast Idle 1	
	Data Byte20/21	WORD: CO% @ Fast Idle 1	(In 1000^{ths})
	Data Byte22/23	WORD: HC @ Fast Idle 1	
	Data Byte24/25	WORD: Lambda @ Fast Idle 1	(In 1000^{ths})
	Data Byte26/27	WORD: rpm @ Fast Idle 2	
	Data Byte28/29	WORD: CO% @ Fast Idle 2	(In 1000^{ths})
	Data Byte30/31	WORD: HC @ Fast Idle 2	
	Data Byte32/33	WORD: Lambda @ Fast Idle 2	(In 1000^{ths})
	Data Byte34/35	WORD: rpm @ Idle Limit Value - min	
	Data Byte36/37	WORD: rpm @ Idle Limit Value - max	
	Data Byte38/39	WORD: CO% @ Idle Limit Value	(In 1000^{ths})
	Data Byte40/41	WORD: rpm @ Idle	
	Data Byte42/43	WORD: CO% @ Idle	(In 1000^{ths})
	Data Byte44/45	WORD: HC @ Idle	
	Data Byte46	Time - Seconds	
	Data Byte47	Time - Minutes	
	Data Byte48	Time - Hours	
	Data Byte49	Date - Day	
	Data Byte50	Date - Month	
	Data Byte51	Date - Year LSB	
	Data Byte52	Date - Year MSB	
	Data Byte53	Test Duration - Minutes (from selection of MOT procedure to printout of results)	
	Data Byte54/55/56/57	DWORD: Mileage	

Data Byte58/59	WORD: Engine size in cc	
Data Bytes60-77	ASCII representation of Vehicle Manufacturer(18 chars)	
Data Bytes78-95	ASCII representation of Vehicle Model(18 chars)	
Data Bytes96-105	ASCII representation of Registration Number(10 chars)	
Data Byte106	Bit 7 6 5 4 3 2 1 0	
	- - - - - - - X	Overall Result (0=Fail, 1=Pass)
	- - - - - - X -	Fast Idle Test 1 (0=Fail, 1=Pass)
	- - - - - X - -	Repeat Fast Idle (0=No, 1=Yes)
	- - - - X - - -	Fast Idle Test 2 (0=Fail, 1=Pass)
	- - - X - - - -	Idle Test
	X - - - - - - -	Test Completed (0=No, 1=Yes)

Note 1:
If the Vehicle Manufacturer is shorter than the allocated bytes then the remaining bytes should all be set to zero, similarly for Vehicle Model and Registration Number.

Note 2:
Where RPM or oil are not measured, or where some of the above data is not recorded (eg during the non-catalyst test, or if the test is aborted, or if the second fast idle test is not required), the surplus bytes should all be given the value FF(hex).

Note 3:
Where a WORD (two bytes) are required in 1000^{ths}, this will give a possible range of values from 0.001 - 65. Therefore, for CO the range would be 0.001% - 65% and for lambda it would be 0.001 - 65.

2	**CLEAR TEST DATA**	**Data Bytes = 1**
	Data Byte1	0 = Test Data Not Cleared
		1 = Test Data Cleared

WORD = 2 Byte, LSB transmitted first
DWORD = 4 Bytes, LSB transmitted first

3: Communication Mode

Communication method:	RS232
Baud Rate:	9600
Data Bits:	8
Stop Bits:	1
Parity:	EVEN

4: Timings

Analyser Response Time-out period:	10 Seconds Max
Time-out between bytes:	50mS Max

1 Start Bit + 8 Data Bits + 1 Parity + 1 Stop Bit = 11 Bits (1.14mS per Byte @ 9600)

Min Packet Length = 4 Bytes	(4.58mS @ 9600)
Max Packet Length = 255 Bytes	(292mS @ 9600)

5.1: Analyser Requirements

Either 9 or 25 `D' Type Male:

9 Pin `D' Type Male:	Pin 2	Tx Data - Data from Analyser to PC	} Software handshaking
	Pin 3	Rx Data - Data from PC to Analyser	}
	Pin 5	Ground	
	Pin 7	CTS - PC to Analyser (CTS=Clear to send)	} Hardware handshaking
	Pin 8	RTS - Analyser to PC (RTS=Request to send)	}
25 Pin `D' Type Male:	Pin 2	Rx Data - Data from PC to Analyser	} Software handshaking
	Pin 3	Tx Data - Data from analyser to PC	}
	Pin 4	CTS - PC to Analyser	} Hardware handshaking
	Pin 5	RTS - Analyser to PC	}
	Pin 7	Ground	

(This allows a 5 Way, one to one cable to connect the Analyser to the PC)

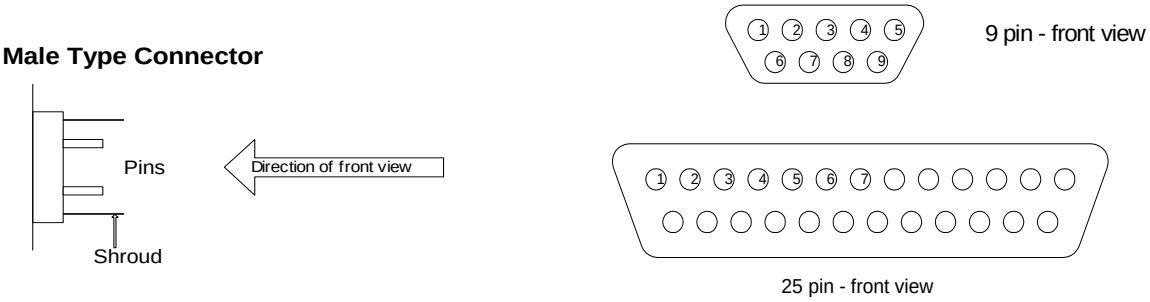
Note 1: Analyser to store last test result until overwritten by end of next test, or clear test data command received.

Note 2: Both software and hardware handshaking are obligatory. Software handshaking is required to maintain data reliability. Hardware handshaking is required to provide additional flow control.

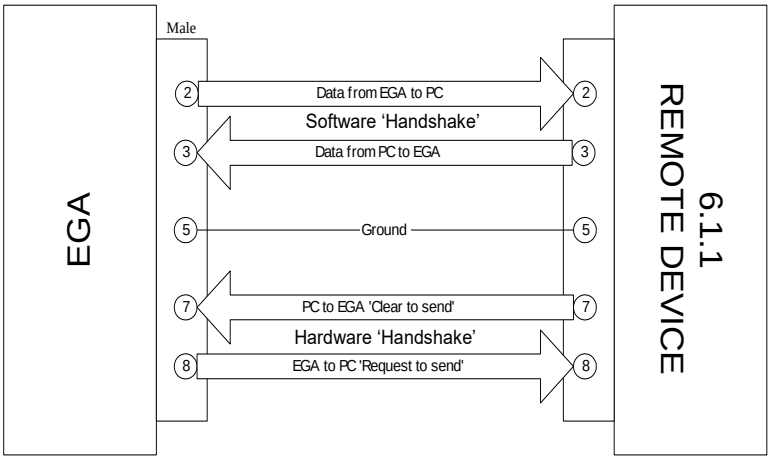
Note 3: Tx Data ≡ Actual test data as per section 2.
Rx Data ≡ Request from PC to receive data
CTS ≡ Analyser to check CTS line is active before transmitting.
RTS ≡ Any future VI software will look at RTS line before transmitting. Analyser can keep RTS line permanently active or toggle depending whether busy or not.

5.2 Cable Requirements

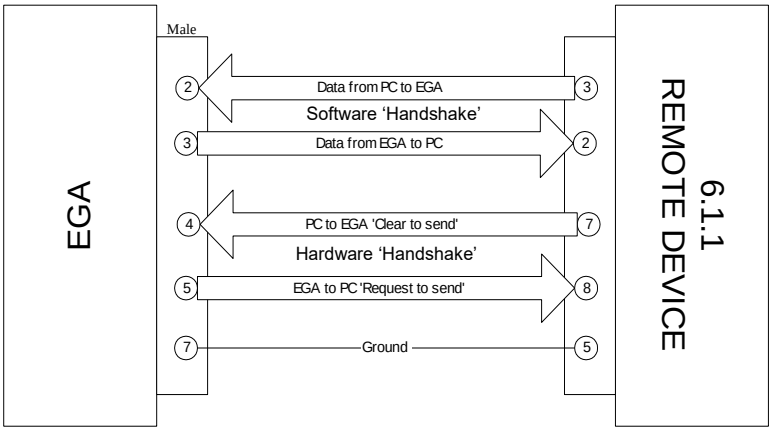
1) 5 Core Cable
2) Overall Screen (Screen connected to Chassis Ground at PC end)
3) Max Length 30M



9 pin D-type2, 3, 5, 7 and 8 should be for MOT use



25 pin D-type2, 3, 4, 5 and 7 for MOT use



Appendix 3: Calculation of Lambda value according to Brettschneider

Calculation of Lambda value according to Brettschneider (Source: Bosch Technische Berichte, VOL. 6 (1979) No. 4, p177-186)

Simplified Lambda calculation:-

$$\lambda = \frac{[CO_2] + \frac{[CO]}{2} + [O_2] + \left(\frac{H_{CV}}{4} \times \frac{3.5}{3.5 + \frac{[CO]}{[CO_2]}} - \frac{O_{CV}}{2}\right)([CO_2] + [CO])}{\left(1 + \frac{H_{CV}}{4} - \frac{O_{CV}}{2}\right)([CO_2] + [CO] + K1[HC])}$$

[ ] = Concentration in % vol
K1 = Conversion factor for NDIR measurement to FID measurement (provided by manufacturer of measurement equipment)
H_{CV}= Atomic ratio hydrogen to carbon
O_{CV}= Atomic ratio oxygen to carbon

FUEL TYPES

The following values for the constants shall be used.

Petrol
(4 Star, unleaded and super unleaded)

H_{CV}=1.7261
O_{CV}=0.0175

Appendix 4: Annual Conformity of Production Checks

1. The conformity of production checks will be performed by a test house which is a member of the European Accreditation of Laboratories (EAL) or in certain cases (see paragraph 6) by an accredited ISO 9000 certification body. The manufacturer/importer will nominate the test house or the ISO 9000 certification body which will be carrying out the conformity of production checks and will notify the GEA of the contact name and address.

Conformity of Production by Test House

2. The test house will nominate a suitably qualified auditor who will visit manufacturers/importers at any point between their manufacturing premises and point of sale. He will visit the manufacturer/importer annually, starting from one year after the date when the analyser was approved as meeting the requirements of the MOT 1996 exhaust gas analyser specification.

3. The manufacturer/importer will be required to provide two sets of the following at the time of approval.

   i) Quality colour photographs (10" x 8") showing the following

	Number of photographs
Analyser	- at least 2 external (taken from opposite corners such that all sides of the analyser are visible) - at least 1 internal (showing all circuit boards)
Probes	1
Sensors	1

   ii) Documents as listed in paragraph 8.0, sections a) - h) of this specification (VPB\07\24\20) which must bear unique references, information about the issue status, and a validation stamp from the test house.

   The above sets will be distributed as follows after approval.

   a. Manufacturer/importer
   b. Test house
   c. ISO 9000 certification body (where applicable)

4. The manufacturer/importer will also be required to maintain a file of any modifications to the meter since it was first approved. The onus lies with the manufacturer/importer to decide whether the modification requires re-approval. Where a modification has not been re-approved, the file shall include a statement explaining why the modification does not

affect the original approval.

5. At the annual inspection, the test house auditor will compare the original set of photographs, technical drawings and specifications to the analyser currently being manufactured or offered for sale. Should there be any discrepancies, the test house auditor should advise appropriate action. If any discrepancies cannot be resolved between the auditor and the manufacturer/importer, they should be referred to the GEA. The analyser may then be re-submitted for approval testing to check whether it still meets the requirements of the specification. If it is found that the analyser no longer meets the requirements of the specification, it will be removed from the MOT List of Acceptable Equipment. The analyser will not be reinstated until the required modifications have been made to both current production of the analyser and to all identical models already being used for MOT purposes.

6. **ISO 9000 Conformity of Production**
Where the analyser **manufacturer** holds a UKAS accredited approval (or an approval accredited by any other body which is a member of the European Accreditation Council, EAC) to BS EN ISO 9000 covering the products concerned, then the annual test house conformity of production check can be replaced by obtaining the following: an annual written declaration, based on items 4 and 5 of this Appendix, from the manufacturer, endorsed by the Certification Body auditor to further the assurance, that no unauthorised changes have been made to the approved product. The declarations are to be retained by the manufacturer's representative in the UK.

7. **Annual Conformity of Production Reports**
Copies of Conformity of Production reports or declarations must be submitted to the GEA on an annual basis.

Appendix 5: Performance Tests for Pattern Approval of 1996 Exhaust Gas Analysers

The following is a list of performance tests which manufacturers must provide evidence of having passed before their analyser can be approved for testing catalyst equipped vehicles in the MOT testing scheme. Unless exemptions apply, these tests should be carried out by UK test house(s) accredited by UKAS to perform such tests. Test houses are not required to be accredited to perform all the tests in this appendix and so it may be necessary for analyser manufacturers to use a number of different test houses in order to obtain all the necessary test reports.

1.0 OIML R99

In the first instance, either perform or verify the existence of an OIML R99 (Class 1) approval for CO, CO_2 and HC measurement (which may be supplied by an approved European Test House ie. a test house accredited by a member of the European Accreditation of Laboratories (EAL)). PTB certificates for the German AU2 programme will be an acceptable alternative where a separate OIML certificate does not exist.

2.0 O_2 CHANNEL

NB. Analysers with an approval from the Physikalisch-Technische Bundesanstalt (PTB) to the German Abgasuntersuchung (AU2) requirements are exempt from the tests on the oxygen channel (ie. all parts of sections 2 & 3).

2.1 OIML R99 tests on the O_2 channel

Perform the following OIML R99 tests on the O_2 channel, and ensure that the oxygen measurements are within the accuracy limits of paragraph 4.1 of this specification (ref. VPB/07/24/20). (Where the O_2 channel has already been checked during previous OIML testing and was found to be within the VPB/07/24/20 specification limits, then these results will be acceptable). Tests 2.1.2 to 2.1.9 shall be performed using the gases as specified in each OIML R99 test. Test 2.1.1. shall use the gases as specified below.

2.1.1 Calibration Curve (OIML R99, Ref 8.1)

Perform the OIML R99 test for each of the following recommended volume fractions:

O_2 Volume fraction
0 %vol (zero gas as per section 2.3.2)
10 %vol (balance nitrogen)
20.9 %vol (ambient air)

Where special gas mixtures are required (sections 2.1.1 and 2.3.2), BOC Alpha Standard or equivalent should be used. Equivalent grades of gas are: Linde Gas "Diamond Standard"; Air Products "Gold Standard"; Distillers, equivalent; Scott "Gravimetric Master Gas". NB Higher grade gases may be used.

2.1.2 **Stability with time or drift** (OIML R99, Ref 8.2)
2.1.3 **Repeatability** (OIML R99, Ref 8.3)
2.1.4 **Dry heat** (OIML R99, Ref 8.4.1 (a))
2.1.5 **Cold** (OIML R99, Ref 8.4.1 (b))
2.1.6 **Damp heat, steady state** (OIML R99, Ref 8.4.1 (c))
2.1.7 **Atmospheric pressure** (OIML R99, Ref 8.4.1 (d))
2.1.8 **Mains variation** (OIML R99, Ref 8.4.1 (e))
2.1.9 **Mechanical shock** (OIML R99, Ref 8.5 (a))
2.1.10 **Short time power reduction** (OIML R99, Ref 8.5 (b))
2.1.11 **Voltage bursts from the mains** (OIML R99, Ref 8.5 (c))
2.1.12 **Electrostatic Discharge** (OIML R99, Ref 8.5 (d))
2.1.13 **Electromagnetic fields** (OIML R99, Ref 8.5 (e))
2.1.14 **Mains frequency magnetic fields** (OIML R99, Ref 8.5 (f))
2.1.15 **Warm-up time** (OIML R99, Ref 8.6 (a))
2.1.16 **Low flow** (OIML R99, Ref 8.6 (c))
2.1.17 **HC residue** (OIML R99, Ref 8.6 (e))
2.1.18 **Filter unit** (OIML R99, Ref 8.6 (f))
2.1.19 **Water separator** (OIML R99, Ref 8.6 (g))

2.2 Cross sensitivity

2.2.1 Supply an oxygen free test gas of 14% vol CO_2 in N_2 to the measuring instrument at a rate which prevents back diffusion of air. Check that the oxygen sensor generates an offset signal which leads to a display of an oxygen concentration of less than 0.1% vol without any additional sensor-specific offset corrections by the measuring instrument.

2.2.2 Supply oxygen-free test gas with at least 14% vol CO_2 in N_2 to the sensor (at a rate which prevents back diffusion of air) in a cycle as follows; 20 times, for a period of 10 minutes each time, during an 8 hour period, on five successive days. During the interim period between successive applications of the test gas, the instrument should be left switched on; but with the sample pump turned off. After the five day cycle has been completed, repeat item 2.2.1.

2.2.3 Supply a test gas with about 8% vol CO_2 and about 10% vol O_2 (balance N_2) to the sensor (at a rate which prevents back diffusion of air) continually for 64 hours. After this, repeat item 2.2.1.

2.2.4 Oxygen sensors which have already been approved by the PTB as meeting the cross sensitivity requirements are exempt from the tests in this section (2.2) ie. Teledyne (Class R17A, R21A, R22A), Envitec (Oxiplus A, Andros Oxygen sensor) and City Technology (CiTiceL AO2).

2.3 Response time (must be performed after item 2.2)

2.3.1 A measurement shall be taken to determine the time required for the instrument to respond to zero gas after sampling calibration gas supplied at the probe. A means for

instantly changing from sampling calibration gas through the probe to sampling zero gas through the probe shall be employed. The calibration gas and the zero gas shall be supplied at the probe with a pressure of ambient or above (to within +750Pa). The response time shall meet the requirements as specified in paragraph 4.2 of this specification (VPB/07/24/20).

2.3.2 The volume fractions to be used are:

Zero Gas:	Measurand	Volume fraction	Balance
	CO_2	14%	N_2
or			
	CO	3.5% }	
	CO_2	14% }	N_2
	HC (Propane)	2000ppm }	

Calibration Gas:	Measurand	Volume fraction
	O_2	20.9% (Ambient air)

2.4 Leakage

2.4.1 An adjustable leak shall be introduced artificially into the gas handling system near the pump where a leak of an appropriate orifice size will have the greatest effect on the measurement. With this artificial leak closed, a zero gas shall be supplied at the probe with a pressure of ambient or above (to within +750Pa).

2.4.2 While sampling the zero gas, adjust leakage rate so that the indication of the oxygen reading is higher than the value indicated without the leak by an amount equal to the requirement of paragraph 5.1 in this specification (VPB/07/24/20). Without disturbing the artificial leak, remove the zero gas supplied at the probe, and conduct the leakage test procedure as described in the manufacturer's operating instructions to ensure that the leak is detected, and further indications of λ and further measurements of any gas are prevented.

2.4.3 The zero gas volume fractions to be used are defined in section 2.3.2.

3.0 OXYGEN SENSOR FAILURE

A suitable method shall be used to apply a known voltage across the oxygen sensor terminals (e.g. an oxygen sensor with an appropriate known voltage or a voltage source). The following tests shall then be conducted:

3.1 During an adjustment of the sensor with the surrounding air (at zero adjustment of the infra-red channels) apply a voltage of 2mV lower than the lowest value given by the specification for a new sensor across the O_2 terminals to ensure that the analyser prevents any further indication of λ and any further measurements of any gases (during the catalyst MOT procedure), and gives an error message.

3.2 The procedure for fitting a new sensor shall be followed as per the manufacturer's instructions. During an adjustment with the surrounding air, apply voltages across the O_2 sensor terminals just below and just above the O_2 sensor specification range to ensure that the analyser does not permit further indication of λ or further measurements of any gases (during the catalyst MOT procedure). Then, again during an adjustment with surrounding air, apply a voltage just inside the O_2 sensor specification range to ensure that the analyser does permit measurements.

3.3 Supply a zero gas (see section 2.3.2) to the analyser and ensure that any further indication of λ or further measurement of any gas (during the catalyst MOT procedure) is prevented where negative values appear which are outside the maximum permissible error (ie. on the negative side of -0.1% vol O_2).

3.4 Remove the oxygen sensor and ensure that further indications of λ and further measurements of all gases are prevented during the catalyst MOT procedure.

Note: O_2 sensor voltages are normally specified for sea level and 25°C. For example "Output voltage: 9 - 14mV in air, 25°C, sea level; temperature compensation error:±5% of the reading". Therefore, in tests 3.1 and 3.2 above the following limits would apply:
3.1 Lowest limit at the adjustment with air: 7mV (could be corrected to sea level)

3.2 Limits for the new sensor at the first adjustment with air: The voltage must be between 8.5mV and 14.6mV (could be corrected to sea level).

4.0 LAMBDA MEASUREMENT

4.1 Obtain a non-catalyst vehicle with indicated emission levels as follows:

1-3% CO	100-300ppm HC
12-14% CO_2	0.5-2% O_2

4.2 Use the analyser to measure the emissions from this vehicle and select the fuel type as `petrol'. Allow the readings to stabilise for 30 seconds and then record the four gas readings and lambda (by obtaining a printout).

4.3 Calculate lambda using the above gas readings and the Brettschneider equation as per Appendix 3, VPB/07/24/20).

4.4 Compare the displayed value of lambda with the calculated value and ensure that it is accurate to two decimal places.

5.0 ENGINE SPEED MEASUREMENT

5.1 The analyser shall be supplied with as many engine speed measurement devices as necessary to meet the requirements of paragraph 5.4 (VPB/07/24/20). The analyser shall be used to measure the engine speed on three vehicles with different ignition systems, ie.

Conventional HT system, Distributorless Wasted Spark system and Distributorless Direct Ignition. The analyser must be able to measure engine speed on all three types of ignition system.

5.2 For each engine speed measuring device, compare the speed indicated on the analyser with the output from a spark simulator. (For engine speed measuring devices which do not use ignition system signals, a suitably calibrated alternative method of simulating engine speed shall be used.) Compare the speeds at 1000rpm and 3000rpm to ensure that the analyser complies with the requirements of paragraph 5.3 (VPB/07/24/20).

6.0 ENGINE OIL TEMPERATURE MEASUREMENT

6.1 Check the analyser can measure engine oil temperature to the requirements of paragraph 5.5 (ref.VPB/07/24/20).

6.2 Disconnect the oil probe from the analyser and check that no oil reading is displayed. Also, check that the automated procedure cannot proceed past the oil temperature check (unless oil temperature measurement by-passed is selected).

6.3 Ensure that the probe will fit down the dipstick hole of the worst case vehicle, currently considered to be a Rover Metro 1400 K series (dipstick tube part No. LQN 10015).

7.0 ALPHA NUMERIC DISPLAY

7.1 Check presence and function.

8.0 ALPHA NUMERIC DATA ENTRY

8.1 Check presence and ensure that the alphabet and digits 0-9 can be input or selected as necessary.

9.0 REAL TIME CLOCK

9.1 Check the requirements of the clock as per paragraph 5.8 (VPB/07/24/20).

10.0 DATA TRANSFER & STORAGE

10.1 Verify presence of 9 or 25 pin `D' type male communication port.

10.2 Obtain evidence from the manufacturer that the analyser meets the requirements of paragraph 6.1 and Appendix 2 (VPB/07/24/20). In addition, perform two successive catalyst emission tests and ensure that, for each test, the test data is successfully retrieved by the remote PC in the format as required in Appendix 2.

10.3 Select 10 vehicle makes and model at random and ensure that the data required in paragraph 6.2 (VPB/07/24/20) is available and used in the appropriate part of the test

procedure (Appendix 1, VPB/07/24/20). Check that the retrieved data is correct by comparing with the data supplied by the Department of Transport.

11.0 PRINTER

11.1 Check presence of printer and ensure the printout contents meet the requirements of Appendix 1 (VPB/07/24/20). Also, ensure that the display information matches the content of the printer.

11.2 Check ability of analyser to produce a second print copy as per paragraph 6.3.3 (VPB/07/24/20).

11.3 With the printer disconnected, complete an emission test to ensure that the analyser is unaffected.

12.0 OPERATING INSTRUCTIONS AND CALIBRATION MANUAL

12.1 Check for presence and contents as per paragraphs 6.4 and 6.5 (VPB/07/24/20).

13.0 PROCESS CONTROL

13.1 Check the calibration routine as per the calibration manual and paragraphs 7.1 (VPB/07/24/20). The clock may be advanced manually to check that the analyser locks out on the correct date. Also, check that the requirements of paragraph 7.8 (VPB/07/24/20) are satisfied.

13.2 Ensure that the HC residue check is performed correctly as per paragraph 7.3 (VPB/07/24/20).

13.3 Ensure leak check sequence is performed correctly as per paragraph 7.4 (VPB/07/24/20).

13.4 Confirm pre-conditioning routine and test sequence are performed correctly as per Appendix 1 (VPB/07/24/20). ie perform the test procedure as prompted by the analyser, trying every possible route through the test, and ensure that the procedure meets the requirements of Appendix 1.

13.5 Confirm the ability to store current set of results as per paragraph 7.7 (VPB/07/24/20).

13.6 Check that when selected, the hydrocarbon readings for LPG vehicles are automatically converted as per paragraph 7.9 (VPB/07/24/20).

Appendix 6: ROUTE TO APPROVAL

See separate document:

MOT TESTING SCHEME

APPROVAL PROCEDURE

FOR

TEST EQUIPMENT

TO BE USED FOR

STATUTORY MOT TESTING

VEHICLE & OPERATOR SERVICES AGENCY

1996 EXHAUST GAS ANALYSER CALIBRATION REQUIREMENTS

May 1995
1st Revision: August 1995

1. INTRODUCTION

The requirements detailed in this document cover the calibration of MOT exhaust gas analysers approved for testing catalyst equipped vehicles.

2. FREQUENCY

A. Equipment with an approved automatic self-gassing facility:

Automatic monthly calibration by the operator using gases certified to UKAS requirements and;
12 monthly checks by a UKAS approved operator.

B. All other equipment:

3 monthly checks by UKAS approved operator.

Note: The calibration period may be varied if the analyser is being used as part of a performance trial. The calibration period may then be extended to 6 or 12 month intervals on successful completion of such trials - see Appendix 7A.

Notes:

i) Only UKAS approved operators can perform statutory calibration checks.

ii) Calibration certificates are normally valid for 3, 6 or 12 months from the date of issue. However, if the certificate is issued no more than 14 days before the expiry of an existing certificate, then the expiry date may be entered as 3, 6 or 12 months from the date of expiry of the old certificate.

3. CALIBRATION LIMITS

Equipment must be calibrated to within 3% rel. of the actual gas bottle values on the CO, CO_2 and HC channels.

The O_2 channel should read 0.1% or less on calibration gas. When ambient air is drawn through the analyser, the O_2 channel should display between 19.8%vol and 22%vol.

4. COMPOSITION OF CALIBRATION GAS

Calibration gas is to be of the following nominal composition:

3.5% Carbon Monoxide
2000ppm Propane
14% Carbon Dioxide
balance Nitrogen

The composition of the gas mixture shall be quoted with an uncertainty of less than ± 1% of concentration of each component (at 95% confidence probability) and be traceable to National Standards according to UKAS requirements.

5. ANALYSIS OF RESULTS

The Vehicle & Operator Services Agency will monitor the results of calibrations to verify the adequacy of the calibration periods. Details of the form of the data to be given to the Vehicle & Operator Services Agency will be agreed with individual accredited laboratories.

6. CALIBRATION PROCEDURE

The items detailed below must be included in the periodic calibration checks of gas analysers used for MOT testing.

1. Measure and record ambient temperature and pressure.

2. When the analyser has completed its warm-up phase, perform a zero check.

3. Perform a leak check.

4. Present the calibration gas to the instrument via the calibration port and check the calibration of the CO, CO_2 and HC channels and the zero of the oxygen channel. Then draw ambient air through the instrument via the sample probe and check the calibration of the O_2 channel. Record the results of each test.

5. Check that:

    a) the exhaust probe can be inserted into an exhaust pipe;
    b) the holes at the end of the probe are clear;
    c) the sample hose is of the correct material;
    d) the sample hose is not chafed to the extent that failure is imminent;
    e) the sample hose is not collapsed or kinked;
    f) filters are clean;
    g) filter bowls are correctly seated and undamaged and 'O' rings are in place;

h) internal pipes are secure and not damaged or deteriorated to the extent that collapse or leakage is imminent;

i) the pump draws gas through the complete sample system at the rate specified by the manufacturer;

j) the input voltage to the gas bench is within the tolerance stated by the manufacturer;

k) visual displays are readable and function correctly;

l) the casing is complete and there is electrical continuity between the earth on the input socket and all parts of the case.

m) the clock is reading the correct time and date.

6. Perform a 'self-test' check (where applicable).

7. Perform a zero check

8. Perform a gas calibration and adjust the instrument to bring it within calibration requirements.
Note: It is important that the gas bottle values are corrected for ambient pressure. However, this is not necessary where the analyser incorporates a pressure measuring device to correct the calibration gas pressure. In the case of these analysers, ensure that the pressure-measuring device is accurate to ±20mbar when measuring the ambient pressure.

9. Repeat the self-test check (where applicable).

10. Complete and affix calibration seals as appropriate.

11. Complete and issue a calibration certificate of a type approved for the purpose by UKAS and the Vehicle & Operator Services Agency.

APPENDIX 7A: EXTENSION OF CALIBRATION INTERVAL

The three monthly UKAS calibration interval can be extended in the following circumstances;

(a) Calibration Drift Data

Calibration drift data will be monitored for each make and model of analyser in the field which has a three monthly calibration period. The calibration interval for a particular model of analyser may be extended to six months when 95% of the CO_2, 95% of the CO, 95% of the HC and 95% of the O_2 measurements are within 6% of calibration gas values on the initial calibration check.

(b) Calibration Trial

An analyser manufacturer can pursue an extended calibration period at the point of approval by requesting a UKAS accredited calibration authority to conduct the following trial. (Where the manufacturer has UKAS accredited engineers, they shall be allowed to carry out the trial).

- Manufacturer to identify twenty analysers being used to conduct MOTs in twenty different MOT stations. (Stations must have an annual MOT throughput of at least 1000 vehicles).

- Vehicle & Operator Services Agency to select five analysers from twenty to be monitored.

- A UKAS accredited calibration authority checks and records the analyser drift ten times over a six month period (approximately equal time intervals between each check). The calibration check should be performed as per the Vehicle & Operator Services Agency and UKAS requirements ie. VPB/07/24/20/CAL; but no adjustment should be made. A dedicated gas bottle may be used throughout the six month period.

- During the six month period, all measurements for each analyser must be within 6% of the calibration gas values for CO, CO_2, HC and O_2 without any adjustment (O_2 sensors may be replaced where the analyser automatically prompts the user to do so).

- Calibration period extended to six months on satisfactory completion of the above and once a report to that effect is received by the Vehicle & Operator Services Agency from the UKAS accredited calibration authority.

- The calibration period can be extended to twelve months if the trial is extended to twelve months and the analysers are still within drift limits.

- Reports from other countries will be assessed by the Vehicle & Operator Services Agency on an individual basis to determine whether they meet the above requirements.

(c) Six month declaration

Manufacturers may elect to state their calibration frequency as six months at the point of approval with a subsequent audit as follows:

- Manufacturer to identify 100 MOT analysers in different MOT stations.

- For each of these analysers, a UKAS accredited calibration authority checks and records the gas measurements six months after the analyser has been installed. The calibration check should be performed as per the Vehicle & Operator Services Agency and UKAS requirements ie. VPB/07/24/20/CAL.

- Where the manufacturer has UKAS accredited engineers, they shall be allowed to carry out this audit.

- 95% of the CO_2, 95% of the CO, 95% of the HC and 95% of the O_2 measurements must be within 6% of calibration gas values after six months without any adjustment (O_2 sensors may be replaced where the analyser automatically prompts the user to do so).

- After receipt of a report from the calibration authority stating the analyser has met the above requirements, the Vehicle & Operator Services Agency will confirm the six month calibration period.

- In the event that a manufacturer's product fails to achieve the above requirements, then a three monthly calibration period will be adopted. The cost of the additional calibration visit for any units sold with a guarantee of six months calibration frequency will be absorbed by the manufacturer.