## CHAPTER 3 : CALIBRATION OF EQUIPMENT FOR EVAPORATIVE EMISSION TESTING

## 1 CALIBRATION FREQUENCY AND METHODS

- 1.1 All equipment must be calibrated before its initial use and then calibrated as often as necessary and in any case in the month before type-approval testing. The calibration methods to be used are described in this Appendix.
- 2 CALIBRATION OF THE ENCLOSURE:
- 2.1 Initial determination of enclosure internal volume
- 2.1.1 Before its initial use, the internal volume of the chamber must be determined as follows. The internal dimensions of the chamber are carefully measured, allowing for any irregularities such as bracing struts. The internal volume of the chamber is determined from these measurements.
- 2.1.2 The net internal volume is determined by subtracting 1.42 m<sup>3</sup> from the internal volume of the chamber. Alternatively the volume of the test vehicle with the luggage compartment and windows open may be used instead of the 1.42m<sup>3</sup>.
- 2.1.3 The chamber must be checked as in item 2.3. If the propane mass does not agree with the injected mass to within  $\pm 2\%$  then corrective action is required.
- 2.2 Determination of chamber background emissions

This operation determines that the chamber does not contain any materials that emit significant amounts of hydrocarbons. The check must be carried out at the enclosure's introduction to service, after any operation in the enclosure which may affect background emissions and at a frequency of at least once per year.

- 2.2.1 Calibrate the analyser (if required), then zero and span.
- 2.2.2 Purge the enclosure until a stable hydrocarbon reading is obtained. The mixing fan is turned on if not already on.
- 2.2.3 Seal the chamber and measure the background hydrocarbon concentration, temperature and barometric pressure. These are the initial readings C  $_{\rm HCi}$ , Pi and Ti used in the enclosure background calculation.
- 2.2.4 The enclosure is allowed to stand undisturbed with the mixing fan on for a period of four hours.
- 2.2.5 At the end of this time use the same analyser to measure the hydrocarbon concentration in the chamber. The temperature and the barometric pressure are also measured. These are the final readings C  $_{HCf}$ , P  $_{f}$  and T  $_{f}$ .

- 2.2.6 Calculate the change in mass of hydrocarbons in the enclosure over the time of the test according to section 2.4 The background emission of the enclosure must not exceed 0.4 g.
- 2.3 Calibration and hydrocarbon retention test of the chamber:

The calibration and hydrocarbon retention test in the chamber provides a check on the calculated volume in 2.1 and also measures any leak rate.

- 2.3.1 Purge the enclosure until a stable hydrocarbon concentration is reached. Turn on the mixing fan, if not already switched on. The hydrocarbon analyser is zeroed, calibration if required, and spanned.
- 2.3.2 Seal the enclosure and measure the background concentration, temperature and barometric pressure. These are the initial readings C  $_{\text{Hei}}$ , P  $_{\text{I}}$  and T  $_{\text{I}}$  used in the enclosure calibration.
- 2.3.3 Inject a quantity of approximately 4 grams of propane into the enclosure. The mass of propane must be measured to an accuracy and precision of  $\pm 0.5\%$  of the measured value.
- 2.3.4 Allow the contents of the chamber to mix for five minutes and then measure the hydrocarbon concentration, temperature and barometric pressure. These are the final readings  $C_{HCf}$ ,  $P_{f}$  and  $T_{f}$  for the calibration of the enclosure.
- 2.3.5 Using the readings taken in 2.3.2 and 2.3.4 and the formula in 2.4, calculate the mass of propane in the enclosure. This must be within  $\pm$  2% of the mass of propane measured in 2.3.3.
- 2.3.6 Allow the contents of the chamber to mix for a minimum of four hours. At the end of this period measure and record the final hydrocarbon concentration, temperature and barometric pressure.
- 2.3.7 Calculate using the formula in 2.4, the hydrocarbon mass from the readings taken in 2.3.6 and 2.3.2. The mass may not differ by more than 4% from the hydrocarbon mass given by 2.3.5.
- 2.4 Calculation

The calculation of net hydrocarbon mass change within the enclosure is used to determine the chamber's hydrocarbon background and leak rate. Initial and final readings of hydrocarbons concentration, temperature and barometric pressure are used in the following formula to calculate the mass change.

$$M_{HC} = k * V * 10^{-4} [C_{HCf} * P_f / T_f - C_{HCi} * P_i / T_i]$$

where:

 $M_{HC}$  = hydrocarbon mass in grams.

- $C_{HC}$  = hydrocarbon in the enclosure (ppm Carbon (NB: ppm carbon = ppm propane \*3)),
- V = enclosure volume in cubic metres.
- T = ambient temperature in the enclosure, K.
- P = barometric pressure in kPa.

k = 17.6:

when:

- i is the initial reading.
- f is the final reading.

## 3 CHECKING OF FID HYDROCARBON ANALYSER:

3.1 Detector response optimization:

The FID must be adjusted as specified by the instrument manufacturer. Propane in air should be used to optimize the response on the most common operating range.

3.2 Calibration of the HC analyser:

The analyser should be calibrated using propane in air and purified synthetic air. See section 4.5.2 of Part III (Calibration and span gases).

Establish a calibration curve as described in sections 4.1 to of this Chapter.

3.3 Oxygen interference check and recommended limits:

The response factor (R) for a particular hydrocarbon species f in the ratio of the FID C reading to the gas cylinder concentration, expressed as ppm C. The concentration of the test gas must be at a level to give a response of approximately 80% of full scale deflection, for the operating range. The concentration must be known, to an accuracy of  $\pm 2\%$  in reference to a gravimetric standard expressed in volume. In addition the gas cylinder must be preconditioned for 24 hours at a temperature between 293 K and 303 K (20° and 30°C). Response factors should be determined when introducing an analyser into service and thereafter at major service intervals. The reference gas to be used is propane with balance purified air which is taken to give a response factor of 1.00.

The test gas to be used for oxygen interference and the recommended response factor range are given below:

Propane and nitrogen  $0.95 \leq Rf \leq 1.05$ .

## 4 CALIBRATION OF THE HYDROCARBON ANALYSER

Each of the normally used operating ranges are calibrated by the following procedure:

- 4.1 Establish the calibration curve by at least five calibration points spaced at evenly as possible over the operating range. The nominal concentration of the calibration gas with the highest concentration to be at least 80% of the full scale.
- 4.2 Calculate the calibration curve by the method of least squares. If the resulting polynominal degree is greater than then the number of calibration points must be at least the number of the polynominal degree plus 2.
- 4.3 The calibration curve must not differ by more than 2% from the nominal value of each calibration gas.
- 4.4 Using the coefficients of the polynominal derived from 3.2, a table of indicated reading against true concentration shall be drawn up in steps of no grater than 1% of full scale. This is to be carried out for each analyser range calibrated. The table shall also contain other relevant data such as: date of calibration, span and zero potentiometer readings (where applicable) nominal scale, reference data of each calibration gas used.

The actual and indicated value of each calibration gas used together with the percentage differences.

FID fuel and type, FID air pressure

4.5 If it can be shown to the satisfaction of the Regulatory Agency that alternative technology (e.g. computer, electronically controlled range switch) can give equivalent accuracy, then those alternative may be used.