# Implementation of the Noise Rules per 01-01-2010

## 1. Introduction

From January 1st 2010, Annex 5P Noise rules of the F3D Pylon Racing Sporting Code will be effective. Since this is a new rule in Pylon Racing the following document is written to give assistance to pilots, manufacturers and officials with the implementation of these new rules.

The text of the new noise rules can be found in the 2009 Sporting Code as an addendum.
In 2010 Annex 5P will be included in the body of the F3D volume of the Sporting Code.

## 2. Principles

All current pylon racing engines are used in competition with a tuned exhaust pipe. The new rules state that a secondary muffler with certain effectiveness has to be added to this pipe.

The effectiveness of the muffler can be checked by the contest director in three ways (A.5P.2):

1. By homologation of the exhaust system. (A.5P.3) for further explanation see paragraph 4.1. (This is the route to be used by manufacturers of exhaust systems)
2. By testing the exhaust system with an electro acoustic actuator. (A.5P.2.2) for further explanation see paragraph 4.2. (This is the route to be used by individual constructors of exhaust systems or modified commercial units.)
3. By measurement on a running engine at a reduced piston speed ( A.5P.2.1)

For practical reasons the third method is not preferred. The time to process the exhaust systems will be simply too long. However, since this method is similar to noise tests in other model flying classes, its explanation in the annex 5P is sufficient and no further reference will be made to it in this document. A competitor may insist on a measurement using (A.5P.2.1).

The other two measurement techniques are new in aeromodelling so they need explanation in this document.

The type of the secondary muffler as requested in the rules can be of any design as long as it fulfils the noise reduction requirements of (A.5P.2). To give development of the mufflers a start, paragraph 3 of this document describes a type of muffler that does not affect the performance of the current tuned pipes. This is done to make the transition from the current pipe to a muffled pipe possible without complications in engine behaviour.

The extra weight that the muffler will add to the model is already taken care of in the Sporting Code of 2007.

## 3. Example of muffler design

In Annex 5.P examples of muffler types are given. At the time those designs were made, only a little experience and data were available. This implies that those designs are slightly over dimensioned. In the figure below the dimensioning of the muffler is based on the latest testing.

The muffler as drawn in figure 1 can be used as a working example.

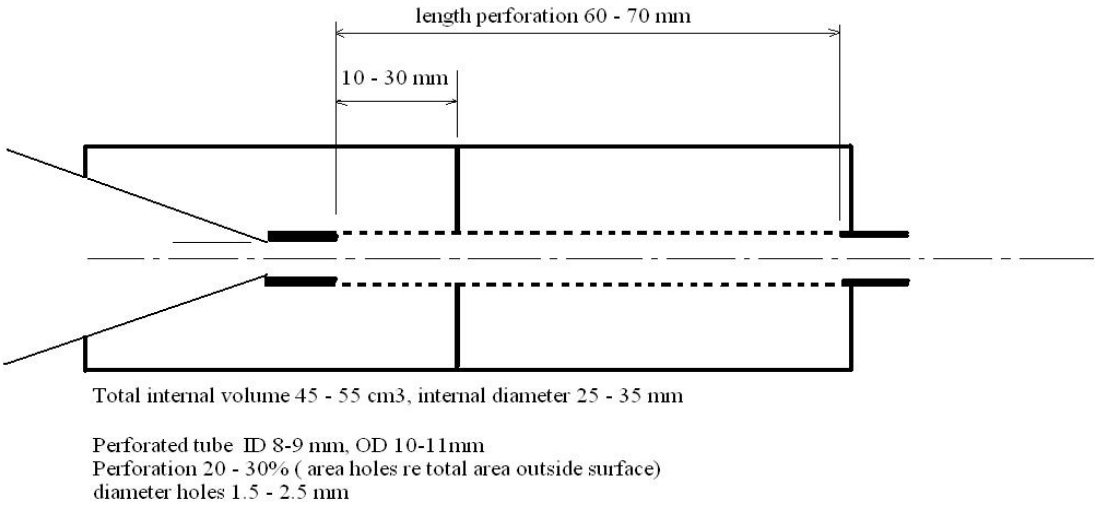


Fig 1. Example of secondary silencer connected to tuned pipe.

It is based on the principle that the muffler is added to the tuned pipe without having an effect on gas flow and tuning effects of the pipe.

The tail pipe length is reduced to approximately 10 mm to make space for the perforated pipe. Tests show that compared to identical pipes with longer tail pipes, there is no change in effectiveness of the pipe, but the average pipe pressure drops from less tail pipe flow resistance, which may have some effect on needle settings.

The perforated pipe should preferably be made of steel. Because of the exhaust gas temperatures aluminium may weaken of even melt under certain circumstances, since there is no cooling air around it.

The outer pipe can be aluminium. A minimum wall thickness of 1 mm is recommended.

Measured with the electro acoustic actuator this type of integrated muffler gives approximately 16 dB reduction compared to the pipe without the muffler.

The baffle in the middle improves the reduction by about 4 dB. The same muffler without the baffle meets the rule's criterion of 12 dB reduction compared to the un-muffled pipe without any real margin for error.

With the addition of the internal baffle there was no relationship between the improved acoustic effect and the engine's behaviour and performance; in other words, no deterioration in engine performance.

Be aware that this is just an example design; it will be possible to develop very different resonator types of mufflers, but these may affect the gas flow behind the tail pipe and the tuning effect of the pipe in a more complex way.

## 4. Testing and processing of exhaust systems

### *4.1 Homologation*

#### 4.1.1. Principles.

Homologation is the simplest way to deal with the noise rules. It is based on the principle that suppliers of exhaust systems will have their exhaust systems tested by the CIAM F3D Pylon Subcommittee to get a homologation identification number for that exhaust system. That ID number will be valid for pipe lengths within a range defined by the manufacturer/supplier.

An exhaust system will be marked by the supplier with that ID number and can be processed at competitions without further testing.

Competitors that use homologated exhaust systems are not allowed to modify the exhaust systems concerning internal dimensions, tail pipe length and diameter. When a homologated system is used with modifications, the test procedure has to be followed for non homologated systems (4.2).

4.1.2. Procedure of homologation.

Anyone who wishes to have a muffler or a pipe/muffler unit tested and homologated must submit 2 samples and a drawing, before January 1st of the year in which it will be used, to one of the muffler homologation officers appointed by the CIAM F3D Pylon Subcommittee. These can be Subcommittee members or experts outside the Subcommittee. For the first two years, 2010 and 2011, this period will be extended to 31st of December to give everyone the opportunity to develop pipes in these first years and to have them homologated immediately.

One example will be kept by the Subcommittee for future reference.

The drawings will be available through the CIAM web site for organizers of competitions and their technical directors.

These mufflers and pipe/muffler units will be tested before March 1st and published on the F3D page of the CIAM website before March 15th of that year. For 2010 and 2011 pipe/muffler units will be tested 6 weeks after they are submitted, publication will follow within 4 weeks. All homologated mufflers will stay on the web site until further notice by the supplier.

The test method will be as described in paragraph 4.2.

Each manufacturer/supplier will receive a homologation number and test form filled in and signed by the homologation officer.

The homologation number will be of the format: F3D - (AAA) – (NUMBER)

AAA is a 3 letter code for the manufacturer/supplier, to be proposed by them.

NUMBER is the homologation number as given by the F3D Pylon Subcommittee.

The test forms will be published on the F3D page of the CIAM website.

The format of the test form for homologation can be found in Annex 1 of this document.

*4.2 Testing with an electro acoustic actuator.*

4.2.1. Introduction.

There are several reasons that the use an electro acoustic actuator is the preferred way of testing the exhaust systems.

- There is no need to run engines to test the effectiveness of an exhaust system. Running engines for each exhaust system is too time consuming and practically impossible, certainly at a competition with many competitors such as a World Championship. Also it makes random checks viable where the engine may not be in a condition to run, such as after a competition flight.
- The method is very quick.
- The method gives good reproduction of results. Measurements on running engines don't give good reproduction because of many other variables, like the propeller and the engine's needle setting, playing a major role.

The most important disadvantage of the electro acoustic actuator is that there may be a discrepancy of attenuation result between an exhaust system tested on the electro acoustic system and on the real engine. For one parameter, which is the effect of exhaust gas temperature, the rules take this into account. There may be other effects related to engine rpm and all kinds of resonance effects in exhaust systems that make the comparison less accurate. The order of magnitude of the effectiveness can be established however with sufficient accuracy.

The method was successfully tested in model car racing to find prohibited modifications by competitors using homologated mufflers. These modifications could then be proved by physically opening the mufflers afterwards.

### 4.2.2. Equipment.

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

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

To avoid discrepancies in measurements by differences in equipment, it is proposed to standardise the equipment, especially the loudspeaker, as much as possible.

The Paso UT 35, a professional 1" horn driver, is proposed. http://www.paso.it

If you have a problem finding it, it can be supplied by the Subcommittee for a price of approx. €45 excluding VAT (through a Dutch Paso dealer).

The noise generator electronics can also be supplied by the Subcommittee for €25 excluding VAT. This is without casing or power supply, only the electronics. It will be built and adjusted to standard specs in limited numbers.

The loudspeaker needs an adapter to fit it to the pipe. It has a 15 mm internal diameter opening and an O-ring seal similar to O-rings used on current engines.
(O-ring OD 21 – 21.3 mm), so it will fit all current pipes. The adapter is designed for minimum volume.

Adapters to fit the Paso UT35 can be supplied by the Subcommittee for €8 excluding VAT.

See fig 2. for the equipment.


Fig 2. The system for electro-acoustic testing.

The measurements can be carried out with any simple sound level meter. A meter according to IEC 61672-1:2002 class 1 can be used. It will be used with frequency weighting "A" in mode "slow".

### 4.2.3. Measurements.

All measurements take place at a distance of 1.00 m ±2 cm to the centre of the relevant opening perpendicular (within ± 5 degrees) to the axis of the pipe.

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

The sound source is placed on a stand at a height above the ground of 1.5 m.

There should be no sound reflecting objects (like walls) within a distance of 3 metres from source and microphone.

*Note: For quick measurements a different distance (but not less than 10 cm due to effects of wavelength) can be taken as long as the measurements of the source, the standard pipe and the muffled pipe are made at the same distance within 5%. The result for the effectiveness of a muffler is basically independent of measurement distance. It is likely that the measurement distance in Annex 5P will be reduced to 10 cm in a next edition (2011) of the Sporting Code. When doing measurements at a small distance like 10 cm reflecting objects at 1 metre or more will have no effect on the readings, which makes it possible to do the measurement on a table in a room (minimum room volume approximately 30 $m^3$. During development of exhaust systems this is an easy way to do indicative measurements in the workshop.*

The 1 meter distance can be easily controlled by a (max) 3 mm diameter distance piece of appropriate length fixed to the microphone as shown in fig.3 - 6. Such a distance piece will not affect the readings.

The measurement procedure is simple:

**A.** In the case that the original (non-muffled) pipe is <u>not</u> available, use this procedure.

1. Measurement of the source @ 1 m, see fig. 4, gives result X0 dB (A)
2. Measurement of the pipe plus muffler @ 1 m, see fig 5 and 6, gives result Y dB (A)

The insertion loss IL0 of the pipe+muffler is defined as X0 – Y.

From measurement it was found that the insertion loss X0 – X1 of the currently most commonly used un-muffled pipes ( De Chastel and van den Bosch) is 8 dB(A) so the minimum requirement for above as derived from the rules is **IL0 ≥ 20 dB(A).**

**B.** In the case that the original (non-muffled) pipe is available, use this procedure.

1. Measurement of the un-muffled pipe @ 1 m, see fig. 4, gives result X1 dB (A)
2. Measurement of the pipe plus muffler @ 1 m, see fig 5 or 6, gives result Y dB (A)

The insertion loss IL1 of the added muffler is defined as X1 – Y.

The minimum requirement for according to the rules is **IL1 ≥ 12 dB (A).**

Since it may be expected that after some years the original, non-muffled pipes will not be available anymore, it is likely that the current requirement of 12 dB (A) for IL1 will be replaced by a requirement of 20 dB (A) for IL0.

With the equipment as described above X0 is 88±1 dB (A) and X1 is 79±1 dB (A).

If another type of source is used, it is recommended, that X0 is between 80 and 95 dB (A).

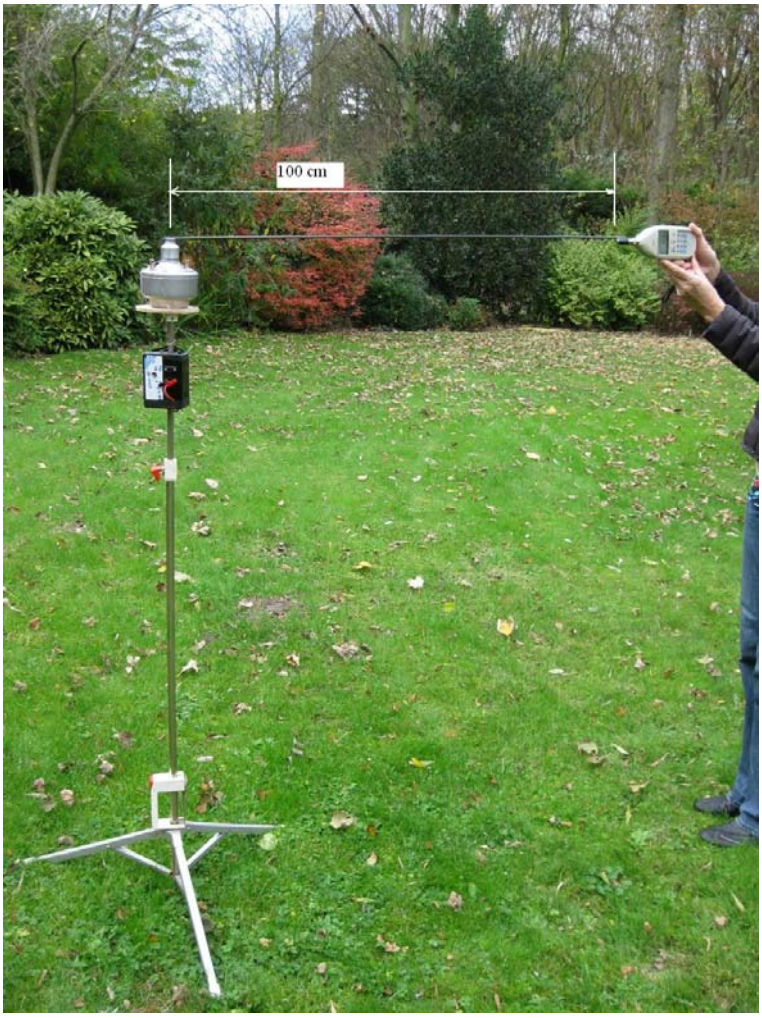


Fig 3 Reference measurement at a distance of 1.00 m (±5 cm) from the adapter opening. This is the X0 reading. Source and measuring microphone 1.5 metres above ground. No other objects within 5 metres.

Fig.4 Reference measurement @ 1 m of the standard pipe without muffler. This is the X1 reading.

Fig. 5 measurement @ 1 m of the pipe plus muffler (integrated type). This is the Y reading

Fig. 6 measurement @ 1 m of the pipe plus added muffler. This is also a Y reading.

# Annex 1

CIAM F3D Pylon Subcommittee

## Test form for F3D mufflers.

| | |
|---|---|
| Manufacturer or Supplier | …… |
| Three letter code manufacture/supplier | …… |
| Type | …… |
| Date | …… |
| Drawings | as attached |
| Sound level of source @ 1.00 m (X0) | ……. dB(A) |
| Sound level exhaust w/o muffler @ 1.00 m(X1) | ……. dB(A) |
| Sound level exhaust with muffler @ 1.00 m (Y) | ……. dB(A) |
| Insertion loss IL0 = X0 – Y | ……. dB(A), requirement 20 dB(A) |
| Insertion loss IL1 = X1 – Y | ……. dB(A), requirement 12 dB(A) |

This exhaust system is homologated with homologation Identification number:
*Note: (Format F3D-AAA- CIAM homologation number), AAA is the three letter code of the manufacturer/supplier*

## F3D - ……. - …….

The CIAM F3D Pylon Subcommittee
For and on behalf of this Subcommittee
The homologation officer

…….. (Signature)

…… (Name) (Print)