Maximum Take-Off Weight[1] for Gliders in Championships

White Paper

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Introduction

This paper is a summary of the issues regarding the maximum take-off weight for gliders that have been discussed over the years. The purpose is to provide facts and recommendations as a base for future decisions in IGC.

The maximum weight and the weighing of gliders became an important issue in the 1970´s when most competition gliders used larger and larger amounts of water ballast to widen the speed range and increase the performance in strong soaring conditions. It became important to check the weight of gliders during championships because pilots tended to load the gliders above the certificated weight in an attempt to gain a sporting advantage.

A base for checking the weight was also needed for the organisers, because gliders sometimes appeared with an experimental certificate of airworthiness (C of A) that allowed a higher maximum weight than similar gliders flying on a normal C of A based on the manufacturer's type approval.

In the 1980's the manufacturers started to further increase the maximum weights of new glider types. As a result the Nordic countries proposed that IGC limit the wing loading to a maximum of 45 kg/m^2 for the Standard and 15M classes. **The purpose of the Nordic proposal was to lengthen the useful competition life of gliders**, *because it was felt that the cost to buy a new glider for each WGC was prohibitive. The designers were unhappy with such a rule. They felt that they could still improve the gliders by changing the wing design, but restricting the wing loading would make the improvements more costly and result in glider designs that were both less practical and less attractive. Also, they did not like the uncertainty regarding whether IGC might, or might not, introduce a limit, because such a decision would affect their new designs. The proposal idled in IGC for a few years and was finally withdrawn.*

Increasing the flying weight also became an operational issue, because the higher weight limits sometimes exceed the towing weight approved for the tugs. Also, operating on some airfields requires a maximum weight limitation due to the available take-off distance, air density (affected by air pressure, temperature and altitude), wind conditions and other local factors.

In competition classes that do not allow disposable ballast (Club Class and World Class), checking the glider weight has become a more difficult issue to handle, because the organisers need to confirm that the established take-off weight is not changed from day to day.

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[1] While "Maximum Take-Off Mass" is the technically correct term, Maximum Take-Off Weight is an accepted terminology in Civil Aviation texts and regulations. In this paper the word "weight" is interchangeable with "mass".

The Purpose of Limiting the Take-Off Weight

Take-off weight limitations may be imposed for several purposes. For example:

- For operational safety reasons.
- To provide a fair and equitable competition.
- To protect the value of current gliders (by eliminating the performance potential of higher maximum weight as designers manage to make new gliders that can safely be flown and be certified for higher weights).

In the past the IGC has not imposed any limitations to safeguard existing glider designs. On the contrary, new and better gliders have been developed continuously. Among other changes, this has usually led towards higher maximum weights. This evolution has generally been seen as beneficial for the sport. If additional arbitrary limits are set, for certain glider classes, it may result in an undesired long-term stagnation of development of the affected class. It will also make the make designers uncertain about the intentions of IGC as to when new limits or changes may be imposed. A new limitation could, for example, suddenly make the investment of thousands of hours of planning and development useless.

Note: The Sporting Code Section 3, Annex A, does not deal with class definitions, so if there is to be a limitation for a Class it is not strictly an Annex A issue.

Gliders/ Motor-gliders

Until recently, there were separate WGCs for gliders and motor-gliders. Motor-gliders could compete in gliding WGCs only if the power plant was inoperable.

IGC then decided to discontinue motor gliding WGCs, mainly because of the shortage of entries in motor-glider WGCs. The motor-gliders, usually motorised models of contemporary gliders, now have the same aerodynamic characteristics and performance as pure gliders, so, with adequate rulings, the engine can be used for launching without a competitive advantage over non-motorised gliders. Also, with GNSS flight verification, pilots can make a technical outlanding by starting the engine and self-retrieve the glider, without gaining a sporting advantage over a pure glider.

There is, however, one important difference. Some Open Class self-launching motor-gliders can use a higher maximum take-off weight than 750 kg (the max weight approved for pure gliders), because the weight is not affected by the aero towing limits that cause the 750 kg limit for pure gliders. This difference has evolved into a major sporting issue that needs to be resolved.

Open Class

The maximum take-off weight of Open Class gliders is limited to 750 kg. Most Open Class motor-gliders have a higher maximum weight.

Single seaters

The following weight limitations appear on the manufacturers' web sites:

ASW 22 BLE	810 kg
Nimbus-4M	800 kg

Two-seaters

ASH 25 M	790 kg
Nimbus-4DM	820 kg

This difference in maximum weight is a sporting problem because IGC has decided to integrate gliders and motor-gliders in championships. Pilots have stated that they are buying motor-gliders to gain a sporting advantage from the higher maximum weight, and then complained that they were not allowed to use that advantage in the Bayreuth WGC because the local rule prohibited single-seat motor-gliders from exceeding 750 kg. Also, pilots have complained that two-seat motor-gliders were given a competitive advantage because they were allowed to exceed 750 kg (but were not allowed to carry disposable load) if flown with a pilot plus a second crew-person.

The current situation is that the maximum weight allowable in the Open Class is governed by local rules rather than by an Annex A rule. It seems that IGC wants to allow two persons on board (already approved). The two-seat motor-gliders usually can't get below the 750kg weight limitation if two persons are carried on-board. **But -** *a competitive advantage for the heavy two-seat motor-glider has not been verified by actual results in championships. Only single-seaters appeared in the top placings in Bayreuth, in spite of strong conditions that should favour the heavy two-seaters. It seems that the extra drag of the two-seater at high speeds means that it is not an attractive choice of glider for prospective winners. This is despite the opportunity available to fly the glider at a higher weight in championships where strong conditions are expected.*

A complicating factor is that a new, 30-metre span motor-glider, the Eta, is now on the scene. The Eta can only be operated as a motor-glider because it cannot be certified for 750 kg empty weight. This means that the concept of integrating gliders and motor-gliders is no longer valid for the Open Class because the motor-glider will have both an aerodynamic advantage (due to the large span) and a weight advantage.

Possible solutions for the Open Class

Solution	Advantage	Disadvantage
1. Do away with maximum weight limitation.	This is in the spirit of the Open Class.	Pure gliders will not be competitive with motor-gliders due to the 750 kg limitation for pure gliders.
2. Incorporate the Bayreuth local rule in Annex A.	This works well with the current generation gliders/ motor-gliders and complies with the desire and decision to integrate gliders and motor-gliders in gliding championships.	Future new Open Class designs (for example Eta) will be motor-gliders only. The concept of integrating gliders and motor-gliders is no longer valid, being overtaken by the development of the 30-metre span two-seat motor-glider.
3. Limit the maximum	Fair competition between	Competitions provide no

	weight for all gliders/ motor-gliders to 750 kg in all championships.	pure gliders and motor-gliders.	incentive to design and build bigger motor-gliders. Effectively stops having two pilots on-board a motor-glider. Motor-glider performance in weak conditions will be relatively less due to their higher minimum weight.
4.	Increase the maximum weight for pure gliders to 850 kg.	Fair integration between gliders and motor-gliders.	IGC can't decide on this on it's own. Amendment required to JAR-22.

Recommendations for the Open Class:

1. Adopt Solution 2 (Bayreuth Local Rule) until a next-generation sailplane (Eta or similar) appears on the competition scene, then go to Solution 1 (no limitation).
2. Try to get a change of JAR-22 to introduce Solution 4 (Increased maximum weight for pure gliders.

<u>Comment</u>: IGC could collaborate with OSTIV SDP (Sailplane Development Panel) regarding Solution 4.

Standard/ 15M Class

The current trend is for pilots to choose gliders with an empty weight as low as possible in order to be able to stay aloft in very weak soaring conditions. This seems to be important with the small span and wing area of these gliders. Unlike the Open Class, very few, if any, motorised gliders in these classes have appeared in recent WGCs. it is likely that this situation will change if smaller and more efficient engines are developed and the structure of the gliders can be made lighter. But this will not change anything regarding the sporting aspects of weight limitations.

The 750 kg limit does not affect the Standard and 15M classes, because in practice the maximum certificated weight is limited by other design criteria in the JAR-22 design regulations, such as stall speed and terminal dive velocity with extended airbrakes. Also, 15M gliders flying at 750 kg, or thereabouts, are not suitable for competition flying with present technology or that available in the foreseeable future.

The two leading competition designs in the 15M class, the Ventus-2 and the ASW-27, have somewhat different design parameters

	Ventus-2	**ASW-27**
Wing area	9.67 m^2	9.00 m^2
Max weight	525 kg	500 kg
Max wing loading	54.29 kg/m^2	55.56 kg/m^2

The ASW-27 has a lower maximum weight but a higher wing loading than the Ventus-2. Both of these 15M class designs have been developed without any constraints other than the JAR-22 airworthiness requirements. If there had been a maximum weight imposed that was less than 525kg, the designer of the Ventus-2 would have needed to consider that and to have perhaps made the design somewhat different. It would likely have had a slightly smaller wing area, like the ASW-27. (A similar comparison can be done between the established standard class types LS8/Discus-2 versus the new LAK-19).

It is interesting to note that different designs (in terms of wing area and wing loading) compete head-to-head. This suggests that it may be reasonable to permit the Open Class to develop as an unlimited class in terms the maximum weight limit.

Possible solutions for the Standard and 15M Class

Solution	Advantage	Disadvantage
Do nothing *Note: Nobody has asked for a solution.*	New improved designs will evolve, as designers develop new ideas and according to market demand.	Pilots have to periodically buy new designs to remain competitive.
Impose a weight limit that seems reasonable in relation to the present design parameters, for example 525kg.	Current designs can be used until the limit is adjusted to take incorporate new designs and/ or technology.	Designers will be reluctant to develop improved versions, as they will be uncertain of the timing of changes to design-critical rules by IGC.

Recommendation for the Standard/ 15M Classes:

Retain the status quo.

18M Class

The considerations regarding the Standard/ 15M Class are, in principle, also valid for the18M Class. One difference is that the 18-metre glider is better suited to carrying the weight of an engine, so motorised versions will be likely to be more popular in this class. It appears that there was a mix of pure gliders and motorised ones in the first 18M WGC in Spain this year.

The current 18-metre gliders are essentially stretched versions of 15-metre gliders, and have the same weight limit, usually 525 kg. The design principle applied to these gliders was to provide for recreational flying, not competitive racing. It is quite clear that the next generation of 18-metre class racing gliders will need to be much heavier to take advantage of the larger wing-area and higher aspect ratio available with the larger span. The maximum certificated weight is likely to be in the 600-700 kg range. Completely new designs will be needed to enable this development.

If the maximum weight is limited at the current design parameters, the18-metre gliders will remain light and easy to handle, similar to the existing 15-metre models. This could conserve the popularity of these types for recreational flying when combined with contest flying, but later 15-metre models without any arbitrarily imposed maximum

weight limit would likely be faster than their 18-metre counterparts in medium and strong weather conditions.

Possible solutions for the 18M Class

Solution	Advantage	Disadvantage
Do nothing *Note: Nobody has asked for a solution.*	New improved designs will evolve, as designers develop new ideas and according to market demand.	Pilots have to buy new designs now and then to remain competitive.
Impose a weight limit that seems reasonable in relation to the present design parameters, for example 550kg, and entrench the decision for an extended period, say >20 years.	A popular solution for current owners and for pilots who like to combine recreational flying with contest flying.	New 15M gliders, cheaper than the 18M ones and with superior performance, may swamp the 18M class over time.

Recommendation for the 18M Class:

Retain the status quo.

Club Class

The Club Class has evolved from the desire to enable gliders, which have become obsolete in the Standard Class, to continue competitive flying. One of the original requirements of the Club Class was to prohibit disposable ballast. To fulfil this requirement most organisers have arranged for daily weighing checks to make sure that the participants comply and do not change the aircraft weight from day to day.

Because of the need to check that the weight of the glider does not change from day to day, checking the weight of the gliders, in the Club Class, has become a more difficult issue than in the old FAI-classes.

There are no guidelines about the tolerance for any change in weight, so each organiser currently has to decide this on his own. It is also difficult to weight the gliders accurately on the airfield if there is any significant wind.

An alternative solution (used in the first European Club Class Championships in 1979) is to replace extensive daily weighing with administrative checking. The pilot declares before the start of the championships what flying weight and what fixed ballast he will use, including the type of ballast (lead plates, lead shots etc) and the weight and location of the ballast (if any). The scrutiniser inspects and approves the ballast installation, and the organiser makes spot checks on a daily basis that the ballast is installed as specified.

Another alternative is to permit disposable ballast in the Club Class and use the certified weights like in the other classes.

Possible solutions for the Club Class

Solution	Advantage	Disadvantage
Permit water ballast and apply the certified weight limits	Requirements become symmetrical with the other classes and the same weighing methods can be used. (Most Club Class types used in current competitions have provision for water ballast.)	The different ballast capacity of the glider types may create problems in defining the appropriate handicap factors.
Set a weight limit for each glider type (as used in Gawler) and check the gliders daily for conformance. Note: A tolerance for weight change will be required in Annex A.	It is easy to define the handicap factor	More complex weighing procedure than if water ballast is used.
Administrative checking that the pilot does not change the weight of the glider.	Easy to do. No daily weighing required.	Water cannot be used for ballasting, because it is too difficult to check without weighing.

Recommendations for the Club Class:

1. Establish the actual flying weight of the glider at scrutineering, with nil water ballast, to enable the handicap to be set, and
2. Require that each pilot declare the amount and type of fixed ballast he will use (weight, type, location) to be checked and approved by the scrutineer, and
3. Check conformance by daily inspections instead of weighing the gliders, and
4. Establish parameters for the tolerance for weigh variation in Annex A.

World Class

The goal of this class is low cost and simple management. However, the World Class faces the same problems with daily checking of the glider weight as the Club Class. A feasible solution is to do away with weighing and use administrative checking as described above.

Recommendations for the World Class:

1. Establish the actual flying weight of the glider at scrutineering, with nil water ballast, to enable the handicap to be set, and
2. Require that each pilot declare the amount and type of fixed ballast he will use (weight, type, location) to be checked and approved by the scrutineer, and

3. Check conformance by daily inspections instead of weighing the gliders, and
4. Establish parameters for the tolerance for weigh variation in Annex A.

Operational Factors

The effect of short, or high runways, with or without high temperatures, will all have an impact on the performance of tow planes. The effect of such performance limitations can be minimised by ensuring that championships are held at sites where the tow planes are not restricted.

Recommendation:

Avoid, if possible, arranging WGCs at sites where limits on the glider weight must be provided for operational reasons, such as short runways, adverse wind conditions or other local factors, and limited performance tow planes.