F2D noise reduction - 2013

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2013 noise rules:

The demand for noise reduction is a political decision from CIAM. At the seminar on noise reduction at the 2010 World Champs in Hungary the F2 subcommittee chairman Bengt-Olof Samuelsson made it clear that F2D and all other control line classes must conform to the general noise level (96 dB@3 m) set by CIAM and FAI.

The control line classes are free to find a set of rules that makes it plausible to meet this target. If a class fails or refuses to do so CIAM will probably set a general noise level or other restrictions that will give a noise reduction for that class. It will not be possible to go on with the high noise level we have now. The 6 mm muffler rule from 2011 was the first step in the noise reduction for Combat. The next step will be a new set of noise rules from 2013. Proposal for these rules must be sent to CIAM no later than October 15. 2011.

The target of the rules for noise reduction is only to reduce the noise. We must try to keep the current engine power, high flying speeds and dynamic fights. The best solution would be to find a way to reduce the noise without any change to the equipment or to the way we fly combat today. It is probably not possible to find this ideal solution. All ideas for noise reductions do have unwanted side effects and we must try to find a way to handle these problems. At the end of the day we must make a hard choice and set up a set of noise rules for F2D combat.

A noise reduction in combat will not stop people from complaining and it might not prevent flying fields from being closed in the future. A general reduction of noise from model flying is the best tool CIAM has for saving as many flying fields as possible around the world.

How to change the rules:

Traditionally only a few persons are involved in writing rules for combat. As soon as a new set of rules are introduced all pilots will do their best to twist, bend or even break these rules. If pilots just spend a small amount of their rule bending creativity on developing the rules we would have much better rules.

All pilots can help making better rules. You don't need to be a member of an exclusive lodge or to participate in the CIAM meeting in Lausanne in order to promote your idea for a new or better rule. Just put your proposal on one of the major combat debate forums. You will have to answer a lot of questions and to argue for your point of view in discussions. If your idea is really good and gets support from more pilots it will probably find its way to the rule book.

A general problem for all rules is that the rule must be very specific to target the problem it was meant to solve. A common problem is: "What we measure is what we get". An example: For years we had a rule for a simple muffler. The intention was to reduce noise but the rule only states a volume, length and a maximum outlet. During all the years the mufflers were inspected to make sure they fulfilled the rules but for a long time the mufflers did not reduce the noise. We measured the size of the muffler, we got mufflers of the right size but we did not get the noise reduction that actually was the intention with the rule.

Background information on equipment manufactures:

To get a better understanding of our sport it is interesting to see where the pilots are located. It is difficult to count the numbers of pilots around the world but here is a very rough estimate:

Russia: 70% Ukraine: 15% Europe: 10% USA: 5%

At the moment all pilots have easy and equally access to high quality engines designed for combat. Just imagine how combat would be if we did not have these engines. Pilots who would not be able to produce their own engines would have to rebuild standard RC engines. The difference between pilots would then be much greater than what we see today. A few pilots would have home built super engines but most pilots would have to fly converted RC engines.

Today there is a big difference between a really good engines and a not so good engines but this difference is much less than what we would see between home built super engines and converted RC engines.

If it will not be possible for all pilots get engines of a good quality in the future a lot of pilots will stop flying. A pilot with a converted RC engine will stand no chance against a pilot with a super engine. It will be like joining a Formula 1 race with an ordinary street car.

Engine manufactures are also dependent on pilots buying engines. The development of new engines is very expensive and the cost can only be paid by the engines sold. For many years the development of new engines has been relatively slow.

If new noise rules force pilots to change to a different engine design e.g. long stroke engines, diesel engines or small 1.5 cc engines all pilots will have to buy new engines. The old engines will be obsolete overnight together with a lot of spare parts, propellers and other equipment.

A big change would also force the engine manufactures into a race on developing new engines. A race where one engine design may be replaced by the next before the number of engines sold can cover the development cost. This will make it a risky business to develop and manufacture engines.

A way to keep the engine manufactures in the F2D business will be to somehow guarantee a long period of stability after a big change. A freeze of the engine rules for 10 years after a big rule change will probably make it realistic for engine manufactures to cover their development costs.

Manufacturers and dealers of all kinds of equipment for combat are in the same situation. If we kill them nobody will be able to buy propellers, engines, RTF-models etc. In the western part of the world only a few pilots will have the time and skills to build their own models and other equipment. We are dependent on the supply of goods from Russia, Ukraine and Moldova.

Pilots, dealers and manufactures are probably more dependent on each other than most pilots realize. If we make rules that do not take these facts into consideration we might start a chain reaction that in the end give a drastic reduction in the number of F2D pilots.

Solutions for noise reduction:

There seems to be only three possible ways to solve the noise problem: use efficient silencers, run the engines at low speed or use standardized silencers. Here is first a description of the three possible solutions followed by descriptions of some ideas that can't be used.

Efficient silencers:

The noise can be reduced by more efficient silencers. The silencer must able to reduce pink noise by e.g. 20 dB when tested on an acoustic noise generator. The design of the silencer can be free and any material, shape and type of silencer can be used. To prevent the use of tune pipes there must be some restrictions on the total size of the silencer.

It will be easy to test silencers at the flying field. With a noise generator and a sound pressure level meter the test can be done in a few minutes. Most pilots will use mass produced multi-chamber silencers and it will only be necessary to take out a few silencers for testing during a competition.
The cost of a noise generator will be less than 100 euro. The biggest hurtle will be the need of a high quality SPL meter (Class II instrument or better). The costs of this instrument will typical be 300 euros.

Even though all silencers will reduce the pink noise by e.g. 20 dB the noise from a running engine can be quite different. The silencer will have to operate on a wide frequency spectrum at the test but on a running engine the noise will be concentrated at some few frequencies (the engines' base frequency and some harmonics). The high temperature and exhaust gases in the silencer will also change the efficiency.

Exhaust noise will only be a part of the noise from the running engine. When running on the ground noise from the propeller and vibrations in the engine and model might add up to a quit strong noise.
The exhaust noise is the most dominant noise right now. It should be possible to meet the 96 dB@3m for a flying model only by reducing the exhaust noise. The propeller noise will typically be stronger at standstill on the ground than when the model is flying.

There will probably be a big difference in noise from different models even when all silencers fulfill the requested noise reduction. Silencers will only have to fulfill a test with pink noise. When it comes to **flying pilots will go for the silencer design that gives the highest power output from the engine.**

This noise rule will only affect the silencer. Pilots will have to change from the 6 mm muffler used today to some new silencers. Engines, propellers, models and other equipment should not be affected by this rule. Only if some pilots will be able to develop silencers that both will reduce the pink noise by e.g. 20 dB and give a higher engine power we might see changes to the equipment in the future.

This is probably the noise rule that will cause less change to combat. There is a chance that the actual noise reductions will not be enough to meet the 96 dB limit. In a few years we might have to come up with more restrictions on the noise.

Low Engine Speed:

The noise can be reduced by forcing all engines to run at a much lower speed than what we have today. The engine speed can be reduced by specifying a minimum propeller diameter, e.g. 200 mm.
At low engine speed the sound pressure level will not only be lower but the noise will also be more pleasant (similar to vintage diesel engines or stunt engines). Some test and noise measurements must be

made to find the engine speed and propeller size that will give an acceptable noise level. The speed will probably have to go down to 20.000 rpm to give an acceptable noise reduction. To keep the same engine power as we have today it might be necessary to open the intake to 4.5 or 5 mm.

This drastic change of the operational conditions for the engines will lead to big design changes. Long stroke engines will perform better than the current engine design. Diesels will probably also get a short revival but theoretically an optimized methanol engine should still be able to achieve a higher power than a diesel engine.

To give engine manufactures some stability in the future a target should be set for the engine speed. If the development over years leads to an increasing engine speed the propeller diameter must be adjusted to regulate the engine speed back to the targeting speed. If engine designers know that higher engine speed will automatically lead to bigger propellers it will not make sense for them to design engines for higher rpm.

A minimum propeller diameter will be simple to test at the flying field by the use of a caliper. Propellers might be made with strange tip designs to comply with the rule but some additional rule on the propeller blade width and/or volume can be added to prevent this problem.

No tests have yet been done to see how a low engine speed will affect the performance of a combat model. Now we are running small, low pitch propellers at an almost constant high speed. With a big propeller the engine speed might vary much more with the flying speed. This will affect the engine performance and might change the dynamics of the flight.

Low rpm might be the most effective and stable solution to the noise problem. The transformation from the high rpm engines we have now to low rpm engines in the future will cause some radical changes to engine and propeller designs. This change cannot be done little by little but must be effectuated by one big step. The change will make all current engines and propellers obsolete for F2D and force all pilots to buy new engines and propellers.

Standardized Silencer:

A silencer can be defined as a standard silencer and all engines must be equipped with this silencer. This standard silencer must be designed to reduce noise at the frequencies that are typical for combat engines. It could be a design similar to the silencer Rob Metkemeijer has developed for Team Race or it could be a multi-chamber silencer.

The connection between the engine and the silencer must be standardized to place the silencer in the right distance from the engine. A standard silencer must be designed and documented by drawings with all relevant dimensions and details. It should be possible for pilots and engine manufactures to produce the standard silencer from these drawings and all silencers should have the same performance on noise and give the same engine speed.

At a competition a suspicious silencer can be checked simply by replacing it by another standard silencer. A simple check of critical dimensions like the size of openings in the silencer, the internal volume or the weight can also easily be made at the flying field. For a more intensive test the silencer can be checked with a pink noise generator and a sound meter. This type of test is used in F3D Pylon Race to find silencers that should be standard silencers but have been modified by the pilots.

No standard silencer has yet been designed for F2D combat. The silencer should be optimized to reducing noise at base a frequency of 450-520 Hz (27.000-32.000 rpm).

If the silencer is used on an engine running outside the frequency range it was designed for the noise reduction may not be as high as intended. Standardized silencers might give a good and reliable reduction of the exhaust noise. The noise from propellers, intake and vibrations will not be reduced.

Noise level measured at the flying field:

A simple solution would be to set a maximum noise level and then measure the actual noise level at the competition. All pilots would have to find their own way to reduce the noise to below the limit. This might seem to be just what we need to reduce the noise but the practical problem in measuring the noise is so big that it is not possible to use this solution.

If noise is measured when the engine is running at the ground a mechanic can easily change the noise level 2-3 dB by just changing the way he holds the model. The influence from wind, surface of the flying field, background noise (other engines running) and even the way the operator is holding the noise level meter will bias the measurement.

Even with a very strict procedure for the test it will still be so easy to manipulate the measurement that pilots will find the result completely random or even suspect officials of not being neutral. Anyone who has ever tried to measure the noise from a combat model with professional equipment will know how difficult it is to retrieve objective and reproducible results even when all parties involved is cooperating and trying to be as neutral as possible.

Noise measurements on flying models would give a more realistic result. But it is very complicated to measure the noise on a flying model and there will be a lot of extra sources for manipulating the result. If the noise is measured at the handle the noise values will change so much and so fast that it is not possible to make a proper reading in real time. The measuring values must be logged for 10-15 seconds and a mean value calculated after the flight. The engine speed (and noise) will vary with the wind and the wind will also affect the noise level at the pilot. Just by changing the flying height from 3 m to 10 m the noise will typical change 2 dB.

It will not be possible to measure the noise from more than one model at a time. With two models in the same circle it will not be possible to tell the noise from one model from the other.

It would be nice to be able to measure the actual noise at the flying field but technically and practically it will not be possible to do so.

RPM limit:

To reduce the noise the engine speed could be limited to a maximum value of e.g. 27,000 rpm. This is part of the Russian proposal from 2010.

The engine speed can relatively simply be checked at the ground right before takeoff by an acoustic tachometer. This test would reduce the engine speed to the value set by the rules but it will not limit the engine speed of the flying models.

The engines used for F2D Combat today are optimized for high revolutions, typical 30,000 rpm or more. If a maximum engine speed is set to 27,000 rpm all these engines will be running well below their potential power.

To get the most power from the engines pilots will try to get their engines run as fast as possible but without breaking the rpm limit. To do this they must find the propeller with the combination of pitch and

diameter that lets their engines run at maximum power as close to the rpm limit as possible. The size of the propeller will not only depend on the weather at the competition (temperature, air pressure, humidity, etc.) but will also be different for each engine. To find the right propeller a pilot must try out different propellers at the flying field and he must make sure that his engines will not break the rpm limit.

If all pilots start to make test runs on all engines right before each combat heat, competitions will be really noisy. If the intention of the rule on engine speed was to reduce the noise level the practical result can easily be a higher noise load than we have today.

If a pilot can find a way to let his engine spin a little faster he will get a higher power output from the engine. This will motivate pilots to find new ways to "optimize" their propellers. The propeller of the future shall not only be able to keep the engine below the rpm limit when it is running on the ground but should also let the engine run at the highest possible rpm when the model is flying.

At the flying test with the Super Silencer the engine changed from 28,300 rpm on the ground to 30,000 rpm in the air. This was a typical FORA engine with a 164 mm Seryogin propeller.
If the propellers can be designed for a bigger difference between the rpm on the ground and the rpm in the air we will soon be back to a situation where the engines are running at high rpm in the air and making the same noise as today. Only difference from today will be some odd propellers, rpm measurements at takeoff and a lot of test runs.

Another side effect of a rule on engine speed at takeoff will be a lot of protests on pilots changing propellers during a heat. A pilot that loses a heat could claim that his opponent's pitman replaced a broken propeller with a propeller that lets the engine spin above the speed limit when it was restarted in the heat. Since the propellers must be individually selected for each engine to optimize the rpm there will be a good chance that the pitman could have made this mistake. The judges can choose to let the pilot restart his engine after the heat to measure the engine speed. This will cost a lot of time and the pilot will not have any interest in demonstrating the highest possible engine speed in this situation.
If the judges choose not to ask for a test run pilots will soon start to deliberately change to propeller that let the engine spin too fast. If a pilot is not 100 % sure that his engine with a replaced propeller will be able to pass the rpm test in a restart he might choose to break the propeller by making a hard landing at the end of the heat.

At first glance the engine speed rule seems to be an easy way of reducing the noise. If it should be introduced in the future it will give pilots a lot of extra work to find the right combinations of engines and propellers. It will give a lot of extra test running during the competition and it will open up a Pandora's box of dirty tricks and protesting.

Propeller noise:

When we reduce the exhaust noise the propeller noise will be the next issue for combat. The key factor in propeller noise is the tip speed. The shape of the tips and the propeller blades do also play a big role in the noise level.

Propellers could be tested and certified under some kind of homologations process. The propeller can be mounted on an electro-engine in a test bench. The power to the electro-engine can be regulated too e.g. 500 W and the noise can be measured in different directions. In the test the noise from the propeller must be below a certain level (e.g. 90 dB @ 3 m) in all directions.

A certified propeller must be clearly marked with a homologation number. A list of all certified propellers must be published. Some critical parameters for each propeller should be published together with the homologation number. This could be the diameter, shape of the blade, blade cord and thickness at certain

positions, weight and volume of the propeller etc. These parameters would make it possible for officials at a competition to verify if a propeller is identical to the tested propeller.

Homologation of propellers will only be possible with some kind of authority to test the propellers. We do not have any kind of bureau or organization to run these tests and it will be very difficult use a homologation process for noise reduction.

Another way to solve the problem with propeller noise could be to put a mechanical gear between the crankshaft and the propeller. The tip speed could be reduced by using a big propeller and only run it at 20,000 rpm. Engines are optimized for 30,000 rpm so a 3:2 gear between the crankshaft and the propeller shaft could be built on to the engine. This type of gear is well known from big RC models.
A gear will make engines more complicated and more expensive than what we see today. This is probably not a way to go.

No changes to the rules:

Some pilots do not want any changes to the rules. They do not have problems with noise and do not see any reason for a reduction of the noise. Some also find that it will make no change if we reduce noise or not.

Some pilots also argue that competitions can be flown at remote flying fields with no noise problems. This might be a solution in some remote places but will not help pilots in places with more dense populations or general restrictions on noise.

Another variation on the “no change” statement is that even a reduction in the noise will not help pilots with noise problems. Neighbors will still complain and as long as they can hear the sound of combat models they will find it too loud and might try to stop the flying.

The proponents of all these “no change” statements do not want to cooperate with CIAM. If we follow this strategy and do not come up with any proposal for noise reduction CIAM will put some restriction on us. We might not make the noise restriction ourselves but will not be able to avoid restrictions. This strategy would be a dangerous gamble with the future of F2D combat.

A new combat class:

Some pilots have been talking about starting a new combat class without the noise restrictions.
All classes under CIAM/FAI must conform to the general noise level and it will not be possible to make such a new class under CIAM/FAI. A noisy combat class may be formed under local rules but the class will never be recognized as an official and international class by CIAM/FAI.
A new non-CIAM/FAI class will not change the fact that we must reduce noise in the official F2D class.

Electro Combat:

All problems with noise from the internal combustion engines can be eliminated by switching to electric engines.

At this moment a new electro combat class (F2D-E) is taking form and some pilots are working hard to find solutions to all the new challenges this technology are bringing.

A change from internal combustion to electro engines would be a very big change to F2D. It is probably better to let the new F2D-E class grow up in parallel with F2D. If electro combat can avoid the problems with propeller noise it might one day become the most popular combat class.

Shut-off on demand:

From 2013 the heat will stop when all streamers are gone and the pilots must stop their engines and land. This will reduce the noise loading and save time at competitions.
There is no rule that the model must have a device for stopping the engine at will. The engine can be stopped by hitting the ground. The engine stop rule will probably only be applied on the competitions where noise or time problems give a reason for ending the flight as soon as possible.
Some of the shut-off systems available today allow the pilots to stop the engine.

Plague or cholera – make your choice!

Next step will now be to decide how we want to reduce noise in the future.
It seems that we will have to choose one of these three options:

• Efficient Silencer can be tested with pink noise and pilots can design and optimize silencers for their engines. This will probably be the solutions that will have the lowest impact on combat but there is a chance that the noise reduction will not be enough and that we will have to make new restrictions in a few years.

• Standard silencers could reduce the exhaust noise but the propeller noise will be the same. It should be possible to get down to an acceptable noise level. No standard silencer has yet been designed or tested. Some kind of standard adapter must be used on all engines.

• The low engine speed will give a strong noise reduction for many years but the big change in equipment will probably make many pilots stop flying. No tests have been done to see how the low engine speed will affect the engine power and dynamic of the flights.

You can contribute to the process by taking part in the discussions on the internet debate forums:

Barton Model Flying Club Forum:	http://www.controlline.org.uk/phpBB2/viewforum.php?f=3
Combat-1 (Yahoo Groups):	http://groups.yahoo.com/group/combat-l/
Russian model aircraft sports forum: РОССИЙСКИЙ АВИАМОДЕЛЬНЫЙ СПОРТИВНЫЙ ФОРУМ	http://www.ramsf.ru/index.php

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