MOTORGLIDERS AND MOTORGLIDING: PRESENT AND FUTURE

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FOREWORD

The actual situation and possible future developments of motorgliders and motorgliding are dealt with. Considerations, data and statements presented here are largely based upon the outcome of meetings organized during the 1st World Motorgliding Championships (Issoudun, France, July 1990), of the meeting of the FAI International Gliding Commission (Queenstown, New Zealand March 1991) and of personal contacts with experts and glider and motorglider designers and manufacturers.

1. THE ACTUAL SITUATION.

1.1 Motorgliders in operation and in production.

The number of flying motorgliders of all types in the world amounts to approximately 3,500, about 1,500 of them in Germany.

They can be classified as self-launching or self-sustaining motorgliders, briefly: SELF-LAUNCHERS (SL) and SELF-SUSTAINERS (SS) .

The SS, with engine and propeller retracted, are high performance gliders. The SL can be split into two categories: the TRAVELLING or TOURING MOTOR GLIDERS (TMG), similar to small aeroplanes but having some soaring capability; the rest, mostly with retractable engine and propeller, are high performance gliders when the power unit is retracted. We may call the latter HIGH PERFORMANCE SELFLAUNCHERS (HPSL) (fig.1, 2).

According to a rough personal estimate, the numbers of motorgliders of the three different types in operation today are as follows (from Jane's 1990/91 and other sources):

SS: 250 (approx. 7%)

HPSL: 700 (approx. 20%))

SL: 3,200(93%)

TMG: 2,500 (aprox. 73%) J

Total: 3,450

In Germany, according to LBA (July 1990), the corresponding figures were:

SS: 140(10%)

HPSL: 180(13%)

SL:1,280(90%)

TMG: 1,100(77%)

Total: 1,420

Where are they produced at present? Table I gives the situation.

In order to get an indication of the actual trends, a simple questionnaire sent to the main manufacturers of both gliders and motorgliders (Glaser-Dirks, Rolladen Schneider, Scheibe, SchemppHirth, Schleicher) produced the answers summarized in Table II.

FIGURE 1. A touring motorglider: The Dimona (Hoffman, Austria).

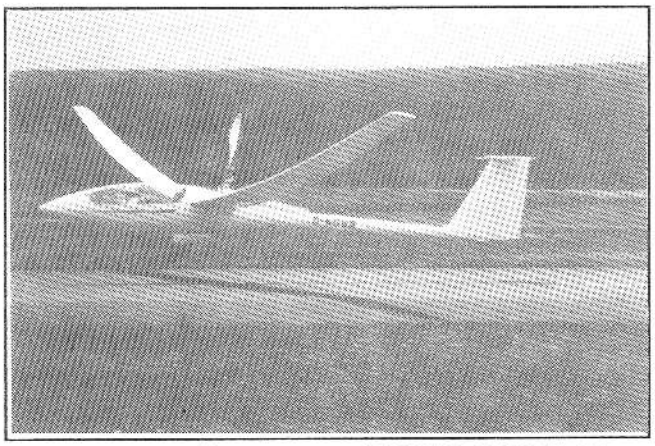

FIGURE 2. A self-sustainer: ASH-25 MB (Schleicher, photo by Selinger).

The picture resulting from the information gathered is quite c ear.

(a) TMG represent more than 70% of the existing motorgliders.

(b) Production of TMG takes place in several countries, whereas HPSL are produced in a few countries and SS only in Germany.

(c) An increasing number of high performance gliders are delivered with an engine on board (on both SL and SS versions) .

(d) All manufacturers building both gliders and motorgliders express opinions which clearly mean that glider pilots (their customers) would appreciate the admission of motorgliders into gliding championships and (all but one) to glider records.

(e) The electrical connection between the propeller and the (electrical) barograph is provided only upon request. This is a detail but relevant in relation to the reliability of the flight documentation system.

1.2 Motorgliding competitions.

Since the 60's motorgliding competitions have been organized in Germany. The competition held at Burg Feuerstein in 1970 can be considered the first championships at national level.

Six European Motorgliding Championships have been held so far, the first one being at Burg Feuerstein, Germany in 1978 and the latest in Issoudun, France, in 1988.

For the first time World Motorgliding Championships were held at Issoudun, France, in 1990.

At the beginning TMG's were the only motorgliders to take part. Their number was still considerable at the European Championships 1986 in Austria. At Issoudun 1988 a class was available for the TMG but the participation was not sufficient for a championship to be declared in this class. At the World Championships 1990 they were totally absent, as expected. At present, therefore, TMG are out of competitions.

At Issoudun 1990 two classes were flown out of three available: with only one entrant, the so-called15 meter class was cancelled.

In Class 1 (wing span over 18 meter) 7 HPSL and 8 SS were competing. In Class 2 (wing span up to 18 meter) there were 10 HPSL and 8 SS. The number of SS, therefore, approximately balanced that of HPSL.

All the above mentioned championships, and other ones at national level, are basically gliding championships for high performance gliders having an engine on board which allows them to avoid an outlanding.

The self-launching capability is not prized at all. SS, therefore, are admitted without problems. The use of the engine is discouraged: if you use the engine you get no speed points; moreover, distance points are reduced in proportion to the engine running time.

From the point of view of scoring, therefore, using the engine has a similar effect as outlanding in gliding championships.

TABLE I. Motorgliders in Production.

SELF-LAUNCHERS - SL						SELF-SUSTAINERS - SS		
TMG			HPSL					
country	manufact.	type	country	manufacturer	type	country	manufacturer	type
Brasil	AEROMOT	AF-10	France	Issoire Av.	Pik 20E 2F	Germany	DIRKS	DG 600 M
China	SHENYANG	HU 1	France	Issoire Av.	Pik 30	Germany	SCHEMPP-HIRTH	Discus bT
CSR	AEROTECHNIK	L-13SE	Germany	DIRKS	DG 400	Germany	SCHEMPP-HIRTH	Nimbus 3T
France	Aeron.Serv.	Marianne M	Germany	DIRKS	DG 500 M	Germany	SCHEMPP-HIRTH	Nimbus 3DT
Germany	Grob	G-109 B	Germany	SCHEMPP-HIRTH	Nimbus 3DM	Germany	SCHEMPP-HIRTH	Janus CT
Germ./Austria	Hoffmann	Dimona	Germany	SCHEMPP-HIRTH	Janus CM	Germany	SCHEMPP-HIRTH	Ventus bT
Germany	SCHEIBE	SF-25 C	Germany	SCHEMPP-HIRTH	Ventus cM	Germany	SCHEMPP-HIRTH	Ventus cT
Germany	TECHNOFLUG	Piccolo	Germany	SCHLEICHER	ASW 22 BE	Germany	SCHLEICHER	ASH 25 E
Germany	VALENTIN	Taifun 17 E II	Germany	SCHLEICHER	ASW 24 E			
Norway	LUNDS	Shilou-ette	Germany	SCHLEICHER	ASW 24 TOP			
Poland	PW	PW 4	Germany	STEMME	S-10			
Rumania	ICA	IS28 M2A	Germany	VALENTIN	Kiwi			
Spain	COPARAVIA	RF 5	USA	MAUPIN	Windrose			
USA	SCHWEIZER	SGM 2-37	USA	STROJNIK	S-2 A			

Data mainly from Jane's 1990/91. Data may be incomplete; in some cases production may have stopped or be discontinued.

1.3 Motorgliders admitted to gliding competitions.

In most cases motorgliders are admitted under the condition that the engine cannot be used at all, even for self-launching.

Therefore, either the engine compartment doors are sealed or the propeller is removed.

In New Zealand, "motorgliders have an isolation switch fitted (a modification fully accepted and approved by the Civil Aviation authority) preventing the motor being raised after launching. Also motorgliders must carry a barograph capable of recording engine running time. This solution has been adopted satisfactorily for nine years." (reported by A.E.Timmermans at the IGC meeting, March 1991).

1.4 Records.

The FAI Sporting Code, Section 3, considers separately gliders and motorgliders. For a long time only SL were admitted to motorglider records. Following a decision taken by IGC in March 1991, from May 1st onwards SS are also eligible for motorglider records.

According to the Code, a motorglider record can be claimed provided that there is proof that the means of propulsion was not operated during the performance. Therefore, the take off and initial climb can take place by any means (using the engine on board or aero-tow or winch or auto-tow or catapult etc.) provided that it is proven that the motorglider has been used as a pure glider from the "departure point" to the "finish point".

According to the Code, also a glider record can be claimed with a motorglider. In this case, however, there must be proof that the means of propulsion prior to take-off was made not capable of being restarted in flight

The philosophy behind the rule that the motorglider be, in a sense, "mutilated" to be allowed to attempt for glider records is that the availability of an engine that can allow the pilot to escape a difficult situation if necessary, allows him to take decisions (as flying over unlandable terrain) which the plain glider pilot would not take for safety reasons. This argument is rejected by many motorglider pilots as untrue on the ground that they do fear that the engine may not start.

There is probably another reason behind the rule: the actual flight documentation systems are not (yet) reliable enough to give a proof, beyond any reasonable doubt, that the engine has not been (re)started during the performance. If so, however, one would obviously object that the same doubt should apply to the case of motorglider records.

1.5 Badge flights.

The Sporting Code allows the use of a motorglider whatever (either SL or SS) for glider badge flights, provided that there is proof that the means of propulsion was not operated during the performance.

This requirement is much less restrictive than that prescribed for glider record flights because, in the case of an aborted attempt, the pilot may avoid an outlanding by using the engine.

This apparent inconsistency can only be explained by admitting that "badge" flights are a matter of lesser importance, relevance and meaning than record flights, an argument which many would probably reject.

TABLE II Answers to Questionaire

Manufacturers	GLASER-DIRKS	ROLL-SCHNEIDER	SCHEIBE	SCHEMPP-HIRTH	SCHLEICHER
1. Types of motorgliders in production. (specify if SL or SS)	DG 400 SL DG 500 M SL DG 600 M SL DG 600 M SS	no motorglider in production	SF 25 C SL	Janus CM SL Ventus cM SL Nimbus 3D M SL Janus CT SS Ventus cT SS Nimbus 3D T SS Discus bT SS	ASW 22 BE SL ASW 24 E SL ASH 25 E SS
2. For each glider type of your production, specify how many (%) are delivered with an engine and how many (%) are delivered without an engine but ready for its installation.	DG 400 100% DG 500 65% DG 600 90% (all with engines installed)		SF 25 C 100%	Janus 11% SL 22% SS 0% Ventus 65% SL 13% SS 8% Nimbus-3D 55% SL 18% SS 0% Discus 0% SL 45% SS 4%	ASW 22 B 81% 5% prepared ASW 24 40% on order with eng. ASH 25 70% 15% prepared
3. Can you indicate if the actual tendency is towards an increase of these %? For SL, SS or both?	Yes, for SL.			Tendency = = constant, except for Discus bT tending to 50% SS.	Yes, for both SL and SS.
4. Is the electrical connection between the propeller and the (electric) barograph for engine time recording provided for in the m/g of your production?	Optional for Aerograph. We don't know other systems.			upon request	upon request
5. What do you think about the possibility that, gradually in the future, m/g (both SL and SS) are admitted to the (actually) pure gliding champs and records with the possibility to use the engine to avoid outlanding?	Dirks: This should be allowed, also engine should be allowed for launching (SL). If engine used during flight only distance to last valid photopoint before engine start can be counted. M/g competitions with present kind of rules must be continued.	Lemke: I cannot imagine that it is useful to mix m/g and pure gliders.		Treiber: m/g should be admitted to pure gliding champs in the future. M/g records should be separate because of the advantage to fly over unlandable terrain.	Waibel: Most of our customers would appreciate this possibility very much. Only a few will wish separate champs.

2. POSSIBLE FUTURE DEVELOPMENTS.

2.1 Touring Motorgliders.

The preceding data and considerations show rather clearly that TMG, the large majority of motorgliders actually in operation, are being produced regardless of competitions, records and badges.

In many clubs and gliding schools they are used for primary instruction, training and leisure flights. In and outside the gliding world they are used for touring or travelling, just as a light aeroplane, but cheaper and normally safer. In particular cases, they are employed for civil or military purposes

(patrol, ecological observation, detection of forest fires, observation and surveillance, aerial survey and photography, etc.): recent examples are the RF-10 in Brazil, the HU-1 in China and the Stemme S.10 in Europe, but many more exist.

From the sporting point of view - the FAI domain - they are under the jurisdiction of the International Gliding Commission (IGC), as everybody knows. The actual rules of the FAI Sporting Code, however, are no more suitable to them: they are no more used for competitions, records, and very little for badge flights. This is a pity, because the stimulus to improve the sporting performance has a powerful beneficial effect on the technical development and refinement of the machine, not to mention other important positive effects.

A competition appealing to them is required. It cannot be based on pure soaring, because the soaring capability of the TMG is relatively modest. It was recognized at the Issoudun meetings (July 1990) that a competition so conceived that the use of the engine is encouraged in case of weak soaring conditions would better suit this type of motorgliders.

A competition of this type, called "International Economy Air Race", was held in Torino, Italy, in July 1988.Four classes were available: 1. light production aircraft up to 1750 kg all-up weight, 2. light homebuilt aircraft up to the same weight, 3. motorgliders with fixed propeller, 4. motorgliders with retractable propeller. Competitors were required to optimize the ratio $V^{1.2}/f$, where V is the speed on the course and f is the fuel consumption per unit of distance covered. The fuel consumption was measured by weighing the aircraft before take-off and after landing. The very accurate scales required (capable to appreciate less than 100 g in a range of weights up to 2000 kg) were provided by Aeritalia (the Italian aircraft manufacturer, now called Alenia) as a form of sponsorship.

Four tasks were flown in the 5 days available. Although the participation was limited (5 in class 1, 2 in class 2, 7 in class 3 and 1 (!) in class 4), much interest was raised, particularly in class 2 and 3. It was evident that the knowledge and skill of a glider pilot played an important role.

At the beginning, for the sake of promotion, competitions of this type could be organized in the same site and at the same date of motorgliding championships, under separate rules. There would thus be possible an exchange of ideas and information among all pilots involved in the parallel events. The presence of a great variety of machines on the same airfield would certainly produce an additional interest.

The availability of suitable scales for the measurement of the fuel consumption is certainly a problem: not only a generous sponsorship is wanted, but also the technical expertise for their construction and operation. In our case in Torino, we were not able to find anything suitable on the market. The dynamometric cells, therefore, equipped with electric strain-gauges, were designed and built by the technical staff of Aeritalia.

A solution of this problem would be an instrument, to be installed on board of each competing aircraft, capable to measure the fuel consumption, but in mass not in volume. The thermal expansion of the petrol, in fact, cannot be ignored and is very difficult to be accounted for. The development of such an instrument should be stimulated in some way: could not OSTIV and/or FAI take some initiative in this direction?

2.2 Self-launchers and self-sustainers.

The actual motorgliding championships are conceived like pure gliding championships. Competing motorgliders have the same level of gliding performance of the gliders entered in the gliding championships: in several cases, when the propulsion unit is retracted, they are the same machine, as far as the external geometry is concerned.

If we look at the gliding performance,however, some differences do exist between the plain glider and the powered version of the same:

(a) The motorglider has a higher empty weight, therefore the range of variation of the wing loading is smaller, the minimum possible wing loading being higher. This is a disadvantage in poor soaring conditions.

(b) In some cases, however, the motorglider can take advantage of the higher max. allowed total weight, being 850 kg (instead of 750 kg for plain gliders) the certification applicability limit set by both JAR-22 and OSTIV AS. This allows a higher max. wing loading and therefore a better high speed performance, beneficial with strong soaring conditions.

(c) It was remarked at the Issoudun meetings that, in case you are about to outland, with a motorglider you cannot fly so low as with a plain glider because you must extend the engine, thereby increasing your rate of sink.

Self-sustainers having been admitted to the championships together with the self-launchers, you need towplanes.

It has been underlined already that the rules discourage the use of the engine. First of all, if you use the engine you get no speed points. Secondly, the distance covered is reduced in proportion to the engine running time. The effect of using the engine, therefore, is similar to that of the outlanding in a gliding championship.

It follows that the only difference between a gliding and a motorgliding championship is that in the latter outlandings can be avoided by using the engine.

Assuming gliders and motorgliders competing together, the opinion that motorglider pilots take less risks was rejected at Issoudun. In fact they risk more if they rely on the engine which may not start. On the other hand, if they do not rely on the engine, they have a disadvantage, not being able to fly so low as a plain glider (see point c above) and being heavier.

A substantial difference which cannot be denied is that avoiding an outlanding during a competition task and getting back home comfortably by using the engine, is an advantage with respect to the plain glider pilot who sometimes is obliged to a long and tiresome retrieve.

It should be acknowledged, however, that, if we put all these considerations together, pros and cons do, at some extent, balance out.

It is, therefore, reasonable to take into account the following possibilities for future development:

(i) to let gliders and motorgliders fly together in championships;

(ii) to abolish motorglider records and to admit motorgliders to glider records.

3. The equipment for flight documentation.

The necessity of an instrument measuring the fuel consumption of a Touring Motor Glider in an Economy Race has already been underlined in para.2.1.

Whenever the motorglider is supposed to perform as a sailplane, the recording of engine or, better, propeller running (in the Stemme S-10, the engine can run with the propeller motionless and retracted) and, if necessary, engine time is obviously essential for the performance evaluation in competition, record or badge flying.

Methods actually in use are:

(a) the mechanical device, i.e. a simple system oscillating in a quasi-resonace condition when excited by the engine vibrations, the oscillations being recorded on a Winter-type barograph.

(b) magnetic impulses produced by the propeller rotation, transmitted to an electric barograph and recorded thereby.

Method (a) is considered more reliable. It is less and less used, however, as the pilots give their preference to the electrical barograph.

In two cases at Issoudun last year pilots honestly declared to have used the engine whereas the organizers had credited them already with full scoring (i.e., no deduction of points for engine running time) because the barogram did not show any record of engine run. Note that the engine run had been regularly recorded prior to the start, as prescribed by the rules! The reason for the malfunctioning is not yet completely clear.

Reliability, however, is not the only problem. The possibility of cheating must be prevented. Cheating is particularly easy if the cable connecting the detector with the barograph is within reach of the pilot (or passenger) in flight.

This connection is realized in many different ways by the pilots themselves. It has been suggested that the connection be provided by the manufacturer of the motorglider in the respect of a given specification. Nowadays manufacturers provide this installation upon request (see Table II).

The detector and the barograph itself are also liable to cheating.

The solution of this problem may come from the adoption of a new recording device, separate and independent of the barograph. The (x) Akaflieg Erlangen, which is entrusted with the scoring of motorgliding competitions since 1982 and is represented regularly at motorgliding championships, thereby gaining experience and competence, has such a device under study.

(°) In the Stemme S.10 the engine can run with the propeller motionless an(l retracted.

The photo-time camera is also a necessary device, as for glider competition, record and badge flying.

Failure of proper functioning, however, occurred also with cameras which have proven practically irreproachable when installed on gliders. Vibrations produced by the engine have been indicated as a possible cause of the malfunctioning (time indication not appearing on one or more photographs).

It can be stated, in general, that we are at a rather primitive stage of development of flight documentation systems. Much progress is still needed on the technical performance, reliability and security of these instruments. On the other hand, if a satisfactory level is not attained, the assessment of a given performance is doubtful.

This situation is actually tolerated in both gliding and motorgliding competitions. If gliders and motorgliders are allowed to compete together, the suspicious attitude of glider pilots towards motorgliders may produce a less tolerable situation.

4. THE ENVIRONMENTAL RESTRAINTS

Actual motorgliders are largely unsatisfactory, particularly with the common two-stroke piston engines: noise level, in particular, is beyond acceptable limits.For this reason, in some countries (Germany and Switzerland, for instance) motorglider operation from some airfields and airstrips has been forbidden. More and more people complain about the sacred silence of beloved mountains-being violated, even increasing the risk of snowslides, and so on.

These complaints should not be underestimated. They are usually founded upon sensible considerations and largely justified. The care for the environment is a mark of progress of our civilization. The noise comes from both the engine and the propeller. To reduce its level is a hard technical problem on motorgliders.

The propeller rotational speed should be reduced. Apart from the reduction mechanism, problems come from the increased propeller diameter. Solutions like that shown on Figure 3 (Ventus CM) may help. Some advantage is also claimed for the solution adopted on a multi-blade propeller for SS, where each blade has a different radius .

Abatement of engine noise would require adequate mufflers, which are not compatible with the limited space available for retracting the engine.

Liquid-cooled engines have appeared on the market, which seem to be sensibly less noisy with respect to the air-cooled engines which produce a turbulent air flow around the cylinders.

Exhaust gases from two-stroke piston engines are highly polluting. Also, their specific fuel consumption is high: this is a negative aspect for the TMG in particular, and more if considered as an economy air racer.

The fear is expressed in highly developed gliding countries like Germany that these problems may not only hamper the expansion of motorgliding but also impair the image of gliding as a sport fully respectful of the environment.

If the matter is not carefully dealt with, even the gliding movement may split into two opposite parties.

If we enlarge the concept of environment including the other users of air space, it is perhaps worth remembering that in Germany, at the start of the real development of motorgliders (in the 70's), there was a rather hostile attitude of some aviation circles against the motorglider: it was feared as an unfair competitor of the light airplane.

After many years and after several tentative definitions, the German Federal Ministry of Transport has issued recently (Feb.24, 1991) the definitions and regulations reported here, translated in English, as an Appendix to this paper. Although they clarify a situation that was rather confused in several respects, they limit the use of the motorglider in a rather sharp and, maybe excessive way: motorgliders are no more allowed to tow gliders and advertising banners and to transport passengers on payment; they can only fly under VFR conditions.

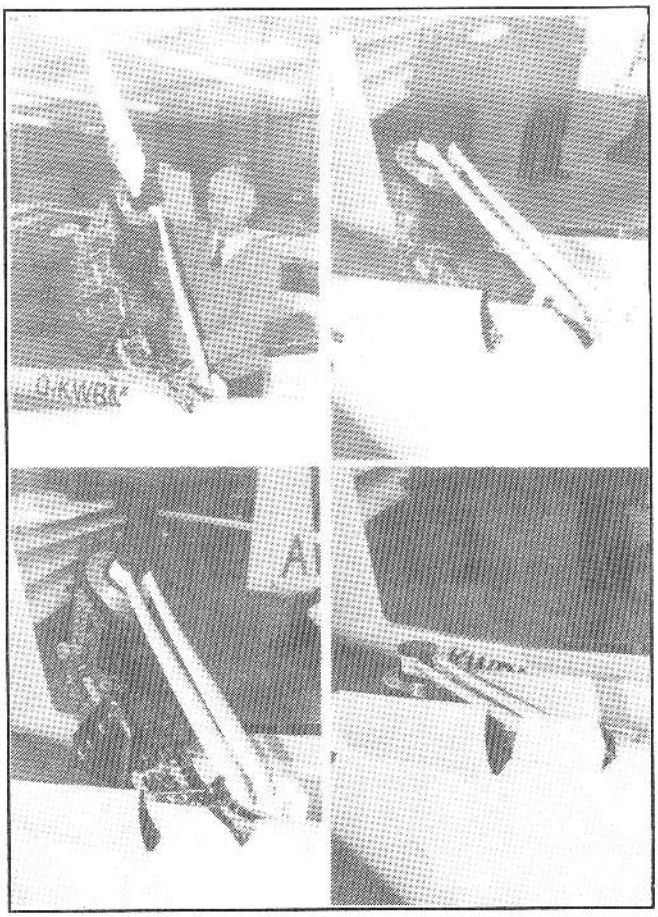

FIGURE 3. Ventus CM (Schempp-Hirth): Sequence of propeller retraction.

Another aspect of the impact of motorgliders, HPSL and SS particularly, into the "environment" in a broader sense, is the Air Traffic Control tending to appreciate the increased capability of autonomous mobility of gliders equipped with an engine.

5. CONCLUSIONS.

The FAI International Gliding Commission at its last meeting (March 1991), acknowledged the fast development of motorgliders, the increasing interest of glider pilots in competitions and records for motorgliders, but also the impending dangers coming from outside and inside the gliding movement. It was recognized that, in general, motorgliders have no advantage on competing with gliders in gliding championships. For the time being, however, the admission of motorgliders to World and Continental Championships should only be allowed upon the condition that, if the engine is used for self- launching, it cannot be re-started in flight.

In general, the meeting was in favour of a long term integration of motorgliders into the gliders' competitions and records. In this direction, experimentation with competitions at national level is encouraged.

The "long term integration" is an important indication of tendency. At the same time, it reflects the concern about the negative aspects surrounding the motorglider development today. More time is needed to make the integration acceptable to the public and to the gliding movement itself.

It is hoped that new technical solutions are introduced in the meantime, bringing the noise within acceptable levels, improving the efficiency of the propulsion unit, making better flight documentation equipment available.

An effort is already being made by the motorglider and engine manufacturers. OSTIV could perhaps stimulate this development.

What about an OSTIV Prize for a good contribution to noise abatement? or for a new instrument capable to measure the fuel mass consumption in flight? or for an improved, more reliable engine running recorder?

APPENDIX

NEW GERMAN DEFINITION OF MOTORGLIDER
(German Federal Ministry of Transport February 25, 1991)
(translated from *Deutscher Aerokurier*, May 1991, page 37)

1. General definition:

Motorgliders are aircraft with all technical characteristics of a sailplane but additionally provided with a means of propulsion.

The requirements on motorgliders being based on their use as sailplanes, they are subject to similar limitations.

Therefore, motorgliders cannot be used for work activities, including towing sailplanes and advertising banners. They are not allowed to take passengers on payment and may only be flown under VFR rules.

2 Technical characteristics

(a) Motorgliders may be single or double-seaters.

(b) The stalling speed in the landing configuration (landing gear and flaps extended, engine idling or retracted, airbrakes extended) at maximum all-up weight, but without water ballast, and with C.G. in the foremost position, may not be greater than 80 km/h.

(c) The sinking speed with engine off, at maximum all-up weight and with C.G. in the most unfavourable location, may not be greater than 1 m/s for single-seaters and 1.2 m/s for doubleseaters.

(d) The maximum all-up weight may not exceed 850 kg.

(e) The coefficient W/b2 (W = max. all-up weight in kg divided by wing span in m squared) may not be greater than 3.

3. Classification according to engine performance:

Depending on engine performance, motorgliders are classified as follows:

(a) Motorgliders capable of safe autonomous take-off (selflaunching motorgliders);

(b) Motorgliders with engine performance insufficient for a safe autonomous take-off, an external aid (e.g.: winch, towplane) being therefore required for starting (self-sustaining motorgliders).