- ANNEX 4M -

Testing of a Silencer with an Electro-Acoustic Actuator.

1. Equipment

The acoustic noise is generated by an electronic white noise generator (electro-acoustic actuator) with a frequency range of 500 – 4000 Hz (-3 dB points, low and high pass filter minimum 1st order, 6 dB/octave).

To avoid discrepancies in measurements by differences in equipment, it is proposed to standardise the equipment, especially the loudspeaker, as much as possible. To attain reproducible results, the actuator and the adaptor are standardised. See figure 2 for the system.

Figure 2. The standard system for electro-acoustic testing.

The loudspeaker is a 1" horn driver type with a resonance frequency of 300 Hz or lower.

The Paso UT 60, professional 1" horn driver, is proposed. http://www.paso.it

The loudspeaker must be fitted with an adaptor which fits the silencer without sound leaks. It must have an 8.7 mm internal diameter and a seal to fit the silencers. See figure 3

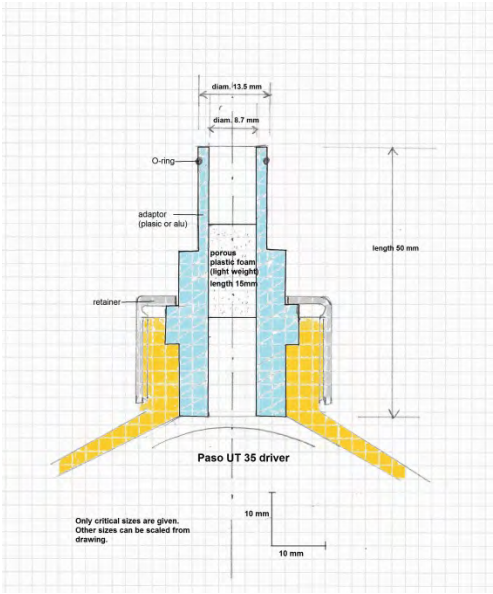

Figure 3. Standard adaptor, essential sizes, section.

The connection of the silencer should have an inner diameter of 13.5 ± 0.1 mm in order to fit the standard adaptor.

For the measurement of the noise source (item 2, photo 1) this manifold needs to be fitted to the noise generator.

If the connection to the silencer is not 13.5 mm diameter, a competitor must bring a device which connects the standard adaptor to his silencer. This device must not increase the length of the acoustic channel by more than 8mm and must have a constant internal section of 60 mm^2. The measurement of the noise source (item 2, photo 1) shall be with this extra device, so it becomes a part of the noise source, not part of the silencer.

If a competitor has a silencing system that cannot be taken out of the model, he must provide an additional adaptor which connects to the standard adaptor and attaches to the silencing system of the model. Item 4 gives further explanation of this option.

Adaptors to fit the Paso UT60 can be supplied by the F2 Subcommittee for €12 excluding VAT.

If there is a problem finding the Paso UT 60 1" horn driver, it can be supplied by the F2 Subcommittee for a price of approx. € 50 excluding VAT.

The noise generator electronics can also be supplied by the F2 Subcommittee for €30 excluding VAT. This is without casing or power supply, only the electronics. It will be built and adjusted to standard specification in limited numbers.

2. Measurements.

The measurements can be carried out with any simple sound level meter. A meter complying with at least IEC 61672-1:2003 class 2 shall be used. It should be used with the frequency weighting "A", in mode "slow".

All measurements should take place at a distance of 10cm ±1 cm to the centre of the relevant opening and perpendicular (within ± 5 degrees) to the axis of the pipe.

To avoid inaccuracies due to sound reflections, the following guidelines should be followed.

i) The sound source must be placed on a stand at a height of 0.5 m or more above the ground.

ii There must be no sound reflecting objects (such as walls) within a distance of one metre from the sound source and microphone.

iii) The 10 cm distance can be controlled by using an appropriate length piece of tubing with a maximum diameter of 3.0mm.

The measurement procedure is as follows:

1. Measurement of the noise source with adaptor at 10cm, see photo 1,
   gives X dB (A). If a device is required to adapt the standard adaptor to the silencer this device must be fitted before reading "X" is taken.
2. Measurement of the noise source silencer at 10cm, see photo 2,
   gives Y dB (A).

The insertion loss (IL) of the silencer is defined as X – Y.

The measurement should be taken for 3 – 5 seconds and the mean reading recorded.

This method can be used for processing silencers and for the homologation of silencers.

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Photo 1: Measurement of noise source , distance 10 cm from adaptor opening.

Photo 2: Measurement of noise source with silencer, distance 10 cm from outlet silencer.

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3. Homologation

Standard silencers which become commercially available should be homologated and marked with a unique identification. Silencers of such a type may be homologated by the F2 Subcommittee using the form below.

Unmodified homologated silencers should be used by all teams who are unable to do their own noise testing.

CIAM F2 Subcommittee

Test form for F2C silencers.

Manufacturer or Supplier	……
Three letter code manufacture/supplier	……
Type	……
Date	……
Drawings	as attached
Sound level of source at 10 cm (X)	……. dB(A)
Sound level exhaust with silencer at 10 cm (Y)	……. dB(A)
Insertion loss (IL) = X – Y	……. dB(A), requirement 14 dB(A)

This exhaust system is homologated with homologation Identification number:

F2C - …… - ……

Note: Homologation number format is F2C-AAA-CIAM. AAA is the three letter code of the manufacturer/supplier

For and on behalf of the CIAM F2 Subcommittee

…….. (Signature)
The homologation officer

…… (Name) (Print)

cont/…

4 Model Aircraft with integrated exhaust systems.

When the silencer cannot be measured in the way described in Item 2, because the silencer is integral or permanently fixed to the aircraft, the following procedure shall be applied:

The connection between the engine's exhaust and the exhaust system must be fully gas tight.

For the measurement of the effectiveness of the silencing system, the competitor must bring a manifold which connects the standard adaptor to his exhaust system. Such a manifold must fulfil the following requirements:

a) It should connect to the exhaust system in an identical way to that which the engine uses.

b) The noise outlet of the device should be 45 - 60 mm^2 and not be blocked in any way by the inlet of the exhaust system.

c) A tube (e.g. high air pressure type) of 10 mm ID and a length of 400 mm will be used to connect the noise generator's standard adaptor to a manifold that has an acoustic channel with a continuous cross section of 60 mm^2. In this manifold, bends and corners, as well as changes of cross sectional shape (e.g. from round to rectangular) are allowed, as long as the cross sections inside the manifold do not vary more than 5%.

*Note: The acoustic quality of the tube and the manifold should be such that no significant sound leakage takes place from these elements, (eg most silicon tubes are too light for this purpose). A simple test is to close the noise outlet with a finger and the measured noise level should drop by at least 25 dB(A**).** The tube is supplied by the Organiser.*

d) The acoustic length (total length of the centreline of the channel) of the manifold must be 55 mm ± 5 mm.

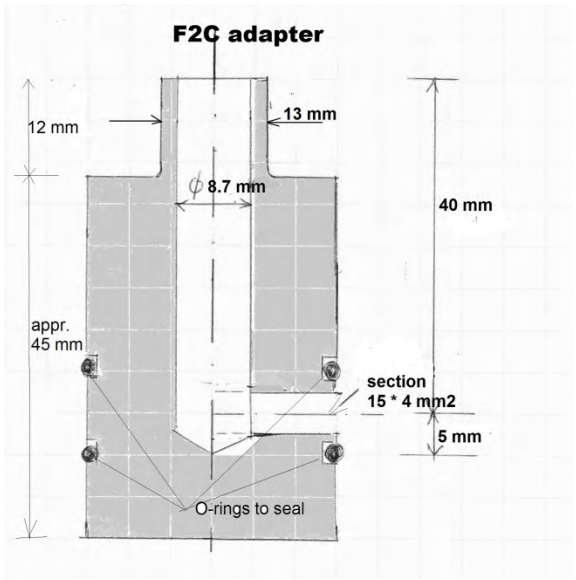
The method of measurement of the insertion loss of the exhaust system is similar to that which is stated in Item 2, with the following modifications:

1. The measurement of the noise source will be carried out at the noise outlet of the manifold.
2. The measurement for the insertion loss will be carried out on the gas outlet of the model.
3. There should be no sound reflecting obstacles within 3 metres.
4. The distance for both measurements is 30 cm. The measurement position is perpendicular to the aircraft's axis at the position of the gas outlet with the gas outlet fully in sight from the measurement's position. The aircraft may be turned around its axis to minimise reflection by the wing as long as the gas outlet continues to be in full sight.

The pictures overleaf illustrate the approach. These are just examples.

Manifold, (dummy cylinder)

Manifold connected to standard adaptor by high air pressure tube



Manifold, (dummy cylinder)

Noise generator connected to model.

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