

## TEST CYCLES & PROCEDURE

1.0 The test facility to be used shall be of the certification agencies or any other facility approved by these certification agencies. The tests shall be carried out under the control of the certification agencies.

2.0 Test equipment, setup, procedure, calculation method and other relevant technical details to be used shall be as per following standards, except where it is mentioned, specifically, in this document.

(a) ISO 8178 – 1

Reciprocating internal combustion engines – Exhaust emission measurement

Part –1 : Test bed measurement of gaseous and particulate exhaust emissions

(b) ISO 8178 – 3

Reciprocating internal combustion engines – Exhaust emission measurement

Part –3 :Definitions & methods of measurement of exhaust gas smoke under steady state conditions.

The smoke shall be measured at all specified mode points of the test cycle.

3.0 The testing shall be done on engines with the engine dynamometer. In case of import of complete genset, the engine shall be decoupled to test with the engine dynamometer. The testing shall be done as per the following 5-mode cycle.

Mode No.	Engine speed	% Load	Weighting Factor
1	Rated speed	100	0.05
2	Rated speed	75	0.25
3	Rated speed	50	0.30
4	Rated speed	25	0.30
5	Rated speed	10	0.10

4.0 Testing shall be done with reference diesel fuel as per the specification given in **Annexure I**. The fuel inlet temperature shall be maintained at  $38\pm 5$  Deg C throughout the test.

- 5.0 Single & two cylinder engines shall be tested with the engine air intake system. All the other engines shall be tested with either air intake system or applying maximum declared air intake depression.
- 6.0 Running in of the engine, for COP, shall be as per clause 7.13 of part II of this document.
- 7.0 Gross observed power shall be the criteria for adjusting dynamometer load as well as calculating specific emission values.
- 8.0 The declared rated gross power shall be verified and corrected as mentioned below.
- 9.0 Power Corrections Factors:

Definition: The power correction factor is the coefficient by which the measured power must be multiplied to determine the engine power under the reference atmospheric conditions specified as below

$$P_o = \alpha P$$

Where:

$P_o$  is the corrected power (i.e. power under reference atmospheric conditions);

$\alpha$  is the correction factor

$P$  is the measured power (test power)

Reference atmospheric conditions:

Temperature (T): 298<sup>0</sup>K

Dry pressure ( $P_{so}$ ): 99kPa

Note: The dry pressure is based on a total pressure of 100 kPa and a water vapour pressure of 1kPa.

Test atmospheric conditions:

The atmospheric conditions during the test shall be the following:

Temperature (T) : Between 283 K and 313 K

Pressure (P) : Between 80 kPa and 110 kPa

Determination of correction factor:

(The tests may be carried out in air -conditioned tests rooms where the atmospheric conditions may be controlled.)

The power correction factor  $\alpha$  for diesel engines at constant fuel delivery is obtained by applying the formula :

$$\alpha = f_a^{f_m}$$

where

$f_a$  – the atmospheric factor

$f_m$ - the characteristic parameter for each type of engine and adjustment

Atmospheric factor ( $f_a$ )

This factor indicates effect of environmental conditions (pressure, temperature and humidity) on the air drawn in by the engine. The atmospheric factor differs according to the type of the engines.

Naturally aspirated and mechanically pressure charged engines:

$$f_a = (99/P_s) * (T/298)^{0.7}$$

Turbocharged engines with or without cooling of charge air :

$$f_a = (99/P_s)^{0.7} * (T/298)^{1.5}$$

Engine Factor ( $f_m$ )

$f_m$  is a function of  $Q_c$  (fuel flow corrected) as follows:

$$f_m = 0.036 Q_c - 1.14$$

where

$Q_c$  –  $Q/r$  and

$Q$  – the fuel delivery in milligrams/cycle per liter of engine swept volume (mg/1.cycle)

$r$  is the pressure ratio of compressor outlet and compressor inlet ( $r = 1$  for naturally aspirated engines)

This formula is valid when  $Q_c$  is  $40 \leq Q_c \leq 65$

For  $Q_c$  values lower than 40, a constant value of  $f_m$  equal to 0.3 ( $f_m=0.3$ ) will be taken.

For  $Q_c$  values higher than 65, a constant value of  $f_m$  equal to 1.2 ( $f_m=1.2$ ) will be taken, as given below:

10.0 The gross declared corrected power of the engine shall be measured on a test bench at rated speed of the engine. The measured power and speed may differ from the power and speed specified by the supplier as specified below:

**Declared rated corrected Power:**

(i) **For Type Approval:**

- For single cylinder engines,  $\pm 5\%$  at the rated power point
- For all other engines,  $\pm 4\%$  at the rated power point

(ii) **For Conformity of Production:**

- For single cylinder engines, at rated power point,  $\pm 6\%$  of the type approved figure
- For all other engines, at rated power point,  $\pm 5\%$  of the type approved figure

**Declared rated Speed at rated power point shall vary within  $\pm 1\%$**

11.0 For verifying the conformity of production, if the selected engine does not meet the smoke limits as applicable, another 2 engines will be taken from the series at random and shall be tested as per this part. The selected two engines should meet the limit values specified.

12.0 For verifying the conformity of production, for the selected engine, if the gross power and rated speed does not meet the limits as per the clause 9.0 of this part, two more engines shall be tested for the rated gross power and rated speed.

13.0 The two selected engines shall meet the limits for the rated gross power and speed, out of the two engines, one engine shall be subjected to the emission test for the conformance of production as mentioned in this part.

14.0 The engine shall be tested with the maximum exhaust back pressure values declared by the manufacturer.

In case of engines fitted with exhaust after treatment devices and external EGR system, the supplier shall declare exhaust back pressure values at all five test points. The engine will be tested with the declared exhaust back pressure values set at laboratory conditions with a tolerance of  $\pm 10\%$  at rated load. At part load points the tolerance shall be as low as possible in the test laboratory conditions.

15.0 The no load speed or high idle speed shall be verified and documented against value specified by the supplier

16.0 If the engine is fitted with the after treatment devices to reduce the engine out emissions, the system adapted shall meet the requirements as specified in Annexure – VI. This Annexure VII shall be prepared and published separately

**Reference:**

***“System & Procedure for Compliance to Emission Limit for Genset Application (Up to gross mechanical power 800kWm)”, published by Central Pollution Control Board, Ministry of Environment & Forests, Govt. of India***