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FAI PROPOSAL FOR NOISE EVALUATION OF SMALLER AIRPORTS

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General Aviation confronts problems with environmental authorities worldwide. They want to dramatically limit the use of smaller airfields, where the larger part of sporting and recreational flying takes place. It is at smaller airfields that the majority of activities involving gliders, microlight aircraft, recreational flying with aircraft below 9 tons weight, hot-air balloons, parachuting and aeromodelling, takes place.

Environmental authorities react to noise problems, which in many cases are imaginary. They demonstrate an exaggerated fear of aircraft noise, due to numerous complaints and high noise level recorded by heavy aircraft around major airports. These complaints overlap operations at small airfields, which then get blamed for being noisy without real justification. In reality, ambient noise levels generated by road and rail traffic are many times more disturbing than noise from small airfields.

At the February 1993 FAI Council meeting, held in Paris, it was agreed that FAI should become actively involved in preserving smaller airfields around the world. Environmental groups around the world should be informed about the truth about noise levels around airports and of the benefits, that the whole of society gets out of both airfields and airsports. Europe Airsports, at its meeting of November 27, 1993, also resolved to address the issue of sporting and recreational aviation and noise.

Further, FAI was to inform national aero clubs worldwide, about how it would be possible to reduce airfield noise by using quieter equipment and by agreeing on special flying corridors for approach and departure. Europe Airsports decided to keep its actions limited to the national aero clubs of the 12 EU member states and the five EFTA states, where similar problems have been encountered.

Finally, FAI decided to recommend a standard method for noise-monitoring around airfields, in order to show that general aviation takes the problem seriously and that efforts should be made to promote the development of quieter aircraft using new technology. This decision was also adopted by Europe Airsports, which it will promote as policy at European level.

DETERMINATION OF NOISE IMPACT AROUND SMALLER AIRFIELDS

The suggested method is limited to propeller-driven aircraft, which have a Mean Take-Off Weight (MTOW) below 9000kg. It is not applicable eigher to jet-powered or heavier aircraft. This is analogous to ICAO's regulations for noise certification, described in Annex 16, Vol. 1, Chapter 10 (Ref. 4). The method is based upon the determination of accumulated sound effect (Pa^2s) at a reference point 2.5 km from the starting point (as stipulated from ICAO in Ch. 10). This method is relatively accurate, easy and cheap to perform and control. It is therefore well-suited both for authorities, which may wish to limit airfield activity, and for airfield users who are willing to impose self-regulation.

Dr. Henning E. von Gierke and Kenneth McEldred have recently published a review of the impact of noise on people (Ref. 1). The article states that both USA and Canada are about to begin dealing with small-airfield noise in the same way as industrial and traffic noise. One weighty argument is given as the possibility of using accumulated experience on the impact of industrial/traffic noise on people as a model to measure the noise generated by small aircraft.
The proposal therefore uses the descriptions of noise outlined by von Gierke (Table 1) for measuring and calculating noise around smaller airfields.

The noise emission from an aircraft is described by its certificated noise number, which is determined by the maximum Sound Level (slow) at ground level 2,5km from the starting point of the aircraft (according to Ch.10, Annex 16), see Ref.4. Until recently ICAO has stipulated that for smaller aircraft, the noise number should be measured according to Annex 16, Chapter 6 (Ref. 2, 3 and 4). Since the new Ch.10 method is far better than the Ch. 6 method, it ought to be Ch.10, which is used. The influence of noise on people is the same, no matter if the source of noise is a car engine or an aircraft engine. This calls for the treatment, measurement and laws of noise from aircraft around airfields to be treated the same way as we in most countries treat noise in and around industries. This is done by measuring the total noise dose at given places (i.e. by a house or a plot line) across a given time period (8 hours, 24 hours, a week, a months or a year), and dose measurements, which may not be exceeded, can be determined. Since it is desirable to reduce noise at night (22:00 to 07:00) considerably, the calculation of noise dose in the night period will be worked in as ten times more. On the contrary, the method which is argued for in some countries, as for instance Denmark, where noise in the evening (19:00 to 22:00) should be worked in as three times more, has proved not to correspond with the human perception of noise. (See Ref. 1).

After time consuming and in-depth research, it has been determined that the regular dose measurement, which we use for industry- and traffic noise, is the one, which corresponds the best to human reactions. Alhough extremely high, but short-term noise levels have a stronger psychological influence, which does not correspond to the contribution these high sound levels add to the total dose. Due to this, an upper level is very often determined, for noise emission from a noise source. It is therefore natural for a smaller airfield to determine both a maximum noise dose, which may not be exceeded, but also to stipulate that aircraft with especially high noise numbers may not use that particular airfield.

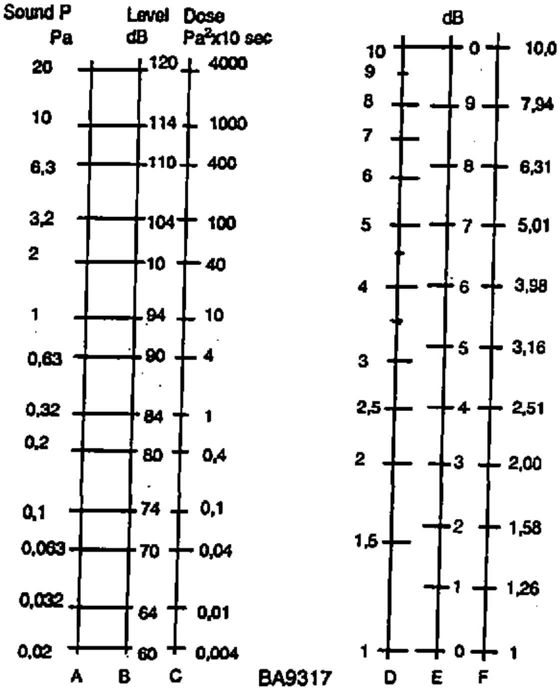
We now have a method, which is both simple and correct, in order for us to express the noise dose from a smaller airfield. We just have to multiply the noise-dose from individual aircraft with the number of engine starts. The noise dose, which is put upon the surroundings from individual aircraft around the point of reference, is the soundpressure squared and multiplied with overflight time. Pascal squared hour (Pa^2 x h). But around smaller airfields the noise dose is considerably less, than what one is used to in industry and we are thus able to use a smaller unit like Pa^2s. Pascal squared seconds, also known as pasques.

Noise number from aircraft is normally expressed in dB (Max L_A Slow), both when the noise number is determined according to Ch.6 and Ch.10. In order to add up the noise dose form individual operations, it is necessary to change the dB number to the absolute soundpressure expressed in Pascal. Thereafter the value of the number for the soundpressure has to be squared and multiplied with the overflight time.
The effective overflight time is defined as time -3dB before maximum, to -3dB after maximum. This time varies from 5 sec., for fast, low flying aircraft, to 15sec. for slow high flying aircraft. Because it is in reality totally impossible to determine the accurate time for every start, we will use 10sec. for all smaller airfields. The 10sec. is slighty above the average from a number of accurate measurements. It is reasonable to use an overflight time, which is slightly above the average, since we are not taking noise from landing into consideration in dose determination. The landing noise from propeller driven aircraft are already insignificant as opposed to starting noise (less than 1/10).

In the table below, it is shown how much noise dose is emitted from one start, when the aircraft has a certification value of L_A max dB. In the table is only shown full dB values. Since the certification value for aircraft is shown in 1/10 dB, it is the idea, that there has to be interpolated for the 0,1 values. This can be in a linear fashion, with no large errors. The scales E and F may also be used.

dB L_A max	Pa	Dose Pasques Pa^2s (10 sec)
50	0,00632	0,00040
55	0,0113	0,00127
60	0,0200	0,00400
61	0,0224	0,00502
62	0,0252	0,00635
63	0,0283	0,0080
64	0,0317	0,0100
65	0,0356	0,0127
66	0,0399	0,0159
67	0,0446	0,0199
68	0,0502	0,0253
69	0,0564	0,0318
70	0,0632	0,0400
75	0,113	0,1265
80	0,200	0,4000
85	0,356	1,267
90	0,632	4,000

At scales A, B, C (pg. 5) are shown the connection between dB (scale B) and soundpressure in Pa (scale A) and the corresponding overflight dose (scale C). Scales D, E and F, at the right is assisting scales, which may be used for interpolating for noise numbers, which are shown in fractions of dB.



EXAMPLE

In the following setup is seen a practical example of a calculation, valid for a smaller airfield with mostly glider activity. The calculation is valid for one full year, but there is flying activity for 5 months only, so all activity is concentrated in this time period. Noise numbers have to be procured for every type of aircraft which use the airfield. The numbers must be according to Ch. 10 method. In this example, all types, except Pawnee PA 28 with tow, have been measured according to Ch. 6, but these noise numbers are changed to Ch. 10, as described later. We will hereafter find the dose for the singular airtypes start in Pa²s. This number is multiplied with the yearly number of starts for the said airtype, and thus the yearly noisedose is found for the singular airtype.

PA 28 has an estimated Ch. 10 noisenumber at 71dB. The dose for 70dB is 0,04 Pa²s. The dose for 71dB is determined with the use of scale E and F, where 1dB corresponds to the multiplication with 1,26: 0,04 x 1,26 = 0,05 Pa²s. Grob 109B has a Ch.10 noisenumber at 69dB. Here we may assume 60dB equivalent to 0,004 Pa²s and multiply with 7,94, or we may draw 1dB from 70dB equivalent to 0,04 Pa²s, by dividing with 1,26. In both cases the result is that 69dB correspond to a noisedose of 0,032 Pa²s.

Example for 1993	Certificated noise no. Ch.6 dB	Ch.10 dB	Dose pr. start (Pa^2s)	Yearly Starts	Total dose Pa^2s (Pasques)
Pawnee PA28 alone	67,8	71	0,050	1300	65
Pawnee PA28 with tow	67,8	77,2	0,21	2500	525
Falco LV8 Alm GA	67,2	70	0,063	100	6
Grob 109B Motor glider	63,2	69	0,032	200	6
Tandemfalke - " -	53,0	60	0,0040	200	1
Total Dose					603 Pa^2s

We may i.e. suggest that this airfield got official approval on the following conditions:

1) Maximum dose	1993 - 95	1000 Pa^2s
	1995 - 2000	500 Pa^2s
	2000 - >	200 Pa^2s

2) No night operation 22:00 - 07:00.
3) No aircraft with noisenumber more than 78dB, Ch.10, may use the field.

A workshop worker may, according to EEC regulations, be exposed to 3600 Pa^2s a day. So, in reality the noise from a smaller airfield is fairly insignificant, compared to industrial- and traffic noise. The serious problem is the large airports, where the noise dose from the start of one single DC9 (300m, 108dB) is 250 Pa^2s, which means 5000 times more than a PA28.

Please note that we are expressing the noiseload for the surroumdings by the noise dose, which is created when the aircraft is climbing approx. 2200m from the starting point (2500m - rolling distance on ground). The dose, which we are determining, is the maximum, the said aircraft can achieve at full load and maximum power. In reality, most aircraft will start with less than full load and often climb with reduced power, in order to save both fuel and wear. This way the noise dose is considerably less.

If the determination of the noise dose from an airfield is carried out according to the above described method, the following advantages is achieved.
1) The method is extremely simple to carry out and can be controlled both by authorities and by local residents.
2) The method does not call for installation of expensive technical devices or any special training.
3) It inspires acquisition and use of quieter aircraft.
4) It gives airfield users the freedom to decide, which aircraft may be used at the airfield. (For example, the use of self-starting gliders for training, instead of airtow, will very often reduce the noise considerably).
5) As an extra bonus for the environment, a lower fuel consumption is achieved, since quieter aircraft are often more energy friendly.

CONVERTING CH. 6 FIGURES TO CH. 10

The problem, which we will have for many years, is that almost all aircraft flying today, are certificated according to Ch. 6. As mentioned earlier, the noisedose determined according to Ch. 10 is much more accurate, especially in connection with smaller airfields. The advantages for Ch. 10 is:

1) that aircraft with fixed-pitch propellers are evaluated more accurately compared with aircraft with constant speed (variable pitch).
2) It is aircraft in the climb, which cause most disturbance.
3) Aircraft with tow are evaluated more strictly than the same craft without tow.
4) Producers of aircraft equipment are called on to create healthier future developments.

If we only have noise numbers according to Ch. 6, we must recalculate these measurement-results to Ch. 10, using the following guidelines:
a) Microphone placement:
According to Ch. 6 the microphone is placed 1,2m above close cropped grass. According to Ch. 10 the microphone is placed at ground level, above a reflecting metalplate with a diameter of 40cm. When measuring with Ch. 10, there will thus be a 5,5dB higher soundpressure (Ref.2) than at Ch. 6. These 5,5dB must then be added to the Ch. 6 number.
b) Fixed propeller:
Aircraft with fixed propeller have, at level flight with maximum power, a higher number of revolutions, than when the same craft is climbing. Tests performed at Deutsche Forschungsanstalt für Luft und Raumfahrt (Ref.5), have shown that the difference is 2,5 - 3dB, dependent on aircraft type. We suggest that there be subtracted 2,5dB from the Ch. 6 value for aircraft with fixed propeller.
c) Measuring hight:
According to Ch. 6 aircraft is measured in a height of 300m, but according to Ch. 10 one should, according to the data in the aircraft handbook, determine the height HR (Reference Height), which the aircraft will achieve with full load and maximum power 2500m removed from the start of the startroll. The correction, which shall be used is
$\delta = 22 \log (HR/300m)$
If the aircraft has strong climbing power and is higher up (calculated) than 300m, f.ex. 600m,
will $\delta = 22 \log 600/300 = 22 \times 0{,}3 = 7{,}3$ dB, which must be subtracted the Ch. 6 value, in order to get Ch. 10.
If the aircraft has a heavy gliderplane on tow and only can achieve f.ex. 200m, the formular will be with opposite sign $\delta = 22 \log (300/200) = 22 \log 1{,}5 = 22 \times 0{,}176 = 3{,}9$ dB, which must be added the Ch. 6 value, in order to get Ch. 10.
To get from Ch. 6 to Ch. 10 one must
1) add 5,5 dB for microphone placement
2) subtract 2,5 dB at fixed propeller
3) calculate HR after the aircrafthandbook and make corrections positively or negatively in proportion to 300m.

REFERENCES

Ref. 1 Henning von Gierke and Kenneth M. Eldred; *Effects of Noise on People*. Noise/News International, June 1993.

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Ref. 3 ICAO annex 16 Vol. 1, Chapter 6 Part H; *Aircraft Noise*. Montreal.

Ref. 4 Annex 16 Chapter 10. Montreal.

Ref. 5 H. Dahlen & H. Heller; *Comparison of the ICAO Annex 16 Chapter 10 and Chapter 6 Noise Certification Procedures on the Basis of Flight Noise Measurements of Ten Light Propeller-Driven Aeroplanes*. DLR-Mitt 90-17, Braunschweig.